Guidehouse
Outwit Complexity

ComEd Industrial Systems Impact Evaluation Report

Energy Efficiency/Demand Response Plan: Program Year 2021 (CY2021) (1/1/2021-12/31/2021)

Prepared for:

ComEd

FINAL

April 18th, 2022

Prepared by:

Kumar Chittory
Verdant Associates

Ben Cheah
Verdant Associates

VERDANT

DRIFTLESS ENERGY

MichaelsEnergy

Submitted to:

ComEd
2011 Swift Drive
Oak Brook, IL 60523

Submitted by:

Guidehouse Inc.
150 N. Riverside Plaza, Suite 2100
Chicago, IL 60606

Contact:

Charles Maglione, Partner
703.431.1983
cmaglione@guidehouse.com

Jeff Erickson, Director
608.616.4962
jeff.erickson@guidehouse.com

Nishant Mehta, Associate Director
608.616.5823
nishant.mehta@guidehouse.com

Sagar Phalke, Managing Consultant
303.493.0350
sagar.phalke@guidehouse.com

This report was prepared by Guidehouse for ComEd. The work presented in this report represents Guidehouse's professional judgment based on the information available at the time this report was prepared. Use of this report by any other party for whatever purpose should not, and does not, absolve such party from using due diligence in verifying the report's contents. Neither Guidehouse nor any of its subsidiaries or affiliates assumes any liability or duty of care to such parties, and hereby disclaims any such liability.

Table of Contents

List of Figures and Tables

1. Introduction

This report presents results from the CY2021 impact evaluation of ComEd's Industrial Systems Program. It summarizes the total energy and demand impacts for the program broken out by relevant measures and program structure details. The appendices provide the impact analysis methodology and details of the total resource cost (TRC) analysis inputs. CY2021 covers January 1, 2021 through December 31, 2021.

2. Program Description

The Industrial Systems Program offers a combination of technical assistance and financial incentives. Franklin Energy implements the program, performing industrial systems studies that assess the performance of the facility's industrial compressed air system, process cooling system, refrigeration system, or wastewater treatment plant to ensure efficient, economical operation. This service examines the system's operating characteristics to help identify energy-saving measures using a combination of capital investments and low- or no-cost measures. ComEd offers a one-time incentive payment of $0.12[1] per annual kilowatt-hour (kWh) saved after proper implementation of recommendations identified through the program. The total incentive cannot exceed 100% of the total implementation costs or 100% of the total incremental costs for improvements recommended in the study.

The program is referred to as Industrial Systems Optimization in the deemed net-to-gross (NTG) spreadsheet. In CY2021, the program had 307 participants with 343 measures, as Table 2-1 shows.

Table 2-1. Number of Participants and Projects

Participation	Industrial Systems
Projects	307
Total Measures	343
Number of Measures per Project	1.12

Source: ComEd tracking data and evaluation team analysis

The program included the measures shown in Table 2-2 and Figure 2-1. In CY2021, the Industrial Systems Program offered 17 different measures (which are shown in tables in later sections of this report); they are grouped into five research categories.

Table 2-2. Number of Measures by Research Category

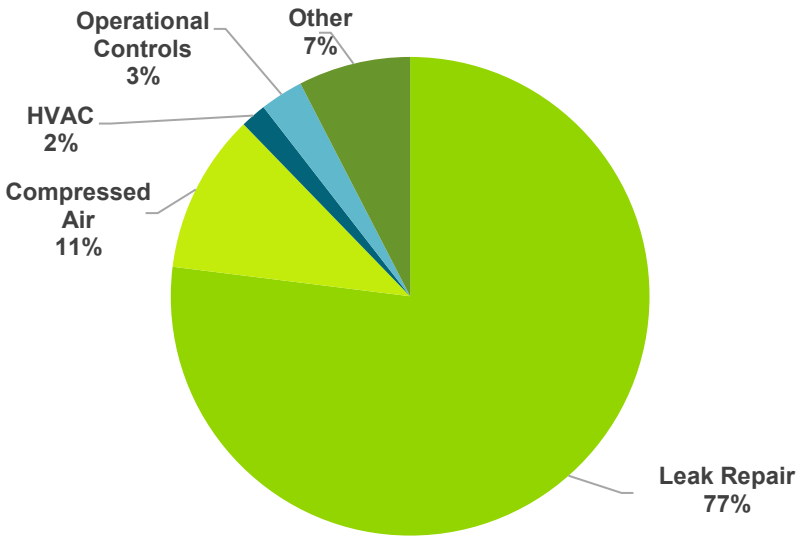
Research Category	Quantity	Unit
Leak Repair	264	Measure
Compressed Air	37	Measure
HVAC	6	Measure
Operational Controls	10	Measure
Other	26	Measure
Total	**343**	

Note: HVAC = heating, ventilation, and air conditioning

Source: ComEd tracking data and evaluation team analysis

[1] The exception to this is wastewater treatment aeration blowers with controls projects where the customer receives $0.21 per annual kWh saved.

Figure 2-1. Share of Measures Installed by Research Category



Source: ComEd tracking data and evaluation team analysis

3. Program Savings Detail

Table 3-1 summarizes the incremental energy and demand savings the Industrial Systems Program achieved in CY2021. There were no gas savings reported for this program and the evaluation team also did not identify any gas savings associated with the program.

Table 3-1. Total Annual Incremental Electric Savings

Savings Category	Units	Ex Ante Gross Savings	Program Gross Realization Rate	Verified Gross Savings	Program Net-to-Gross Ratio (NTG)	CY2019 Net Carryover Savings	CY2020 Net Carryover Savings	Verified Net Savings
Electric Energy Savings - Direct	kWh	45,507,649	0.95	43,225,396	0.77	N/A	N/A	33,283,555
Electric Energy Savings - Converted from Gas	kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Electric Energy Savings	kWh	45,507,649	0.95	43,225,396	0.77	N/A	N/A	33,283,555
Summer Peak§ Demand Savings	kW	6,504	0.93	6,063	0.78	N/A	N/A	4,729

Note: The "Verified Net Savings" in row one (Electric Energy Savings – Direct) includes primary kWh savings as a result of measure implementation. It does not include carryover savings, secondary kWh savings from wastewater treatment or electric heating penalties as they don't apply to this program.
N/A = 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.

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 CY2021. The electric CPAS across all measures installed in 2021 is shown in Table 4-1. The historic rows in each table are the CPAS contribution back to CY2018. Figure 4-1 shows the savings across the effective useful life (EUL) of the measures.

There were no gas savings reported or evaluated for this program for CY2021.

Table 4-1. Cumulative Persisting Annual Savings – Electric

End Use Type	Research Category	EUL	CY2021 Verified Gross Savings (kWh)	NTG*	Lifetime Net Savings (kWh)†	Verified Net kWh Savings 2018	2019	2020	2021	2022	2023	2024	2025	2026
Industrial Systems	Leak Repair	3.0	21,557,084	0.77	49,796,864				16,598,955	16,598,955	16,598,955			
Industrial Systems	Compressed Air - Equipment	13.0	6,015,749	0.77	60,217,652				4,632,127	4,632,127	4,632,127	4,632,127	4,632,127	4,632,127
Industrial Systems	Compressed Air - Controls	13.0	4,103,837	0.77	41,079,413				3,159,955	3,159,955	3,159,955	3,159,955	3,159,955	3,159,955
Industrial Systems	Other	13.0	3,856,264	0.77	38,601,198				2,969,323	2,969,323	2,969,323	2,969,323	2,969,323	2,969,323
Industrial Systems	Operational Controls	5.0	2,045,506	0.77	7,875,198				1,575,040	1,575,040	1,575,040	1,575,040	1,575,040	
Industrial Systems	Pumps	20.0	1,585,271	0.77	24,413,174				1,220,659	1,220,659	1,220,659	1,220,659	1,220,659	1,220,659
Industrial Systems	HVAC Economizer - Air	10.0	1,178,220	0.77	9,072,296				907,230	907,230	907,230	907,230	907,230	907,230
Industrial Systems	Industrial Refrigeration	20.0	980,660	0.77	15,102,164				755,108	755,108	755,108	755,108	755,108	755,108
Industrial Systems	HVAC Equipment	13.0	791,187	0.77	7,919,781				609,214	609,214	609,214	609,214	609,214	609,214
Industrial Systems	HVAC Controls	15.0	317,282	0.77	3,461,329				244,307	244,307	244,307	244,307	244,307	244,307
Industrial Systems	HVAC Economizer - Water	17.5	271,493	0.77	3,658,374				209,050	209,050	209,050	209,050	209,050	209,050
Industrial Systems	Compressed Air - Air Nozzles	15.0	183,070	0.77	2,114,460				140,964	140,964	140,964	140,964	140,964	140,964
Industrial Systems	VFD	15.0	132,204	0.77	1,526,961				101,797	101,797	101,797	101,797	101,797	101,797
Industrial Systems	Chiller	23.0	115,888	0.77	2,052,370				89,233	89,233	89,233	89,233	89,233	89,233
Industrial Systems	Fans	15.0	40,830	0.77	471,590				31,439	31,439	31,439	31,439	31,439	31,439
Industrial Systems	Pump Optimization	8.0	27,823	0.77	171,390				21,424	21,424	21,424	21,424	21,424	21,424
Industrial Systems	Compressed Air - No Loss Drains	10.0	23,026	0.77	177,302				17,730	17,730	17,730	17,730	17,730	17,730
CY2021 Program Total Electric Contribution to CPAS			**43,225,396**		**267,711,516**				**33,283,555**	**33,283,555**	**33,283,555**	**16,684,600**	**16,684,600**	**15,109,561**
Historic Program Total Electric Contribution to CPAS‡						**17,990,719**	**17,990,719**	**59,232,810**	**53,456,675**	**53,456,675**	**32,018,292**	**32,018,292**	**31,763,760**	**31,763,760**
Program Total Electric CPAS						**17,990,719**	**17,990,719**	**59,232,810**	**86,740,230**	**86,740,230**	**65,301,847**	**48,702,892**	**48,448,360**	**46,873,321**
CY2021 Program Incremental Expiring Electric Savings§										**-**	**-**	**16,598,955**	**-**	**1,575,040**
Historic Program Incremental Expiring Electric Savings‖									**5,776,135**	**-**	**21,438,383**	**-**	**254,532**	**-**
Program Total Incremental Expiring Electric Savings#									**5,776,135**	**-**	**21,438,383**	**16,598,955**	**254,532**	**1,575,040**

End Use Type	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Industrial Systems	Leak Repair												
Industrial Systems	Compressed Air - Equipment	4,632,127	4,632,127	4,632,127	4,632,127	4,632,127	4,632,127	4,632,127					
Industrial Systems	Compressed Air - Controls	3,159,955	3,159,955	3,159,955	3,159,955	3,159,955	3,159,955	3,159,955					
Industrial Systems	Other	2,969,323	2,969,323	2,969,323	2,969,323	2,969,323	2,969,323	2,969,323					
Industrial Systems	Operational Controls												
Industrial Systems	Pumps	1,220,659	1,220,659	1,220,659	1,220,659	1,220,659	1,220,659	1,220,659	1,220,659	1,220,659	1,220,659	1,220,659	1,220,659
Industrial Systems	HVAC Economizer - Air	907,230	907,230	907,230	907,230								
Industrial Systems	Industrial Refrigeration	755,108	755,108	755,108	755,108	755,108	755,108	755,108	755,108	755,108	755,108	755,108	755,108
Industrial Systems	HVAC Equipment	609,214	609,214	609,214	609,214	609,214	609,214	609,214					
Industrial Systems	HVAC Controls	244,307	244,307	244,307	244,307	244,307	244,307	244,307	142,666	142,666			
Industrial Systems	HVAC Economizer - Water	209,050	209,050	209,050	209,050	209,050	209,050	209,050	209,050	209,050	209,050	209,050	104,525
Industrial Systems	Compressed Air - Air Nozzles	140,964	140,964	140,964	140,964	140,964	140,964	140,964	140,964	140,964			
Industrial Systems	VFD	101,797	101,797	101,797	101,797	101,797	101,797	101,797	101,797	101,797			
Industrial Systems	Chiller	89,233	89,233	89,233	89,233	89,233	89,233	89,233	89,233	89,233	89,233	89,233	89,233
Industrial Systems	Fans	31,439	31,439	31,439	31,439	31,439	31,439	31,439	31,439	31,439			
Industrial Systems	Pump Optimization	21,424	21,424										
Industrial Systems	Compressed Air - No Loss Drains	17,730	17,730	17,730	17,730								
CY2021 Program Total Electric Contribution to CPAS		**15,109,561**	**15,109,561**	**15,088,137**	**15,088,137**	**14,163,177**	**14,163,177**	**14,163,177**	**2,690,917**	**2,690,917**	**2,274,050**	**2,274,050**	**2,169,525**
Historic Program Total Electric Contribution to CPAS‡		**31,763,760**	**31,763,760**	**31,763,760**	**31,695,332**	**25,678,097**	**25,678,097**	**5,498,602**	**5,498,602**	**651,328**	**651,328**	**651,328**	**651,328**
Program Total Electric CPAS		**46,873,321**	**46,873,321**	**46,851,897**	**46,783,469**	**39,841,274**	**39,841,274**	**19,661,779**	**8,189,519**	**3,342,245**	**2,925,378**	**2,925,378**	**2,820,853**
CY2021 Program Incremental Expiring Electric Savings§		**-**	**-**	**21,424**	**-**	**924,960**	**-**	**-**	**11,472,260**	**-**	**416,867**	**-**	**104,525**
Historic Program Incremental Expiring Electric Savings‖		**-**	**-**	**-**	**68,428**	**6,017,235**	**-**	**20,179,495**	**-**	**4,847,274**	**-**	**-**	**-**
Program Total Incremental Expiring Electric Savings#		**-**	**-**	**21,424**	**68,428**	**6,942,195**	**-**	**20,179,495**	**11,472,260**	**4,847,274**	**416,867**	**-**	**104,525**

End Use Type	Research Category	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Industrial Systems	Leak Repair												
Industrial Systems	Compressed Air - Equipment												
Industrial Systems	Compressed Air - Controls												
Industrial Systems	Other												
Industrial Systems	Operational Controls												
Industrial Systems	Pumps	1,220,659	1,220,659										
Industrial Systems	HVAC Economizer - Air												
Industrial Systems	Industrial Refrigeration	755,108	755,108										
Industrial Systems	HVAC Equipment												
Industrial Systems	HVAC Controls												
Industrial Systems	HVAC Economizer - Water												
Industrial Systems	Compressed Air - Air Nozzles												
Industrial Systems	VFD												
Industrial Systems	Chiller	89,233	89,233	89,233	89,233	89,233							
Industrial Systems	Fans												
Industrial Systems	Pump Optimization												
Industrial Systems	Compressed Air - No Loss Drains												
CY2021 Program Total Electric Contribution to CPAS		**2,065,000**	**2,065,000**	**89,233**	**89,233**	**89,233**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Historic Program Total Electric Contribution to CPAS‡		**651,328**	**651,328**	**651,328**	**651,328**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Program Total Electric CPAS		**2,716,328**	**2,716,328**	**740,561**	**740,561**	**89,233**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CY2021 Program Incremental Expiring Electric Savings§		**104,525**	**-**	**1,975,767**	**-**	**-**	**89,233**	**-**	**-**	**-**	**-**	**-**	**-**
Historic Program Incremental Expiring Electric Savings‖		**-**	**-**	**-**	**-**	**651,328**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Program Total Incremental Expiring Electric Savings#		**104,525**	**-**	**1,975,767**	**-**	**651,328**	**89,233**	**-**	**-**	**-**	**-**	**-**	**-**

Note: VFD – variable frequency drive

Note: The green highlighted cell shows program total first-year electric savings. The gray cells are blank, indicating values irrelevant to the CY2021 contribution to CPAS.

* A deemed value. Source: Illinois Stakeholder Advisory Group (SAG) website: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2021**.

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

‡ Historic savings go back to CY2018.

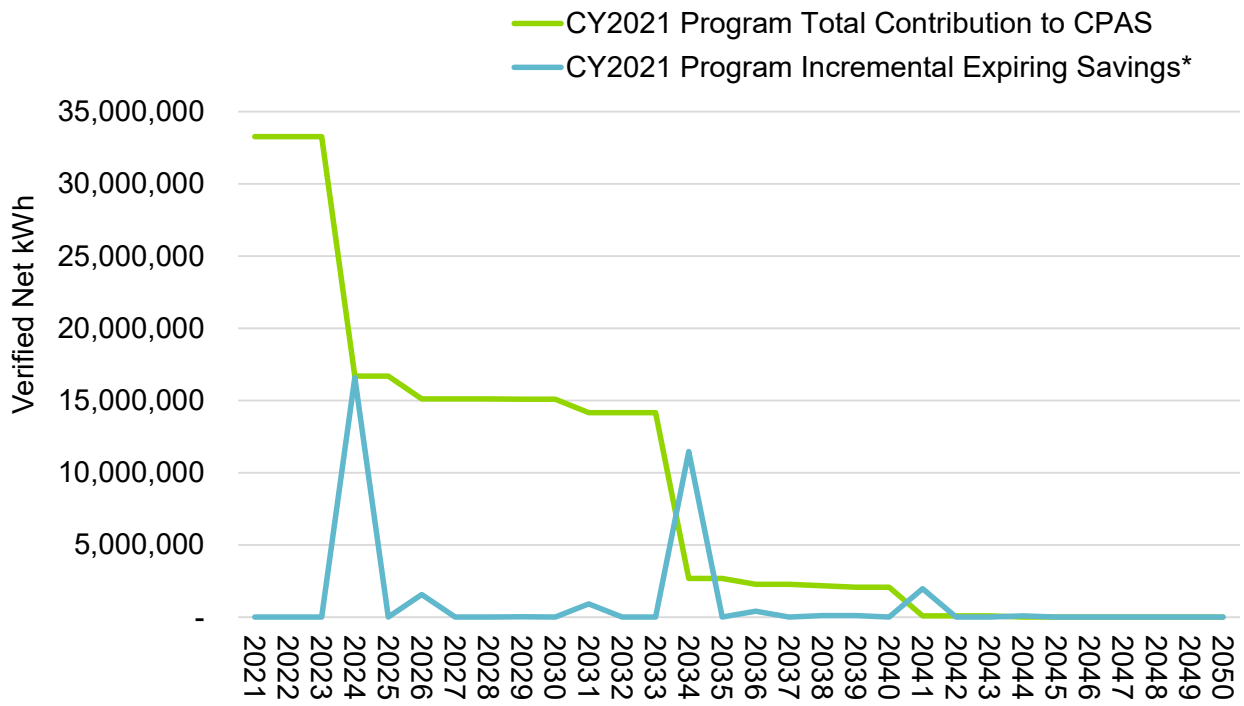
§ Incremental expiring savings are equal to CPAS Y_{n-1} - CPAS Y_n.

|| Historic incremental expiring savings are equal to Historic CPAS Y_{n-1} – Historic CPAS Y_n

Program total incremental expiring savings is equal to current year total incremental expiring savings plus historic total incremental expiring savings.

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

The program included the measures shown in Table 5-1 and Figure 5-1.

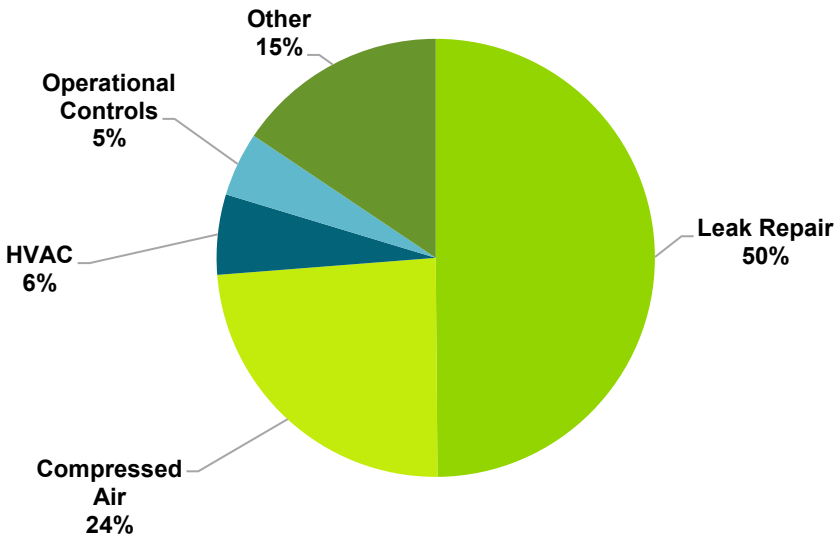
Table 5-1. Number of Measures by Research Category

Research Category	Quantity	Unit
Leak Repair	264	Measure
Compressed Air	37	Measure
HVAC	6	Measure
Operational Controls	10	Measure
Other	26	Measure
Total	**343**	

Note: This is the same table as Table 2-2.

Source: ComEd tracking data and evaluation team analysis

Figure 5-1. Verified Net Savings by Research Category – Electric



Source: ComEd tracking data and evaluation team analysis

Measure-level energy and demand savings are reported in the following tables.

Table 5-2. Energy Savings by Measure – Electric

Research Category	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTG*	Verified Net Savings (kWh)	EUL (years)
Leak Repair	22,695,274	0.95	21,557,084	0.77	16,598,955	3.0
Compressed Air - Equipment	6,333,374	0.95	6,015,749	0.77	4,632,127	13.0
Compressed Air - Controls	4,320,516	0.95	4,103,837	0.77	3,159,955	13.0
Other	4,059,870	0.95	3,856,264	0.77	2,969,323	13.0
Operational Controls	2,153,506	0.95	2,045,506	0.77	1,575,040	5.0
Pumps	1,668,972	0.95	1,585,271	0.77	1,220,659	20.0
HVAC Economizer - Air	1,240,429	0.95	1,178,220	0.77	907,230	10.0
Industrial Refrigeration	1,032,438	0.95	980,660	0.77	755,108	20.0
HVAC Equipment	832,961	0.95	791,187	0.77	609,214	13.0
HVAC Controls	334,035	0.95	317,282	0.77	244,307	15.0
HVAC Economizer - Water	285,828	0.95	271,493	0.77	209,050	17.5
Compressed Air - Air Nozzles	192,736	0.95	183,070	0.77	140,964	15.0
VFD	139,185	0.95	132,204	0.77	101,797	15.0
Chiller	122,006	0.95	115,888	0.77	89,233	23.0
Fans	42,986	0.95	40,830	0.77	31,439	15.0
Pump Optimization	29,292	0.95	27,823	0.77	21,424	8.0
Compressed Air - No Loss Drains	24,242	0.95	23,026	0.77	17,730	10.0
Total	**45,507,649**	**0.95**	**43,225,396**	**0.77**	**33,283,555**	

Note: The verified gross realization rate was calculated at the strata-level and not at the research category level. A program-level verified gross realization rate is used in the table above.
* A deemed value. Source: Illinois SAG website: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2021**.
Source: ComEd tracking data and evaluation team analysis

Table 5-3. Summer Peak Demand Savings by Measure

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)
Leak Repair	3,728	0.93	3,475	0.78	2,711
Compressed Air - Equipment	904	0.93	842	0.78	657
Compressed Air - Controls	512	0.93	477	0.78	372
Other	537	0.93	500	0.78	390
Operational Controls	285	0.93	266	0.78	207
Pumps	201	0.93	188	0.78	146
HVAC Economizer - Air	0	0.93	0	0.78	0
Industrial Refrigeration	118	0.93	110	0.78	86
HVAC Equipment	95	0.93	89	0.78	69
HVAC Controls	23	0.93	21	0.78	17
HVAC Economizer - Water	0	0.93	0	0.78	0
Compressed Air - Air Nozzles	35	0.93	32	0.78	25
VFD	17	0.93	16	0.78	12
Chiller	0	0.93	0	0.78	0
Fans	0	0.93	0	0.78	0
Pump Optimization	45	0.93	42	0.78	33
Compressed Air - No Loss Drains	5	0.93	4	0.78	3
Total	**6,504**	**0.93**	**6,063**	**0.78**	**4,729**

Note: The verified gross realization rate was calculated at the strata-level and not the research category level. A program-level verified gross realization rate is applied above.

* A deemed value. Source: Illinois SAG website: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2021**.
Source: ComEd tracking data and evaluation team analysis

6. Impact Analysis Findings and Recommendations

The evaluation team developed several recommendations for ComEd based on findings from the CY2021 evaluation.

Finding 1. The ex ante savings estimate for project IDS-40762 was calculated based on pre- and post-metered data of the refrigeration system. A review of the data found the refrigeration tonnage was significantly lower during the post-metered period than during the pre-metered period. This resulted in lower energy use not related to the project energy efficiency upgrades.

> **Recommendation 1.** When savings are based on pre- and post-metered data, ComEd should ensure that both the pre- and post-data represent similar operating conditions, including weather, production, or other factors expected to impact energy use. If the operating conditions are not similar, the data should be normalized to typical operating conditions.

Finding 2. The ex ante analysis for project IDS-40762 used a custom or proprietary Excel function that was not available to the evaluation. This function was used to interpolate between table values. The evaluation results using alternate methodologies varied slightly from the ex ante savings estimates.

> **Recommendation 2.** Whenever possible, ComEd should avoid the use of proprietary or custom functions and tools. If they are used, the outputs and functions of the tool must be clear and able to be replicated by the evaluation team.

Finding 3. There were multiple projects where the evaluation team adjusted the verified operating hours of the equipment based on the customer interview. For two projects (IDS-41041 and IDS-41176), the adjustments made to the operational hours had a significant impact on the verified savings.

> **Recommendation 3.** ComEd team should ensure the correct operational hours of the equipment are used to estimate project savings. While the evaluation team understands equipment operation can change over time, care should be taken to ensure the operational hours used to estimate ex ante savings represent the customer's best estimate for the hours the equipment will be in use in the foreseeable future.

Finding 4. Project IDS-40625 reported demand savings of 69,413 kW, likely due to an error in the calculation workbook. The actual demand savings for this project should have been less than 100 kW. This project was not part of the evaluation sample, but it was identified as part of the tracking data review.

> **Recommendation 4.** ComEd team should use additional quality control procedures to identify energy or demand savings that are extreme outliers in the tracking data.

Finding 5. Project IDS-40679 used the average demand reduction for the whole year as the ex ante peak demand savings estimate.

> **Recommendation 5.** ComEd should report peak demand savings based on demand reduction during the PJM peak summer period of 1:00 p.m.-5:00 p.m. Central Prevailing Time on non-holiday weekdays, June through August.

Appendix A. Impact Analysis Methodology

Consistent with the evaluation plan, the evaluation team used a stratified random sampling approach to select the gross impact sample of 10 projects. The team sorted projects based on the level of ex ante kWh savings and placed the projects into three strata, where the total ex ante gross kWh savings for each stratum was approximately equal to one third of the ex ante gross kWh savings of the program.

Table A-1 provides a profile of the gross impact measurement and verification sample for the Industrial Systems Program compared with the program population. The sampled projects make up approximately 9 million kWh, which represents 19% of the ex ante savings in the program population. The table also shows the ex ante-based kWh sample weights for each of the three strata.

Table A-1. CY2021 Gross Impact Sample by Strata

	Population Summary			Sample		
Strata	Number of Projects (N)	Ex Ante Gross Savings (kWh)	kWh Weights	Number of Projects (n)	Ex Ante Gross Savings (kWh)	Sampled % of Population kWh
1	8	14,253,203	0.31	4	6,628,836	47%
2	41	16,060,651	0.35	3	1,913,271	12%
3	258	15,193,795	0.33	3	238,386	2%
Total	**307**	**45,507,649**	**1.00**	**10**	**8,780,493**	**19%**

Source: ComEd tracking data and evaluation team analysis

A.1 Savings Rollup

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 when using stratified random sampling: separate and combined ratio estimation.[2] 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 case of a combined ratio estimator, the evaluation 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 Program. The separate ratio estimation technique follows the steps outlined in the California Evaluation Framework,[3] which identifies best practices in program evaluation. The team matched these steps to the stratified random sampling method it used to create the sample for the program.

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

[3] Tec Market Works, *The California Evaluation Framework*, prepared for the California Energy Commission, June 2004. Available at **http://www.calmac.org**.

Appendix B. Impact Analysis Detail

B.1 Savings by Strata

Table B-1 and Table B-2 break down the verified net energy and demand savings by strata for the Industrial Systems Program.

Table B-1. CY2021 Energy Savings by Strata

Strata	Number of Projects	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTG*	Verified Net Savings (kWh)
1	8	14,253,203	0.84	12,038,455	0.77	9,269,611
2	41	16,060,651	0.99	15,960,500	0.77	12,289,585
3	258	15,193,795	1.00	15,226,441	0.77	11,724,360
Total	**307**	**45,507,649**	**0.95**	**43,225,396**	**0.77**	**33,283,555**

* A deemed value. Source: Illinois SAG website: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2021**.

Source: ComEd tracking data and evaluation team analysis

Table B-2. CY2021 Demand Savings by Strata

Strata	Number of Projects	Ex Ante Gross Savings (kW)	Verified Gross Realization Rate	Verified Gross Savings (kW)	NTG*	Verified Net Savings (kW)
1	8	1,547	0.77	1,190	0.78	928
2	41	2,132	0.98	2,089	0.78	1,630
3	258	2,825	0.99	2,784	0.78	2,171
Total	**307**	**6,504**	**0.93**	**6,063**	**0.78**	**4,729**

* A deemed value. Source: Illinois SAG website: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2021**.

Source: ComEd tracking data and evaluation team analysis

B.2 Savings by Project

Table B-3 provides the ex ante and verified energy savings for all 10 projects in the sample for the Industrial Systems Program.

Table B-3. CY2021 Energy Savings by Project for Sampled Projects

Project ID	Strata	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTG*	Verified Net Savings (kWh)
IDS-40625	1	2,907,736	0.97	2,830,187	0.77	2,179,244
IDS-40762	1	1,387,881	0.32	443,497	0.77	341,493
IDS-40679	1	1,337,111	0.99	1,329,016	0.77	1,023,342
IDS-41191	1	996,108	1.00	996,108	0.77	767,003
IDS-41012	2	621,957	1.02	634,800	0.77	488,796
IDS-40767	2	364,313	0.93	336,992	0.77	259,484
IDS-41076	2	927,001	1.00	929,548	0.77	715,752
IDS-41041	3	11,220	0.80	8,931	0.77	6,877
IDS-41176	3	20,932	1.25	26,195	0.77	20,170
IDS-40979	3	206,234	0.99	203,772	0.77	156,904
	Total	**8,780,493**		**7,739,046**		**5,959,065**

† A deemed value. Source: Illinois SAG website: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2021**.

Source: ComEd tracking data and evaluation team analysis

Table B-4 provides the ex ante and verified peak demand reduction for all 10 projects in the sample.

Table B-4. CY2021 Peak Demand Reduction by Project for Sampled Projects

Project ID	Strata	Ex Ante Gross Peak Demand Reduction (kW)	Verified Gross Realization Rate	Verified Gross Peak Demand Reduction (kW)	NTG*	Verified Net Peak Demand Reduction (kW)
IDS-40625	1	346	0.97	337	0.78	263
IDS-40762	1	167	0.31	52	0.78	41
IDS-40679	1	152	0.63	95	0.78	74
IDS-41191	1	119	1.00	119	0.78	93
IDS-41012	2	70	1.01	71	0.78	55
IDS-40767	2	38	0.87	33	0.78	26
IDS-41076	2	106	1.00	106	0.78	83
IDS-41041	3	4	0.94	3	0.78	3
IDS-41176	3	3	1.00	3	0.78	2
IDS-40979	3	24	0.99	23	0.78	18
	Total	**1,029**		**843**		**657**

* A deemed value. Source: Illinois SAG website: **https://www.ilsag.info/evaluator-ntg-recommendations-for-2021**.

Source: ComEd tracking data and evaluation team analysis

The evaluation team has provided ComEd with site-specific measurement and verification reports for each verified project. These site-specific evaluation reports summarize the ex ante savings, the team's findings from its data collection activities, and the final evaluation analysis and savings. The evaluation team uncovered some issues in five of the 10 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 as follows for each project that saw large differences in savings.

Project IDS-40762: The project involves three energy efficiency measures. This is a Strata 1 project, and it represents around 16% of the total ex ante energy savings in the sample. The measure description and the energy gross realization rates for each measure are listed in Table B-5.

Table B-5. IDS-40762 Measure Description and Energy Gross Realization Rate

Measure	Measure Description	Ex ante Savings (kWh)	Gross Verified Savings (kWh)	Gross Realization Rate (kWh)
ECM1	Floating Head Pressure, reduction of condensing	1,237,179	399,209	32%
ECM2	Installation of VFDs on fans of new condenser EC-1	24,801	28,516	115%
ECM4	Booster compressor (RB-1) suction temperature optimization	125,894	15,772	13%
All Measures		**1,387,874**	**443,497**	**27%**

Source: Evaluation team analysis

The main driver for the reduced verified energy savings is the reduction in annual tons of cooling for the high-side system. The evaluation team calculated 1,716,431 tons of cooling over the year compared to 2,730,282 tons in ex ante analysis. The reduction of 1,013,851 tons (a 37% reduction) resulted in decreased savings.

The second largest driver for the reduction in total energy savings is due to the adjustments made to low-side suction improvements. The condensing pressure in the verified savings analysis was updated to 24 psig from 16 psig, and this resulted in a 30% increase of compressor lift. The significant increase of energy usage in verified model led to reduced savings.

Project IDS-41041: This project involves the repair of compressed air leaks in a manufacturing facility as part of the ComEd Fix-It-Now Program. The energy realization rate for this project was 80%, and it made up less than 1% of the verified net kWh savings in the sample. There are two reasons for the decrease in savings. The primary difference is due to a reduction in runtime from 3,200 hours to 2,730 hours. Additionally, a small reduction in energy and demand savings resulted from adjusting the operating pressure from 125 psig to 110 psig.

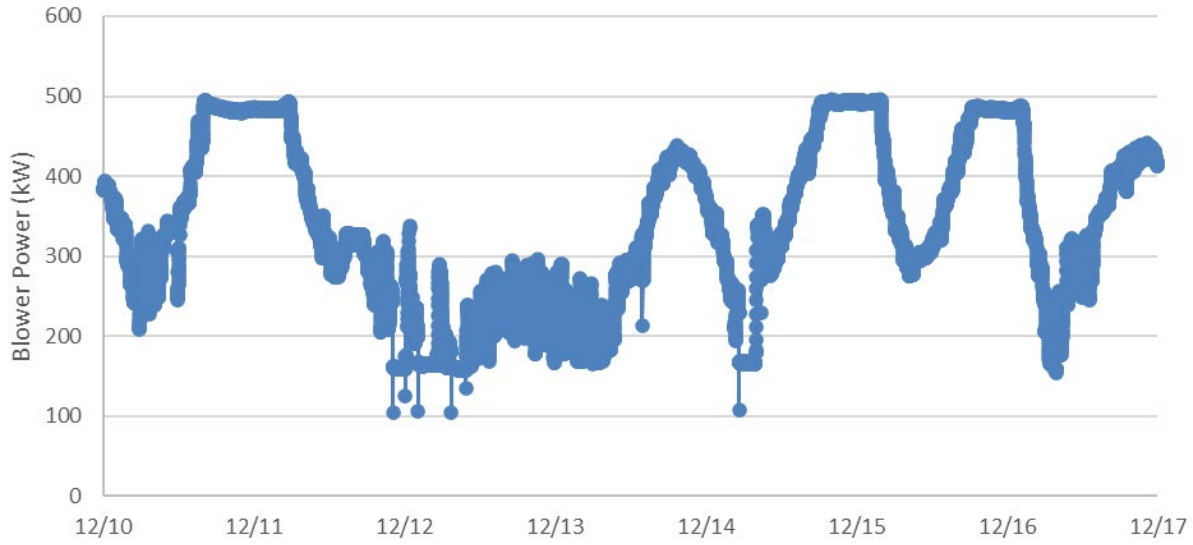
Project IDS-41176: This project involves leak repairs, installation of no-loss drains, and reducing the discharge pressure. The energy realization rate for this project was 125%, and it made up less than 1% of the verified net kWh savings in the sample. The savings were increased in the verified savings analysis based on the evaluation team's interview with the

customer. Per the customer, the compressed air system operates continuously, and thus the operating hours were increased to 8,760 from ex ante estimate of 7,000 hours.

Project IDS-40679: This project involves the installation of four blowers with VFDs at a wastewater treatment plant. The energy realization rate for this project was 99%, but the demand realization rate for this project was 63%.

The ex ante analysis estimated the demand savings by calculating the average peak demand for the entire year. The evaluation team calculated the verified peak demand savings using the average demand over the peak period of 1 p.m. to 5 p.m. on weekdays during summer months. This resulted in a verified peak demand savings of 152 kW compared to ex ante estimate of 95 kW. This difference is due to the blowers operating at a higher average flow rate during the day compared to the night, as shown in Figure B-1.

Figure B-1. Verified Net Savings by Measure – Electric



Source: Evaluation team analysis

Appendix C. Total Resource Cost Detail

Table C-1 shows the 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 incentives, and non-incentive costs) is not included in this table. ComEd will provide this data to the evaluation team later.

Table C-1. Total Resource Cost Savings Summary

Research Category	Units	Quantity	EUL (years)*	ER Flag†	Gross Electric Energy Savings (kWh)	Gross Peak Demand Reduction (kW)	Gross Gas Savings (Therms)	Gross Secondary Savings due to Water Reduction (kWh)	Gross Heating Penalty (kWh)	Gross Heating Penalty (Therms)	NTG (kWh)	NTG (kW)	NTG (Therms)	Net Electric Energy Savings (kWh)	Net Peak Demand Reduction (kW)	Net Gas Savings (Therms)	Net Secondary Savings due to Water Reduction (kWh)	Net Heating Penalty (kWh)	Net Heating Penalty (Therms)
Leak Repair	Measure	264	3.0	NO	21,557,084	3,475	0	0	0	0	0.77	0.78	N/A	16,598,955	2,711	0	0	0	0
Compressed Air - Equipment	Measure	20	13.0	NO	6,015,749	842	0	0	0	0	0.77	0.78	N/A	4,632,127	657	0	0	0	0
Compressed Air - Controls	Measure	3	13.0	NO	4,103,837	477	0	0	0	0	0.77	0.78	N/A	3,159,955	372	0	0	0	0
Other	Measure	14	13.0	NO	3,856,264	500	0	0	0	0	0.77	0.78	N/A	2,969,323	390	0	0	0	0
Operational Controls	Measure	10	5.0	NO	2,045,506	266	0	0	0	0	0.77	0.78	N/A	1,575,040	207	0	0	0	0
Pumps	Measure	4	20.0	NO	1,585,271	188	0	0	0	0	0.77	0.78	N/A	1,220,659	146	0	0	0	0
HVAC Economizer - Air	Measure	2	10.0	NO	1,178,220	0	0	0	0	0	0.77	0.78	N/A	907,230	0	0	0	0	0
Industrial Refrigeration	Measure	1	20.0	NO	980,660	110	0	0	0	0	0.77	0.78	N/A	755,108	86	0	0	0	0
HVAC Equipment	Measure	1	13.0	NO	791,187	89	0	0	0	0	0.77	0.78	N/A	609,214	69	0	0	0	0
HVAC Controls	Measure	2	15.0	NO	317,282	21	0	0	0	0	0.77	0.78	N/A	244,307	17	0	0	0	0
HVAC Economizer - Water	Measure	1	17.5	NO	271,493	0	0	0	0	0	0.77	0.78	N/A	209,050	0	0	0	0	0
Compressed Air - Air Nozzles	Measure	8	15.0	NO	183,070	32	0	0	0	0	0.77	0.78	N/A	140,964	25	0	0	0	0
VFD	Measure	3	15.0	NO	132,204	16	0	0	0	0	0.77	0.78	N/A	101,797	12	0	0	0	0
Chiller	Measure	1	23.0	NO	115,888	0	0	0	0	0	0.77	0.78	N/A	89,233	0	0	0	0	0
Fans	Measure	2	15.0	NO	40,830	0	0	0	0	0	0.77	0.78	N/A	31,439	0	0	0	0	0
Pump Optimization	Measure	1	8.0	NO	27,823	42	0	0	0	0	0.77	0.78	N/A	21,424	33	0	0	0	0
Compressed Air - No Loss Drains	Measure	6	10.0	NO	23,026	4	0	0	0	0	0.77	0.78	N/A	17,730	3	0	0	0	0
Total		**343**	**8.0**		**43,225,396**	**6,063**	**0**	**0**	**0**	**0**	**0.77**	**0.78**	**N/A**	**33,283,555**	**4,729**	**0**	**0**	**0**	**0**

* 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.

N/A = not applicable (refers to a piece of data that cannot be produced or does not apply).

Source: ComEd tracking data and evaluation team analysis