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ComEd Strategic Energy Management Water and Energy Savings Pilot Impact Evaluation Report

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

Prepared for:

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FINAL

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1. Introduction

This report presents the results of the impact evaluation of the CY2021 Strategic Energy Management Water and Energy Savings (SEM Water) Pilot. It summarizes the total energy and water impacts for the pilot broken out by relevant pilot savings structure details. Electric savings for this pilot are derived from the secondary kWh savings for water supply and wastewater treatment associated with water reduction. 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. Pilot Description

The SEM Water pilot was developed as part of the Emerging Technologies initiative. The pilot's objective was to train and guide participants to apply continuous water savings management improvements. Water savings projects were achieved through operational and maintenance changes, efficiency upgrades in planned capital projects, and identification of new water savings operations, maintenance, and capital projects.

The final pilot tracking data had six participants that completed 20 water savings projects in CY2021 (see Table 2-1). Pilot participants submitted final savings reports using custom calculations or a whole building regression model. Custom calculations submissions were provided when there was insufficient participant site-level water billing or submetered data to create adequate water usage regression models.

Table 2-1. Number of Participants and Projects

Participation	SEM - Model	SEM - Custom
Participants	3	3
Installed Projects	7	13

Source: ComEd tracking data and evaluation team analysis

Pilot participation counts broken out by savings method are shown in Table 2-2.

Table 2-2. Number of Participants by Research Category

Research Category	Quantity	Unit
SEM - Model	3	Participants
SEM - Custom	3	Participants
Total	**6**	

Source: ComEd tracking data and evaluation team analysis

3. Pilot Savings Detail

Table 3-1 summarizes the incremental energy savings the SEM Water Pilot achieved in CY2021. Due to the nature of the pilot, at this stage, ComEd did not report gas savings and the evaluation did not attempt to quantify them. This pilot derives energy savings from secondary energy savings due to water, which do not include peak demand savings per the IL TRM.

Table 3-1. Total Annual Incremental Electric Savings

Savings Category	Units	Ex Ante Gross Savings	Pilot Gross Realization Rate	Verified Gross Savings	Pilot Net-to-Gross Ratio (NTG)	CY2019 Net Carryover Savings	CY2020 Net Carryover Savings	Verified Net Savings†
Electric Energy Savings - Direct	kWh	313,596	0.98	307,653	1.0	N/A	N/A	307,653
Electric Energy Savings - Converted from Gas	kWh	N/A	N/A	N/A	1.0	N/A	N/A	N/A
Total Electric Energy Savings	kWh	313,596	0.98	307,653	1.0	N/A	N/A	307,653
Summer Peak§ Demand Savings	kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A = not applicable (refers to a piece of data that cannot be produced or does not apply).
* A researched value. Source: The evaluation team determined the NTG as described in Appendix A.
** 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 "Verified Net Savings" in row one includes secondary kWh savings from water as a result of measure implementation. Carryover savings do not apply to this pilot.

Source: ComEd tracking data and evaluation team analysis

4. Cumulative Persisting Annual Savings

Table 4-1 shows the measure-specific and total verified gross energy savings for the SEM Water Pilot 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. There are no gas savings associated with this pilot, so electric CPAS is equivalent to total CPAS. Figure 4-1 shows the savings across the effective useful life (EUL) of the savings calculation method.

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
Whole Building	SEM - Model	5.0	295,516	1.0	1,477,582				295,516	295,516	295,516	295,516	295,516	
Whole Building	SEM - Custom	7.6	12,137	1.0	90,015				12,137	12,137	12,137	12,137	12,137	6,342
CY2021 Pilot Total Electric Contribution to CPAS			**307,653**		**1,567,597**				**307,653**	**307,653**	**307,653**	**307,653**	**307,653**	**6,342**
Historic Pilot Total Electric Contribution to CPAS‡														
Pilot Total Electric CPAS						-	-	-	**307,653**	**307,653**	**307,653**	**307,653**	**307,653**	**6,342**
CY2021 Pilot Incremental Expiring Electric Savings§										-	-	-	-	**301,310**
Historic Pilot Incremental Expiring Electric Savings									-	-	-	-	-	-
Pilot Total Incremental Expiring Electric Savings									-	-	-	-	-	**301,310**

End Use Type	Research Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Whole Building	SEM - Model												
Whole Building	SEM - Custom	6,342	6,342	6,342	3,962								
CY2021 Pilot Total Electric Contribution to CPAS		**6,342**	**6,342**	**6,342**	**3,962**	-	-	-	-	-	-	-	-
Historic Pilot Total Electric Contribution to CPAS‡													
Pilot Total Electric CPAS		**6,342**	**6,342**	**6,342**	**3,962**	-	-	-	-	-	-	-	-
CY2021 Pilot Incremental Expiring Electric Savings§		-	-	-	**2,380**	**3,962**	-	-	-	-	-	-	-
Historic Pilot Incremental Expiring Electric Savings		-	-	-	-	-	-	-	-	-	-	-	-
Pilot Total Incremental Expiring Electric Savings		-	-	-	**2,380**	**3,962**	-	-	-	-	-	-	-

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

* A researched value. Source: The evaluation team determined the NTG as described in Appendix A.

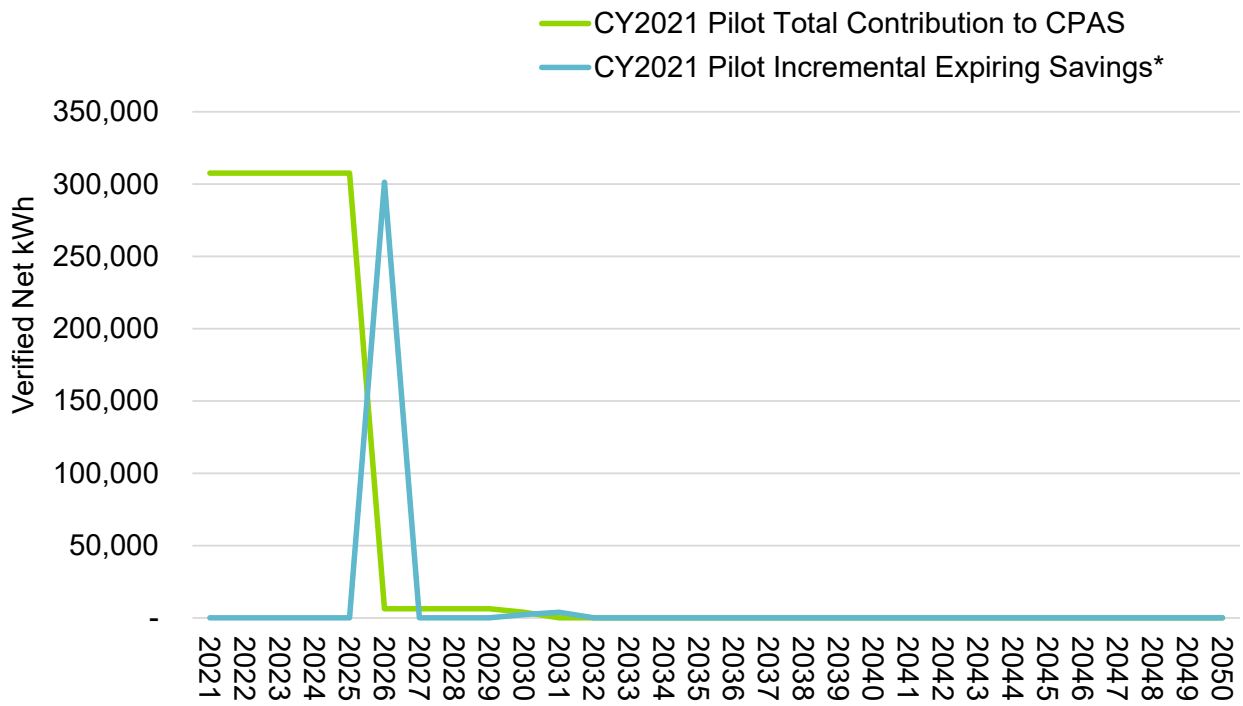
† Lifetime savings are the sum of CPAS savings through the EUL.

‡ Historic savings go back to CY2018.

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

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. Pilot Savings by Research Category

The evaluation team analyzed savings for the SEM Water Pilot by research category using whole building models and custom project analyses (shown in Table 5-1 and Figure 5-1).

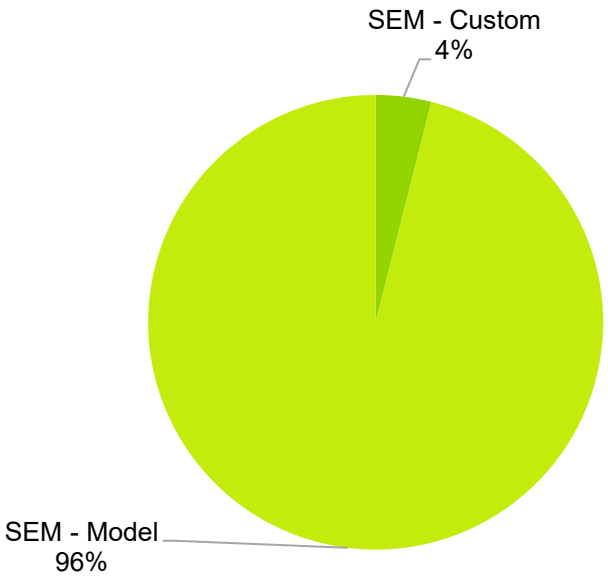
Table 5-1. Number of Water Savings Projects by Research Category

Research Category	Quantity	Unit
SEM - Model	3	Participants
SEM - Custom	3	Participants
Total	**6**	

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

The SEM Water Pilot focuses on measures that save water. That reduction in water produces secondary kilowatt-hour (kWh) savings from water supply and wastewater treatment. Table 5-2 shows the secondary research category-level savings.

Table 5-2. Energy Savings by Research Category – Electric

Research Category	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate	Verified Gross Savings (kWh)	NTG*	Verified Net Savings (kWh)	EUL (years)
SEM - Model	299,399	0.99	295,516	1.0	295,516	5.0
SEM - Custom	14,197	0.85	12,137	1.0	12,137	7.6
Total	**313,596**	**0.98**	**307,653**	**1.0**	**307,653**	**5.1**

Note: The savings in this table are entirely from secondary electric energy (kWh) savings from water supply and wastewater treatment plants for measures claimed by ComEd.
* A researched value. Source: The evaluation team determined the NTG as described in Appendix A.
Source: ComEd tracking data and evaluation team analysis

Water savings by research category are provided in Table 5-3.

Table 5-3. Water Savings by Research Category

Research Category	Ex Ante Annual Water Savings (gallons)	Ex Ante Gross Savings (kWh)	Verified Gross Realization Rate (RR_{water})	Verified Gross Savings (kWh)	NTG*	Verified Net Savings (kWh)
SEM - Model	59,760,287	299,399	0.99	295,516	1.0	295,516
SEM - Custom	2,833,648	14,197	0.85	12,137	1.0	12,137
Total	**62,593,935**	**313,596**	**0.98**	**307,653**	**1.0**	**307,653**

Note: The water savings in this table are entirely from secondary electric energy (kWh) savings from water supply and wastewater treatment plants for measures claimed by ComEd.
* A researched value. Source: The evaluation team determined the NTG as described in Appendix A.
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 water savings calculations for the custom irrigation project at Participant #2 leveraged small amounts of monthly billing data: 4 months at one site and 10 months at the other site. Monthly water usage varied widely and in one case there were two different data points for the same read date at the same site. The evaluation team verified the savings calculations using the data described above, resulting in a 100% realization rate. However, as Recommendation #1 details, more robust data should be collected for future projects.

> **Recommendation 1.** The pilot should attempt to gather a full year of baseline water usage data if feasible. If it is not feasible to collect a full year of usage data, savings estimations should be based on more robust data. For example, in this irrigation project, an irrigation schedule and overall system capacity could be used to estimate water usage when billing data is not available.

Finding 2. The major barrier for building baseline models for this pilot was the lack of additional water metering to support data collection for planned projects. Monthly or bimonthly utility bills are often inadequate to detect seasonality and savings for smaller projects.

> **Recommendation 2.** Increase submetering on water systems to collect adequate data to support savings calculations for future water savings projects.

Appendix A. Impact Analysis Methodology

A.1 Model-Based Verification

For the **model-based participants**, Guidehouse calculated verified gross savings using IC-provided statistical models that were grounded in site-specific data. The multivariable regression baseline models draw on site data including production, weather data, and seasonality effects (including holidays or shutdowns) to predict water usage.

The evaluation team's review of the models was driven by a site-specific analysis approach. Because this pilot contains a mix of behavioral-based, operational, and capital projects, the International Performance Measurement and Verification Protocol (IPMVP) Option C (billing or metered data regression) was the main approach the team used for impact evaluation.

The data collection focused on verifying and updating the assumptions that feed into the IC's energy model for each site. This data included pilot tracking data and supporting documentation (project specifications, invoices, etc.) and utility billing and interval data.

For each site, Guidehouse reviewed and updated the statistical models provided by the IC. The evaluation team generally followed the following process for this review:

- **Step 1:** Recreated the energy models to ensure they aligned with the provided data.
- **Step 2:** Confirmed the model saving calculations accounted for all capital projects. Savings from capital projects unrelated to the pilot were subtracted from total measurement period savings.
- **Step 3:** Identified and accounted for any short-term effects that were occurring outside of the SEM Water Pilot influence.
- **Step 4:** Made additional changes to the models and reran them as needed. Changes included excluding outlier data points or including additional variables. Outlier points that were above 110% or below 90% of baseline period variables were excluded if the residual was out of line with other residuals in the measurement period.

The evaluation team reviewed each model-based site for changes that occurred at the site during the pilot period that had short- or long-term effects on the statistical model. The changes that could potentially affect model savings include the following:

- Change in hours of operation
- Change in numbers of employees at the site
- Change in production

A.2 Custom-Based Verification

For the **custom project-based participants** with no onsite water metering, Guidehouse calculated verified gross savings using the Illinois Technical Reference Manual v9.0 (IL-TRM)[1] when the water savings measure was in the TRM. The project at Participant #1 was the

[1] In this report, unless stated otherwise, IL-TRM refers to version 9.0 (v9.0).

installation of bathroom and kitchen aerators, so the evaluation team used Section 4.3.2 of the IL-TRM to calculate savings. For Participant #5, the team used Section 4.2.10 of the IL-TRM to calculate savings for the efficient ice maker retrofit. There is no IL-TRM algorithm for irrigation projects, so Guidehouse relied on billing data and custom engineering analysis to calculate savings for Participant #2.

A.3 NTG Research

To calculate net savings for this pilot, the evaluation team used the deemed net-to-gross (NTG) ratio of 1.0 from ComEd's CY2021 SEM Program.[2] The participants in the ComEd Water pilot are alumni of ComEd's and Nicor Gas' SEM program. The implementation contractor used the same coaching and resources in the pilot as were used in the SEM program. As a result, the evaluation team determined that the previous research conclusions on freeridership and spillover in the SEM program are applicable to this pilot.

[2] https://www.ilsag.info/evaluator-ntg-recommendations-for-2021/

Appendix B. Impact Findings Detailed Results

Table B-1 shows the water savings by participant. Participant #4 was greatly impacted by the COVID-19 pandemic and was unable to implement any water-saving measures during the measurement period of the pilot. The implementation contractor deemed that modeling was not feasible for Participant #6 and did not report any savings.

Table B-1. Water Savings by Participant

Participant	Research Category	Ex Ante Annual Water Savings (gallons)	Verified Gross Water Savings (gallons)	Verified Gross Realization Rate (RR_{water})
1	SEM - Custom	861,348	790,916	0.92
2	SEM - Custom	1,156,525	1,156,525	1.00
3	SEM - Model	57,887,287	57,887,287	1.00
4	SEM - Model	0	0	N/A
5	SEM - Custom	815,775	810,337	0.99
6	NR	NR	N/A	N/A
7	SEM - Model	1,873,000	1,873,000	1.00
	Total	**62,593,935**	**62,518,065**	**1.00**

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

Source: ComEd tracking data and evaluation team analysis

The evaluation team developed several additional detailed recommendations based on findings from the CY2021 evaluation.

Finding 3. Final regression formulas and techniques and all related formulas were not documented for the two model based SEM projects.

> **Recommendation 3.** All software model settings (e.g. weighted vs. non-weighted least squares, robust vs non-robust standard errors) should be provided.

Finding 4. Pilot goodness of fit thresholds were not clear in the model tracking tools.

> **Recommendation 4.** Identify pilot model goodness of fit and savings uncertainty thresholds in model documentations.

Finding 5. The ex ante calculations for secondary savings from water supply and wastewater treatment use the Illinois Total Water Energy Factor (E_water total) of 5,010 for all measures in this pilot. The energy factor of 5,010 is applicable specifically for measures installed in all counties except Cook County. Only participants #5 and #7 had measures installed in Cook County. The evaluation team used the county-specific energy factors to determine the CY2021 verified secondary savings from water. Moving forward, IL-TRM v10 uses only one factor for all projects regardless of location. The energy factors from the IL-TRM also account for secondary kWh savings from both water supply and wastewater treatment. Water savings projects that are outdoors typically only have impacts on water supply and not wastewater treatment.

Recommendation 5. Use the correct Total Water Energy Factor (E_water total) to calculate secondary kWh based on the TRM in effect when the project was installed.

Recommendation 6. If outdoor water savings measures are going to be included in ComEd's portfolio moving forward, research is recommended to disaggregate savings for outdoor water measures in whole building modeling to accurately estimate secondary kWh savings from wastewater treatment.

Participant #1

Finding 6. Ex ante savings for low flow aerators were calculated using flow rates that do not follow IL-TRM Section 4.3.2.

Recommendation 7. Update flow rates to follow IL-TRM Section 4.3.2. For the baseline flow rate (GPM_base), use 1.39 unless flow rates were measured during direct install. For the efficient flow rate (GPM_low), use the rated flow of the efficient aerator and apply a throttling factor of 0.95.

Participant #5

Finding 7. The ex ante savings did not take into account the difference in potable water consumption rates between the old and efficient ice maker unit. The efficient unit uses 20 gallons/100 lb of ice, while the baseline unit used 19 gallons/100 lb.

Recommendation 8. Calculate the potable water usage of an efficient ice maker using the rate of 20 gallons/100 lb of ice when considering the efficient consumption case.

Participant #7

Finding 8. The regression model with 12 baseline bimonthly aggregated input periods contains two variables. General statistical guidelines recommend 10-20 data points per model input to reasonably detect model effects (goodness of fit metrics).

Recommendation 9. Recommend caution when accepting multivariate baseline models with 12 points and more than one regression prediction parameters. Analysts may not want to combine multiple months of data or consider variable reduction methods to combine the multiple variables into one predictor.

Finding 9. Pearson correlation is used instead of the autocorrelation coefficient for fractional savings uncertainty calculations. The ASHRAE defined autocorrelation coefficient is designed to create an effective (smaller) sample size penalty to compensate for correlation between model residuals so it should only be positive. A negative correlation value increases the effective sample size.

Recommendation 10. Use the autocorrelation coefficient calculation as defined in ASHRAE 14, which is described as *the square root of the R^2 calculated for the correlation between the residuals and the residuals for the prior time period.*

Appendix C. Total Resource Cost Detail

The only electric savings verified in the SEM Water Pilot come from secondary kWh savings for water supply and wastewater treatment. The TRM directs that secondary kWh savings should not be included in TRC tests to avoid double counting the economic benefit of water savings. As a result, the TRC table is not included in this report.