Impact Analysis of 15,000 SEM Measures

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ABSTRACT

At ACEEE's 2023 EER Conference and 2024 Summer Study, research was presented that examined measure completion trends across industrial and commercial strategic energy management (SEM) programs. Those datasets of nearly 30,000 projects across 1,000 facilities showed that approximately half of identified projects per site get completed, action-oriented projects have higher completion rates, and sites have an average of two projects in progress. These findings point toward meaningful untapped savings potential in SEM programs.

To build upon previous findings, we are conducting new research to analyze the relationship between completed projects and verified savings across multiple SEM programs. This new research uses an updated dataset of 15,000 SEM projects correlated with a dataset of approximately 1,000 site-level annual savings claims to explore previously unanswered questions, including:

1. What types of completed projects best correspond to claimed savings?
2. What types of projects are markers for successful SEM engagement?
3. What types of projects do not get completed?

As utilities across the country grapple with once-in-a-generation demand growth and customer pressure to lower electricity prices, SEM programs remain a proven, cost-effective method to help commercial and industrial customers achieve energy reductions. Our previous research shows we are only scratching the surface of what is possible through SEM, and the current research provides more insight to support expanded implementation of SEM programs across the country.

Introduction

Strategic energy management (SEM) is a proven approach to helping commercial and industrial customers achieve sustained energy reductions through a structured, continuous improvement framework. Unlike traditional rebate programs that focus on individual equipment upgrades, SEM engages facility staff in identifying, implementing, and measuring a broad portfolio of energy-saving opportunities ranging from low-cost operational adjustments to capital investments while building lasting organizational capacity for energy management (CEE 2024; Rogers, Whitlock and Rohrer 2019).

As utilities across the country grapple with once-in-a-generation demand growth and customer pressure to lower electricity prices, SEM programs remain one of the most cost-effective tools available. However, previous research (Podell-Eberhardt 2023; Belkhayat, Schnell, and Podell-Eberhardt 2024) revealed that only about half of identified measures at each site get completed, suggesting significant untapped savings potential. Those earlier analyses examined completion trends in isolation - characterizing what gets done, what doesn't, and why - but did not connect those patterns to verified energy-saving outcomes.

This paper takes the next step by linking measure-level project data with site-level verified savings claims. By analyzing the intersection of these two datasets, we can begin to answer questions that program designers and implementers have long grappled with: Which types of completed actions clearly correspond to energy savings? What distinguishes high-performing SEM engagements from low-performing ones? And what practical levers can programs pull to move the needle?

The answers point toward several actionable findings. SEM offerings deliver consistent portfolio-level savings across multi-year engagements. Strong year one engagement leads to better year two results. Breadth of engagement across multiple subsystems has a positive effect on savings. And identifying more projects and fostering participant ownership of projects leads to higher completion rates.

Data and Methodology

This research draws on two de-identified datasets from Cascade Energy's Energy Performance Platform, Gazebo, spanning 13 utility-sponsored SEM programs across the United States.

Savings Claims Dataset

The savings claims dataset contains 967 annual site-level savings claims across 443 unique sites, spanning up to five years of SEM engagement per site, with data from 2021 through 2025. 94 percent of the sites are industrial, and 6 percent are commercial. The dataset captures verified energy savings as determined through IPMVP Option C whole-building regression analysis or IPMVP Option A or B bottom-up engineering calculations depending on the program (IPMVP 2022). 61 percent of savings claims used IPMVP option C, and the remainder used Option A or B.

Project Dataset

The study dataset contains 14,996 individual SEM measures (hereafter referred to as "projects") across 351 sites from 13 programs. These projects are tracked in Gazebo through their lifecycle, from identification through completion or cancellation. About 80 percent of projects in the dataset represent a specific energy-savings action like changing a setpoint, and about 20 percent represent an SEM practice like building an energy map of a facility or setting an energy reduction goal. Each project is characterized by a number of available fields such as type (O&M, capital, energy management, or learning assignment), effort level (high or low), impact level (high or low), subsystem (e.g., compressed air, HVAC, lighting), and source (e.g., treasure hunt, site-generated, follow-up call). 1,727 cancelled projects were removed from the analysis, leaving 13,269 non-cancelled projects. 86 percent of the projects in this dataset are from industrial facilities.

The dataset is not date-filtered and includes the full project history for each site, capturing projects identified at any point during the SEM engagement.

Linked Dataset

148 sites appear in both the savings claims and project datasets, yielding 2,713 projects linked to 342 annual savings claims spanning up to five years of engagement. This linked subset enables analysis of how project-level completion patterns relate to verified site-level savings outcomes.

Findings

SEM Delivers Incremental Savings at Scale

Across 967 annual claims, the data demonstrates that SEM delivers meaningful incremental savings each year of engagement. Table 1 shows that portfolio savings are over two percent in year one and achieve incremental savings across all five engagement years, suggesting that SEM programs generate consistent value at the portfolio level. This persistence finding is relevant to program administrators considering multi-year SEM commitments: while any given site may show volatile year-over-year results, the portfolio shows steady, incremental savings accumulation.

Table 1. Summary of incremental energy savings claims by engagement year

	Claims	Mean kWh savings	Portfolio % savings	Median kWh savings	Median % savings
Year 1	379	492,425	2.2%	170,340	1.8%
Year 2	276	383,040	1.9%	161,425	1.5%
Year 3	154	425,359	1.6%	110,589	1.3%
Year 4	111	441,162	1.5%	158,977	1.3%
Year 5	47	470,628	1.2%	128,814	1.1%

In context, between 2007 and 2015 the US manufacturers reduced their energy intensity by 4.9 percent, or 0.5 percent per year. (Morrow et al. 2017). SEM participation results in savings 2-4x above the historical average. However, SEM participation generates less savings than implementation of the ISO 50001 energy management standard, which has been shown to achieve 4.1 percent mean savings in year one and maintain 3.4 percent savings twelve years after implementation (Fitzgerald et al. 2023). The ISO 50001 standard includes more robust processes, systems and verification that are not required in SEM programs.

Each savings claim represents additional incremental savings vs the prior year; the portfolio continues to accumulate new first-year savings for each of the five years but at a declining rate. This finding mirrors the engagement intensity of typical SEM programs: more treasure hunts, workshops and coaching in year one, followed by lower-intensity continuous engagement. The declining claim count from year one (379) through year five (47) reflects the structure of the dataset, not participant attrition - some programs in the dataset have not yet operated long enough to generate year four or five claims or don’t offer enrollment for that many years.

The mean kWh savings are higher than the median due to skew from very large participants. The portfolio percent savings are calculated by [total kWh saved]/[total portfolio baseline consumption]. One year one claim from a site with an extremely large baseload consumption outlier was removed from this dataset. If that site were included, the year one portfolio savings drops to 1.8 percent.

551 of the 967 claims were labeled with M&V methodology. Programs in the dataset have flexible M&V methodologies that prioritize IPMVP Option C but pivot to Option A/B if the regression model fitness stats do not meet program criteria. Table 2 shows that claims using top-down regression models (Option C) are on average larger and on average applied to smaller sites, while claims using engineering calculations (Option A/B) are on average smaller and applied to larger sites. This finding is intuitive because regression models have stronger fitness when used to calculate higher savings as a percent of baseload. Conversely smaller claims at large sites don't rise above the noise of a facility-wide model, so M&V is more likely to pivot to an Option A/B methodology.

Table 2. Summary of verified energy savings claims by M&V method

M&V Method	Claims	Mean kWh savings	Median kWh savings	Median baseload kWh
IPMVP C	336	361,271	170,848	8,845,066
IPMVP A/B	215	176,185	63,620	13,268,228

What Types of Projects Best Correspond to Verified Savings?

Across the entire dataset, 37 percent of projects were completed, which is slightly higher than the 34 percent completion in the 2023 industrial dataset (Podell-Eberhardt 2023) and lower than the roughly 50 percent completion rate found in the 2024 commercial SEM dataset (Belkhayat, Schnell and Podell-Eberhardt 2024).

SEM projects are commonly characterized in a 2-dimensional value mapping system of low/high impact and low/high effort (see Figure 1). Gem projects are completed at the highest rate of 47 percent. Quick wins are next at 41 percent. Strategic and Low Priority sit at 18 and 17 percent, respectively.

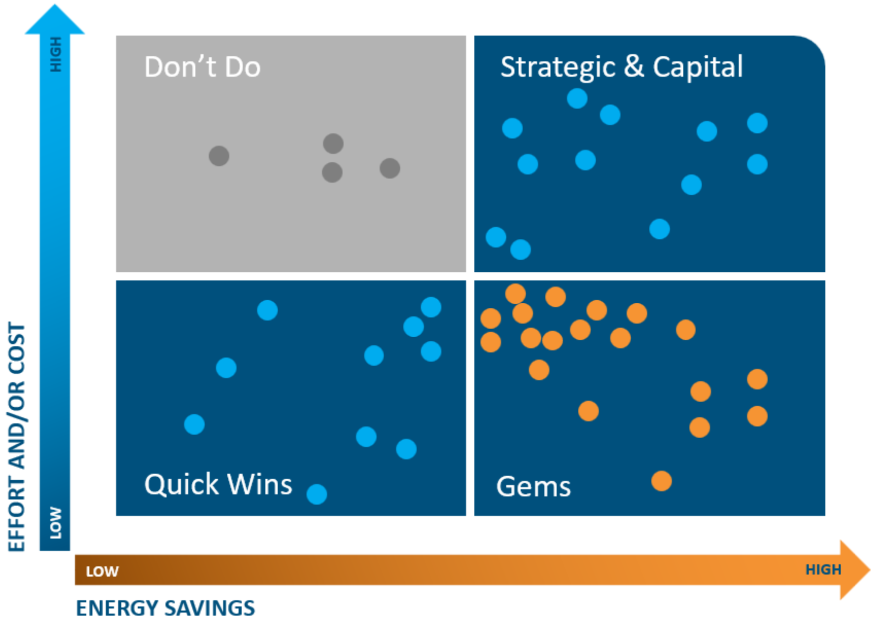

Figure 1:SEM value mapping matrix

More completed projects and more subsystem diversity leads to higher savings. Sites that complete more projects save more energy, as expected. Completing 4-6 projects vs only 1-3 projects roughly doubles median kWh from approximately 50,000 kWh to 100,000 kWh. High impact projects have the highest correlation to savings, which is also expected and validates the practice of labeling and prioritizing high-impact savings opportunities.

The breadth of subsystems addressed in the engagement (compressed air, HVAC, lighting, and process equipment, etc) is also a predictor of savings, even when comparing a similar number of total completed projects. Claims that included projects from 4 or more subsystems saved twice as many kWh as claims with under 4 subsystems, at a 1.55x higher percent of baseline consumption. Table 3 illustrates this pattern across the 342 annual savings claims with linked project-level data.

Table 3. Median savings (kWh and percent of baseline consumption) when under four subsystems were addressed in the engagement, vs 4 or more subsystems.

	<4 unique subsystems (n=157)	**>=4 unique subsystems** (n=127)
Median kWh	96,051	192,965
Median % savings	1.3%	2.1%

The correlation between subsystems addressed and higher savings suggests a benefit of a wider engagement aperture. Programs should encourage participants and delivery teams to look across their facility's energy-consuming systems rather than concentrating efforts on a single area, even if that single area appears to offer the largest individual opportunities.

Strong year one engagement leads to strong year two outcomes. Figure 2 shows that sites completing 16 or more projects during year one (n=18) achieve double the savings in year two compared to sites that complete 0-15 projects in year one. These sites completing 16+ projects in year one also complete a median 10 projects in year two, whereas sites completing 0-5 projects in year one only complete 3 projects in year two. These findings underscore the importance of early engagement momentum: programs that drive strong year one activity set the stage for sustained performance in subsequent years.

75 percent of completed year one projects represent O&M or capital measures that directly save energy, while 25 percent are SEM practices and learning outcomes that build a culture of energy management. Successful sites complete a mixture across all project types. Strong year one momentum predicts strong year two performance, regardless of the specific type of projects completed.

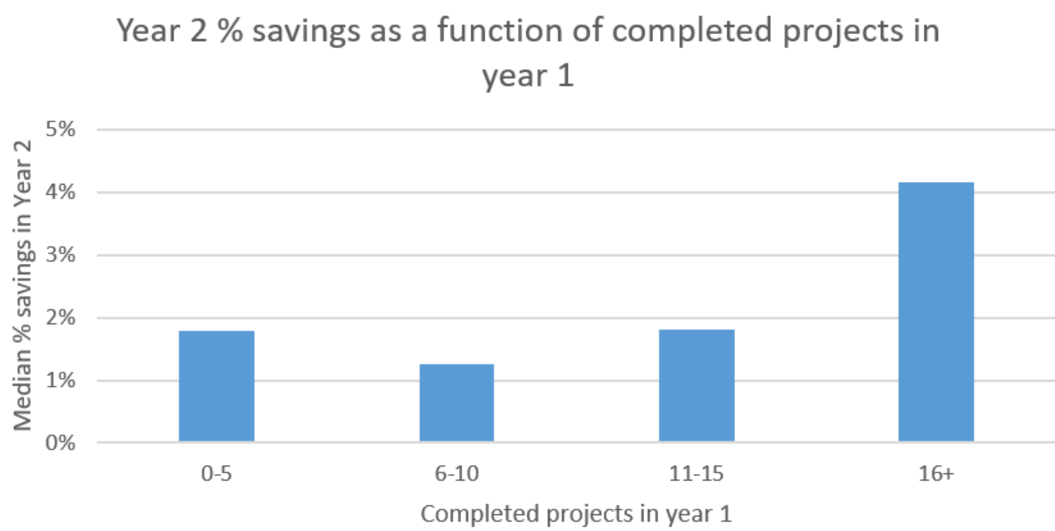

Figure 2. Sites that complete 16+ projects in year one see roughly 2x better year two results.

What Types of Actions Are Markers for a Successful SEM Engagement?

Quantity matters. Project completion rate increases when more projects are identified. Sites with 50+ total projects have a 45 percent completion rate whereas sites 11-25 projects have a 26 percent completion rate, as shown in Figure 3. This likely reflects that more engaged, SEM sites generate more projects and follow through on them in a "virtuous cycle" of engagement. This finding also suggests that breaking down larger projects into smaller phases, thereby increasing total project count, could be a strategy to increase overall completion rates.

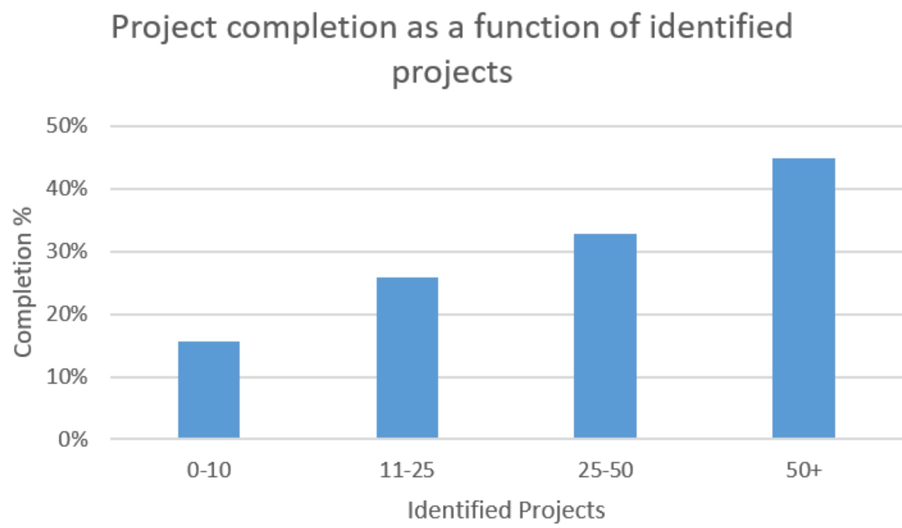

Figure 3. Sites that identify more projects complete projects at a higher rate.

Ownership matters. Project completion rises to 55 percent when the project included a due date, vs 30 percent completion when the project did not include a due date. Additionally, projects generated by site staff outside of the treasure hunt process (n = 794) have a 56 percent completion rate, which is more than double the 26 percent completion rate of projects generated during treasure hunts (n = 8,938).

Establishing due dates and identifying projects outside the treasure hunt are both signals of site staff taking ownership of the project implementation process. The correlation found here suggests that site ownership of the project discovery process leads to higher project completion.

Additionally, there is a correlation between the presence of a documented savings estimate and the completion rate of the project. For Gems and Quick Wins (the low-effort projects prioritized in SEM engagements), the completion rate is 29 percent for projects with no savings estimate, and increases to 39 percent for projects with a savings estimate. This correlation does not assume causality, because the projects most likely to be completed are also most likely to receive due diligence such as calculating the estimated savings.

More prevalent subsystems have higher completion rates. Projects are completed at a higher rate in the subsystems with the most prevalent project ideas in our dataset, as seen in Figure 4. This could point to an opportunity to develop more specialized expertise amongst site stakeholders, coaching teams, and vendors to complete more projects on less prevalent systems like fans and pumps.

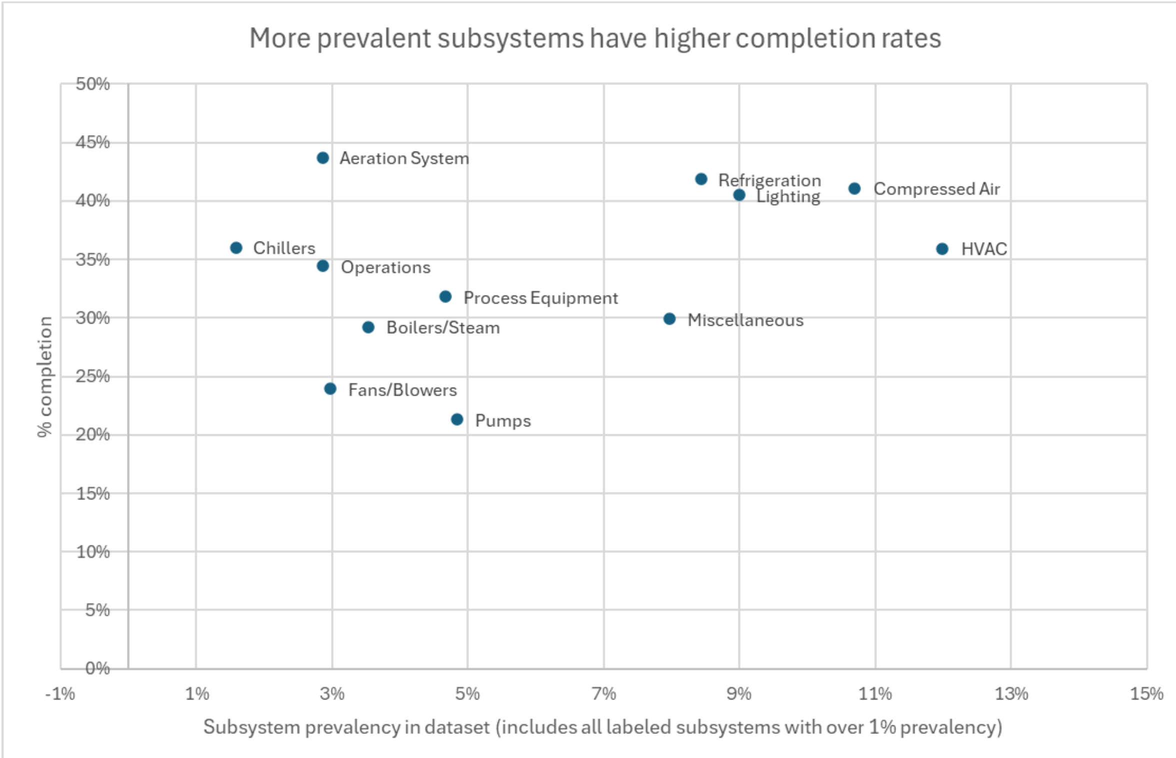

Figure 4. Project completion rates by subsystem and the prevalence of that project in the dataset (n=14,996)

What types of projects do not get completed?

Only 37 percent of projects get completed. The remaining 63 percent of identified projects represent a pool of untapped savings potential. Identified capital projects are an especially valuable source. Only 18 percent of "strategic" (high impact, high effort) projects are completed during the SEM engagement. Depending on the utility program, these projects are often referred to custom or standard incentive offerings. Projects completed in other utility offerings after the SEM engagement period are not captured in this dataset.

Effort level, not impact level, is the primary driver of non-completion. Low-effort projects complete at 44 percent, compared to just 18 percent for high-effort projects—a 2.4× difference. By contrast, impact level has only a modest effect: high-impact projects complete at a slightly lower rate (29 percent) than low-impact projects (33 percent). This finding reflects common SEM practice to prioritize low-effort gem and quick-win projects. The remaining 82 percent of uncompleted high-effort projects represent a source of additional savings.

Project completion takes time. The median time between project identification and completion is 156 days for O&M projects and 272 days for capital projects. This means that many projects identified partway through year one will not get implemented and claimed until year two. Multi-year SEM engagements can capture these savings. This finding aligns with prior analysis (Podell-Eberhardt 2023) that showed 82 percent of projects were completed within a year of the treasure hunt.

Limitations and Future Research

Several limitations should be noted. The linked project-claim dataset of 148 sites limits the statistical power of subgroup analyses particularly for the commercial sector which is represented by only a handful of sites in the linked data. Expanding the linked dataset to include more sites and programs is a priority for future work.

The project dataset does not capture all sources of energy savings at a site. Behavioral changes that are not formally documented as discrete projects in Gazebo may contribute to verified savings but are invisible in the project data. Conversely, capital projects that are identified and tracked in the SEM opportunity register are typically referred to other program offerings and therefore are subtracted from the SEM claim. In one study, SEM graduates completed one additional project per year on average following an SEM engagement, compared to a control group of all industrial customers (Rubado, Batmale, and Harper 2015).

The correlational nature of this analysis means that causal claims should be made cautiously. For example, the due date finding could reflect reverse causation - sites that are already committed to a project may be more likely to assign a due date.

Future research directions include expanding the linked dataset, examining how findings vary by program design (e.g., cohort-based vs. individual engagement), and exploring similar trends in commercial SEM programs.

Discussion and Conclusions

This research provides the first known large-scale analysis linking SEM project completion patterns to verified energy savings outcomes. By connecting nearly 15,000 project records with nearly 1,000 site-level savings claims, we demonstrate that the relationship between what SEM programs do and what they achieve is shaped by a multi-year, consistent engagement pattern.

Our findings carry several practical implications for SEM program design and implementation. Across nearly 1,000 annual savings claims, this data demonstrates that SEM delivers ongoing incremental savings of at least 1 percent of the enrolled baseload for at least five years. These savings are 2-4x higher than historical industry-wide savings, even before counting the additional impact of projects referred to other DSM offerings. Yet SEM savings are also about 2-3x lower than facilities that have implemented ISO 50001 energy management systems. This finding suggests SEM sits in a "sweet spot" that generates meaningful savings at sites who are not ready for a deeper ISO 50001 implementation, and indicates that more savings are achievable when a more robust energy management system is implemented.

Second, the finding that strong year one engagement improves year two outcomes has implications for program resource allocation. Programs may achieve better long-term results by investing more heavily in the first year of engagement. The returns from engaged, high-performing year one sites translate into year two results. The finding that O&M projects have a median time to completion of 156 days supports the value of ongoing engagement – projects with longer time to completion may not get claimed in the same year they are identified.

Third, while not surprising, this data validates that completing more projects, especially high-impact projects, improves energy savings outcomes. Identifying more projects, assessing more subsystems, and driving ownership of projects (as measured by due dates labeled, savings impact assessed, and projects generated by site staff outside the treasure hunt) are behaviors that correlate to higher project completion and could be used to improve year one engagement and set the tone for multi-year success.

As the energy efficiency industry faces growing pressure to deliver more savings from existing program models, these findings suggest that SEM programs continue to drive year-over-year consistent energy savings. The roughly 60 percent of SEM projects that remain incomplete represent a substantial reservoir of savings waiting to be captured.

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