Is it Magic?
What SEM can teach us about energy efficiency in the industrial sector

Dustin Bailey, Guidehouse Consulting
David Bluestein, Guidehouse Consulting

ABSTRACT

Prior to participating in a strategic energy management (SEM) program, customers often tell us "we are already doing everything we can," or "we are already pretty efficient". Despite these sentiments, SEM programs continue to show savings results of at least 2% of a site's total energy usage through the implementation of low/no cost measures. This presentation will explore the tools and techniques employed by SEM programs to tease out energy savings in the industrial sector, including specific low/no cost solutions, results from holistic energy audits, and engaging facility staff to be champions of energy efficiency. Key topics include:

- **Understanding site usage.** Tools such as SEM energy models and detailed equipment cataloging can result in quantifying large savings opportunities. Understanding exactly how your facility uses energy is key to realizing energy efficiency savings.

- **Turn it off**. Midnight audits and careful observation can identify energy waste from equipment running when no one is around to use it. The kick switch and occupancy sensor are effective tools in a variety of situations for automatically turning off equipment.

- **Tail wagging the dog**. Similar to understanding site usage, identifying the main equipment used in any industrial process is key to increasing productivity and reducing energy waste. This includes checking support equipment that could be preventing the main equipment from operating as intended.

- **Common Low-Cost Measures.** Using compressed air efficiently, insulating equipment, and capturing lost heat can lead to substantial energy savings.

By the end of this presentation, we hope to raise the curtain and dispel the magic behind strategic energy management programs by providing practical steps for understanding industrial energy use and reducing energy waste through smarter operational practices.

Introduction

Strategic energy management (SEM) is a unique program that has realized significant savings at a relatively low program cost in the industrial and large commercial sectors. Like other behavioral programs, SEM focuses on low cost and no cost measures along with changes in daily energy use behavior to achieve electric and gas savings of 2 to 3% of total site energy

usage[1]. This report will explore the reasons why SEM has such success in the industrial sector, drawing from the authors' 10 years of experience evaluating industrial energy efficiency programs and 7 years' experience with SEM.

The first step in understanding SEM's success in the industrial sector is to acknowledge the common barriers industrial facilities face when attempting to improve energy efficiency and recognize how SEM's tools and delivery mechanisms work to overcome these barriers.

Secondly, SEM seeks to identify and reduce energy waste from common industrial practices seen across a variety of industries, regardless of site-specific operational routines. This allows SEM programs to leverage experience and successful behavior training for all program participants. This report will provide details on these common industrial practices and what SEM does to reduce wasted energy.

Finally, SEM uses simple but powerful energy models to track energy consumption before, during, and after SEM activities. These models have been vetted for nearly a decade by many utilities across the United States and found to deliver accurate and trustworthy results for all SEM portfolios. This paper will explain how these models track energy savings for a wide array of industrial processes, and how the ease-of-use of these models could seem like magic.

Common Barriers to Energy Efficient in Industry

Evaluation of the industrial sector has identified common barriers preventing industrial facilities from participating in energy efficiency programs and installing energy efficiency technologies. The table below lists these common barriers and how an SEM program addresses and overcomes these barriers.

Table 1: How SEM addresses common industrial barriers to energy efficiency

Barriers		Potential solutions offered by SEM
Lack of Knowledge regarding:	Energy efficiency opportunities available for industrial customers either through efficient technologies or partnerships with utilities	First and foremost, SEM is a training program. SEM trains participating facilities to think deeply about their energy use, identify ways to reduce energy waste and become champions of their energy future. Participants enter into a long-term partnership with the utility to collaborate on reducing energy waste, improving efficiency through capital projects, and learning how become champions of energy efficiency. SEM participants receive expert advice through onsite energy audits regarding behavioral, low/no-cost, and capital project opportunities available at their facility.
	Energy use and energy waste at their facility	Industrial participants receive energy management tools and equipment for cataloguing energy consumed in day-to-day operations. Through better understanding of their energy flow, facilities can identify energy waste and implement technologies that improve efficiency.

[1] These results are based on Guidehouse's evaluation work for AEP Ohio (2014 to 2020), ComEd (2015 to 2020), Nicor Gas (2017 to 2020), and People's Gas and North Shore Gas (2018 to 2020)

Barriers		Potential solutions offered by SEM
	Improvements in the industry	Participants attend meetings with facility managers and staff from other sites participating the SEM program to share ideas and collaborate on the latest trends appearing in their given industry.
Financial	Difficulties affording the upfront cost to replace equipment that still works	SEM focuses on low and no cost measures such as set point changes, improvements to operation, and general equipment maintenance.
	High costs for critical energy management and monitoring systems which are beneficial for understanding energy consumption	SEM offers expert advice during the early design and construction phases of equipment monitoring systems, streamlining processes, and reducing overall costs. Utilities also offering financing options through third-party lenders to cover high capital project costs, often with payback periods between 3-5 years based on the reduction in energy use.
Product Quality	Energy efficiency upgrades must not jeopardize the facility's compliance with regulation or product quality.	SEM staff work closely with the facility managers, operational staff, and onsite engineers to ensure that none of the energy efficiency improvements negatively impact product quality. This expert advice from staff familiar with their industry assures participants that operation time and product quality will not suffer.
Seasonal and Continuous Operation Cycles	Certain industrial processes require continuous operation, making energy efficiency upgrades challenging	The SEM program clearly defines the energy flow of each facility through run-time assessments of all equipment. SEM staff work with facility operators to identify what equipment can be taken down for maintenance and when, to limit the overall impact on production. Site can also turn to backup power or parallel operation schedules while energy efficient upgrades are being installed on their main production systems.
	Seasonality of industrial operations limits windows of opportunity and runtime hours	For seasonal operations, SEM incorporates advanced planning techniques to schedule downtime for energy efficiency upgrades when equipment is not in use.
Organizational Concerns	Industrial facilities often lack clear initiatives for championing energy efficiency across the entire company	The SEM program creates Energy Teams at each participating company that includes team members at all levels, from CEO's and facility managers, to engineers, plant operators, and maintenance staff. Energy Teams receive training on energy efficiency opportunities and are encouraged to share ideas on additional ways to improve efficiencies across the facility.

SEM offers solutions that address the barriers identified in the industrial sector. Energy efficiency programs that do not consider these barriers will continue to have limited participation from industrial facilities.

Common Opportunities for Energy Efficiency in Industry

Energy use in the industrial sector relies less on HVAC and lighting, and more on process equipment (motors, and process heating and cooling). Based on potential model research conducted in 2019, motors represent approximately 62% of the industrial energy use and process equipment another 20%, as shown in Table 2.

Table 2: Industrial energy end use distribution

End use	Motor-compressed air	Motor-fans	Motor-pump	Motor-other	Motor-process other	HVAC	Lighting	Process cooling	Process heating	Other process
Average Industrial Site	14.05%	9.88%	17.17%	20.47%	1.74%	8.43%	3.64%	4.92%	11.99%	7.70%

Traditional Commercial and Industrial (C&I) and Residential rebate programs focus on lighting and HVAC equipment for energy savings. Industrial SEM programs focus on the technologies common to industrial facilities, including motors and process equipment. Table 3 provides further descriptions of these common industrial technologies.[2]

Table 3: Common industrial technology upgrade opportunities

Measure name	Description
Compressor motor controls	Air compressor motors controlled through throttle or other simple controls can be upgraded to load/unload controls or variable frequency drive (VFD) controls.
Compressor motor optimization	The compressor pressure setpoint can be reduced to meet to minimum needed operational setpoints. Compressor leaks can also be addressed through leak audits and repairs.
Machine drive motor controls	This control technology focuses on the variety of variable speed drive (VSD) controls that can be installed on machine drive motors. Depending on the motor type (pump, fan, general process) and load, VSD's can greatly reduce the energy use of a motor and reduce maintenance.
Machine drive motor upgrade	This includes upgrades to machine drive motors such as energy efficient belts, high efficiency motors, properly sized motors and pumps, and conveyor upgrades.
Kick switch or occupancy controls	Equipment switches or controls that automatically deactivate equipment when not in use.
Heat recovery or exchange on process heating equipment	The most common application for this technology is recovering waste heat from an industrial cooling process and directing it to where heating is needed (such as HVAC for offices).
Process equipment insulation	Insulation for open tanks (floating insulation), storage tanks, process pipes, and bare process equipment can significantly reduce energy waste

[2] Technologies included in this table are not exhaustive. SEM participants often have equipment unique to their industry that could benefit from energy efficiency improvements.

SEM programs also train facilities on no cost opportunities such as best practices in operations and maintenance (O&M), optimal equipment setpoints, and behavioral changes to reduce energy waste. Despite the limited scope of common technologies and no cost opportunities, an SEM program is able to significantly impact a facility's energy use, with an average evaluated energy savings of around 3% of total site usage.

Creating Tools that Consistently Measure Energy Savings

The final ingredient of a successful SEM program is the creation and use of a unique energy model. Each participating facility in the SEM program receives an energy model that employs advanced metering infrastructure (AMI) data to monitor energy consumption before and during SEM program activities. With diligent documentation of SEM and capital project upgrade efforts, these models can clearly identify the impacts from changes in energy use.

Unlike other custom C&I programs that rely on data loggers, engineering calculations, and code baselines, SEM energy models look at the energy consumption of the entire facility and have several advantages over custom calculation tools, including:

- Ability to detect the impact of several measures at once
- Use of "as found" building conditions instead of code baseline conditions to estimate savings[3]
- Consistent repeatability in creating models for different facilities, while maintaining high quality savings estimates
- Use of statistical regression analysis for calibration
- Applicability across various industries regardless of site-specific operations
- Ability to follow best practices in design (ESI 2015)
- Provides timely feedback that encourages customers to continue SEM activities
- Ability to be used as a commissioning tool to detect changes in energy use that may be a result of equipment or operational issues
- Reduced effort in gathering data to inform savings estimates

As more utilities turn to SEM programs, the energy models will continue to gain acceptance and validity as easy and accurate ways to estimate reductions in energy consumption for custom installations. Custom engineering tools will always have a place in the industrial sector, but SEM energy models have proven to capture more savings with less cost and effort. Using AMI data to track energy use will allow additional market segments to take advantage of SEM program model and move away from costly custom programs engineering analysis.

Conclusion

The industrial sector represents a huge opportunity for saving energy and reducing energy waste. The custom nature of industrial facilities often requires complex and costly engineering tools to estimate savings. SEM programs offer a more cost-effective way to meet the needs of this sector by removing long-standing barriers to energy efficiency, provide common low/no-cost

[3] Calculating energy savings using the as found condition instead of the code baseline condition (i.e., T12 linear fluorescent fixtures as found onsite versus the use of a T8 code baseline) allows the model to estimate the true savings realized at a facility.

solutions, and track reductions in energy use through powerful energy models. It is not magic; it is good program design that meets the needs of complex industrial customers.

References

ESI Energy Performance Tracking (EPT) Team, 2015. *Monitoring, Targeting and Reporting (MT&R) Reference Guide.* www.bpa.gov/EE/Policy/IManual/Documents/MTR-Reference-Guide-Rev5.pdf