Decarbonizing Industry Through the Adoption of Strategic Energy Management

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ABSTRACT

Sustainability goals can oftentimes be broad and unfocused if not given the same level of attention as other organizational goals, this paper will highlight how Strategic Energy Management (SEM) can play a pivotal role in decarbonizing industry and identify key considerations toward the collective effort to reduce industry's carbon emissions impact.

Since 2018, CLEAResult has worked in Alberta to implement a first of its kind SEM program focused entirely on greenhouse gas (GHG) emission reduction. With over 80 participants across the province, the results from this program can help future energy efficiency efforts be better adjusted to maximize GHG emission reduction and inform how SEM can be adapted to focus on GHG. This paper will compare data from the Alberta SEM programs to the capital replacement programs also running in Alberta to evaluate key metrics such as cost-effectiveness of emission savings, economic stimulation provided, and overall business competitiveness. In addition, we will examine the results of similar US-based SEM programs focused on energy efficiency to highlight a few key considerations when delivering programs based on decarbonization.

This paper will seek to answer the following questions:

1. How does GHG-focused SEM compare to GHG-focused capital replacement programs across key metrics?
2. Are GHG-focused programs more successful in decarbonizing industry than energy-focused programs?
3. What aspects of an SEM program need to be adjusted when shifting focus to GHG and what are the associated benefits?
4. What considerations need to be made when allocating funds to energy efficiency programs (SEM, capital, renewables, etc.) and in general when considering decarbonization?

Introduction to SEM

Strategic Energy Management (SEM) is a program concept with significant potential for new and sustained energy savings across all sectors including industrial, commercial, institutional and municipal. The goal of SEM is to achieve energy savings through low/ no cost efficiency improvements, usually through operational, maintenance, and behavioral changes, as well as identifying potential capital incented projects.

Figure 1 shows that SEM is a continuous cycle. SEM takes a holistic approach to energy management. The majority of CLEAResult's SEM programs recruit a cohort of participants and include collaborative group workshops with other cohort members, one-on-one coaching and support, and continuous technical/energy modeling and engineering support. These three mediums of cohort delivery enable participating organizations to adopt a culture of energy efficiency by encouraging:

- Organizational commitment
- Identification, prioritization, planning, and implementation of energy measures
- Energy modeling for measuring and reporting performance.

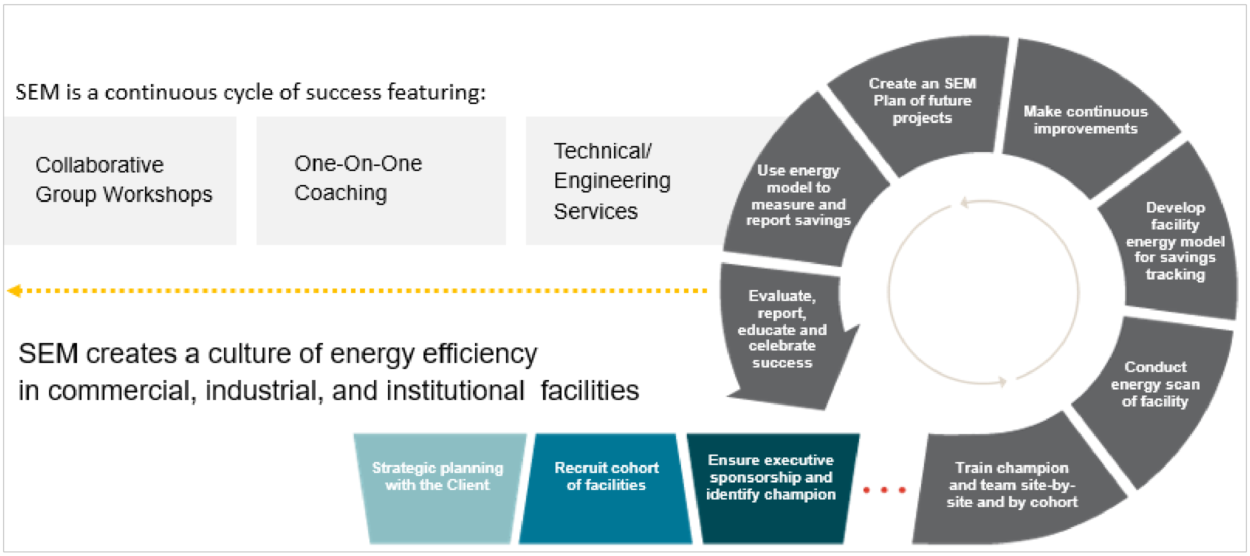

Figure 1. The SEM Cycle.

The energy savings attributable to SEM programs can range from zero to 33.7% with an average of 2.9% savings in electricity and 3.8% savings in natural gas typically observed in the first year of the program (from the implementation of low/no cost measures alone). SEM helps organizations create specific targets, actionable initiatives, and detailed metrics that result in persistent energy, greenhouse gas, and other resource savings.

GHG-Focused SEM and Capital Replacement

This section explores Question 1: How does GHG-focused SEM compare to GHG-focused capital replacement programs across key metrics?

Methodology

As program administers in Alberta, CLEAResult can provide a unique perspective in how industrial SEM compares to industrial capital replacement programs with a focus on GHG emissions. This enables us to encompass all the costs of running an SEM program such as administration and participant incentives as well as all the cost associated with capital replacement program such as administration, outreach/key account manager costs, energy study and scoping audit costs, and participant incentives. The comparison includes a large dataset of sites across both programs including 69 capital investment projects and delivery of 6 SEM cohorts across Alberta (totaling 60 recruited SEM participants across more than 250 facilities). To ensure a representative view of performance, all program related costs were captured, and the lifetime years of savings were also considered for each program and project respectively.

Results

Based on a performance analysis and an Alberta program retrospective, the following main conclusions can be made:

- SEM was more cost effective than the capital project funding program. The analysis of the two Alberta based GHG-focused programs concluded that a 2-year SEM engagement with industrial participants achieved three times greater cost efficiency ($ invested/tCO2e savings over the lifetime of the savings) in comparison to the capital program. It is fair to assume that this ratio could be even greater as most of the capital projects were oil and gas which typically achieve more significant savings in comparison to the rest of the industrial sector. In this case 3 oil and gas projects out of the entire 69 capital projects implemented accounted for 66% of the savings achieved through the program.
- The SEM program had a higher realization rate of claimed to verified savings. This is due to the continuous tracking using the whole-site energy modeling created through the SEM programs. Following measurement and verification of the capital projects it can be concluded that typically calculated/forecasted savings underperformed in comparison to actual performance.

Considerations

SEM increases energy awareness and provides training on how to build a business case around energy projects. Delivering SEM in parallel with the capital program lead to greater capital program success, as the SEM approach assists with energy study assessments following through to project implementation. Organizations who are engaged with SEM will typically have improved operating and maintenance practices. These improvements increase the likelihood of newly installed equipment being operated efficiently, which can assist with realization rates, the sustainment of savings, and even increase the savings performance of an installed project. Additionally, SEM can aid in creating a pipeline of prioritized viable projects as well as assisting with the resolution of any claims of free ridership through capital project incenting.

Success in Decarbonizing Industry

This section explores Question 2: Are GHG-focused programs more successful in decarbonizing industry than energy-focused programs?

Methodology

We reviewed the results of the previously mentioned Alberta GHG-focused SEM program and compared them to the results of similar industrial electricity and natural gas energy efficiency focused SEM programs. This comparison aimed to determine if there was a significant difference in the decarbonization effects of programs focused on decarbonization versus energy efficiency; efficiency focused programs are referred to as "non-GHG-focused" in this study. The analysis was performed on 6 GHG-focused SEM cohorts consisting of 23 industrial sites and 4 non-GHG-focused SEM cohorts consisting of 27 industrial sites.

The analysis compared both gross (total savings including SEM and all other implemented projects) and net (SEM-specific savings) SEM savings percentages by facility for the first two program years between the GHG-focused and non-GHG-focused programs; GHG savings were calculated by converting kWh, therms, and GJ to GHG using the GHG conversion rates supplied by the government of Alberta GHG to all GHG- and non-GHG-focused savings. Each participant in all cohorts included in this study had not participated in a utility/government sponsored SEM program prior to the participation years utilized in this study. A students t-test was performed at a 95% confidence level on the means of the two data sets. When comparing savings results, it is necessary to ensure that the two data sets are not skewed by industrial sectors included in each population. Because the GHG-focused program is comprised of NAICS sector businesses that have average savings that are typically larger than those found in the non-GHG-focused programs it was necessary to normalize for this effect. Therefore, the GHG-focused data sets were adjusted based on the weighted average difference in savings to determine if the results of the two program types were statistically significantly different after normalization.

Results

Initial comparisons of the two data sets (GHG-focused and non-GHG-focused) suggest that the GHG-focused programs save an extra 4.38% gross GHG percent savings in the first program year at 95% confidence shown in Figure 2 with a t Ratio of -2.997 and probability <t of 0.0022.

Figure 2. Gross year 1 savings percent comparison.

When looking at the SEM-specific (net savings), the data shows a 4.46% increase in GHG savings at 95% confidence in the first program year with a t Ratio of -3.032 and probability <t of 0.0020; the results of the means comparison can be found in Figure 3. However, as discussed in the methodology section, the average savings based on NAICS sectors for the GHG-focused data are higher than the NAICS sectors for the non-GHG data.

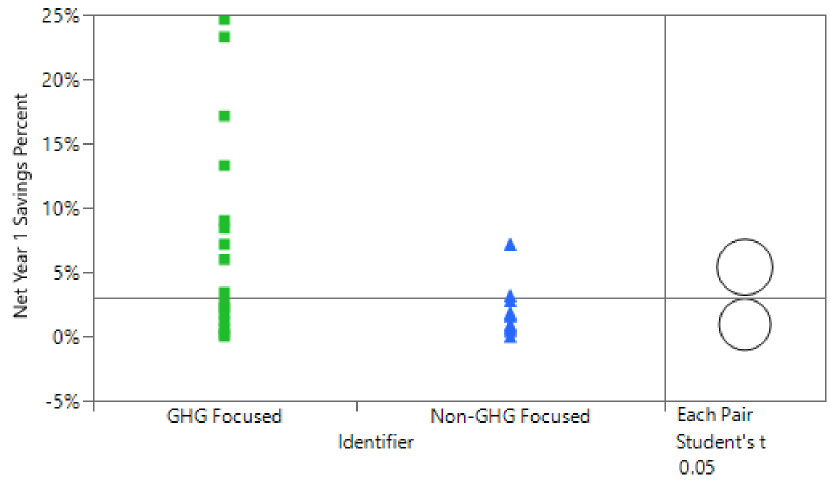

Figure 3. Net year 1 savings percent comparison.

The average savings based on NAICS sector are 4.08% and 3.16% for the GHG-focused and non-GHG-focused programs, respectively. When weighting the average savings based on number of facilities per NAICS sector in the GHG-focused and non-GHG-focused groups, the average savings are 4.38% and 2.82% respectively; this suggests that the non-GHG-focused programs save 64.4% of the GHG-focused programs. When reducing the GHG-focused program savings to 64.4% of their original value, the comparison of gross savings still shows a 2.41% increase in savings at 95% confidence with a t Ratio of -3.447 and probability <t of 0.0086 when compared to the non-GHG-focused programs; the results of the means comparison can be found in Figure 4.

Figure 4. Adjusted gross year 1 savings percent comparison.

The results for the net savings (SEM only), shown in Figure 5, also suggest that the GHG-focused programs increase overall decarbonization by 2.54% at 95% confidence with a t Ratio of -2.601 and probability <t of 0.0062

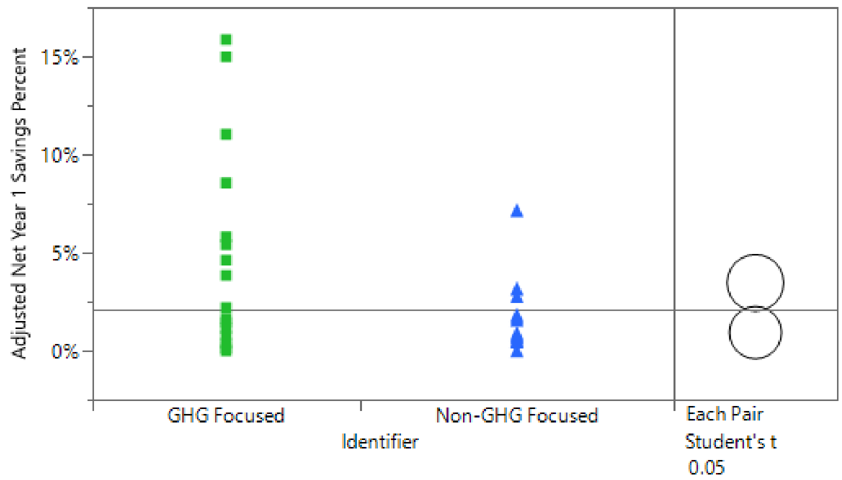

Figure 5. Adjusted net year 1 savings percent comparison.

SEM Program Adjustments

This section explores Question 3: What aspects of an SEM program need to be adjusted when shifting focus to GHG and what are the associated benefits?

Methodology

The methodology used to assess this hypothesis came from evaluating our previous SEM program delivery experience and comparing that to the program design for the GHG-focused SEM in Alberta. CLEAResult is the largest provider of SEM and embedded energy manager services in North America, and has delivered SEM since 2009 to more than 3,000 facilities and worked with more than 50 utility clients. During the design phase of the GHG-focused SEM program we used this past experience to adjust specific aspects of the SEM program to maximize GHG emissions reduction, the following sections outline the changes in program design.

Results

- Energy modeling development – Each site in the cohorts received a gas and electric model measured in standard energy units. An additional step was taken to convert the energy units to emissions-based savings to measure the participant's program performance and to determine incentive payments.
- Fuel switching – Typically in utility-run energy efficiency programs, fuel-switching is not an option that is promoted or incented. When programs are emissions based, so too are the incentives, meaning organizations can receive incentives to implement projects that require fuel switching to save emissions (e.g., CHP installation etc.). Although fuel-switching was permitted to receive incentives there was very few instances where these project types were implemented.
- Measure Identification and Planning – Over 90% of SEM programs delivered by CLEAResult are focused on one fuel type (typically electricity). When a participant is engaged in a single fuel SEM program, such as electricity only, electricity saving measures will be the focus of the entire program (e.g., only electricity measures being identified onsite and only an electricity energy model being generated to measure and verify savings). A

minority of SEM programs delivered are dual fuel – focused on electricity and natural gas. In dual-fuel programs, electricity and gas measures are identified and supported with an energy model created for each fuel type. With emissions-focused SEM cohorts, all fuels that are consumed onsite can be in scope provided the associated emissions are large enough and there is optimization potential of the applicable end users. This enables participants to prioritize all savings opportunities based on level of effort and GHG emissions savings, not just one fuel type, resulting in a better return on investment for the time and money they input. In Alberta, most sites consumed natural gas and electricity but there can be sites with equipment or process that used other fuel types such as diesel, propane, or biomass.

- Incentives – Typically incentives are based on a dollar per kWh, GJ, or therm. With emission focused programs the energy models and engineering calculations used to track and quantify savings are converted to tCO2e based on the emissions factor of the given fuel type. In Alberta, the SEM incentive was $40/tCO2e saved, up to a maximum of $50,000 per participant.
- Emission Factors – With emission-based programs incentives are tied to the tCO2e of each fuel saving. When delivering an emission-based programs, ensuring emission factors are updated is a key consideration as the emission factors can be updated based on the fuel emissions intensity being updated (e.g., the electricity grid transitioning from coal to natural gas).

Allocation of Funds for Energy Efficiency

This section explores Question 4: What considerations need to be made when allocating funds to energy efficiency programs (SEM, capital, renewables, etc.) and in general when considering decarbonization?

Methodology

The methodology used to assess this hypothesis came from observing the implementation of energy management, capital replacement, and renewable technology programs through CLEAResult’s exposure to the US and Canada energy efficiency markets. CLEAResult is a leading Conservation and Demand Management (CDM) services provider in North America, and we focus exclusively on helping utilities, governments, and program administrators develop and implement energy efficiency and carbon reduction programs. CLEAResult has 30 years’ experience designing, marketing, and delivering energy programs. With more than 2,500 employees across 60+ offices in North America, and a current portfolio of 250 clients and 700 programs, we help save more than 4,500 GWh and 5.74 million GJ of natural gas annually. This market placement and exposure provides a unique perspective across all facets of energy efficiency.

Results

The “Energy Efficiency Pyramid” shown in Figure 6 illustrates key concepts in how decarbonization can be achieved in an efficient and persistent manner.

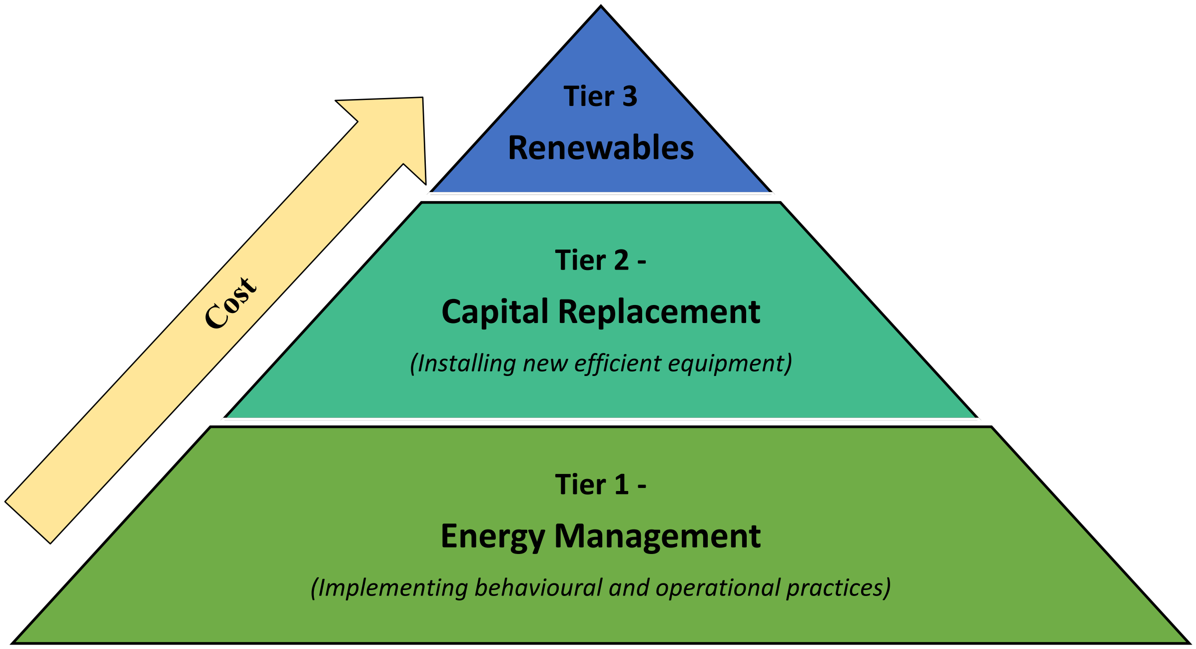

Figure 6. Energy Efficiency Pyramid

Tier 1 is largely based on behaviour and operational and maintenance improvements of existing equipment and processes, resulting in the highest return on investment. This is where energy management approaches such as SEM reside, and includes the following benefits to organizations:

- Provides the framework to move through the different tiers of energy efficiency towards decarbonization in a more sustainable and effective manner
- Supplies the tools to be more effective in efforts towards decarbonization as it relates to facility consumption
- Enables organizations to incorporate energy management into regular operations by setting up energy teams, identifying conservation and capital-intensive measures, creating an energy model to track and measure performance, and providing continuous technical and coaching support to help support measure implementation onsite (e.g., how to build a business case for an energy saving related project or how to engage employees etc.).

These essential foundational tools are vital to optimizing current processes and teach organizations how to do more with what they have and be more successful moving into Tier 2 and beyond. Tier 1 measures require the lowest level of relative effort and investment. It is also worth considering that decarbonization is most impactful when organizations are in the Tier 1 due to the embodied carbon associated with installing new equipment and alternative energy solutions in Tier 2 and 3.

Tier 2 involves purchasing and installing more efficient equipment and processes. Tier 2 typically performs most effectively with Tier 1 as a base as shown in a 2015 study conducted by Energy Trust of Oregon. This study revealed that facilities who participate in an SEM program completed 50 percent more incentivized capital projects than non-SEM participants. This supports the concept that the fundamentals and habits acquired by an organization embracing

Tier 1 practices helps increase the effectiveness and impact of organizations engaging in Tier 2 and beyond.

Tier 3 involves the installation of renewable technologies like; solar, wind, and hydro etc. This Tier typically involves a larger investment per unit of energy offset in comparison to the other tiers. The installation of renewable technology is usually the most impactful when all other processes and equipment onsite are optimized.

With the concept of continuous improvement in mind, no tier can ever be “complete”, as operational practices and equipment need ongoing monitoring and maintenance in Tier 1, and there will always be continued technological advances in Tiers 2 and 3. To achieve total decarbonization, all tiers are required, and to increase the likelihood of success, adequate effort and emphasis needs to be spent in each tier. Organizations must proceed through all tiers to achieve decarbonization in an effective and persistent manner.

Considerations

- Program sponsors and regulators who fund efficiency programing should be mindful of the value and potential of each tier of energy efficiency and allocate funds/resources accordingly.
- For decarbonization to be effective there needs to be a synergy between the different tiers. For example, an organization should not receive funding for a new air compressor until they have an air leak program, or an organization should not install renewable technology until they have an energy plan and/or team that ensures equipment is turned off when not in use.
- SEM programs were able to focus on GHG in Canada because of the carbon policy and carbon tax.

Conclusions

The Alberta study demonstrated that SEM programs are more than three times more cost effective than capital replacement programs in the industrial sector. This can be greater in the absence of oil and gas capital projects which typically yield much higher levels of savings in comparison the rest of the industrial sector. SEM also offers many more non-energy benefits that aid program success and persistence of savings.

GHG-focused programs proved to be more successful in decarbonizing industry in comparison to energy-focused programs. There may be multiple reasons for this, one reason could be that more savings were achieved due to all fuel types, processes, and equipment being in scope which resulted in the highest savings potential measures being identified, prioritized, and supported through the delivery of the SEM program.

The GHG program informed us that some key SEM program delivery components need to be considered and adapted to deliver a successful GHG-focused SEM program. The main elements included energy modeling development, fuel switching, measure identification and planning, incentives, and fuel emission factors.

Lastly our study highlighted the benefits program sponsors and regulators would see if programs were designed and funded with the value of SEM-type programming in mind, with a greater synergy between capital replacement and renewable technology offerings. These programs are also very cost effective for the program sponsor, as with more fuels in scope, more overall savings can be achieved.

Our study concluded that the GHG SEM program was more successful in achieving a higher % of baseline savings due to their lack of capital incentives available to them which ensured greater focus on site optimization before site upgrades. This illustrates that there is more potential for program sponsors to optimize the structure of program offerings. By considering how programs interact the most amount of savings can be achieved from all programs. Using an energy management type program as a base, will increase cost effectiveness in capital replacement and renewable technology programs.

To be successful in decarbonizing industry, we need to leverage programs like SEM more fully. SEM creates a strong foundation and cultural shift within organizations which is essential in setting organizations up for persistent and sustainable success as they move towards higher efficiency capital replacement projects and renewable technology in the future.

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