CANADIAN STRATEGIC ENERGY MANAGEMENT MARKET STUDY

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ACEEE Report**

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Contents

About ACEEE

The **American Council for an Energy-Efficient Economy** (ACEEE), a nonprofit research organization, develops policies to reduce energy waste and combat climate change. Its independent analysis advances investments, programs, and behaviors that use energy more effectively and help build an equitable clean energy future.

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Executive Summary

KEY FINDINGS

- Strategic expansion of strategic energy management (SEM) programs and practices across Canada could be a valuable contributor to GHG emission reductions, providing 1–19% of the 46 million metric tons/year of CO_2e reductions objective for the industrial sector by 2030 for the industrial sector depending on scenario.[1]
- To accelerate the growth and impact of SEM in reducing energy use and GHG emissions, several initiatives are required to overcome barriers and grow participation, and federal leadership is needed to support participants and utilities involved with SEM.
- An investment of resources is also necessary to promote SEM. Options could include financing of energy efficiency measures and capital expenditures, deferment or discount of the carbon tax for companies aggressively delivering energy and GHG reductions via SEM, and recognition of companies that attain high levels of SEM practice and performance in order to spur others to follow.

Strategic energy management is an approach that creates a foundation for continual efficiency improvement that can result in incremental and persistent energy savings and emission reductions. Canada has set ambitious targets for energy efficiency and greenhouse gas (GHG) reductions, prompting two questions: How can SEM growth help accomplish these goals? And what resources will be needed across the provinces to accelerate SEM growth and impact?

The research team developed three separate scenarios to estimate the magnitude of SEM's impacts on electricity use and GHG emissions by 2030. Each scenario is based on various

[1] Environment and Climate Change Canada. 2021. *Canadian Environmental Sustainability Indicators: Progress towards Canada's Greenhouse Gas Emissions Reduction Target*. Gainteau, Quebec www.canada.ca/content/dam/eccc/documents/pdf/cesindicators/progress-towards-canada-greenhouse-gas-reduction-target/2021/progress-ghg-emissions-reduction-target.pdf

assumptions including the rate of uptake of SEM and the rate of energy savings. The three scenarios are defined below.

- **Market Potential:** a bottom-up approach leveraging actual program information to inform uptake rates and impacts, focused principally on electricity
- **Economic Potential:** a top-down look at impacts using various uptake estimates, focused principally on electricity and gas
- **Technical Potential:** a top-down look at impacts across all fuels at the upper bounds of industrial uptake projections

Our analysis indicates that SEM impact by 2030 could be a valuable contributor to reductions in energy use and GHG emissions in the industrial sector.[2] The estimates of annual impact from the scenarios in this report are shown below. Note that these are not goals but estimates based on the assumptions and data associated with each scenario.

- **Market Potential**: 0.4–6.7 petajoules (PJ) electrical savings, 0.02–0.38 million metric tons (MMT) avoided carbon dioxide equivalent (CO_2e)
- **Economic Potential:** 7.7–90.7 PJ electrical savings, 0.4–4.3 MMT avoided CO_2e
- **Technical Potential:** 19–181 PJ electrical savings, 0.9–8.6 MMT avoided CO_2e

The CO_2e reduction objective in Canada is 40–45% by 2030, according to the enhanced nationally determined contribution.[3] As industry is a major contributor to emissions, assuming a reduction of up to 45% from the 166.7 million metric tons of industrial emissions in 2005 a

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[2] Electricity savings *estimates* are in petajoules, and CO_2 equivalent (CO_2e} in million metric tons. Both are per year. One million metric tons of CO_2e is equivalent to the emissions from 217,500 vehicles driven for a year, or the emissions produced by generating power for 181,600 homes (EPA 2021).

[3] Environment and Climate Change Canada. 2021. *Canada's Climate Actions for a Healthy Environment and a Healthy Economy,* Government of Canada. www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/actions-healthy-environment-economy.html.

Natural Resources Canada Statistics, Industrial Sector Table 2 Emissions by Source, Government of Canada, 2021. oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=id&juris=ca&rn=2&page=0.

reduction target could be up to 75 MMT/year. Therefore, at the higher end of these ranges, the contributions of SEM to this goal could be as much as 0.5%, 6%, and 11%, respectively.

Several recommendations emerge from this market study for overcoming barriers and accelerating the uptake and impact of SEM in Canada, including:

- Improve information availability, transparency, and consistency on SEM impacts and practices.
- Improve information collection and transparency of facility-level energy consumption.
- Integrate energy use with Canada's Greenhouse Gas Reporting Program (GHGRP) database.
- Encourage uniform reporting of SEM program data and impacts.
- Provide support for training on SEM programs and practices and develop a performance label for programs that excel.
- Establish federal government leadership in supporting participants and utilities in maximizing SEM growth and impact. Some possible options include:
    - Provide funding to expand utility SEM program offerings to serve more and new customer segments.
    - Integrate ISO 50001, 50001-Ready, and EMIS with SEM.
    - Standardize SEM savings reporting methods to be able to capture CO_2 benefits in a consistent manner.
    - Establish a national roundtable on energy management to encourage a conversation among utilities and provinces regarding the role of energy management and energy management programs in accelerating CO_2 reduction.
- Highlight and reward practices among SEM programs that drive energy and GHG reductions (e.g., offer incentives to utilities and participants for energy/GHG reductions above a certain level via a standardized method of quantifying SEM savings), such as:
    - Special financing options for energy efficiency measures and capital expenditures.

- Deferment of, or discount on, carbon tax.
- Recognition for those that implement and maintain ISO 50001 or 50001-Ready certification.

Introduction

For decades, large industrial facilities such as refineries, steel mills, and other manufacturers have sought to improve their energy performance to minimize costs and optimize processes; energy efficiency (EE) is a key component of these efforts. At the same time, the link between energy efficiency and carbon emission reductions has been emphasized in recent years as governments and other organizations strive to meet climate goals.

Canada has set ambitious targets for energy efficiency and, more specifically, for industrial energy management. These targets include improving EE by 3% per year and having 75% of industrial energy use benefit from energy management systems by 2030 (Natural Resources Canada 2018b; The Energy Mix 2020). Prior national estimates have suggested that 117 petajoules (PJ) of industrial energy could be saved annually by 2030 via implementation of energy management systems such as ISO 50001 (Natural Resources Canada 2019a).[1] To reach these goals, the uptake of energy management systems in the industrial sector will need to greatly accelerate. In this paper we explore ways to make this happen.

Several energy management programs are active in Canada, and there is growing interest in increasing participation and offerings to drive greater impact (Natural Resources Canada 2020). Multiple drivers underpin the growing interest in energy management, including corporate, provincial, and federal GHG emission reduction targets and increasing global competition. Additionally, investment in industrial EE has been demonstrated to save more energy per program dollar than investment in other utility customer segments (ACEEE 2016). Energy savings helps keep energy prices low by avoiding expenditures on new infrastructure like transmission lines and distribution systems.

Strategic energy management (SEM) is an approach that creates a foundation for continual energy efficiency improvement. It is a data-driven, systematic process that enables organizations to save energy and make better use of their energy resources (DOE 2021b). It is distinguished by its focus on people and organizational change resulting in the implementation of policies, practices, and procedures that lead to incremental and persistent energy savings and emission reductions. Early investment in energy management can avoid unnecessary upgrades and retrofits, and controls/checks added to monitor performance can

[1] 1 petajoule = 1 *10^{15} joules = 277.8 GWh (gigawatt-hours).

ensure continuous improvement. SEM presents an opportunity to bring about lasting energy savings and emission reductions across the entire industrial sector. Many provinces have begun to see the potential of SEM, and the industry is poised for its increased adoption. However, energy savings and emission reductions will not be uniform across Canada given different starting points, fuel mixes, industries, and other variables. It should be noted, though, that SEM aligns well with Natural Resources Canada's (NRCan) existing program supporting ISO 50001, 50001-Ready, and EMIS.

Utilities started offering SEM programs more than 10 years ago for their large industrial customers. Since then, SEM has evolved as utilities across North America administer it with unique design characteristics, different customer segments, and multiple approaches to measuring impacts. The North American SEM Collaborative (NASEMC) formed in 2018 to establish a community of practice and to promote SEM across the United States and Canada (NASEMC 2021).

Considering the drivers for carbon reductions and trends in setting more aggressive energy and GHG reduction targets, there is more focus on the magnitude of these reductions made possible by SEM. With support from NRCan and the NASEMC, the American Council for an Energy-Efficient Economy (ACEEE) pursued a study in Canada on the market growth potential of SEM, specifically for the industrial sector to 2030. ACEEE examined current Canadian SEM offerings; evaluated the potential growth and impact of SEM in Canada's industrial sector; and explored the barriers, needs, and opportunities for SEM to reach its potential.

This report provides an overview of Canada's industrial sector, an introduction to energy management programs, and a summary of enabling policies. It is intended to inform policymakers, program administrators, implementers, and others about SEM programs, the magnitude of SEM's impact across Canada, and how to accelerate action.

INDUSTRY, ENERGY, AND EMISSIONS IN CANADA

SEM was initially designed for large industry, and while interest has expanded into commercial and institutional settings, this report focuses exclusively on the industrial sector, defined as the North American Industry Classification Codes (NAICS) 31–33, and 21 (mining). To assess the market and impacts, it is helpful to have a basic understanding of Canada's industrial sector. Figure 1 shows secondary energy use for the top energy-consuming sectors in Canada by province.[2]

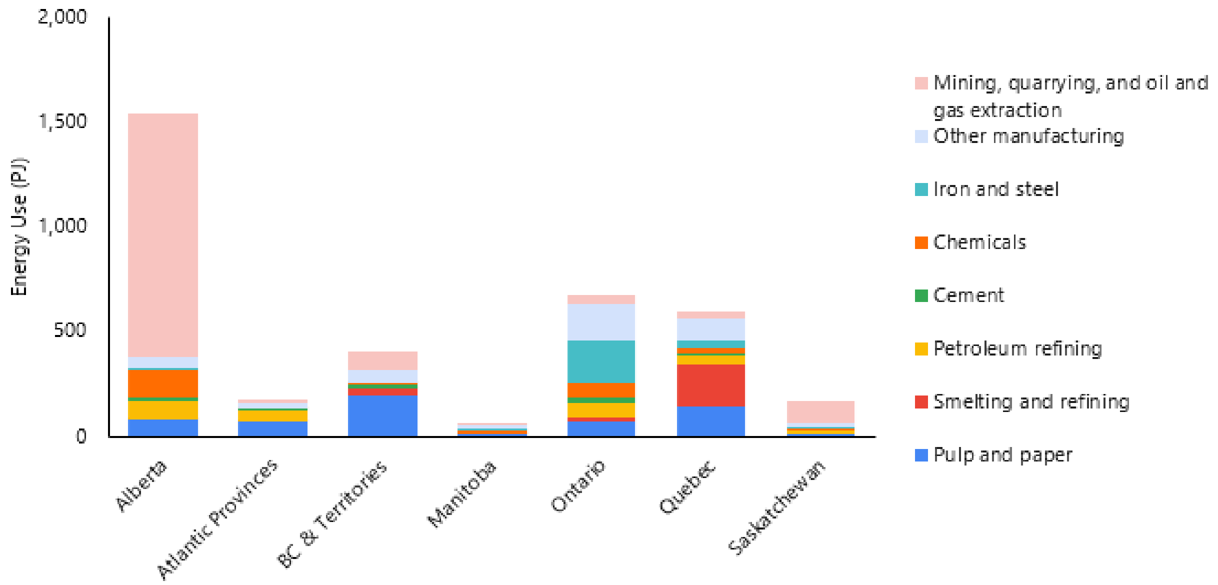

Figure 1. Energy use in industry by sector and province. Source: Natural Resources Canada 2019b.

Broadly, Canada is home to a diverse set of industries, but there are concentrations of industry within some provinces. Most striking is the amount of energy consumed by the mining, quarrying, and oil and gas extraction industries in Alberta. Also of note is the iron and steel concentration in Ontario, the smelting and refining concentration in Quebec, and the distribution of the pulp and paper industry across Canada. Considering the diversity of these industries, it is important to note that energy management is not limited to any particular one; SEM has served customers in Canada across many industries. SEM programs run by utilities and other public agencies can offer cohorts that provide shared learning opportunities to participants, often designed for specific industries. Clusters of similar industries may indicate an opportunity to leverage this type of engagement.

Another way to explore Canadian industrial sector energy use is to examine the variation of energy sources, as shown in figure 2. Natural gas is a major fuel source for industry across the country, constituting more than 40% of secondary energy use in 2018 (Natural Resources Canada 2019b). It is worth noting the high level of carbon-intensive fuels in

[2] Secondary energy use is the energy used by final consumers.

Alberta and Ontario, such as the still gas and petroleum coke in Alberta and the coke and coke oven gas in Ontario. Industries in Quebec, British Columbia, and Ontario have a proportionally greater share of industrial energy consumption coming from electricity. These details tend to correspond with the major industries and available energy sources across the provinces.

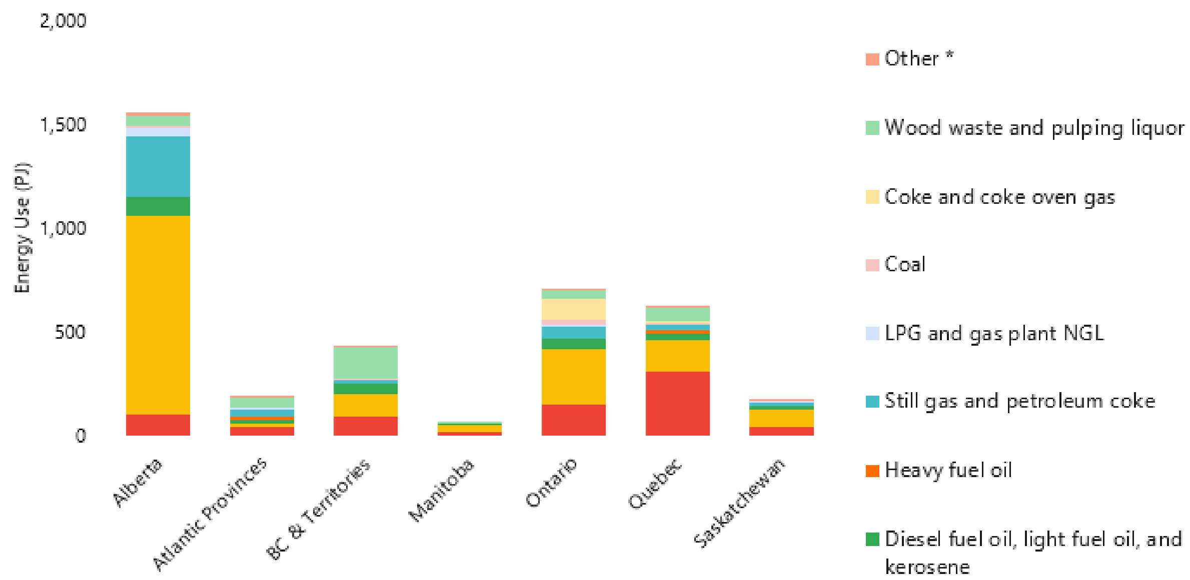

Figure 2. Canadian industrial secondary energy use, by province and energy source. *"Other" includes steam and waste fuels from the cement industry. Source: Natural Resources Canada 2019b.

Energy management is not limited to a particular fuel type. However, utilities tend to focus their SEM programs on the fuels they sell, namely electricity and/or natural gas. In some cases, electricity and gas utilities may offer a joint program. British Columbia (BC) Hydro and Fortis BC have such a program; Énergir and Hydro Quebec also have some coordination between their SEM offerings. In some provinces, efficiency organizations or government offices administer SEM programs that tend to be fuel agnostic. However, electricity and gas savings are typically the easiest to target; energy used in industrial processes, like direct reduction of steel or lime calcination, and industrial by-products used as fuel, such as wood waste, coke, and still gas, may be more difficult to reduce without process changes and capital investment.

The industrial sector is a major source of GHG emissions. In 2018 industry accounted for more than 185 million metric tons of carbon dioxide equivalent (CO_2e) emissions, with roughly half coming from natural gas. Still gas and petroleum coke; electricity; and diesel, light fuel oil, and kerosene largely accounted for the remaining industrial GHG emissions, as seen in figure 3.

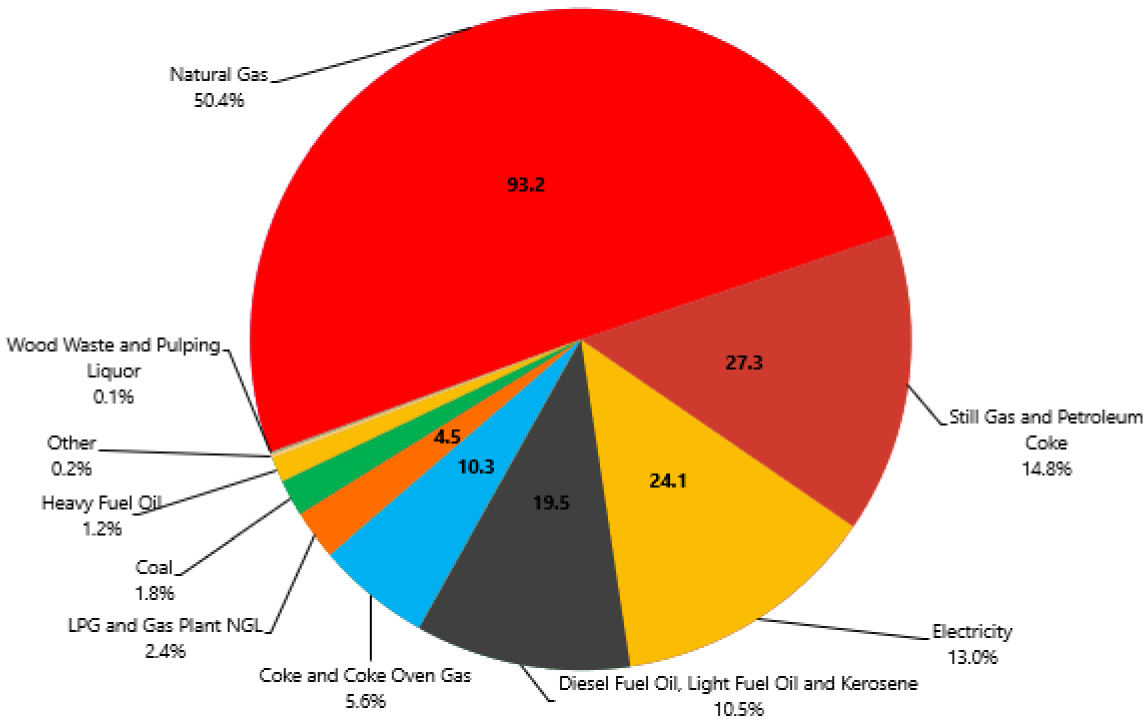

Figure 3. Share of Canadian industrial emissions (in million metric tons) from secondary energy consumption in 2018. Source: Natural Resources Canada 2019b.

Reducing energy consumption results in fewer emissions, but not all energy savings are equal when it comes to emissions. The emission intensity of fuels depends on location and application. Electricity has the largest variability in emission intensity across provinces since utilities have vastly different fuel mixes for electricity generation. The emission factors for electricity can be seen in table 1. Alberta and Saskatchewan have high emission factors driven largely by high levels of natural gas generation. Contrast these with the low emission factors in Quebec and Manitoba, where electricity is produced largely by hydropower.

Table 1. Emission factors for electricity consumption, by province

Province	CO_2e emissions (kg/GJ)
Alberta	219.6
Saskatchewan	200.2

Atlantic provinces[3]	97.3
Ontario	5.56
British Columbia	2.8
Manitoba	0.5
Quebec	0.4

Source: ENERGY STAR 2021

Similarly, natural gas has some provincial variability, as seen in table 2. The difference is not as stark as for electricity; gas consumption emission factors range from 53.6 to 56.4 kg/GJ.

Table 2. Emission factors for gas consumption, by province

Province	CO_2e emissions (kg/GJ)
Alberta	50.5
Atlantic provinces[4]	49.8
British Columbia	50.4
Manitoba	49.4
Ontario	49.4
Quebec	49.4
Saskatchewan	47.9

Source: ENERGY STAR 2021

Other fuel sources tend to be more emission intensive. Although the exact intensity will vary by use, rough estimates are provided in table 3.

[3] This estimated emissions factor was used for the Atlantic provinces where emission intensity was widely dependent on individual province.

[4] This estimated emissions factor was used for the Atlantic provinces where emission intensity was widely dependent on individual province.

Table 3. Emission factors for other industrial fuel sources

Energy source	CO_2e emissions (kg/GJ)
Coal	95.0
Coke and coke oven gas	44.0
Diesel, light fuel oil, & kerosene	74.0
Heavy fuel oil	73.0
LPG and gas plant NGL	64.2
Still gas and petroleum coke	97.5
Wood waste and pulping liquor	112.0

Source: IPCC 2006

Methodology

ASSESSING THE STATE OF ENERGY MANAGEMENT PROGRAMS IN CANADA

This paper sought to discover all self-identified SEM programs in Canada run by utilities or other program administrators. The research team first assembled a list of active energy management programs in Canada using publicly available information. Primarily through online research, the team collected more than 60 resources on Canadian energy management programs, including demand-side management evaluation reports, program plans, annual reports, and various additional resources. This search also turned up other energy management offerings—like energy manager and energy management information system (EMIS) programs and financial incentives for energy management systems (EnMS)—but they were not classified as SEM programs for this report. The team then assembled a high-level summary of SEM programs in Canada to illustrate the broad range of program practices and their locations in Canada. The summary also provides insights into the challenges involved in developing a national estimate of SEM program uptake and impacts, including differences in program design, target customer markets, and reported metrics.

EVALUATING THE POTENTIAL GROWTH AND IMPACT OF SEM

In 2015 and 2019, ACEEE conducted analyses of the market potential for SEM across North America (Rogers, Whitlock, and Rohrer 2019). This report took a more granular approach to assessing impacts in Canada and across its provinces. Without robust information on the topic, it was evident that multiple approaches would be needed to present a wide-ranging view of potential outcomes for SEM uptake and impact. Because there are such diverse SEM practices and programs, our analyses present impact estimates from various fuel sources and qualifying energy savings (from operational, maintenance, and behavior [OMB] measures alone or combined with capital expenditures [CapEx]), as well as various uptake rates. Using a combination of past research, national data, and interviews with program leads, the research team designed three separate analyses of the SEM market, as shown in figure 4.

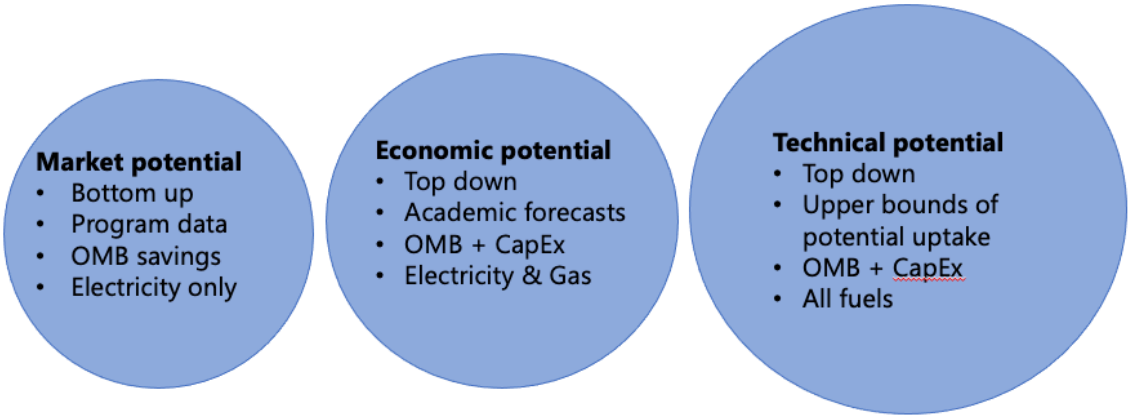

Figure 4. Illustration of scope of various scenarios

- **Market Potential:** a bottom-up approach leveraging actual program information to inform uptake rates and impacts, focused principally on electricity
- **Economic Potential:** a top-down look at impacts in various uptake scenarios, focused principally on electricity and gas
- **Technical Potential:** a top-down look at impacts across all fuels at the upper bounds of industrial uptake projections

These analyses are not forecasts; they serve only to demonstrate the potential magnitude of SEM impacts from multiple perspectives. There are many uncertainties given the limited data and sampling size and the models' multiple variables: participation rates, the size of facilities participating in SEM, energy savings rates, savings persistence, future energy consumption, changes in fuel mix, grid-level emissions intensity, and resource constraints for SEM program offerings in Canada.

Market Potential

We used a combination of publicly available documentation and phone interviews for the Market Potential analysis, which demonstrates the current scale of provincial SEM program impacts and provides a foundation for extrapolating growth based on actual experience. The results reported here include impact estimates from electricity savings only for participants starting SEM post-2021; they do not include estimates for past or current participants. Only the impacts from electricity are included in this analysis. Also, savings and persistence values are representative of operational and behavioral actions only insofar as they demonstrate how utilities assign savings over time. The steps of this bottoms-up approach are outlined below:

1. Estimate current level of SEM participation by province.
2. Apply compound annual growth rates (CAGR) of participants in programs.
3. Assume average energy consumption of participants.
4. Apply savings rates and persistence.
5. Convert to CO_2e impacts.

This analysis consisted of a low, medium, and high savings rate applied to three separate growth scenarios. Details of this analysis can be found in Appendix A.

Economic Potential

To analyze the Economic Potential, we used past market research and academic studies on the impact of SEM. This top-down analysis assumes various amounts of industrial energy will be consumed by facilities implementing SEM practices in 2030 in three separate scenarios. The model applies multiple savings scenarios to gas and electricity use that include impacts from capital projects implemented as a result of involvement in SEM programs. All savings are assumed to persist, and thus the impacts are proportional to each province's energy use. The results capture the expected total impact from SEM participants in 2030. The detailed methodology for the Economic Potential analysis can be found in Appendix B.

Technical Potential

The analysis of Technical Potential demonstrates the assumed ceiling of potential energy and carbon impacts from SEM in the industrial sector. This analysis follows the same top-down approach as the Economic analysis but expands the uptake of SEM to the highest estimated levels of industrial energy consumption and applies the impacts across all fuel types. The purpose of this analysis is to identify the magnitude of potential SEM impacts in 2030. Although it is unlikely that uptake will reach the levels suggested in this analysis, it provides an upper marker for impact. Details can be found in Appendix C.

ACCELERATING SEM UPTAKE AND IMPACT

To analyze the potential for various policy drivers to enable SEM, the team examined the landscape of current energy management approaches to mitigate industrial GHG emissions in Canada and elsewhere. We also sought to capture those policies that might support or drive energy management in parallel, such as Canada's federal carbon tax, as well as those that might deepen the impact and savings of existing program offerings. We studied both federal and provincial approaches, prioritizing the analysis of government-funded initiatives.

Finally, we conceived several federal policy recommendations for Canada to increase SEM and energy management practices in general.

Landscape of Energy Management Programs in Canada

ENERGY MANAGEMENT PROGRAMS

Energy management is not a destination but a journey; it requires time, effort, and dedication. Not every facility is equipped to improve energy management practices, and even sophisticated facilities have room for improvement. ISO 50001 was designed to institutionalize energy management; however, North American industry has been slow to adopt the standard. Utility and government programs have offered a variety of incentives and technical assistance to customers interested in improving their energy management capabilities.

Traditional programs take a project-level approach, offering incentives and technical assistance on equipment like pumps, motors, and fans. Energy management programs do so as well, but they are also about people, designed to encourage continual improvement through changing operational, maintenance, and behavior business practices, often with performance incentives. There are multiple components of energy management programs that pursue this goal, as seen in figure 5. These programs typically support the implementation of EnMS and EMIS or provide funding for on-site energy managers (OEMs). Having an energy management system in place can help identify energy efficiency opportunities including retrofits, process upgrades, and fuel switching. Energy management programs provide a basis for a minimum level of performance, continued pursuit of energy reductions, and data-based decisions on energy use. SEM integrates assessment, management, measurement and verification, and capacity building to help large energy users implement a systematic improvement approach to energy management. Early energy management programs like Track and Tune and continual energy improvement offerings started to incorporate some of these components (Bonneville Power Administration 2020; Rogers, Whitlock, and Rohrer 2019).

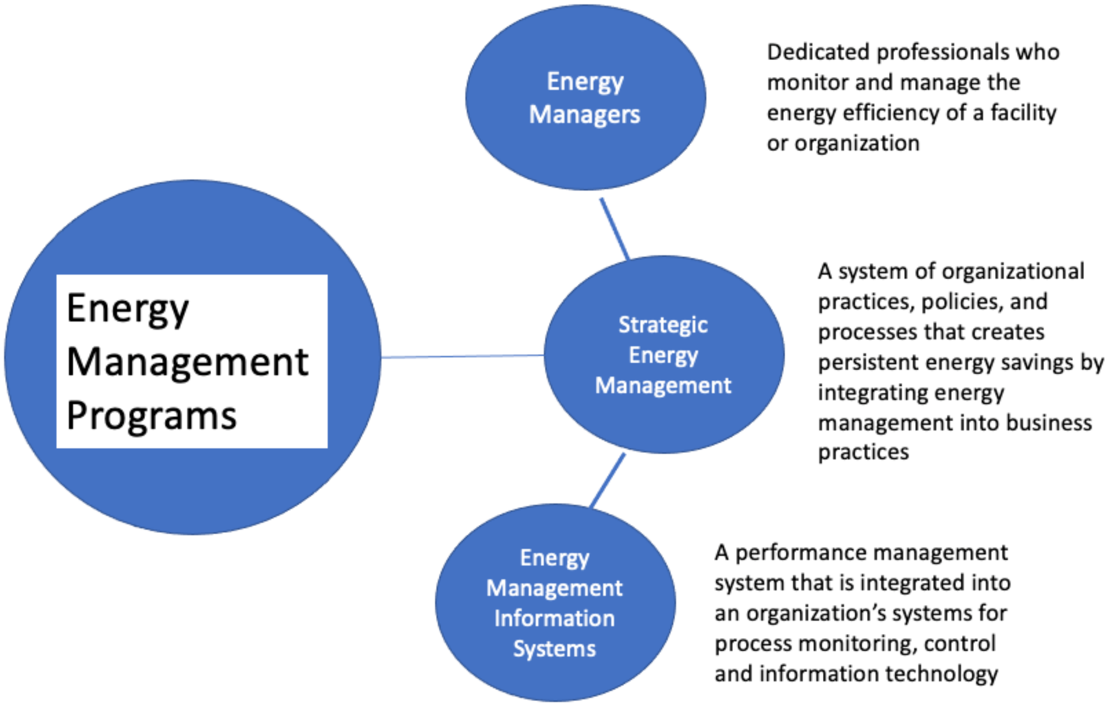

Figure 5. Components of energy management programs

Some SEM programs have utilized OEMs to lead change-management activities and help implement and operate an EnMS. EnMS (such as ISO 50001 and 50001 Ready) can be broader and deeper in multiple areas. Others integrate an EMIS that provides consistent data management to identify opportunities for energy improvement (Natural Resources Canada 2018b). Both OEM and EMIS programs have been offered separately from SEM, but they may be more effective when combined with the holistic approach that SEM programs take (Rogers, Whitlock, and Rohrer 2019). SEM also leads to greater uptake of more traditional efficiency offerings, including capital projects, by participants (Rubado, Butmale, and Harper 2015).

SEM programs must be designed to meet customers where they are in terms of technical expertise and available resources and to help them develop deeper understanding about their energy consumption. As customers advance in their energy management capabilities and sophistication, they increase their ability to systematically and continually save energy, as shown in figure 6.

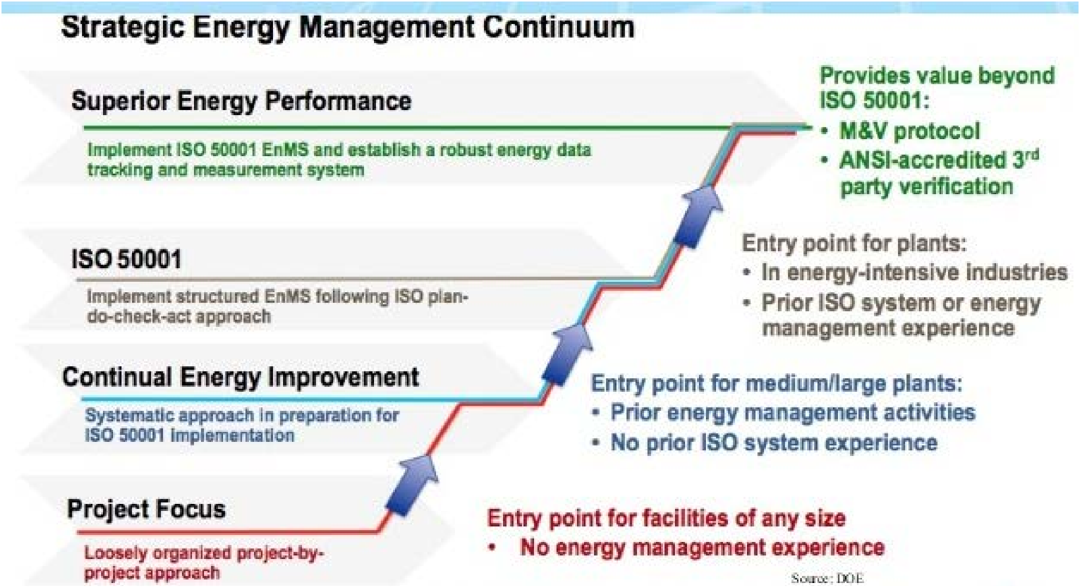

Figure 6. Illustration of SEM program hierarchy. Reprinted from: Therkelsen et al. 2013.

SEM IN CANADA

Canada has a long history of energy management, and interest in SEM is growing. Most provinces now offer or plan to offer SEM, as seen in figure 7. Perhaps most notable is the absence of SEM in Ontario; however, there is a suite of energy management programs including on-site energy manager and pay-for-performance offerings. Save on Energy, based in Ontario, as well as Efficiency Manitoba and New Brunswick (NB) Power, all have plans to offer SEM in the coming years.

Canadian SEM programs demonstrate the fact that no two SEM programs are alike. For instance, in British Columbia SEM is delivered through cohort engagements, while in Quebec it is delivered to participants individually. Mature SEM offerings like Efficiency Nova Scotia are standalone programs, whereas others, such as SaskPower's Energy Management program, offer SEM as a subcomponent of a larger custom program.

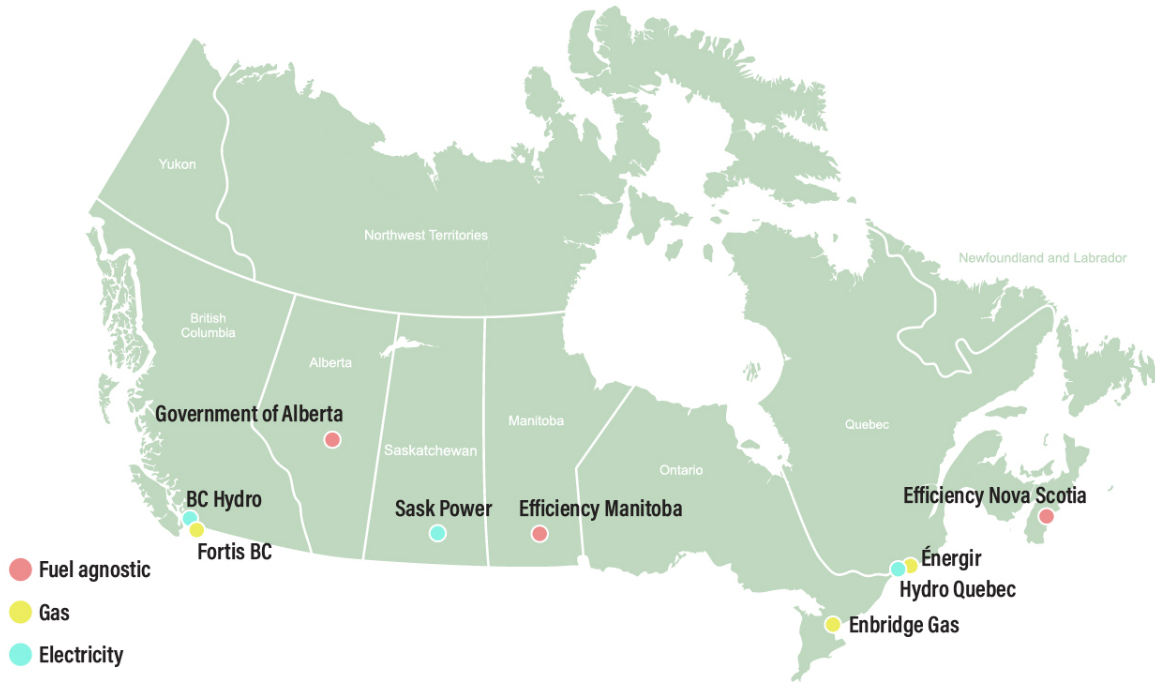

Figure 7. Map of identified SEM programs in Canada

Many program performance details are not comparable and were beyond the scope of this report. Table 4 highlights information about the SEM programs identified by the ACEEE research team. In some provinces there are multiple programs, which do not appear in figure 7. Additional details can be found in Appendix D.

Table 4. SEM program summary

Province	Program administrator	Program name	Current program launch	Customer segments served
Alberta	Government of Alberta	SEM Cohorts	November 2018	Industrial, commercial, and institutional
Alberta	Government of Alberta	SEM—Large Final Emitters	October 2019	Industrial
British Columbia	BC Hydro	Industrial Energy Manager	2010	Industrial

Province	Program administrator	Program name	Current program launch	Customer segments served
British Columbia	BC Hydro	Strategic Energy Management—Industrial Cohort	2016	Industrial
British Columbia	Fortis BC	Cohort	2019	Large and medium industrial
British Columbia	Fortis BC	Individual	2019	Large and medium industrial
New Brunswick	Énergie NB Power	SEM Pilot Program	September 2021	Large industrial
Nova Scotia	Efficiency Nova Scotia	SEM	Pilot 2014, custom incentive program component in 2016	Industrial and institutional
Ontario	Enbridge Gas	Comprehensive Energy Management Program	2016, with savings first claimed in 2018	Commercial and industrial
Manitoba	Efficiency Manitoba	Strategic Energy Management Cohort	2020–2023	Commercial, industrial, and agricultural
Quebec	Energir	Energy Management Systems—Pilot	January 2020	Industrial
Quebec	Hydro Quebec	Electricity Management Systems Program	2015	Large industrial
Quebec	Transition Energétique Québec (TEQ)	Energy Management Program	2019	Industrial

Province	Program administrator	Program name	Current program launch	Customer segments served
Saskatchewan	SaskPower	Energy Management Program*	2012	Industrial
British Columbia	Fortis BC	Cohort	2019	Large and medium industrial

*Industrial Energy Optimization program, ended before 2020

Results

MARKET POTENTIAL

The Market Potential analysis utilized SEM and adjacent energy management program data to inform assumptions about current SEM participation, growth rates, and savings rates. Impacts were estimated by applying three energy savings projections to three growth rate scenarios to determine potential impacts. The full methodology can be found in Appendix A. In this section, the results for mid-level growth and medium savings are presented.

In the mid-growth scenario, we assumed that participation would increase at a 10% compound annual growth rate, given that resources will be available to support that growth. The 10% figure was discussed with several program leads who felt it was a reasonable growth-rate assumption. This means that most growth will occur in provinces that have established SEM programs or other, similar programs promoting continual energy improvement. Figure 8 shows the number of new SEM participants each year, totaling more than 530 new participants by 2030. The growth in participation is not uniform across provinces, as some provinces have been practicing SEM for years while others are just starting to roll out energy management programs.

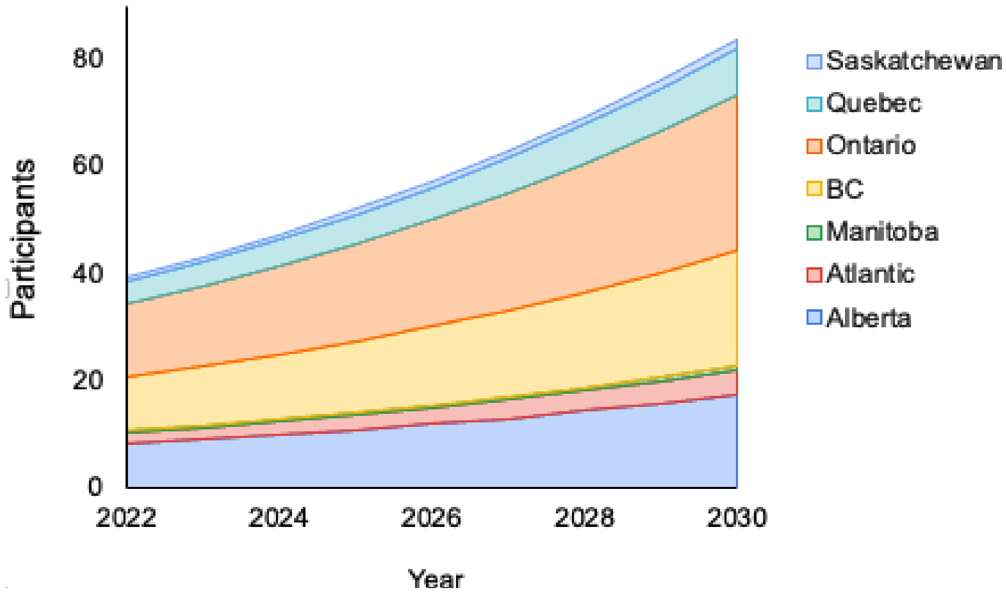

Figure 8. Participant growth by province through 2030 in the mid-growth scenario

The energy savings achieved in the mid-growth scenario for low, medium, and high savings can be seen in figure 9. In this analysis, we assumed an average participant electricity consumption of 0.15 PJ/year (43 GWh/year), and savings were assumed to persist for three years. More details on savings calculations can be found in Appendix A. In 2030, the annual savings range from 1.0 to 3.3 PJ/year, with cumulative savings of between 5.2 and 18.5 PJ. These values represent only the energy savings achieved from new SEM participants joining beyond 2021. These savings do not include incremental or persistent savings from current or past SEM participants. So these savings would be additional to the savings the SEM is already generating in Canada.

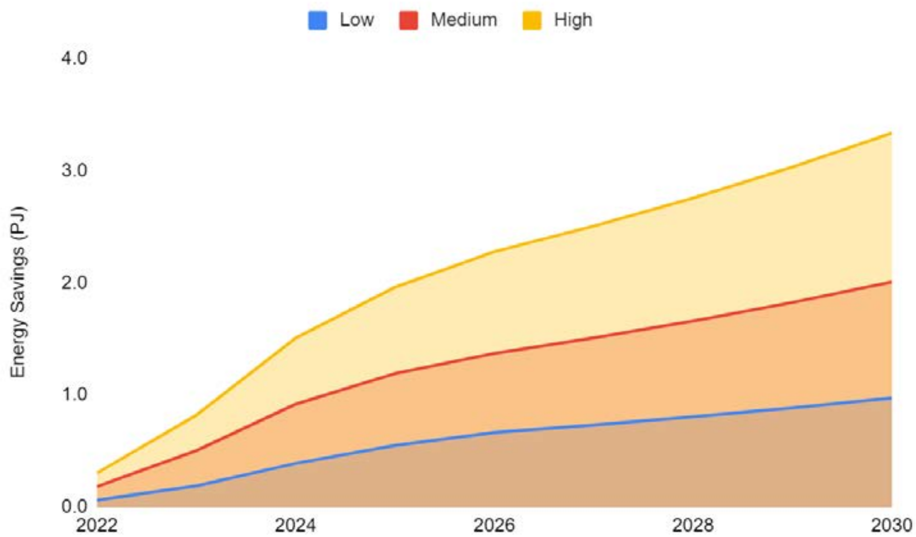

Figure 9. Market Potential cumulative energy savings under the mid-growth scenario

The medium savings rate applied to the mid-growth scenario results in a reduction of more than 0.11 Mt (metric tons) CO_2e annually from electricity savings by 2030, as seen in figure 10. Cumulatively this amounts to nearly 0.64 Mt CO_2e avoided by 2030. The relationship of energy savings to emission reductions is not a consistent one but rather depends on the emission intensity of the electricity grid where the energy savings occur. Much of the incremental SEM growth is in provinces with low electricity emission intensities. Savings are assumed to persist for only three years, but it is likely that savings from SEM will persist for much longer, especially in provinces where there has been little experience with SEM. Hence, it is likely that the estimates for potential SEM impact underestimate the total impact of SEM.

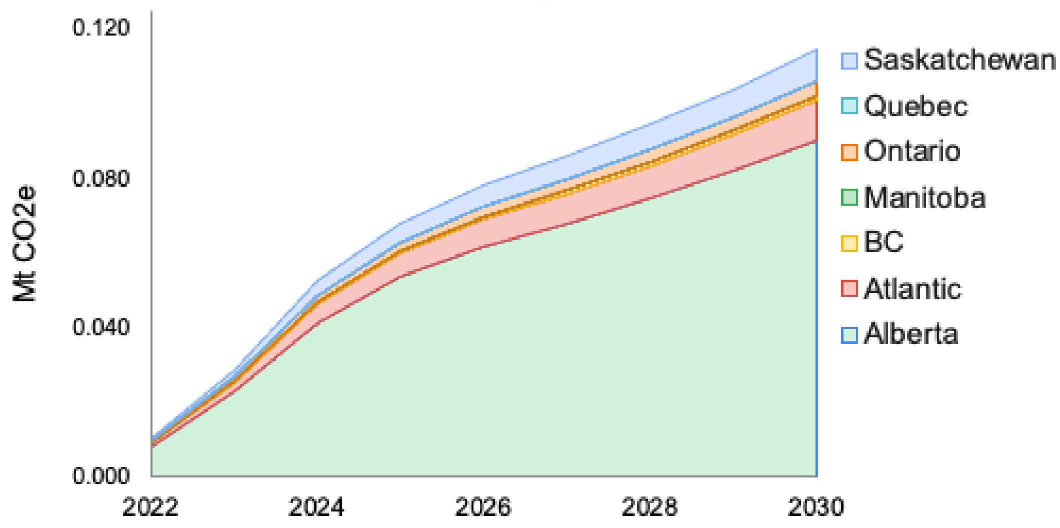

Figure 10. Market Potential emission reductions from SEM-generated electricity savings assuming mid-growth and mediuum savings.

Because utility-administered SEM programs have focused primarily on electricity savings, those are the only savings that we have modeled in this scenario. In some cases, dual-fuel utilities have also targeted natural gas savings. Gas utilities have shown a greater interest in SEM in recent years and are forming partnerships with their electric counterparts, such as in the collaboration between Fortis BC and BC Hydro. Gas-specific SEM programs, such as Energir's energy management system offerings, have also been piloted in Canada. However, data from gas programs were not comprehensive enough to permit a bottom-up energy savings model. Additionally, SEM could result in energy savings from other energy sources, but those opportunities are either not a program focus or are not reported. We explore the potential savings from other energy sources in the next two scenarios.

ECONOMIC POTENTIAL

The Economic Potential scenario presents a range of outcomes and impacts if certain thresholds of industrial energy consumption are met by facilities implementing SEM. Table 5 shows the fraction of total annual consumption enrolled in SEM at various uptake levels in 2030. The uptake levels were informed by academic research on the potential market for SEM; energy consumption was assumed to grow at 0.5% per year. More details can be found in Appendix B.

Table 5. Forecast industrial electricity consumption by SEM participants, Economic Potential scenario

Province	Low growth 19% of electricity consumption (PJ)	Medium growth 28.25% of electricity consumption (PJ)	High growth 37.5% of electricity consumption (PJ)
Alberta	20.6	30.7	40.7
Atlantic provinces	8.0	11.9	15.8
British Columbia and territories	19.2	28.6	37.9
Manitoba	4.2	6.2	8.2
Ontario	30.5	45.4	60.3
Quebec	62.3	92.6	122.9
Saskatchewan	8.3	12.4	16.4
Total	153.1	227.6	302.2

Energy saving rates of 5%, 17.5%, and 30% were applied to the 2030 electricity use values to estimate annual energy savings. The energy savings are proportional to provincial energy use; therefore, Quebec and Ontario have the largest opportunity to reduce industrial electricity consumption with SEM. Figure 11 shows the potential electricity savings when SEM is applied to 37.5% of industrial electricity use in each province. Electricity savings range from 15.1 to 90.7 PJ per year in 2030.

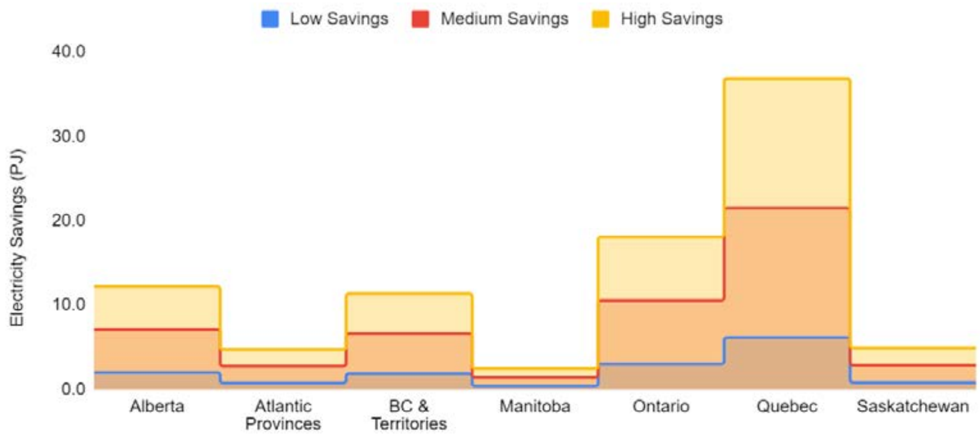

Figure 11. Electricity savings scenarios if 37.5% of industrial energy is consumed by participants implementing SEM

In 2018 industrial electricity consumption in Canada resulted in the emission of roughly 24.1 Mt CO_2e, which was 13% of the sector's secondary emissions (Natural Resources Canada 2019b). The energy savings generated in the high-growth, high-savings scenario results in the avoidance of nearly 4.3 Mt of CO_2e annually. Alberta would achieve the largest emission reductions of any province, as seen in figure 12, due largely to the high emissions factor for electricity generation in this province. Although the greatest electricity savings potential is in Quebec, the low emissions factor results in lower emission reductions. However, as previously noted, there are many other benefits of reducing energy use, including greater industrial competitiveness and lower energy costs as a result of fewer investments in new utility generation and transmission and distribution infrastructure.

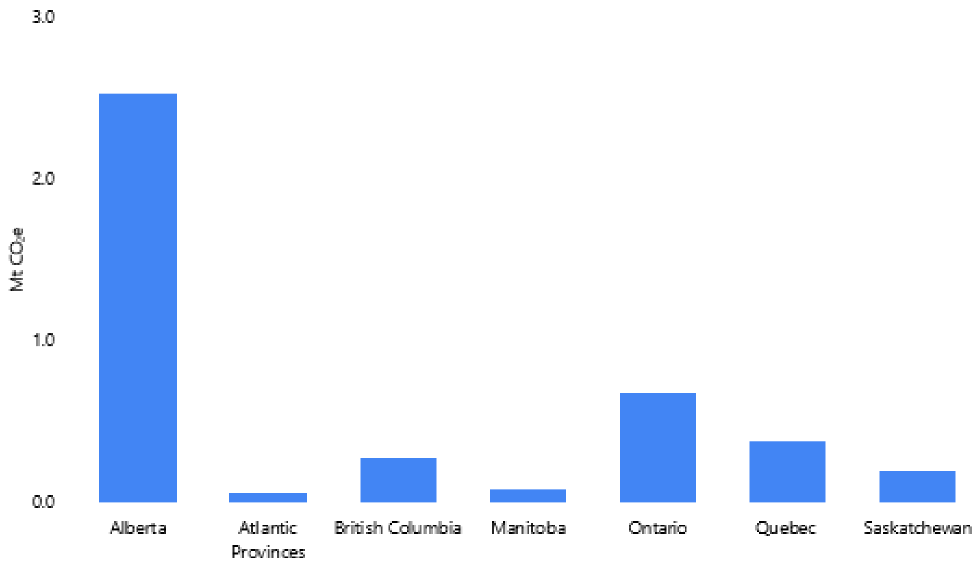

Figure 12. Emission reductions from SEM applied to electricity use in the high-growth, high-savings scenario, by province

As mentioned earlier, we also included gas consumption in our top-down Economic Potential analysis. Table 6 shows various levels of forecasted 2030 gas consumption under SEM.

Table 6. Forecast industrial gas consumption (PJ) by SEM participants, Economic Potential scenario

	Low growth	Medium growth	High growth
Province	19% of natural gas consumption (PJ)	28.25% of natural gas consumption (PJ)	37.5% of natural gas consumption (PJ)
Alberta	33.1	49.2	65.3
Atlantic provinces	4.6	6.8	9.0
British Columbia	11.7	17.4	23.1
Manitoba	4.9	7.3	9.7
Ontario	48.4	72.0	95.6
Saskatchewan	8.1	12.0	15.9
Quebec	29.5	43.9	58.2
Yukon	0.0	0.0	0.0
Total	140.2	208.5	276.8

Alberta consumes more gas than any other province in Canada, but a good portion of this is connected with the mining and extraction of hydrocarbons. For this analysis the gas usage for mining and oil and gas extraction was removed to avoid anomalous impact estimates. (The gas usage of petroleum refining activity was retained as SEM could have an influence on energy usage in this area.) Under the high growth scenario, SEM could result in annual savings of between 14 and 83 PJ.

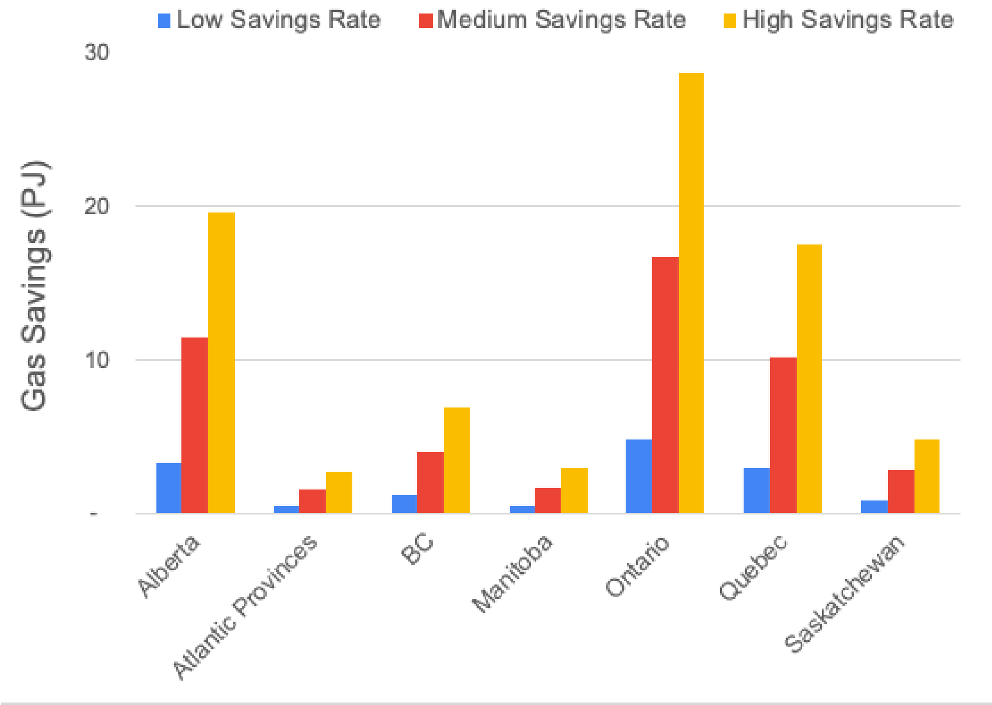

Figure 13. Economic Potential gas savings if 37.5% of industrial gas is consumed by facilities implementing SEM and low (5%), medium (17.5%), or high (30%) savings rates are achieved.

TECHNICAL POTENTIAL

The Technical Potential analysis demonstrates the entirety of the SEM impact opportunity. Although these outcomes are a long shot within the 2030 time frame, it showcases the magnitude of impact if programs catalyze extensive uptake of SEM and facilities implement a rigorous approach to systematically and continuously reduce energy use across all fuels. Prior estimates have assumed that SEM could be applied to 50% of industrial energy use. However, the research team has observed an extension of SEM programs to serve smaller industrial customers, and therefore we increased this technical potential to 75% of industrial energy use to align with targets set by the Generation Energy Council. Figure 14 shows the total forecast industrial energy use under SEM, by province.

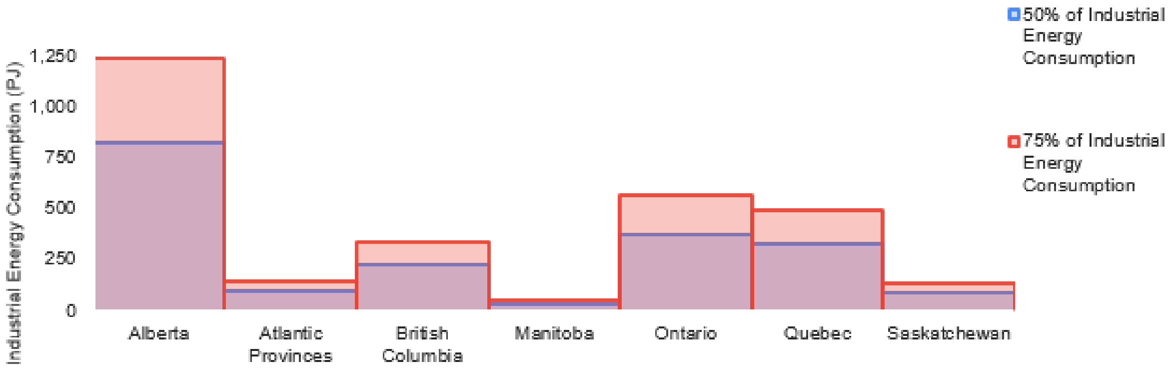

Figure 14. Total forecast industrial energy consumed by SEM participants for the Technical Potential scenario.

If 75% of industrial energy were consumed by facilities applying SEM and these facilities were able to achieve savings of 30% (our high savings assumption), energy consumption would be nearly 900 PJ lower than our 2030 forecast. This assumes that savings are uniform across provinces relative to total energy consumption. The application of this expanded SEM participation for all provinces and all three savings assumptions is shown in figure 15.

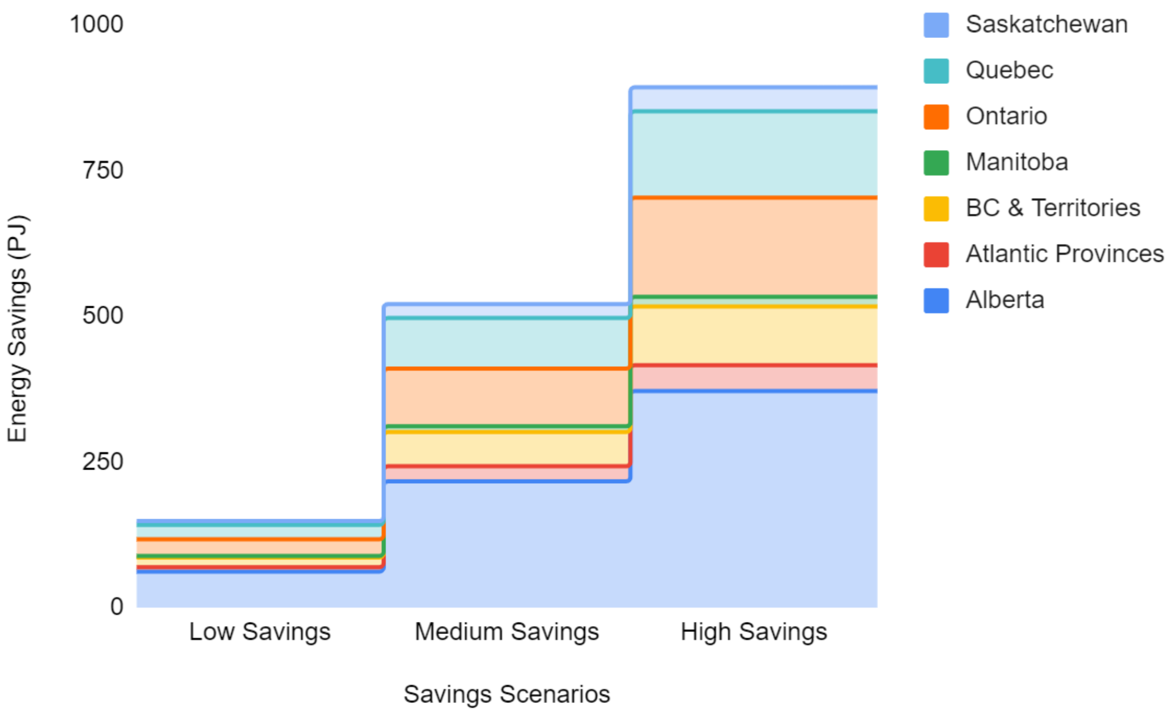

Figure 15. Energy savings by province in the 75% SEM energy consumption Technical Potential scenario

If these savings were applied equally across all fuel types, more than 60% of savings would come from gas and electricity use, as seen in figure 16, and would amount to 18.8% of Canada's 2018 industrial energy use.

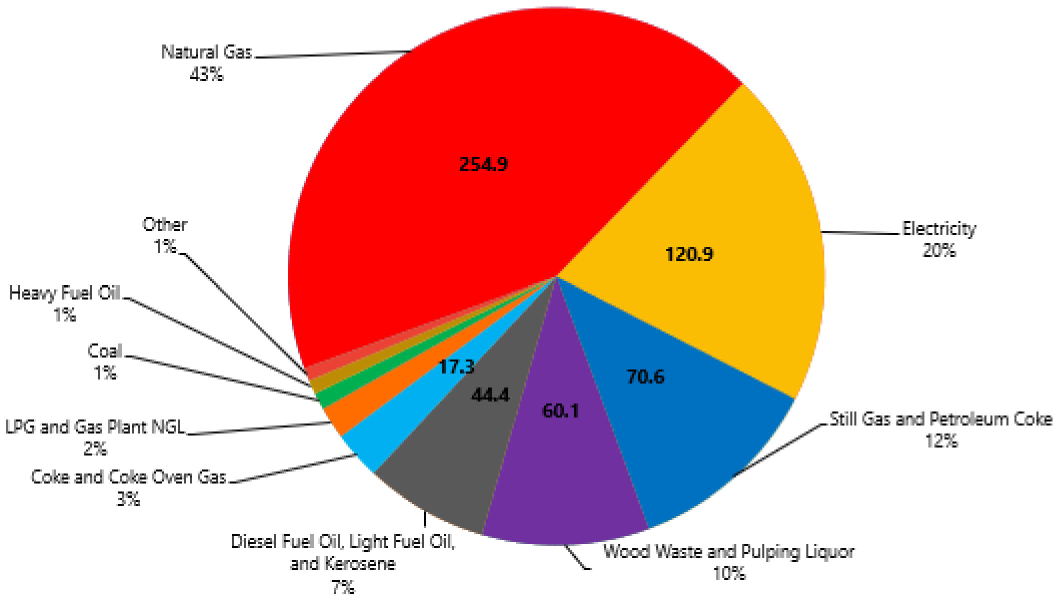

Figure 16. Energy savings (PJ) by fuel type if savings are applied equally across all fuels

Similar to the Economic Potential results, emission reductions for electricity and gas are greatest in provinces with high electricity emission factors as seen, in figure 17. Under the 75% uptake and high savings (30%) scenario, industrial electricity savings would reduce emissions by 8.6 Mt CO_2e. Gas savings could result in an emission reduction of 19.1 Mt CO_2e.

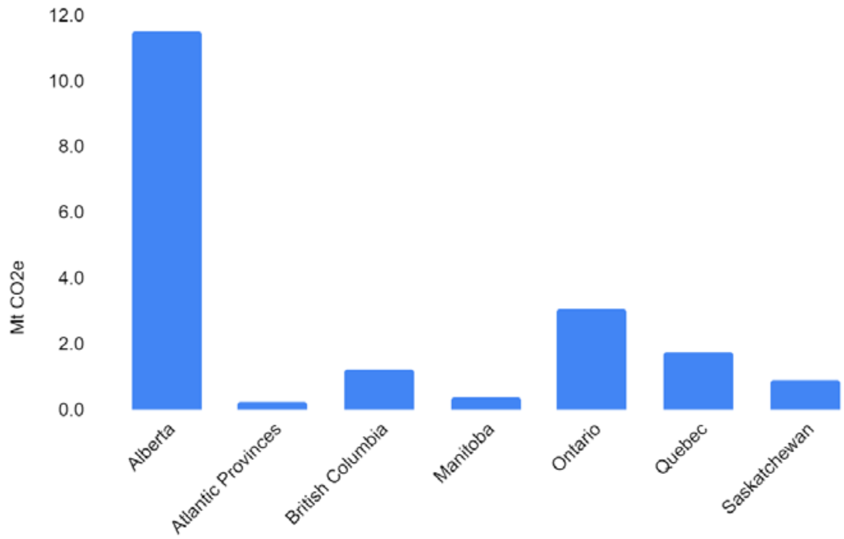

Figure 17. Emission reductions from electricity use by province under 75% energy consumption and 30% savings assumptions

Significant emission reductions can also result from lower consumption of still gas and petroleum coke; wood waste and pulping liquor; and diesel, light fuel oil, and kerosene, as seen in figure 18. Under this scenario, the additional savings would come to 19.4 Mt CO_2e. As previously noted, these reductions may not be economic or may require new, transformative processes to achieve.

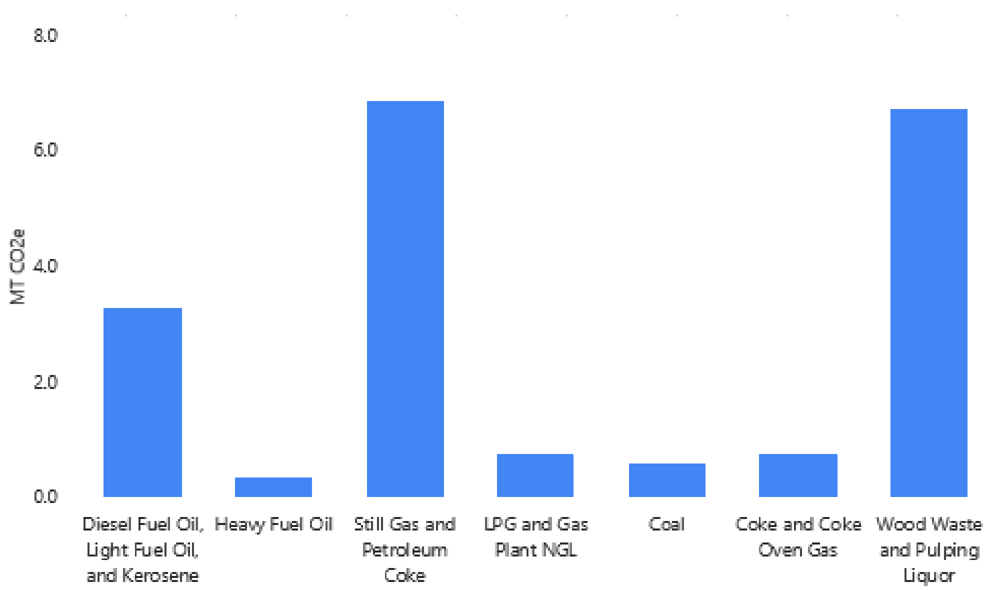

Figure 18. Emission reductions by fuel type (other than electricity and natural gas) under the 75% SEM energy consumption and 30% savings scenario

ENERGY AND EMISSIONS IMPACTS ACROSS CANADA (ALL SCENARIOS)

One impact that the research team was able to compare across all three analyses was the amount of electric power–related energy savings SEM can achieve annually. Table 7 shows the estimates for the Market Potential scenario, and table 8 does the same for the Economic and Technical Potential scenarios. (They are split into two tables as different methodologies were used, as described earlier and in Appendix B.) As previously noted, very high-level estimates have suggested that 117 PJ of energy could be saved in 2030 via implementation of energy management systems such as ISO 50001 (Natural Resources Canada 2018). The three scenarios show divergent outcomes, and there are multiple factors that contribute to this. The upper-end estimates are within range of the 117 PJ figure; however, even greater energy savings could be achieved in the Technical scenario with the assumption of 75% of industrial energy under SEM and with a savings rate of 30%, aligned with the Generation Energy Council's target of 75% for SEM.

Table 7. Summary of Market scenario energy savings impact estimates

Scenario	CAGR	Savings	2030 electricity savings (PJ)	2030 emission reductions (Mt CO_2e)
Market	5%	Low	0.4	0.02
Market	5%	Mid	0.7	0.04
Market	5%	High	1.2	0.07
Market	10%	Low	1.0	0.06
Market	10%	Mid	2.0	0.11
Market	10%	High	3.3	0.19
Market	15%	Low	1.9	0.11
Market	15%	Mid	4.0	0.23
Market	15%	High	6.7	0.38

Table 8. Summary of Economic and Technical scenario energy savings impact estimates

Scenario	% of energy under SEM in 2030	Savings rate	Electricity savings (PJ)	Gas savings (PJ)	All other fuel savings (PJ)	Total energy savings (PJ)
Economic	19.00%	5.0%	7.7	16.1	N/A	23.8
Economic	19.00%	17.5%	26.8	56.5	N/A	83.3
Economic	19.00%	30.0%	45.9	96.9	N/A	142.8
Economic	28.25%	5.0%	11.4	24.0	N/A	35.4
Economic	28.25%	17.5%	39.8	84.0	N/A	123.8
Economic	28.25%	30.0%	68.3	144.0	N/A	212.3
Economic	37.50%	5.0%	15.1	31.9	N/A	47.0
Economic	37.50%	17.5%	52.9	111.5	N/A	164.4
Economic	37.50%	30.0%	90.7	191.2	N/A	281.9
Technical	50.00%	5.0%	19.0	42.5	36.6	98.1
Technical	50.00%	17.5%	66.4	148.7	128.2	343.3
Technical	50.00%	30.0%	113.9	254.9	219.8	588.6
Technical	75.00%	5.0%	30.2	63.7	54.9	148.8
Technical	75.00%	17.5%	105.8	223.0	192.3	521.1
Technical	75.00%	30.0%	181.3	382.4	329.7	893.4

An estimate of electricity consumption by SEM program participants in the various provinces for different rates of growth in participation is shown in table 9.

Table 9. Percentage of 2030 forecast electricity consumed by SEM participants in the Market scenario, by province

	2030 energy consumption under SEM		
Province	Low growth: 5% CAGR	Mid growth: 10% CAGR	High growth: 15% CAGR
Alberta	18%	27%	40%
Atlantic provinces	12%	18%	27%

Province	2030 energy consumption under SEM Low growth: 5% CAGR	Mid growth: 10% CAGR	High growth: 15% CAGR
British Columbia and territories	24%	37%	55%
Manitoba	4%	7%	10%
Ontario	20%	31%	46%
Quebec	3%	5%	7%
Saskatchewan	4%	7%	10%
Total	11.7%	17.8%	26.5%

We also estimated the impact of the growth in SEM on CO_2e emissions. Results for the Market scenario can be found in table 7, above; results for the Economic and Technical scenarios are provided in table 10, below.

Table 10. Summary of emissions reduction potential for the Economic and Technical scenarios

Scenario	Energy under SEM in 2030	Energy savings	Reduction from electricity savings (Mt CO_2e)	Reduction from gas savings (Mt CO_2e)	Reduction from all other fuel savings (Mt CO_2e)	Total emissions reduction (Mt CO_2e)
Economic	19.00%	5.0%	0.4	0.4	N/A	0.8
Economic	19.00%	17.5%	1.3	1.4	N/A	2.7
Economic	19.00%	30.0%	2.2	2.4	N/A	4.6
Economic	28.25%	5.0%	0.5	0.6	N/A	1.1
Economic	28.25%	17.5%	1.9	2.0	N/A	3.9
Economic	28.25%	30.0%	3.2	3.5	N/A	6.7
Economic	37.50%	5.0%	0.7	0.8	N/A	1.5
Economic	37.50%	17.5%	2.5	2.7	N/A	5.2
Economic	37.50%	30.0%	4.3	4.6	N/A	8.9
Technical	50.00%	5.0%	0.9	1.0	3.2	5.1

Scenario	Energy under SEM in 2030	Energy savings	Reduction from electricity savings (Mt CO_2e)	Reduction from gas savings (Mt CO_2e)	Reduction from all other fuel savings (Mt CO_2e)	Total emissions reduction (Mt CO_2e)
Technical	50.00%	17.5%	3.1	3.6	11.3	18.0
Technical	50.00%	30.0%	5.4	6.2	19.4	31.0
Technical	75.00%	5.0%	1.4	1.5	4.8	7.7
Technical	75.00%	17.5%	5.0	5.4	16.9	27.3
Technical	75.00%	30.0%	8.6	9.3	29	46.9

Discussion

The analyses of impact potential demonstrate multiple pathways of assessment, using different approaches and assumptions and yielding wide-ranging outcomes. In this section, the research team explores connections and differences among the models, draws comparisons across the results, and identifies areas where additional research is required.

We expected that the emissions impact of the Market Potential scenario would be lower due to lower market penetration and savings rates. The low annual emissions impact is also attributable to the fact that not all participants are saving energy simultaneously in this scenario. This raises two questions: How can SEM programs reach more customers while maintaining their current SEM user base? And how can participants continuously generate incremental and persistent savings to maximize impacts? We explore these two questions in the next section.

How can growth be encouraged?

Utilities have been the driving force behind SEM growth in Canada to date. Program administrators are well suited to deliver these programs; they have the expertise and, just as important, have established relationships with their customers. While some Canadian utilities have had great success leveraging these relationships with SEM offerings, other utilities have not developed comprehensive energy management programs.

Figure 19 shows three strategies to grow the SEM market.

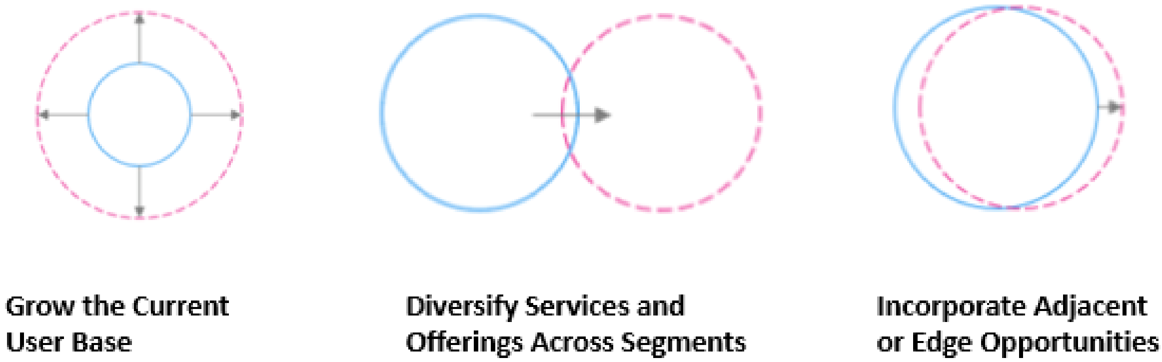

Figure 19. Types of market growth opportunities for SEM. Source: Hales 2020.

Growing the current user base. Utilities can enlarge the current base of SEM participants by engaging more participants for longer periods. Additional program growth can be encouraged within currently served segments by recognizing and rewarding participation, increasing the participation of dedicated energy managers in large companies, or increasing support for cohorts, for example.

Expanded SEM program designs could be used to increase the number of participants served. To give an oversimplified example, one program model could serve a cohort of participants for a discrete, short period while another provides one-on-one assistance to participants for a longer-term or open-ended period.

Reinforcing SEM practices of the current user base while reaching new participants is key to growth. The Energy Management Assessment Tool has been used to assess the self-sufficiency of a participant's energy management system (SEM Hub 2021). Additionally, programs may encourage participants to stay engaged with SEM through an alumni cohort or other means. There is limited experience assessing how long energy management practices persist, and thus there are large variances in the effective useful life that program administrators apply to energy savings, ranging from 1 year to more than 10 years.

Diversifying across sectors. In recent years, SEM programs have expanded to serve sectors other than industry. The commercial and institutional sectors have benefited from SEM, as has small and medium industry. Health care, education, and provincial governments have been identified as prime candidates for SEM. Continuing to diversify the user base across sectors will expand the impacts of SEM. Offerings may need to be tailored to the target user base. While large, energy-intensive industry may benefit from one-on-one engagement, smaller participants may be better suited for cohorts or a self-service approach.

Incorporating adjacent or edge opportunities. SEM serves as the foundation of a comprehensive energy management strategy, but there are other energy management programs that are adjacent to SEM. The two clearest cases are energy manager and EMIS programs, where efforts are made to improve internal energy management and energy data systems, respectively. These types of programs can evolve to include an SEM curriculum, or SEM can expand to include these services, as appropriate. Integrating an SEM curriculum into workforce development programs is another key strategy to leverage adjacent opportunities.

SEM expansion will not be uniform in Canada due to differences among provinces in industry makeup, goals, and other variables. Regardless, in order to expand and increase impact, program administrators will need to allocate funding to develop, operate, and enlarge SEM offerings. While some Canadian SEM programs have been successful and likely have the needed support from utility and provincial leaders to continue and expand their offerings, others may face obstacles. Continuity of SEM programs is important to maintaining relationships with participants and keeping their trust; loss of funding can stunt growth. Policies and incentives for administrators and their customers may enable persistent and accelerated growth in participation.

How can impacts grow and persist?

With scarce resources and competing priorities, there are a multitude of challenges to overcome to reach the technical potential identified in this report. Governments can help overcome these challenges and provide additional support to increase program impacts.

One challenge is that utility programs tend to focus on generating energy savings from the energy source(s) they sell: An electric utility will focus on electricity savings, a gas utility will focus on gas savings. Utilities should work together to reduce energy use from all energy sources in SEM. For example, in British Columbia, Fortis BC has started to leverage BC Hydro's SEM program to identify candidates for its own SEM program. This type of joint program is a good start but may overlook other opportunities. Additionally, there is no mandate or financial incentive for utilities to reduce their participants' on-site energy use.

Ratepayer-funded SEM programs also target the fuel sources that are sold by the program administrator. However, SEM in theory could help reduce usage of other fuel types. In the Market and Economic Potential scenarios, energy savings were limited to just electricity or electricity and gas, the energy sources that are targeted and reported by the majority of ratepayer-funded SEM programs. Our Technical Potential estimate includes energy savings across all fuels, many of which have higher carbon intensity. Hence, a way to grow impacts would be to leverage SEM programs across all fuel types.

Utilities offer a diverse set of energy efficiency programs, and energy savings are siloed according to the program implemented. In many cases SEM participants take advantage of multiple offerings; in fact, SEM has been shown to increase participation in other utility programs. However, energy savings from capital projects that are undertaken during SEM engagement are usually credited not to the SEM program but to a prescriptive or custom program. Government SEM programs, such as Superior Energy Performance in the United States, credit all energy savings achieved by a participant to the program. While Canada is working on a national SEM savings methodology guide, reported impacts may differ depending on who is measuring them. To grow the impact of SEM programs, credit for savings achieved by capital projects could be allocated to the SEM programs in a consistent way.

A government emphasis on carbon reductions can reinforce the focus of utility SEM programs. For example, the primary focus of the Government of Alberta's SEM program is to reduce emissions. From program design through evaluation, emissions are front and center. This highlights an important role that the government can play to support emission reductions from SEM programs.

Policy Drivers and Enablers

There are numerous policies that have driven trends in energy management. The strength of these drivers has been increasing as governments strive to meet commitments for GHG reductions, including the Paris Accord. This has led to federal and provincial carbon pricing, GHG reduction targets, and transitions to lower-carbon energy sources. The ability of energy management to deliver a multitude of both energy and nonenergy benefits (such as better productivity, lower maintenance costs, enhanced safety and health, job creation, increased competitiveness, and workforce upskilling) has led to growth in the general energy management area. The COVID-19 pandemic caused a slowdown in energy management adoption, but this approach is poised to be a key strategy for delivering cost savings, creating jobs, and reducing GHG emissions as Canada recovers. In addition to initial energy savings, energy management activities could help build momentum for other industrial decarbonization projects (e.g., SEM enhances EE capital projects and other decarbonization initiatives such as electrification/fuel switching).

In late 2016, Canada announced the Pan-Canadian Framework on Clean Growth and Climate Change with carbon pricing as a main pillar. The framework required provinces either to have a carbon pricing program in place by 2019 or to rely on the existing federal program instead (Environment and Climate Change Canada 2021). The federal carbon tax in Canada (used in Alberta, Manitoba, Ontario, Saskatchewan, and partially in Nunavut and the Yukon Territory) is slated to increase by $10/ton to $50/ton in 2022, then by $15/year until it reaches $170/ton in 2030 (Energyhub.org 2021). This adds significant impetus and value for energy management. Yet, to achieve long-term, deep carbon reduction goals, carbon pricing will need to be complemented by other approaches (Nadel, Geade, and Haley 2021). The approach used for carbon pricing varies across the provinces, as shown in figure 20. The varied nature of the pricing mechanism, approaches, and programs in the provinces may require some adjustment in energy management approaches, incentives, program offerings, etc. from one province to the next.

Figure 20. Variation in provincial carbon pricing. Reprinted from C2ES 2020.

Additionally, Canada has signaled its intent to phase out traditional coal-fired electricity by 2030 (Natural Resources Canada 2021). This action and others that lower the emission intensity of the electric grid have two major effects on energy management: smaller emission reductions from electricity savings and more opportunities for beneficial electrification. Although electricity savings may not result in as much carbon avoidance, they are critically important to offset demand growth and can help meet energy efficiency resource standards or other, similar policies. As energy management becomes increasingly tied to decarbonization efforts, identifying fuel-switching opportunities and capital projects may become more integrated with SEM practice.

To meet the federal government's Generation Energy Council recommendation that 75% of industrial energy use benefit from energy management by 2030, Canada will need a suite of policies and programs to increase participation. There are several policy enablers that can be used to lower barriers, stimulate increased participation, and grow the impact of energy management programs. The policy levers can be broadly grouped into five categories, as shown in table 11.

Table 11. Potential policy enablers and their areas of focus

Type	Focus
Economic instruments	Direct investment Fiscal/financial incentives Market-based instruments
Information and education	Advice/aid in implementation Information provision Performance labeling Professional training and qualification
Research, development, and deployment	Demonstration projects Research programs
Policy support	Institutional policies Strategic planning
Regulatory instruments	Auditing Codes and standards Monitoring Obligation schemes Other mandatory requirements

As policymakers consider the various policy tools available to drive the uptake of SEM, there will be varying levels of acceptance for different policy types. This will influence what, how, and at what level of funding policy instruments are implemented. It is likely that higher levels of funding and rigor will result in faster growth and more emission reductions.

To support energy management, Natural Resources Canada provides a suite of tools and programs, such as an Energy Savings Toolbox and an EMIS Planning Manual and Tool. A recent NRCan offering, the Energy Manager Program, provided $3.1 million CAD across four provinces from 2019 to 2020. Cost sharing was available for activities including hiring energy managers and conducting assessments. The program was quickly oversubscribed, demonstrating that there is strong market interest in SEM and that more funding is needed to meet the demand.

The Canadian Industry Partnership for Energy Conservation (CIPEC) is a voluntary national network of industrial companies, trade associations, and allies established in 1975 to improve industrial energy efficiency and administered by NRCan. The "leaders" in the CIPEC program receive cost-sharing benefits for implementing ISO 50001 and EMIS, recognition through ENERGY STAR®, and other benefits.

Some provincial governments have also positioned themselves to support SEM. In addition to forming partnerships with NRCan to administer SEM programs, they are offering incentives to help spur adoption of SEM. For example, Energy Transition Quebec provides financial support to facilities in Quebec for energy management, including funding for energy managers and ISO 50001 training. From 2015 to 2020, the British Columbia Ministry of Energy and Mines provided funding on top of NRCan's industrial energy management program incentives.

Other policies and programs that support energy management in Canada can be found in Appendix D.

Summary and Recommendations

This study shows that SEM has great potential to reduce energy use and GHG emissions in Canada. These impacts can be realized by growing the participation rate of SEM across more industrial and other segments and by increasing the effectiveness and persistence of SEM practices. While some provinces have demonstrated success with SEM, there is much more that can be done to grow the SEM user base and drive greater impacts across Canada. For instance:

Utilities that have not yet coalesced their energy management programs around SEM program design should do so rapidly to build a foundation of continual energy improvement practices at participant sites within their service territory.

SEM programs could integrate on-site energy managers or provide more individual attention at their largest sites and EMIS for technically advanced participants.

A cohort approach could be promoted for industrial clusters, and innovative light-touch, virtual, or self-serve designs can be offered to reduce time and travel.

Throughout, SEM practices could expand into the commercial and institutional sectors, as is done in some provinces already.

A concerted effort could be made to reduce emissions by focusing on decreased use of fuels with high carbon emissions intensity.

Rapid advancement in the uptake and impact of SEM in Canada will require policies that support SEM programs and lasting participant engagement. A step change to current funding levels will be needed to launch SEM initiatives across the country, as will a concerted effort to engage the largest facilities. This will have an outsize effect as the top 10% of industrial facilities can account for as much as 50% of the sector's total energy use. Information collection and savings validation will be needed to ensure programs are meeting expected outcomes.

There are multiple routes for accelerating the impact of SEM programs, tailoring approaches to the needs of provinces, and providing enabling policy support. More detailed recommendations are listed below.

<u>Improve availability, transparency, and consistency of information on SEM impact and practices.</u>

Improve information collection and transparency of facility-level energy consumption.

Integrate energy use with the CAN GHGRP database.

Encourage uniform reporting of SEM program data and impacts.

Highlight and reward practices among SEM programs that drive energy and GHG reductions (e.g., offer incentives to utilities and participants for energy/GHG reductions above a certain level via a standardized method of quantifying SEM savings).

Provide support for training on SEM programs and best practices, and a develop a performance label for programs that excel.

<u>Promote collaboration.</u>

Establish federal government leadership in supporting participants and utilities to maximize SEM growth and impact. Some possible options include:

Provide funding to expand utility SEM program offerings to serve more and new customer segments.

Integrate ISO 50001, 50001-Ready, and EMIS with SEM.

Standardize SEM savings reporting methods to also be able to capture CO_2 benefits in a consistent manner.

Establish a national roundtable on energy management to encourage a conversation among utilities and provinces regarding the role of energy management and energy management programs in accelerating CO_2 reduction.

Offer separate government programs in areas where SEM is not being practiced.

Advance SEM though supply chains.

Provide support for SEM facilitators across entities to leverage growth opportunities for:

- Industrial clusters
- Small to medium-size manufacturers in a region
- Provinces aiming to start SEM programs

Prompt shared learning across sectors (industrial, residential, commercial, etc.).

<u>Provide incentives and motivation.</u>

Offer special incentives for utilities and/or participating companies that that attain high levels of SEM practice and performance (impact), through:

- Special financing options for energy efficiency measures and capital expenditures
- Deferment of, or discount on, carbon tax
- Support for companies that implement and maintain ISO 50001 or 50001-Ready certification

<u>Promote strategic planning and implementation.</u>

Target the 10% of industrial companies that together consume more than 50% of the energy across Canada to implement and maintain SEM practices.

Increase government funding assistance to SEM programs at levels much higher than current levels to spur adoption (10x is suggested, but we did not perform a rigorous analysis of the relationship between program funding and SEM impact).

Incorporate SEM into strategic planning for utilities, provinces, and the nation as a whole, establishing a precedence for energy management first.

Develop a strategy to tailor policy support for provinces to their needs and level of progress with SEM, and move policy offerings toward an aggressive approach, as appropriate, to accelerate progress.

SEM provides a foundation to continually improve all aspects of energy management for multiple stakeholders. While some provinces have demonstrated success with SEM, there is still a large growth opportunity in industry and beyond. This research has explored how to achieve the highest levels of adoption, energy savings, and carbon reductions. At a minimum, a deeper understanding of the effectiveness of policy levers to increase SEM participation and performance is needed to inform decision making.

Additionally, an assessment of carbon accounting methodologies used to determine program level impacts may provide a basis for expanded and better accounting practices. More granular research on the potential impacts of SEM for the various fuel sources and industries could help uncover high-impact areas and improve resource planning. The potential exists for SEM to generate significant and lasting energy savings and emission reduction, but more work is needed to achieve it.

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Appendix A. Market Potential Analysis Methodology

Initial Participation

The research team used available information and personal communications to establish a starting level of industrial participation in SEM. Participant counts were developed as they were reported; however, there is likely to have been inconsistency in how these programs reported this information (e.g., utilities may report participants at the account, customer, or facility level). It is unclear if participant counts included multiple facilities, or how many. Additionally, it is possible that facilities were double counted if they participated in multiple energy management programs. The research team acknowledges the high level of uncertainty within the estimates of participation.

SEM was not offered in all provinces at the time of this study; in those cases, the research team applied participant counts from similar energy management programs. This assumes that SEM programs will achieve uptake rates similar to those of other energy management programs. Estimates of starting energy management participants are shown in table A1.

Table A1. Estimates of energy management program participants, by province

Province	Total starting participants
Alberta	80
Atlantic provinces	21
British Columbia and territories	101
Manitoba	4
Ontario	136
Quebec	41
Saskatchewan	8

Compound Annual Growth Rate

As new SEM programs are offered, and programs expand to serve more participants, market growth can accelerate rapidly. However, as programs mature and the proportion of the untapped market diminishes, it is likely that growth rates will slow. The ISO 50001 Impact Estimator Tool (IET), which demonstrated the impacts of ISO 50001 on a global scale, used a logarithmic function to model this phenomenon. The s-curve type market growth can be seen in figure A1.

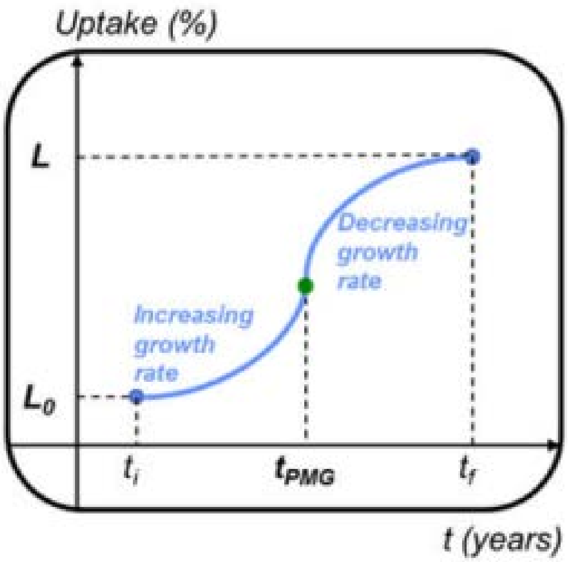

Figure A1. Logistic model used in the IET to estimate global impacts from ISO 50001. Source: Therkelsen, Aghajanzadeh, and McKane 2016.

This particular tool was not used in this study due to a lack of granularity in assessing impacts at the provincial level. Because of the low penetration of SEM in Canada to date, the research team used instead a compound annual growth rate through 2030, as shown in this equation:

$$\text{CAGR} = \left(\frac{V_{\text{final}}}{V_{\text{begin}}}\right)^{1/t} - 1$$

For each SEM program, we estimated a high growth rate and a low growth rate via two methods: using program start dates and the number of unique facilities served (where data were available), and using growth rates provided by program administrators during interviews (where data were not sufficient to estimate growth rates). The administrator-reported rates were not separately validated, but they helped provide additional context to build out our assumptions. The growth rates of individual programs can be seen below in Table A2.

Table A2. Growth rate estimates for Canadian energy management programs

Interviews	Historical through 2020	Projected	Current unique (2020)	Total unique by 2030	Low end over 10 years	High end over 10 years
Efficiency Nova Scotia —SEM	Program launch 2015, 18 unique customers (3.6/year)	Adding about 1 or 2 new participants/year	18	28–54	4.52%	11.61%
Hydro Quebec—EMS	Program launch 2015, 25 unique customers (5/year)	Projected to add 4 participants/ year	25	65–75	10.03%	11.61%
Energir (gas) —SEM		Adding 9 participants/year	10	100		25.89%
NB Power—EMIS	Program launch 2017, 5 participants in 2020 (1.67/year)		5	15–25	11.61%	17.46%
Program data						
Government of Alberta	2-year engagements assuming the same level of participation		53	265		17.46%
BC Hydro	Program launch 2016, 116 unique customers in 2020	29 customers/year	67	357	14.71%	18.21%

The research team determined that three growth rate scenarios were appropriate for this bottom-up analysis based on the range of growth rates, shown in table A3.

It should be noted that program design will impact growth rates. For example, growth rates may differ for a cohort program designed to run for two years and an SEM program designed for individual attention and longer-term engagements. Additionally, there may be resource constraints that limit how many facilities participate in each program. The compound annual growth rates are applied to each province's initial facility count through 2030. This variable will affect impacts as energy savings and emissions are derived from the number of facilities.

Distribution of Facility Energy Consumption

To estimate gross energy savings, the research team needed to consider the size of facilities that could be served by SEM through 2030. Because there is no publicly available information on the distribution of facility-level energy consumption in Canada, the research team relied on prior research and conversations with program administrators to determine such a distribution. SEM was originally designed to serve the largest industrial facilities; early program success has encouraged administrators to extend SEM offerings to small and medium-size industrial facilities as well as large commercial segments. Because the established SEM programs focus primarily on industry and have minimum energy consumption (or similar) requirements, the research team focused primarily on large industrial facilities, using the classification scheme outlined in table A4.

Table A4. Selected energy consumption thresholds and average facility consumption values applied to participants

Classification	Small	Medium	Large	Very large
Consumption range (GWh/year)	<25	25–100	100–500	>500
Average facility consumption (GWh/Year)	12.5	60	300	500

The research team assumed a right-skewed distribution of facility energy consumption, as seen in figure A2. It has been noted that small and medium-size manufacturers make up 90% of industrial establishments but account for only 50% of the sector's energy use (York et al. 2015). Most industrial participants will fall into the small classification.

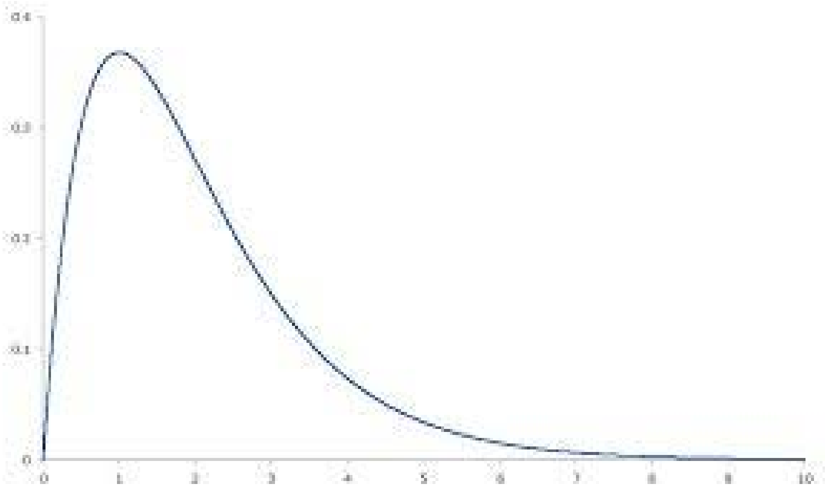

Figure A2. Right-skewed distribution

While there is wide variation in industry sectors, targeted customers, and average facility size across provinces and programs, the research team assumed the distribution of participants by energy consumption shown in table A5.

Table A5. Energy consumption distribution of participants

Classification	Small	Medium	Large	Very large
Distribution	65%	30%	4%	1%

ENERGY SAVINGS

To estimate the impacts of various growth rates, the research team needed to understand the performance of SEM programs. While many programs release annual reports with gross energy savings, those numbers fail to provide insight into the percentage of load that facilities save, on average, via their SEM programs. Further, some SEM program savings include capital project savings, while others include only the savings that come from operational, maintenance, and behavioral (OMB) measures. Our estimates were designed to be conservative and exclude capital savings; however, we acknowledge that SEM has been shown to spur an increase in capital projects, leading to additional energy savings. Estimates of annual energy savings for Canadian energy management programs are shown in table A6.

Table A6. Participants’ average annual energy savings, per research and interviews

Program administrator	Expected annual energy savings
Hydro Quebec	1% per year

Program administrator	Expected annual energy savings
Efficiency Nova Scotia	Average of 3–4% in first year, 1–2% in subsequent years
GOA/CLEAResult (electric)	5% (2-year program)
Program data	
NB Power—EMIS	3–5%
Energir (gas)	1% per year
GOA/CLEAResult (gas)	6.7% (2-year program)
Union Gas	4–8%

The goal of SEM is to enable facilities to implement a continual improvement approach to energy management. This means that energy savings will occur not all at once but over time. Program design may also play a role in when energy savings occur; a short-term program may be more aggressive in securing first-year savings, whereas a long-term program may seek a steadier approach. The bottom-up model employs a conservative assumption of three years of incremental savings. This period is analogous to the required performance period for SEP 50001 certification before recertification is required (DOE 2021a).

On the basis of personal communications and SEM program energy savings estimates, the research team developed three energy savings scenarios, as shown in table A7.

Table A7. Energy savings scenarios applied in the model

Market Potential savings scenarios	Savings, year 1	Incremental savings, year 2	Incremental savings, year 3
Low savings	1%	1%	1%
Medium savings	3%	2%	1%
High savings	5%	3%	2%

Savings Persistence

Because SEM programs focus on operational, maintenance, and behavioral change, estimating how long energy savings will last can be difficult. SEM programs strive to ingrain energy management practices into company culture, so they survive employee turnover; however, the savings are dependent on people and their actions. How well companies adopt these energy management practices is likely to impact how long energy savings persist. The measure life of SEM savings has been observed to range from 1 to 10-plus years, depending on the program. Since longer measure life tends to coincide with programs that include capital savings, we selected a conservative effective useful life (EUL) of three years for the model. Support for the assumption a three-year useful life is supported by persistence values applied by Canadian SEM programs (table A8) and in recent work examining EUL for SEM programs in North America (Therkelsen et al. 2021).

Table A8. Energy savings persistence values applied by Canadian SEM programs

Program administrator	Persistence (years)
BC Hydro SEM cohort	1 or 5
Efficiency Nova Scotia—SEM	Persistence lasts for length of program with a 50% decay rate post-engagement. Average length of engagement is 2–3 years
Efficiency Nova Scotia—EMIS	3
Hydro Quebec—EMS	10
Government of Alberta	5

Because the results include savings only from facilities participating in SEM post-2021, projected energy savings ramp up in the first few years, as seen in figure A3. This is due to incremental savings in subsequent years, the persistence of energy savings, and savings generated from new participants.

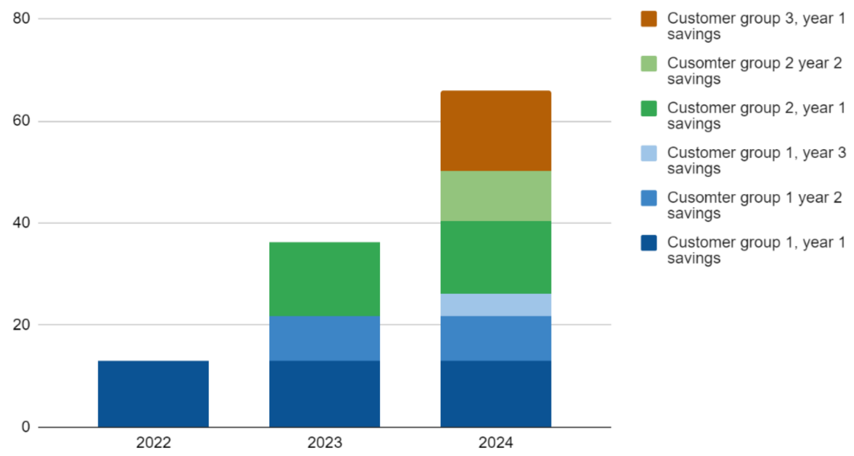

Figure A3. Visualization of the first three years of energy savings demonstrating incremental savings and persistence

Appendix B. Economic Potential Analysis Methodology

Energy Consumption Forecast

The Economic Potential scenario forecasts 2030 energy usage on the basis of assumptions used in the reference case for industrial end-use demand in the *Canada's Energy Future 2020* report, which suggested a 0.5% annual growth rate. Historical data from the Comprehensive Energy Use Database, which includes data up to 2018, served as the basis for the forecast. This model assumes that growth will be steady across the years leading up to and including 2030 and uniform across all provinces.

Demand Participation

On the basis of prior ACEEE research, we estimated that about 50% of industrial energy consumption could be covered by SEM and that by 2030 participation could reach 38–75% of that load. For the Economic Potential scenario, we relied on this information to estimate the amount of industrial demand that could be under SEM practices by 2030, shown in table B1.

Table B1. Three participation scenarios

Economic Potential growth scenario	Industrial consumption under SEM
Low growth	19%
Mid growth	28.25%
High growth	37.5%

Energy Savings

While energy savings in the Market Potential analysis were informed by program data and insights from Canadian SEM program administrators, the energy savings rate estimates in the Economic Potential scenario were expanded to include assessments from other sources of information. For example, ISO 50001 has been estimated to reduce energy consumption by 5–30%. (Lazarte 2016). These estimates include capital savings generated from SEM participation. Although not all utilities attribute capital savings to SEM, SEM participants have been observed to implement more capital projects than non-SEM participants. Canadian energy efficiency reports have also alluded to the potential of energy management to save up to 30% of industrial energy use (Natural Resources Canada 2018). Over the course of 10 years, this averages out to 3% per year, a goal of the Three Percent Club, which Canada joined in 2020 (The Energy Mix 2020). Energy savings for the Economic Potential (table B2) are more aggressive than for the Market Potential study to demonstrate the upper boundaries of energy savings that may be achieved by reaching greater levels of participation.

Table B2. Energy savings rate applied to each economic scenario

Economic Potential savings scenario	Cumulative savings
Low savings	5%
Medium savings	17.5%
High Saving	30%

Emission Reductions

To estimate emission reduction impacts, the research team applied the emission factors found in table 1 of the main report, fuel sources, and other factors. In some regions of Canada, hydropower makes up a large portion of electricity generation, resulting in low emission factors.

Table B3. Indirect emission factors for electricity consumption, by province[5]

Province	CO_{2eq} Emissions (kg/MBtu)	CO_{2eq} Emissions (g/kWh)
Alberta	231.54	790.0
British-Columbia	2.99	10.2
Manitoba	0.56	1.9
New Brunswick	76.20	260.0
Newfoundland and Labrador	11.72	40.0
Northwest Territories	46.89	160.0
Nova Scotia	213.95	730.0
Nunavut	222.74	760.0
Ontario	5.86	20.0
Prince Edward Island	76.20	260.0
Quebec	0.41	1.4
Saskatchewan	211.02	720.0
Yukon	16.41	56.0
National Average	**41.03**	**140.0**

The emission factors for natural gas are not as variable across provinces but tend to differ most according to the application or use of the fuel. The reported emission factors for natural gas can be seen in table B4.

[5] www.nrcan.gc.ca/science-data/data-analysis/energy-data-analysis/energy-facts/energy-and-greenhouse-gas-emissions-ghgs/20063.

Table B4. Emission factors for natural gas consumption, by province[1]

Province	CO_{2eq} Emissions (kg/MBtu)	CO_{2eq} Emissions (g/m^3)
Alberta	53.24	1,939
British-Columbia	53.19	1,937
Manitoba	52.09	1,897
New Brunswick	52.50	1,912
Newfoundland and Labrador	52.50	1,912
Northwest Territories	52.50	1,912
Nova Scotia	52.50	1,912
Nunavut	52.50	1,912
Ontario	52.14	1,899
Prince Edward Island	52.50	1,912
Quebec	52.12	1,898
Saskatchewan	50.53	1,840
Yukon	52.50	1,912

Table B5. Emission factors for other fuels[2]

Fuels	Emissions factor
Wood fuel/waste	1,715 g/kg
Coke oven gas	687 g/m^3
Coke	1,912 g/kg
Coal	2,200 kg/Mt
LPG and NGL	1,515 g/L CO_2e
Still gas, petcoke	1,797-3,761 g/L
Heavy fuel oil	3,156 g/L
Diesel	2,681 g/L

[1] www.nrcan.gc.ca/science-data/data-analysis/energy-data-analysis/energy-facts/energy-and-greenhouse-gas-emissions-ghgs/20063.

[2] data.ec.gc.ca/data/substances/monitor/canada-s-official-greenhouse-gas-inventory/Emission_Factors.pdf.

Appendix C. Technical Potential Analysis Methodology

Energy Consumption Forecast

The Technical Potential analysis uses the same forecast method as that used for the Economic Potential analysis.

Demand Participation

The Technical Potential scenario assumes the ability to reach the highest levels of participation suggested in past research. This includes the 50%-of-industrial-demand target from past ACEEE estimates and expands to up to 75% of industrial load indicated as a target for 2030 by the Generation Energy Council (Natural Resources Canada 2018a).

Energy Savings

Energy savings rates (table C1) are the same as for the Economic Potential analysis; however, the savings in this section go beyond electric and gas savings and assume that a facility can meet various levels of energy savings distributed equally across all fuels. The research team acknowledges that SEM measure opportunities may not be equal across all fuel types and that some SEM measures may not be applicable to all of a facility's energy consumption, including some industrial processes. However, if emphasis is placed on reducing carbon emissions, SEM efforts may target fuels other than electricity and gas.

Table C1. Energy savings rates applied to the Technical Potential scenario

Technical Potential savings scenario	Cumulative savings
Low savings	5%
Medium savings	17.5%
High savings	30%

Emission Reductions

In order to estimate the emission reduction impacts, the research team applied the emission factors found in tables 1, 2, and 3 of the main report to the respective energy savings calculation.

Appendix D. SEM Program Offerings

Table D1. SEM program offerings in Canada

Province	Program administrator	Program name, launch year, and segment served*	Customer requirements	Program description	Program duration	Program performance	Program costs in CAD (incentives)
British Columbia	BC Hydro	Strategic Energy Management—Industrial Cohort, 2016 Industrial	Energy consumption of 4–20 GWh/year, online access to facility electricity use data	• Intended to build SEM at customer sites that are not large enough to support a dedicated industrial energy manager. • Goals include knowledge sharing; translating insights into changes by using a customer's data; continuous, systematic improvements; identification through operational models.	2 years		Performance payment of $0.02 per kilowatt-hour based on verified energy savings at the end of the program (to a maximum of $5,000). An additional $2,000 will be available for achieving specific milestone targets.

Province	Program administrator	Program name, launch year, and segment served*	Customer requirements	Program description	Program duration	Program performance	Program costs in CAD (incentives)
Alberta	Government of Alberta	SEM cohorts, 2018 Industrial, commercial, and institutional	5,000–100,000 GHG tons	• Tailored improvements for high energy users. Delivered in cohort-structured working groups of participants based on geographical location, along with on-site. • Takes place over two years, includes an alumni cohort designed to enable continuation of SEM.	2 years	48,762 GHG tons saved in year 1. Cost of savings: $3/GHG ton. Energy savings approx. 3–5% annually with little to no capital investment.	
Alberta	Government of Alberta	SEM—Large Final Emitters, 2019 Industrial	Greater than 100,000 GHG tons		2 years	320,000 GHG tons saved in year 1.	

Province	Program administrator	Program name, launch year, and segment served*	Customer requirements	Program description	Program duration	Program performance	Program costs in CAD (incentives)
Nova Scotia	Efficiency Nova Scotia	SEM, 2014 Industrial and institutional	Minimum of 15 GWh in electricity use annually	• Structured approach to identifying, prioritizing, and completing energy-saving actions. • Provides participants with mapping, assessments, monitoring, reporting tools. • Provides employee training and organizational support.	1 year, with 2nd-year option	2 GWh saved in 2019, 7.3 GWh lifetime net energy savings, 0.3 GWh incremental annual net demand savings.	Investment: $0.5 million, first year unit cost: $0.180/kWh, lifetime unit cost: 0.062/kWh

Province	Program administrator	Program name, launch year, and segment served*	Customer requirements	Program description	Program duration	Program performance	Program costs in CAD (incentives)
Quebec	Hydro Quebec	Electricity Management Systems Program, 2015 Large industrial	Minimum annual spend of $750,000 or more	• Offer is limited to the biggest industrial customers. Hydro Quebec presents opportunity, business case analysis. • Provides technical resources, cost sharing and energy monitoring equipment.	5 years formalized by contract		a. Business Plan: 50% of eligible costs (max. $25,000) b. EMS, flexible inventive envelope, over a 5-year period i. EMIS: 50% of eligible costs (max. $75,000) ii. EMS: 50% of eligible costs (max. $75,000) iii. Conditional upon eligible energy efficiency measure implementation, a further 1¢/kWh in eligible annual savings may be added ea. year (up to a max. of 5¢/kWh).

Province	Program administrator	Program name, launch year, and segment served*	Customer requirements	Program description	Program duration	Program performance	Program costs in CAD (incentives)
Quebec	Transition Énergétique Québec (TEQ)	Energy Management Program, 2015		• Provides funding for different stages of an EnMS: energy audits, hiring an energy manager, and providing training on ISO-50001.			Hiring an energy manager: $10,000 Training on energy management and ISO 50001: $50,000 Support and advisory services from external specialists for implementation of the system, audits by third parties, and certification by an accredited certification body: $100,000 Acquisition of measuring equipment, probes, and programming: $150,000
Saskatchewan	Sask Power	Energy Management—Energy management plan, 2012 Industrial	1 MW and above		Continuous		

Province	Program administrator	Program name, launch year, and segment served*	Customer requirements	Program description	Program duration	Program performance	Program costs in CAD (incentives)
British Columbia	Fortis BC	Cohort, 2019 Large and medium industrial	Available to BC Hydro Industrial Cohort participants	• Provides energy analytics, energy expertise, technical assistance, industry collaboration, cohort support. • Includes pay-for-performance for verified savings or for milestones. • Supplementary offer to SEM program offerings by BC Hydro.			
British Columbia	Fortis BC	Individual, 2019 Large and medium industrial	Available to BC Hydro Industrial Cohort participants			25,450 GJ incremental actual annual gas savings in 2019	$263,000 in utility expenditures for incentives, $8,000 in administration, $4,000 in labor

Province	Program administrator	Program name, launch year, and segment served*	Customer requirements	Program description	Program duration	Program performance	Program costs in CAD (incentives)
Manitoba	Efficiency Manitoba	Strategic Energy Management Cohort, 2020 Commercial, industrial, and agricultural	Annual energy consumption of 4–50 GWh	• Provides support and incentives. • Cohort approach, customers commit staff part time to energy management activities over engagement. • Services include energy coaching, energy map, energy management assessments, group workshops, training, webinars, energy modeling, technical assistance, building walkthroughs, energy audits, and networking.	3 years		2022–23: $30,476.00, TRC ratio: 1.1
Quebec	Energir	Energy Management Systems—Pilot, 2020 Industrial	2 million m^3 natural gas consumption annually		4–5 years		50% diagnosis, 50% implementation, 50% cost of EMS, payment on incremental savings

***The start year for the program is provided with the best information available.**

Appendix E. Policy Enabler Analysis

At the federal level in Canada, we analyzed the federal carbon tax, the federal Baseline and Credit System, the federal Greenhouse Gas Offset System, the former Energy Manager Program, the Canadian Industry Partnership for Energy Conservation (CIPEC), and other NRCan tools. Each of these programs and its parameters not only provide information and insight into Canadian industry, eligibility threshold assumptions for large customers, and both former and existing methods for approaching energy management, but also demonstrate the potential for SEM to deliver additional, cost-effective savings in Canada. We captured this information primarily from NRCan resources and the government of Canada's official website. At the provincial level in Canada, we looked at existing enabling policies that could further the need for SEM practices, such as Alberta's 2021 mandate that industrial emitters reduce their emissions by a minimum of 1% annually, as well as eligibility thresholds for large industrials. We found this information on provincial government websites.

Internationally, we captured SEM and energy management practices from the European Union, the United States, Asia, and elsewhere. We found many successful policies and programs that enable meaningful industrial savings. Offering technical and financial assistance for hiring energy managers, conducting energy audits, and implementing energy management are significant components of many countries' commitments to reaching GHG reduction goals in the industrial sector. Voluntary programs and training programs, like the New York State Energy Research and Development Authority's SEM on Demand and North Carolina's Environmental Stewardship Initiative, are other methods that we found by which the financial burdens of energy management can be eased, and workforce transitions can be accommodated.

SEM-enabling policies in Canada and internationally are summarized in table E1.

Table E1. Policy enablers for energy management across multiple geographic areas

Canada	Outside Canada or trans-boundary
Energy Manager Program (2019–2020) in Ontario, Saskatchewan, Manitoba, and New Brunswick, provided support (up to 75% of total project costs, up to $100,000/organization) for energy managers and energy assessments, using proceeds from federal carbon tax.[11]	China's Top 10,000 Program drives uptake of energy management systems by setting mandatory intensity goals for large industrials, establishing requirements to implement energy management, and developing a Chinese-specific national energy management standard.[12]
Canadian Industry Partnership for Energy Conservation (CIPEC) expands peer-to-peer sharing among facility managers, access to cost-shared assistance for energy management projects, recognition for ENERGY STAR.[13]	Europe: Enterprises implementing energy management system can be exempted from the audits, which are required to be conducted every four years in Article 8 of the Energy Efficiency Directive.[14]

[11] www.NRCan.gc.ca/energy-manager-program/21917.

[12] c2e2.unepdtu.org/kms_object/enms-under-chinas-top-10000-program/.

[13] www.NRCan.gc.ca/energy-efficiency/energy-efficiency-for-industry/canadian-industry-program-energy-conservation-cipec/20341.

[14] iea.blob.core.windows.net/assets/imports/events/208/EnMSanddigitaltech_workshopreport_final_web.pdf.

Canada	Outside Canada or trans-boundary
Financial assistance for industrial energy management projects (to CIPEC leaders) provides up to 50% of eligible costs to $40,000 per facility, supporting ISO 50001, EMIS, with coverage for many project expenses.[15]	Denmark: Long-term agreements require implementation of ISO 50001 and cost-effective efficiency measures, with payback of up to five years.[16]
The North American Energy Management Pilot Program, sponsored by the Commission for Environmental Cooperation (CEC), helps industrial facilities improve energy management practices with a cohort approach and is available to Canadian companies.[17] Three Canadian companies have participated.	Ireland: provides subsidized energy audits, requires progress toward ISO 50001 certification.[18]
NRCan helps administer ENERGY STAR for Industry certification. Twenty facilities in Canada have this certification. NRCan also provides an Energy Savings Toolbox, which offers a guide for self-audits and for analyzing energy information, as well as an EMIS Planning Manual and Tool.[19]	Netherlands: Participants in long-term agreements pay a lower energy tax. Program requires that enterprises develop an energy efficiency plan every four years and road maps to reduce emissions by 50% by 2030.[20]

[15] www.NRCan.gc.ca/energy-efficiency/energy-efficiency-for-industry/financial-assistance-energy-efficiency-projects/20413#ISO.

[16] iea.blob.core.windows.net/assets/imports/events/208/EnMSanddigitaltech_workshopreport_final_web.pdf.

[17] oee.NRCan.gc.ca/publications/statistics/parliament/2017-2018/pdf/parliament17-18.pdf.

[18] www.seai.ie/business-and-public-sector/large-business/lien/our-members/.

[19] www.NRCan.gc.ca/energy-efficiency/energy-star-canada/energy-star-for-industry/energy-star-industry/19858#registered.

[20] iea.blob.core.windows.net/assets/imports/events/208/3.Waide_169.pdf.

Canada	Outside Canada or trans-boundary
Thirty-five organizations in Canada, 16 of which are CIPEC leaders, have been certified to ISO 50001.[21]	Finland: Energy efficiency agreements give a 20% subsidy for EE-related capital expenditures. Companies improve their EE in accordance with a plan.[22]
	United Kingdom: reduction of the Climate Change Levy (65% for gas, 90% for electricity). Requires that companies agree to implement measures to meet EE targets every two years.[23]
	Germany: Large energy users are eligible to apply for a 90% reduction of an industrial electricity tax liability if they prove that they have implemented an energy management system certified to ISO 50001 or the German national standard.[24]
	Indonesia: Facilities with annual energy consumption of more than 6,000 toe (ton of oil equivalent) are required to implement energy management practices including appointing an energy manager, developing an energy conservation program, periodically conducting energy audits, implementing

[21] www.NRCan.gc.ca/energy-efficiency/energy-efficiency-industry/energy-management-industry/iso-50001-energy-management-systems-standard/20405.

[22] epatee.eu/sites/default/files/epatee_case_study_finland_energy_efficiency_agreement_for_industries_ok_0.pdf.

[23] iea.blob.core.windows.net/assets/imports/events/208/EnMSanddigitaltech_workshopreport_final_web.pdf.

[24] www.aceee.org/files/proceedings/2017/data/polopoly_fs/1.3687931.1501159107!/fileserver/file/790291/filename/0036_0053_000022.pdf.

Canada	Outside Canada or trans-boundary
	recommendations from that audit, and submitting implementation reports.[25]
	South Korea: Korean companies that use more than 2,000 toe of energy per year must undertake an energy audit and identify actions to improve EE. The voluntary Superior EnMS Program is modeled on the U.S. SEP Program, providing training and certificates of energy savings.[26]
	Japan: The Top Runner Program includes a set of energy efficiency standards for the manufacture of energy-intensive products. Japanese companies that consume more than 1,500 kiloliters of crude oil equivalent per year must appoint energy managers, report on energy consumption, and submit energy reduction plans. Businesses that have been classified as energy efficient for two years under the Energy Efficiency Act can benefit from accelerated depreciation of their EE investments.[27,28]

[25] iea.blob.core.windows.net/assets/imports/events/208/EnMSanddigitaltech_workshopreport_final_web.pdf.

[26] iea.blob.core.windows.net/assets/imports/events/208/EnMSanddigitaltech_workshopreport_final_web.pdf.

[27] www.futurepolicy.org/climate-stability/japans-top-runner-programme/.

[28] www.meti.go.jp/english/policy/energy_environment/energy_efficiency/pdf/121003.pdf.