ENABLING STRATEGIC ENERGY MANAGEMENT (SEM) TO SUPPORT U.S. DECARBONIZATION

Jonah Eisen and Anna Johnson

July 2023

ACEEE
Smart Energy. Clean Planet. Better Lives.

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.

About the Authors

Jonah Eisen assists ACEEE's industry team in researching a wide array of technologies, policies, and clean energy pathways that help reduce energy intensity and GHG emissions in the manufacturing sector. He joined ACEEE in 2022. Prior to that, Jonah worked as an analyst at Growing Smart, an international agriculture project development firm, where he conducted market research on agro-technology and medical cannabis industries in the United States and around the world. Jonah holds a bachelor of arts in environmental studies from University of California, Los Angeles.

Anna Johnson conducts research and analysis to support industrial decarbonization efforts. She joined ACEEE in 2022. Her work has focused on enabling use of variable renewable power by industry, strategic integration across approaches to supply- and demand-side energy management, and projects specific to steel, aluminum, and petrochemical manufacturing. Prior to joining ACEEE, Anna worked in the Pennsylvania Natural Heritage Program's Western Pennsylvania Conservancy as a conservation planner and communication specialist. She developed public-facing reports and geospatial databases to help prioritize state-level conservation management and planning goals. Anna earned a PhD in geography and environmental systems from University of Maryland, Baltimore County, and a bachelor of arts in liberal arts from St. John's College.

Acknowledgments

This report was made possible through the generous support of the U.S. Department of Energy (DOE), the Tennessee Valley Authority (TVA), and in-kind support from the North American Strategic Energy Management Collaborative (NASEMC). The authors gratefully acknowledge external reviewers, internal reviewers, colleagues, and sponsors who supported this report. External expert reviewers included Peter Bassett from Energy Performance Services and Ethan Rogers from DOE. Internal reviewers included Neal Elliott and Nora Esram. The authors also gratefully acknowledge the assistance of Peter Bassett, Holly Farrah, Mike Kelly, and John Nicol for their support as NASEMC research advisors. External review and support do not imply affiliation or endorsement. Last, we would like to thank Ethan Taylor for managing the editing process, Mariel Wolfson for developmental editing, Keri Schreiner for copy editing, Roxanna Usher for proofreading, Kate Doughty for graphics design, and Mark Rodeffer and Ben Somberg for their help in launching this report.

Suggested Citation

Eisen, J., and A. Johnson. 2023. *Enabling Strategic Energy Management (SEM) to Support U.S. Decarbonization*. Washington, DC: ACEEE. aceee.org/white-paper/2023/07/enabling-sem-to-support-us-decarbonization

Abstract

Strategic energy management (SEM) programs have been an important driver of energy and cost savings for large industrial and commercial customers over the past two decades in the United States. SEM programs were originally designed to prioritize "avoided energy consumption," not to track carbon savings or address a dynamic and variable electric grid. Today, SEM programs and the regulatory environment that oversees them would benefit from realigning with these additional considerations, especially as federal and state governments, utilities, and major companies set ambitious greenhouse gas (GHG) reduction goals. SEM programs that have historically focused on avoided energy consumption can build on the success of their existing frameworks by expanding their scope and helping customers implement a suite of opportunities to save energy and reduce GHG emissions. Among these opportunities are fuel switching, electrification, demand-side management (DSM), on-site renewables, optimal use of batteries, and reductions in supply chain emissions. To achieve these goals, SEM programs need to track and optimize carbon emissions and time-variable energy costs, in addition to absolute energy use.

With its long-term approach to continuous improvement and its focus on education and organizational change, SEM is uniquely positioned to help meet decarbonization goals and support the power and gas sector and its energy customers in the transition to an energy future that is both increasingly sustainable and complex. This paper explores the various policy, regulatory, economic, and program design challenges and opportunities that may arise when SEM programs broaden beyond their historical focus on reducing energy use to include decarbonizing our economy.

For the SEM practitioner community, policymakers, and federal and state governments to successfully realign SEM programs, we propose the following pathways:

- Develop stronger policies, standards, and protocols that can enable SEM programs to incorporate carbon reductions into their scope of activity
- Implement strategies and programs to connect federal money for carbon reduction with existing utility-funded SEM programs to increase national capacity to rapidly accelerate carbon emissions reduction
- Improve synergy between DSM and SEM implementers and create the proper infrastructure to support better tracking, transparency, and sharing of time-variable carbon intensity metrics

Introduction

Energy efficiency has long been the backbone of demand-side management (DSM) programs offered by utilities, local governments, and state and federal agencies. Efficiency-based strategies such as conducting energy audits and optimizing equipment and systems are essential tools for helping businesses—especially those with energy-intensive operations—to conserve energy and reduce costs. Urgency around solving the climate crisis in recent years has demonstrated that it is equally imperative to develop the necessary strategies, policies, and technologies to reduce carbon emissions alongside energy consumption. Given that almost three-fourths of emissions are tied to energy use, there is a direct connection between energy efficiency programs and reaching carbon reduction goals (Ritchie, Roser, and Rosado 2020). This paper will explore the role of strategic energy management (SEM) as a framework that is uniquely positioned to support commercial and industrial decarbonization—that is, the reduction of carbon emissions from energy-consuming processes. We will also delve into the challenges and opportunities associated with expanding SEM's scope beyond "avoided energy consumption" to include explicit carbon reduction.

In 2021, the United States set national greenhouse gas (GHG) emissions goals that include cutting emissions in half by 2030, achieving a 100% carbon-free electricity grid by 2035, and reaching net-zero GHG emissions by 2050 (The White House 2022). These targets are essential to meeting Paris Agreement commitments and building a resilient and sustainable U.S. economy. To meet them, sectors such as industry (which is responsible for almost 30% of U.S. GHG emissions) will have to drastically decarbonize. These national goals are ambitious, and some newer decarbonization pathways remain expensive to implement or are not yet ready to deploy at scale. However, various low-to-no cost opportunities such as SEM are currently underutilized despite their potential for significant energy, carbon, and cost savings in sectors that are difficult to decarbonize.

SEM is a set of practices and principles that creates the foundation for long-term, continuous energy performance improvement. It involves securing buy-in from top-level management, forming an energy team, setting energy-related targets, identifying opportunities for energy management and efficiency improvements (action plans), implementing action plans, continuously monitoring and reviewing progress, conducting measurement and verification of avoided energy consumption, and creating organizational change. On average, participating customers in SEM programs realize a 2–10% energy consumption reduction within the first year of program engagement (Rogers, Whitlock, and Rohrer 2019). SEM is administered mainly through utilities' energy efficiency resource acquisition programs and is delivered by program administrators and third-party implementers.

Several companies began to implement what we think of today as SEM in the 1990s, as large companies such as the Dow Chemical Company and 3M began to incorporate energy into the scope of their enterprise resource planning (ERP) systems, including those implemented by SAP, Oracle, and other consultants (N. Elliott, director emeritus, ACEEE, pers. comm., February 2, 2023). This trend took hold after the turn of the century as Y2K efforts led to a consolidation of corporate ERP systems in comptroller offices across corporate America. One of the first structured SEM program concepts was developed in the 1990s in Australia by a firm named Energetics (AU) and targeted at small and medium enterprises (SMEs) (N. Elliott, director emeritus, ACEEE, pers. comm., February 2, 2023). U.S. implementation began as a market transformation initiative with early implementations in the Pacific Northwest by Northwest Energy Efficiency Alliance (NEEA) and in New York by the New York State Energy Research and Development Authority (NYSERDA) in the late 1990s. Part of the focus of these efforts was to bring the ERP experience to SMEs that did not have internal programs.

The North American Strategic Energy Management Collaborative (NASEMC), a working group formed in 2018 by practitioners and hosted by ACEEE and others, developed a database that documented known SEM administrators, implementors, and programs throughout North America. Currently, 51 administrators, 39 implementers, and more than 48 programs have been documented in the United States.[1] Figure 1 shows the general distribution of program administrators.

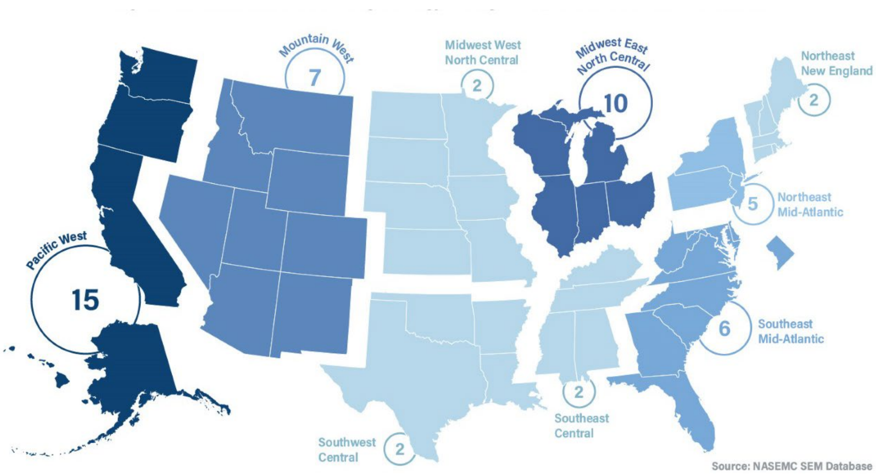

Figure 1. Regional distribution of SEM administrators across the United States

The Pacific Northwest is where SEM first took root in the United States, and it founded its own regional collaborative, NW SEM (https://semhub.com/nwcollaborative), in 2011. This strong coalition of regional utilities and energy organizations is largely responsible for SEM's high prevalence and success in this region. In contrast, there is a relatively low presence of SEM administrators in the South and Southeast, even though Texas and Louisiana are two of the largest energy-consuming states in the country.

[1] Some program administrators support multiple SEM programs and support separate commercial-, industrial-, or institutional-focused programs or customers. Some administrators also service multiple regions.

Given the heterogeneity of customer contexts and goals, SEM implementation strategies exist on a spectrum, ranging from assisting in minor operational changes or guiding retrofit implementations to following the highest program standards and third-party certifications to the International Organization for Standardization (ISO) 50001 energy management standard. Private consultants, government agencies, and energy utilities deliver SEM programs directly to individual customers, or to multiple customers via a cohort model. Large industrial, commercial, and institutional facilities (such as manufacturing plants, hospitals, hospitality, government buildings, and universities) are the most common customers. However, SEM's general principles can be harnessed by all types of sectors and company sizes, and SMEs are increasingly taking advantage of SEM-based solutions. Even cities, such as Bend, Oregon, and Missoula, Montana. have adopted SEM plans to help meet their energy and emissions goals.

Compared to energy efficiency programs, which typically focus on technology and infrastructure deployments that require capital, energy management programs such as SEM seek operational energy savings and may or may not include capital energy efficiency projects. The Environmental Protection Agency's (EPA) ENERGY STAR program offers various certifications and resources for energy efficiency and management. The U.S. Department of Energy (DOE) has a self-paced 50001 Ready program that is a specific designation for facilities and companies that have successfully implemented energy management systems (EnMSs) via the 50001 Ready Navigator tool. The program has engaged approximately 4,700 U.S. users as of 2022.[2] In 2018, the Tennessee Valley Authority (TVA), a major electric utility serving seven southeastern states, implemented 50001 Ready at its Magnolia plant in Mississippi. The plant, which includes more than 45 buildings, saved approximately 18 gigawatt hours of energy and close to $1.2 million from 2018–2020 with no capital investment (DOE 2022). DOE also facilitates the Federal Energy Management Program (FEMP) that works with stakeholders to enable federal agencies to meet their energy-related goals. This program has helped the federal government achieve a 50% reduction in energy intensity since 1975 (Alliance to Save Energy 2022). Engagement in ISO 50001, the DOE's 50001 Ready, FEMP, and Superior Energy Performance (SEP) 50001,™ or utility-run SEM programs are all ways that energy management concepts and practices are being delivered and recognized across the United States today.

Over the past quarter century, various national and global energy management standards and estimation methodologies—including ISO 50001 certification and the SEP program—have been developed to amplify SEM and its potential impact. ISO 50001 is an international

[2] P. Sheaffer, energy/environmental researcher IV, Lawrence Berkeley National Laboratory, Building and Industrial Applications Department, pers. comm., September 23, 2022.

standard that sets requirements for EnMS design, implementation, and maintenance. The SEP 50001 program,[3] administered by DOE, certifies facilities that meet ISO 50001 requirements, use the robust measurement and verification SEP protocol to track and document energy savings, and demonstrate sustained excellence using an EnMS. ISO 50001 has the potential to precipitate 105 exajoules of cumulative global energy savings by 2030, avoiding 6,500 megatons (Mt) of CO_2 emissions and $700 billion (McKane et al. 2017). This is equivalent to removing about 215 million cars from the road by 2030. ISO 50001 and SEP 50001 are certifications that rely on a standardized framework for energy management. Both can be worked toward using SEM or other complementary programs to support organizations in achieving even deeper energy savings.

SEM as a Greenhouse Gas Reduction Strategy

SEM can be an important element of GHG reduction strategies. SEM programs across U.S. industry could help reduce energy use in the industrial sector by 16 terawatt-hours (TWh) of electricity and 218 trillion British thermal units (Btus) of natural gas by 2025, resulting in $4.6 billion in savings and the reduction of 26 million metric tons (MMT) of carbon emissions (Ungar 2018; EPA 2023). Goldstein and Levin (2017) even suggest that if the entire industrial sector achieved the annual energy savings that SEM participants typically reach, the sector could reduce carbon emissions by 150–350 MMT by 2030. A recent analysis of the role of SEM programs in Canada illustrated that, depending on the given scenario, expanding SEM programs across the country could provide 1–19% of the 46 MMT/year of CO_2e reductions objective for the industrial sector by 2030 (Whitlock, Rightor, and Hoffmeister 2021). To actualize these large GHG reduction potentials, however, SEM will need to better integrate carbon management principles and strategies.

Currently, SEM is focused on avoided energy consumption, which poses uncertainties for programs and participants seeking to use it as a GHG reduction measure. In most cases, energy efficiency *does* result in GHG emissions reductions since less fuel is burned to produce the heat or electricity used by the facilities. However, as figure 2 shows, in some cases, GHG reducing measures may not result in energy reductions, and vice versa. A prime example is the electrification of fossil fuel processes, which may result in increases in on-site energy compared to a highly efficient combustion system. Electrification can be an important GHG reduction strategy when the electricity is sourced from low-GHG resources such as renewables and nuclear generation. This caveat is not always present, however, as some electricity pools continue to rely on fossil fuel for their generation, and where and when energy is used now (in a more mixed fossil-and-renewable-based electricity grid than in past decades) plays a much bigger role in how we account for and hopefully reduce GHG emissions. In 2022, approximately 40% of utility-scale electricity generation came from

[3] https://betterbuildingssolutioncenter.energy.gov/iso-50001/sep-50001

natural gas, 20% from coal, 18% from nuclear, and 22% from renewables (EIA 2023). In the future, the grid will become cleaner, as the International Energy Agency's *Renewables 2022* report predicts, with renewables becoming the largest source of electricity generation (Abdelilah et al. 2023). Energy management strategies enabled by SEM can allow for flexibility of energy usage in addition to increasing efficiency, thus accelerating the decarbonization of the grid.

Efficiency measures enabled by SEM represent an important pathway to GHG reductions, particularly when the GHG measures are tracked. This suggests that SEM implementations that collect both energy and GHG emission data can help reduce emissions by balancing different strategies—such as electrification, energy efficiency, and low-GHG energy resources—to achieve the optimal solution for an individual facility. Thus, there is an opportunity to focus on energy management strategies that are most likely to co-optimize both energy efficiency and GHG emissions reductions and to work toward strategies that will reduce both over the long-term.

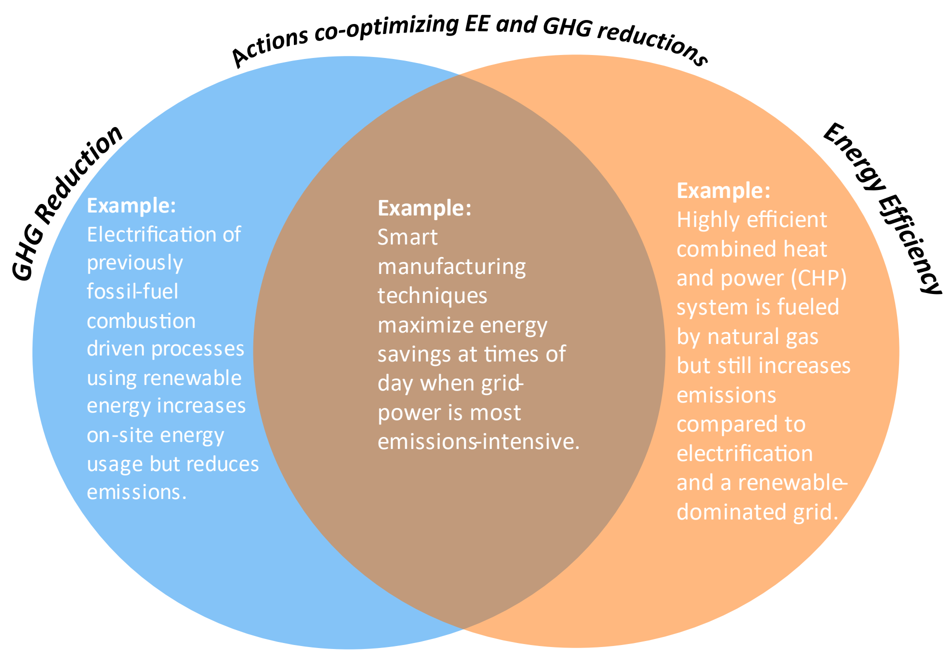

Figure 2. Interventions focused on energy efficiency often also lead to reductions in GHG emissions (the overlapping central area of the circles). In some cases, however, energy usage outcomes do not align with GHG emissions outcomes.

AVOIDED ENERGY CONSUMPTION VERSUS ABSOLUTE CARBON SAVINGS

We measure avoided energy consumption as the amount of energy savings (typically in Kwh or therm) that result from energy efficiency improvements relative to what would have been consumed had those actions not taken place.

Absolute carbon savings refers to the measurable reduction of GHG emissions expressed in tons of carbon dioxide (CO_2) as a result of the savings from energy efficiency improvements or adoption of renewables.

Because SEM programs were not originally designed for tracking carbon savings or dealing with a more dynamic electric grid, the regulatory environment, in addition to the programs themselves, would benefit from realigning to better match current power system characteristics. However, SEM's proven track record of delivering savings, building organizational capacity, and focusing on continuous energy improvement and optimization make it well positioned to incorporate these new components into its framework.

Expanding SEM to Support Decarbonization

While energy efficiency improvements are essential tools for reducing emissions, energy management programs themselves will need to become better integrated with decarbonization pathways and resources to significantly contribute to state and federal GHG reduction goals. Because many companies are already familiar with SEM program delivery models, having SEM provide information and technical support focused on reducing carbon emissions could improve business acceptance of these new energy and carbon management strategies. Being part of a collaborative user community, especially when combined with robust government policy support, has been a key aspect of many successful rapid national energy transitions.[4] SEM provides a long-term approach to continuous energy improvement using the Plan-Do-Check-Act (PDCA) model. This iterative process leverages behavioral change and education to shift an organization's culture so that it values energy management and optimization. Integrating carbon (which is often driven primarily by energy consumption) into this process will enable companies to more holistically understand how to manage their energy sustainably and cost effectively.

[4] National Research Council, Energy Research at DOE: Was It Worth It? Energy Efficiency and Fossil Energy Research 1978 to 2000, 2001, http://www.nap.edu/catalog/10165.html, and Prospective Evaluation of Applied Energy Research and Development at DOE (Phase Two), 2007, http://www.nap.edu/catalog/11806.html.

While interest in linking decarbonization with SEM has grown substantially over the past few years, the concept is still relatively new and is just beginning to take off in the United States. NASEMC webinars and surveys offer anecdotal evidence that some administrators and implementers are already including GHG-related actions in their SEM efforts. But programs that are focused more comprehensively on carbon reduction are not yet readily available. In the following sections, we address some of the key opportunities and challenges we see in expanding SEM program scope to manage carbon.

SEM PROVIDES A PREEXISTING FRAMEWORK FOR CARBON MANAGEMENT

Companies and some utilities are taking the lead on reducing GHG emissions in line with state, federal, and international goals. For example, approximately 75% of U.S. customer accounts fall under an individual utility or a utility owned by a parent company that has a 100% carbon-reduction target (SEPA 2022). Energy-intensive sectors, in particular, are increasingly interested in more dynamic energy management strategies to reduce peak demand charges, which can be a substantial portion of commercial and industrial customer utility bills. While energy efficiency programs are great at meeting annual energy reduction goals, they have not yet standardized their methods for managing energy on an hourly basis (i.e., 8,760 hours per year) to maximize the economic or carbon efficiency of energy usage.

Strategic management of carbon emissions and time-variable energy costs can build off well-established SEM program frameworks for managing avoided energy usage. Most industrial facility GHG emissions are linked to energy usage, either through a direct combustion process on-site (e.g., a gas-fired boiler)[5] or through electricity consumption.[6] For example, LED lightbulbs with an ENERGY STAR label use up to 90% less energy than incandescent lightbulbs. Reducing this demand for electricity that powers the lightbulbs will decrease the amount of fossil fuels needed to produce that electricity, ultimately reducing GHG emissions (ENERGY STAR 2023). But the link is not always direct or consistent, and it depends on the power grid's carbon intensity, as well as the timing of energy usage. Often, the lowest carbon energy is also the lowest cost energy; at midday, for example, system demand is lower than evening peaks and solar power supply is maximized. Programs that specifically incentivize efficiency or demand reduction when energy is most carbon intensive and most expensive—such as in early evening, when demand is high and renewable supply is lower—will save users more money and reduce more carbon emissions. To effectively

[5] This is an example of a Scope 1 emission, which is defined as direct emissions from company-owned or -controlled resources (see https://www.wri.org/initiatives/greenhouse-gas-protocol).

[6] This is an example of a Scope 2 emission, which is defined as indirect emissions from the generation of purchased energy (see https://www.wri.org/initiatives/greenhouse-gas-protocol).

operate like this, the scope of SEM programs could be expanded to educate customers about and advocate for actions commonly associated with DSM or demand flexibility programs and address these spatial and temporal variations in carbon intensity and the economics of power consumption. Education, technical and engineering assistance, and action-oriented workshops are the basis of any successful SEM program; these training curricula can easily incorporate topics related to demand response and flexibility.

SEM CAN BUILD SUPPORTIVE DECARBONIZATION COMMUNITIES ACROSS ENERGY-INTENSIVE FACILITIES

Long-term partnerships between SEM program implementers and energy users are a key element in creating a successful cycle of continuous energy improvement. SEM program implementers empower customers to realize significant energy savings by continually engaging facilities in workshops and training focused on organizational change and technical services. SEM coaches often work with energy champions, top-level management, facility managers, and engineers and staff on the ground to develop a plan that creates a *culture* of energy efficiency, bringing a holistic perspective to energy management that is typically unavailable in-house.

This investment in education and a baseline level of trust can be leveraged to raise awareness about decarbonization options. For example, electrification (e.g., installing an industrial heat pump to replace fossil-fuel powered heating or cooling) has a significant role in decarbonization but is often too complex for customers to assess on their own, and it can feel novel and intimidating when first introduced to customers who are not accustomed to electrification technologies. SEM professionals can introduce these concepts and technical solutions prior to a customer need arising (e.g., exploring electric boilers while customer fossil-fuel boilers are still operational) and preemptively help those customers recognize the value of flexible energy demand and carbon management. Having this awareness prior to a natural opportunity arising (e.g., conventional equipment reaching the end of its lifecycle) for shifting to electrified equipment or more fully integrating renewable power into their business operations can improve facility uptake of decarbonization solutions.[7]

---

[7] A good example of how sustained social support and messaging around decarbonization solutions leads to success comes from the 2000s, when utilities and energy agencies across Germany developed an awareness campaign about heat pumps, which serve as a promising decarbonization solution for heating and cooling. To amplify messaging around the importance of heat pumps, and how and where to acquire them, NRW Energy Agency and RWE utility took advantage of multiple platforms including radio ads, addressing town halls, attending trade centers, and setting up a national database where consumers could find nearby installers via their postal code. These efforts helped Germany see heat pump purchases grow from 10,000 in the early 2000s to more than 70,000 in 2008 (Peran 2021). According to the German heat pump association, BWP, 236,000 heat pumps were sold in 2022 (EHPA 2023). This major growth is in large part a result of continued campaigning on climate friendly and efficient heating opportunities, the introduction of new financial incentives and climate

The cohort delivery model is a great example of how SEM can assist with the adoption of decarbonization efforts, as the model is designed for customers to share their challenges and success with 6–12 other similar organizations. In March 2020, for example, the District of Columbia Sustainable Energy Utility (DCSEU) launched a SEM pilot cohort of eight universities across the District of Columbia focused on identifying quick cost and carbon savings opportunities. Despite the barriers associated with the COVID-19 pandemic, including the lack of typical on-site engagement, these universities were able to successfully conduct individual energy assessments, participate in remote workshops, and receive technical assistance and educational materials (DCSEU 2022). The SEM curriculum also supported the universities in designing EnMSs that could help them meet and track emissions compliance with the district's Building Energy Performance Standard (BEPS).

SEM CAN SUPPORT BETTER INTEGRATION OF SUPPLY- AND DEMAND-SIDE ENERGY SUPPLY

SEM programs are uniquely situated between industrial/commercial energy consumers and the power sector, and they can support improved alignment between demand- and supply-side decarbonization strategies. As the power sector becomes more complex, increasing demand for clean energy requires more effective utilization of preexisting infrastructure. To accomplish this, bidirectional communication between energy suppliers and energy consumers will be necessary. And, as rate structures necessarily become more complex to signal when and where energy demand shifts are necessary, SEM programs could be a tool for educating customers on cost-effective alignment of facility energy management. This education would help ensure that customers are able to take advantage of low-cost and low-carbon power and avoid steep peak demand charges. When large energy-consuming facilities optimize energy demand to support broader grid operations, they also help support better rates for all customers as well as a grid with lower carbon emissions. Google, for example, signed a 2021 energy supply agreement with AES Corporation that will serve its Virginia data centers with 90% carbon-free energy when measured on an hourly basis (Bird, Hutchinson, and O'Shaughnessy 2021). Data communications platforms will need to communicate pricing signals (related to carbon intensity and power availability) to utility customers in (almost) real time and offer day-ahead predictions.

To communicate these pricing signals, companies first need the infrastructure to monitor and understand their energy and carbon intensity data on a sufficiently granular level. Some facilities lack energy sub-metering and energy management dashboards to use for such advanced energy management. Industrial facilities often already have sophisticated measurement and data storage and display systems for managing their production

change policies, and an increase in the higher-skilled workforce. With the help of governmental policies and strategic messaging, SEM professionals with technical skills and decarbonization knowledge can offer a strong argument for why it is so important to begin thinking about and implementing these solutions.

processes. These existing system platforms can be leveraged to add energy meter data to enable generation of energy management information. Energy management information systems (EMIS)—that is, devices and software applications that collect, monitor, and control various energy consumption indicators—are used to maximize SEM customers' energy and cost savings potential. Tracking, storing, analyzing, and controlling system performance and energy use data is a core SEM component and enables facilities and buildings to develop their energy baselines and goals when beginning to participate in a program. Yet, many of these data tracking platforms are not yet equipped to perform advanced GHG emission accounting measures. Accounting for carbon data in a manner similar to how SEM programs already track kilowatt-hour (Kwh) and therms for electricity and gas consumption will help utilities better understand how to utilize and optimize their available resources, such as determining the best times to use renewables on site. To ensure that customers are aware of and capable of reducing their GHG emissions along multiple parts of their supply chain, they must first have access to data management platforms that can record information about carbon intensity. The table below summarizes (1) some of the challenges of expanding SEM to support decarbonization and (2) pathways to overcome these challenges.

How SEM can increase carbon reduction	Barrier	Potential solution
Reporting carbon reductions in addition to "avoided energy consumption"	Integrated Measurement & Verification (M&V) protocols related to energy and carbon savings are not currently in place.	Government/regulatory support (DOE/EPA) to establish protocols for capturing the carbon reduction component of SEM that differentiates the need for absolute carbon reduction from avoided energy consumption
Expand SEM scope to generate not only avoided energy consumption improvements but also carbon reduction improvements	Utility SEM programs are funded by ratepayers for resource acquisition, and regulators may not permit ratepayer money to be used for carbon reduction.	Work with utility regulators and legislators to create a policy environment that accepts and incentivizes the inclusion of carbon management into SEM programs
Capital funding for SEM carbon reduction projects	Current SEM funding is ratepayer money and excludes carbon.	Connect federal investment money with utility programs via a DOE RFO to utilities

Strategies for Deploying SEM for Decarbonization

FITTING SEM INTO UTILITY AND STATE INDUSTRIAL DECARBONIZATION AGENDAS

Achieving continuous energy improvement requires buy-in from all levels of management and a cultural shift within an organization, which is why most SEM programs are predominantly focused on operations and management, behavioral, and low-no-cost capital investment opportunities. These projects and practices are excellent at improving productivity, eliminating energy waste, and reducing operating expenses in a cost-effective manner. But SEM programs can also help contribute to state and utility industrial decarbonization plans by identifying opportunities for fuel switching, electrification, DSM, on-site renewables, optimal use of batteries, and reductions in supply chain emissions, and then by helping individual facilities strategically apply these approaches.

Successfully incorporating these decarbonization strategies into SEM's framework, however, is contingent on individual state public utility commissions (PUCs) and their willingness to expand their mandates. PUCs are the state agencies that regulate investor-owned utilities to ensure that utility investments and services are reasonable, safe, and reliable. The rules and language around what and how PUCs are allowed to regulate are narrowly focused and can be slow to change to match updated business practices. Since many energy efficiency programs (including SEM) are delivered via utilities, their scopes must fall within the confines of each specific PUC's statute. As a result, some companies and facilities seeking to integrate carbon management strategies into their SEM program may not initially be authorized to do so by their utility program sponsors. Thus, it will be critical to design policy that enforces progress tracking toward carbon reduction goals in detailed, transparent ways, and makes room for carbon management strategies that also align with energy efficiency goals. Progress is already happening; some jurisdictions, such as the District of Columbia and Connecticut, have already expanded their PUC charter to include the impacts of climate change and their state climate goals, while other states are directing their PUCs to develop their own social cost of carbon metric in addition to the one already established by the federal government. [8]

An example of a specific decarbonization strategy that is being either restricted or embraced across different U.S. states and PUCs is fuel switching—that is, replacing carbon-intensive fuels with cleaner, more renewable fuels. In many cases, switching from fossil fuels to

[8] In 2018, the District of Columbia passed the Clean Energy Omnibus Act, which included a specific provision for the Public Service Commission to consider the effects of climate change and the district's public climate commitments. Also in 2018, Connecticut passed Public Act 18-82, which included a two-step process that embeds Connecticut's climate targets into the Public Utility Regulatory Authority's decision-making framework (Duncan and Klee 2020).

electrical equipment can be more energy efficient, in addition to reducing carbon emissions from on-site combustion. The carbon savings will be even greater if the electricity supplied by the grid is from renewable sources. Once fuel-switching policies are in place, SEM can help facilities assess these opportunities with a carbon analysis.

Some states (approximately 12, according to a 2022 ACEEE policy brief) prohibit utilities from providing incentives that would help customers purchase equipment that uses different fuels, while other utilities or states have built in additional GHG reduction policy incentives that support this strategy. Minnesota, for example, passed the Energy Conservation and Optimization Act (ECO) in 2021, which provides utilities with the opportunity to include load management and efficient fuel-switching programs in conjunction with the state's demand-side energy efficiency programs. Also in 2021, Illinois passed the Climate and Equitable Jobs Act (CEJA), which allows electric utilities to incorporate fuel-switching programs into energy efficiency portfolio plans (Berg 2022). These recent pieces of legislation enable utilities to create fuel-neutral targets and adopt more holistic energy efficiency strategies. Industrial processes, which often release air pollutants and use carbon-intensive fuels such as oil and propane, present significant opportunities for decarbonization and fuel switching due to their lower baseline of carbon efficiency. Utilities that provide both gas and electric SEM programs (such as Pacific Gas & Electric or San Diego Gas & Electric) could simply transfer the load from one energy source to the other as opposed to losing profit. Thus, more states and PUCs must update their fuel-switching policies and rules so that utility, commercial, and industrial decarbonization plans can include fuel-neutral targets.

Similarly, there are a wide range of economical and carbon-efficient strategies to help utilities optimize energy supply and demand that would increase utilization rates of preexisting assets and avoid the need for building additional fossil-fuel-fired generating capacity, but that are beyond the traditional purview of energy efficiency programs. For example, TVA found that it was underutilizing its assets and deployed SEM programs to provide a path toward targeted increases of industrial energy demand to avoid curtailment of energy supply.

FITTING SEM INTO A FEDERAL INDUSTRIAL DECARBONIZATION AGENDA

Energy efficiency programs have proven to be some of the most cost-effective ways to reduce GHGs in the near term, but carbon tracking tools, resources, and policies may not always be provided by the utilities themselves. While support and cooperation from utilities and individual states is imperative, the federal government can also promote SEM adoption and the broadening of SEM's scope to include decarbonization. Developing various carbon management and reporting standards, developing educational resources, and allocating funds are all ways that the federal government can play a key role in these efforts.

Given that there are numerous ways to measure and verify energy and carbon savings, developing additional standards and protocols would be useful for program evaluators. Various national measurement and verification (M&V) guidelines and other standards have already been produced by entities such as ISO, DOE, and Bonneville Power Association. These include ISO 14064's GHG verification standard, DOE's Qualified Energy Savings Measurement and Verification Protocol for Industry, the Superior Energy Performance Measurement and Verification Protocol, and the International Performance Measurement and Verification Protocol. These protocols provide clear and standardized methodologies for implementers, customers, and evaluators to assess program performance and cost effectiveness. DOE and other agencies can work in collaboration to establish similar national guidelines and more robust M&V standardization methods that include carbon and GHG emissions metrics for SEM evaluators alongside more familiar energy efficiency and energy savings metrics.

Developing and disseminating educational tools and resources is another key area in which the federal government can be a strong asset. DOE's recent Industrial Decarbonization Roadmap recognizes the importance of SEM as a crosscutting tool for helping certain industrial sectors decarbonize over the next several years. Additionally, in 2022, DOE added a new decarbonization feature to its 50001 Ready digital navigator tool. The 50001 Ready program includes an online navigator tool that provides guidance on implementing an ISO 50001-based EnMS in 25 steps. The new feature applies to each one of these steps and offers specific guidance on how to comprehensively manage energy-related GHG emissions. The tool helps organizations develop a more rigorous system for data collection and analysis of energy-related GHG emissions and improves data transparency between customers, regulatory authorities, and other key stakeholders. It also establishes a systematic approach to managing and reducing these emissions by helping organizations internally align their systems and processes to be more conducive to various decarbonization strategies and technologies. The addition of this guidance to the 50001 Ready program is an indicator of the market demand for integrating carbon management into SEM programs and of DOE's capacity in helping to facilitate and advocate for these changes (DOE 2022).

While 50001 Ready is a great program for those who opt in, having national, state, and local GHG emission reduction targets could require many more companies across the nation to provide further transparency around tracking, reporting, and addressing their emissions. In March 2022, the Securities and Exchange Commission (SEC) proposed a climate disclosure rule that would require all publicly listed U.S. companies to report climate-related risks (including GHG emissions) in a standardized manner. This regulation would provide more clarity around carbon tracking procedures and could also help drive market demand for energy management programs like SEM (especially if they were to include strategies for decarbonization). The rule, however, would not apply to non-publicly traded companies. So, to further incentivize management of GHG emissions through SEM, DOE could offer capacity-building grants to help program administrators, implementers, and even private companies themselves develop the standards and resources needed to accomplish emission reduction goals.

PROVIDING WORKFORCE DEVELOPMENT AND ENVIRONMENTAL JUSTICE OPPORTUNITIES THROUGH EXPANDED SEM PROGRAMMING

Investing in workforce development focused on carbon accounting and management is an important factor in ensuring that SEM programs can succeed in this new arena. In addition to ensuring that sufficient training resources and programs are available, federal subsidies to cover the costs of hiring energy managers would be a great way to incentivize participation in and wide scale adoption of SEM. As an example, Canada's federal government allocated $3.1 million in funding toward its Energy Manager Program in 2019–2020; this funding covered 75% of the costs to hire an energy manager, in addition to providing financial assistance for energy assessments (Natural Resources Canada 2019).

Expanding SEM to include broader topics of climate change and decarbonization could also allow for engagement with more diverse sectors and communities. While SEM programs typically target large industrial and commercial customers, the more than 30 million U.S. SMEs are the backbone of the economy and should also be given the opportunity to reduce costs, energy consumption, and GHG emissions through SEM. Compared to large facilities, however, SMEs might not have the same goals, resources, direct staff expertise, or capacity to support a more comprehensive SEM program. However, condensed versions of SEM, such as SEMLite, might be well suited for these smaller organizations. The COVID-19 pandemic also demonstrated the importance of adapting to unexpected and challenging conditions. PowerTakeOff decided to launch a fully virtual SEM program, or vSEM,™ to make SEM more accessible and flexible for SMEs. While a greater percentage of national emissions might come from larger companies, engaging all levels of the economy in decarbonization will be necessary to meet future GHG reduction targets. Furthermore, many of these smaller businesses are part of larger companies' supply chains. So, efforts to reduce large companies' Scope 3 emissions (the indirect emissions that result from a company's value chain) will put pressure on SMEs to decarbonize as well (WWF 2022). SEM programs targeting these diverse customers would help drive decarbonization across the economy and support SMEs' ability to achieve the necessary emissions reductions to retain their positions in the lower-carbon value chains of the future.

In addition to engaging customers of different sizes, low-income and disadvantaged communities should also be entitled to take advantage of SEM opportunities. SEM can help build economic resilience and overcome barriers of energy management for smaller, under-resourced businesses that might not have direct staff expertise or access to financial capital to implement more costly decarbonization strategies. Prioritizing funding and expansion of SEM programs in areas that have large energy-intensive and emissions-intensive facilities located in disadvantaged communities could also provide non-energy benefits—including reducing GHG emissions and pollution to improve the health and wellness of these communities. For example, the industrial corridor spanning 130 miles along the lower Mississippi River in Louisiana has more 200 industrial facilities and has been called "cancer alley" (Bruggers 2023). Expanding SEM programs to this area could help lower the GHG emissions that the area's facilities produce and, as a result, lower the amount of toxic pollutants being released into the atmosphere.

Conclusion and Next Steps

To swiftly move along its decarbonization journey, the United States must take a more holistic approach to energy and environmental management and repurpose successful, preexisting efficiency programs such as SEM to facilitate the U.S. economy's decarbonization. Challenges to achieving this goal remain both at the program level and within the broader regulatory framework; meeting these challenges will require strategic collaboration between the SEM practitioner community, federal, state, utility, and private partners. We recommend three main pathways that can broaden SEM's scope to better meet the needs of a fast-changing power grid and a net-zero economy:

1. Communicate to utility regulators the importance of capturing GHG reduction benefits, and leverage federal and nongovernmental organization (NGO) partners to help update mandates and drive other necessary policy reforms.
2. Support SEM program expansion by connecting federal carbon reduction money with SEM programs and by including carbon in the existing utility rate-payer structure.
3. Update SEM reporting guidelines and national standards to enable SEM programs to better incorporate carbon management.

1. WORK WITH UTILITY REGULATORS TO BROADEN SEM PROGRAM MANDATES

SEM already serves as an important tool for many utility energy efficiency programs across the country. However, its framework was originally designed to address avoided energy consumption and exists within a specific regulatory context today. Consequently, state legislators and utility regulators should redesign policies to expand the PUC mandates so that SEM practitioners can integrate carbon metrics into their programs.

To create these needed policy reforms, it is imperative that the SEM practitioner community communicate to utility regulators the importance of capturing GHG reduction benefits that could accrue from SEM implementation. States and PUCs could build off policy successes (e.g., those in Canada, the District of Columbia, and Connecticut) and leverage the federal government and the NGO community as partners in communicating these needs to policymakers and legislators.

2. IDENTIFY FEDERAL FUNDING OPPORTUNITIES TO SUPPORT SEM PROGRAM DEVELOPMENT

Developing strategies and programs that connect federal carbon reduction money with existing utility-funded SEM programs will help grow national capacity to rapidly accelerate carbon reductions.

The most common way SEM programs are financed today is through the utility ratepayer model. As figure 3 shows, utility customers pay a charge or fee (sometimes referred to as a public good or system benefit charge) to their utility companies. This money is then held in a fund designated for energy efficiency programs, which is used to pay a third-party SEM implementer to implement the program for the customers. Some of these charges may be directed at the electric bill, gas bill, or both, but few account for carbon emissions. Maintaining this existing model could provide a streamlined pathway toward acquiring funds specifically for tracking and reducing carbon emissions. Including carbon in this circular ratepayer structure is dependent on the laws and regulations of individual state PUCs, which may go through a long process of approval, so it is essential to garner near-term investment and support from other entities. This strategy may be more effective in utility markets where carbon reduction goals are already in place and incorporated into utility rate designs and programming. However, utilities and utility regulators will still need to either redefine what is considered an energy efficiency program—for example, climate-forward efficiency (Specian, Gold, and Mah 2022)—or change how program success is measured.

Receiving top-down funding from the federal government (as illustrated in the right-hand image in figure 3) is another pathway for SEM programs to incorporate decarbonization solutions. Since 2020, four monumental energy and climate focused packages totaling over $500 billion have been signed into law in the United States. While SEM was not directly funded through these bills, some provisions support the expansion of energy management and could indirectly include SEM programs. The Bipartisan Infrastructure Law or Infrastructure Investment and Jobs Act (IIJA) allocated $40 million to DOE for the Energy Auditor Training Grant Program, which covers the cost of training and certifying auditors as part of state or state-certified programs. The IIJA also allocated a $150 million grant for Industrial Research and Assessment Centers to identify opportunities for optimizing energy efficiency at manufacturing and other industrial facilities, including developing EnMSs. While SEM programs could tap into some of these grants and other bill appropriations, there needs to be a more clearly defined stream of funding for SEM program administrators and implementers to take advantage of, especially as it relates to decarbonization efforts, including investments in updated training curricula on carbon management for both customers and implementers.

The United States can follow in the footsteps of other countries that are successfully funding SEM at a federal level. In February 2023, Natural Resources Canada (NRCan) announced the Green Industrial Facilities and Manufacturing Program (GIFMP), which will provide up to $20 million per proposal in financial assistance to help industrial facilities maximize energy efficiency and reduce emissions in their operations (Natural Resources Canada 2023). SEM was included as one of the six eligible activity areas.[9] GIFMP allows for a clear funding stream from the federal level directly to utility program administrators to support SEM growth and provide funding to support GHG reductions. In addition to supporting industrial facilities, NRCan is also offering financial assistance between 2023–2025 to help commercial and institutional buildings implement ISO 50001 EnMSs (up to $40,000 per building).

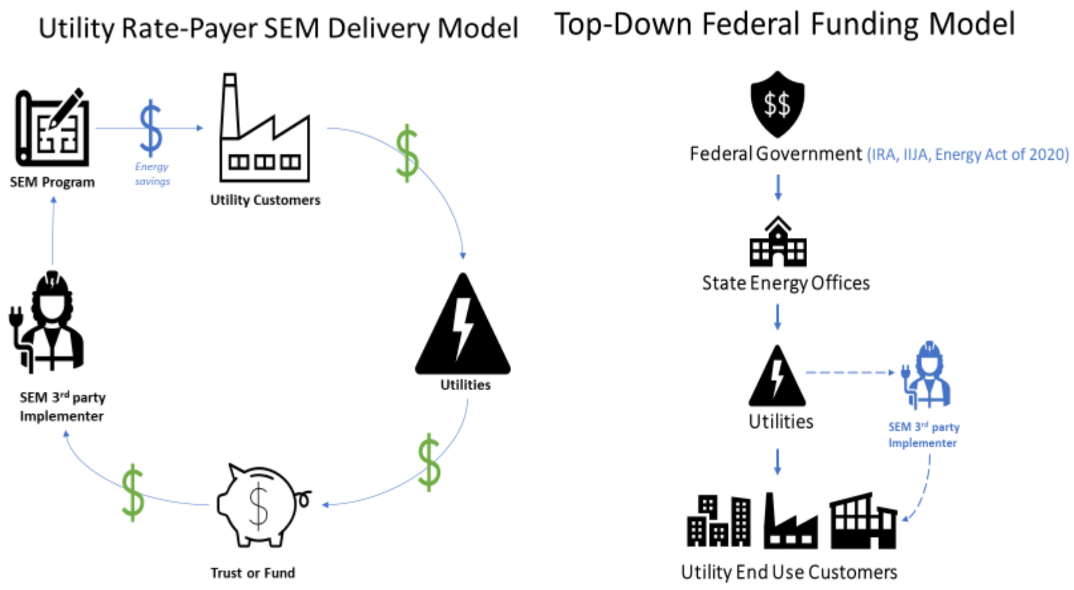

Figure 3. Models for financing and delivering SEM programs

3. UPDATE SEM REPORTING AND ACCOUNTING STANDARDS TO EXPAND SEM'S BREADTH AND DEPTH

As consumer and investor demand for action on climate change continues to increase, and as federal and state governments, as well as utilities, establish ambitious GHG reduction targets and reporting regulations, SEM has a significant opportunity to evolve and thrive. To maximize its impact in this new environment, however, better synergy must be built between DSM and SEM implementers to support improved tracking, transparency, and sharing of time-variable carbon intensity metrics.

Moreover, creating national standards, protocols, and guidelines that can enable SEM programs to better incorporate carbon management would not only help to expand its scope, but it would also help garner broader adoption of SEM programs as a whole, as they would be more valuable assets to industrial, commercial, and institutional participants

[9] While the Energy Manager Program mentioned earlier was phased out after 2020, the GIFMP includes the same eligible activities that it covered (energy managers, energy assessments, etc.), scaled-up and expanded to the national level.

looking to better align with customer values. The increased appeal of decarbonization, coupled with federal and state policies, mandates, and funding, would also allow for the strategic expansion of SEM programs across all U.S. regions, and especially in areas where SEM is not as predominant.

The following chart illustrates some of the key SEM practices that could be updated to include decarbonization.

Current SEM practice	How to adapt for decarbonization	Key stakeholders
Tracking, analyzing, and reporting avoided energy use data using an EMIS	Incorporate absolute carbon emission tracking into existing EMIS	SEM implementers, utility providers, energy management software companies
Offering incentives to SEM participants who demonstrate energy savings (dollar per Kwh or therm)	Convert energy values into CO_2e based on the regional grid emissions intensity factor and fuel type	SEM implementers, utility providers
M&V guidelines for SEM evaluation	Establish more robust guidelines that include carbon metrics for SEM evaluation	Federal and state governments and their agencies, NASEMC
ISO 50001, SEP, 50001 Ready, and FEMP programs	Follow ISO 50001 Ready by creating more decarbonization tools and educational materials for SEM programs	Department of Energy, NASEMC

Expanding SEM programs to include GHG management is an attainable and perhaps even necessary goal that can be expedited with proper support from major federal, state, and utility stakeholders. Ultimately, establishing a clean energy economy and effectively mitigating the climate crisis demands a multifaceted approach, and harnessing the full potential of SEM principles and practices could serve as a key piece to that puzzle.

References

Abdelilah, Y., H. Bahar, T. Criswell, P. Bojek, F. Briens, J. Moorhouse, and L. Martinez. 2023. *Renewables 2022: Analysis and Forecast to 2027*. Paris: IEA (International Energy Agency). www.iea.org/reports/renewables-2022.

Alliance to Save Energy. 2022. "Efficiency 101: What Are the Main Federal Energy Efficiency Programs?" *Alliance to Save Energy Blog*, March 24. www.ase.org/blog/efficiency-101-what-are-main-federal-energy-efficiency-programs.

Berg, W. 2022. *State Policies and Rules to Enable Beneficial Electrification in Buildings through Fuel Switching*. Washington, DC: ACEEE (American Council for an Energy-Efficient Economy). aceee.org/policy-brief/2022/07/state-policies-and-rules-enable-beneficial-electrification-buildings-through.

Bird, L., N. Hutchinson, and E. O'Shaughnessy. 2021. "6 Ways Large Energy Buyers Can Transform the US Electrical Grid." *World Resources Institute*, August 20. www.wri.org/insights/how-large-energy-buyers-modernize-power-grid-us.

Bruggers, J. 2023. "Q&A: Cancer Alley Is Real, and Louisiana Officials Helped Create It, Researchers Find." *Inside Climate News,* February 8. insideclimatenews.org/news/08022023/louisiana-cancer-alley/.

DCSEU (DC Sustainable Energy Utility). 2022. *A Decade of Transformation: 2021 Annual Report.* Washington, DC: DCSEU. www.dcseu.com/Media/Default/docs/about-us/DCSEU-FY2021AnnualReport-web.pdf.

DOE (Department of Energy). 2022. "Tennessee Valley Authority (TVA)—50001 Ready Facility." betterbuildingssolutioncenter.energy.gov/iso-50001/showcase-projects/tennessee-valley-authority-tva-%E2%80%94-50001-ready-facility.

___. 2022. "50001 Ready Decarbonization Management Guidance." Accessed October. navigator.lbl.gov/decarbonization.

Duncan, J., and R. Klee. 2020. "Transforming Utility Regulation to Achieve Climate Goals." *IMT News,* June 23. www.imt.org/news/transforming-utility-regulation-to-achieve-climate-goals/.

EHPA (European Heat Pump Association). 2023. "Germany's Impressive Heat Pump Sales Growth: +53% in 2022." *EPHA News,* January 19. www.ehpa.org/2023/01/19/ehpa_news/germanys-impressive-heat-pump-sales-growth-53-in-2022/.

EIA (Energy Information Administration). 2023. "What Is U.S. Electricity Generation by Energy Source?" www.eia.gov/tools/faqs/faq.php?id=427&t=3.

ENERGY STAR. 2023. "About Energy Star: Energy Efficiency." Accessed January. www.energystar.gov/about/about_energy_efficiency.

EPA (Environmental Protection Agency). 2023. "Greenhouse Gas Equivalencies Calculator." www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

Goldstein, D., and A. Levin. 2017. "The Strategic Value of Industrial SEM in Limiting Climate Pollution." *Proceedings of the 2017 ACEEE Summer Study on Energy Efficiency in Industry* 3: 55–66. Washington, DC: ACEEE. www.aceee.org/files/proceedings/2017/data/polopoly_fs/1.3687856.1501159039!/fileserver/file/790255/filename/0036_0053_000057.pdf.

McKane, A., P. Therkelsen, A. Scodel, P. Rao, A. Aghajanzadeh, S. Hirzel, R. Zhang, R. Prem, A. Fossa, A. Lazarevska, M. Matteini, B. Schreck, F. Allard, N. Villegal Alcántar, K. Steyn, E. Hürdoğan, T. Björkman, and J. O'Sullivan. 2017. "Predicting the Quantifiable Impacts of ISO 50001 on Climate Change Mitigation." *Energy Policy* 107: 278–88. doi.org/10.1016/j.enpol.2017.04.049.

Natural Resources Canada. 2019. "Energy Efficiency: Energy Manager Program." natural-resources.canada.ca/energy-manager-program/21917.

___. 2023. "Minister Wilkinson Announces New Program to Support Decarbonization of Industrial Facilities and Manufacturing to Maximize Energy Performance and Industry Competitiveness." www.canada.ca/en/natural-resources-canada/news/2023/02/minister-wilkinson-announces-new-program-to-support-decarbonization-of-industrial-facilities-and-manufacturing-to-maximize-energy-performance-and-i.html.

Peran, A. 2021. "Building a UK Heat Pump Market—Lessons from Abroad." *Electrify Heat,* December 21. electrifyheat.uk/article/lessons-from-abroad/.

Ritchie, H., M. Roser, and P. Rosado. 2020. "CO_2 and Greenhouse Gas Emissions." *Our World in Data*. ourworldindata.org/co2-and-greenhouse-gas-emissions.

Rogers, E., A. Whitlock, and K. Rohrer. 2019. *Features and Performance of Energy Management Programs*. Washington, DC: ACEEE. aceee.org/research-report/ie1901.

SEPA (Smart Electric Power Alliance). 2022. "Utilities' Path to a Carbon-Free Energy System." Accessed December. sepapower.org/utility-transformation-challenge/utility-carbon-reduction-tracker/.

Specian, M., R. Gold, and J. Mah. 2022. *A Roadmap for Climate-Forward Efficiency*. Washington, DC: ACEEE. www.aceee.org/research-report/research-report/u2202.

The White House. 2022. "Fact Sheet: New Innovation Agenda Will Electrify Homes, Businesses, and Transportation to Lower Energy Bills and Achieve Climate Goals." www.whitehouse.gov/ostp/news-updates/2022/12/14/fact-sheet-new-innovation-agenda-will-electrify-homes-businesses-and-transportation-to-lower-energy-bills-and-achieve-climate-goals/.

Unger, L. 2018. "Doing Our Part: The Contribution of Energy Efficiency Policies to Meeting US Climate Goals." In *Proceedings of the ACEEE 2018 Summer Study on Energy Efficiency in Buildings,* 9:1-14. Washington, DC: ACEEE.

Whitlock, A., E. Rightor, and A. Hoffmeister. 2021. *Canadian Strategic Energy Management Market Study*. Washington, DC: ACEEE. www.aceee.org/research-report/ie2102.

WWF (World Wildlife Fund). 2022. "Small Businesses Play a Pivotal Role in Driving Corporate Climate Action." *Sustainability Works*, September 19. www.worldwildlife.org/blogs/sustainability-works/posts/small-businesses-play-a-pivotal-role-in-driving-corporate-climate-action.