Unleash the Potential of Data-Driven Energy Management Programs

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ABSTRACT

Energy management programs, when executed effectively, serve as bridges connecting utility goals with customer aspirations to optimize their energy costs and reduce their energy use and carbon emissions. The comprehensive use of energy, rate schedule, and customer data from program design through outreach and delivery is central to this alignment.

Accessing and integrating this data before program launch optimizes the program's ability to target ideal participants that will best benefit from the program and help it achieve its goals. During the program, this data generates insights that help clarify the program's value for the customer. Finally, this data prepares programs to capture auxiliary utility and customer benefits that may be outside of the initial program or customer scope. For instance, by presenting data on a customer's 'hourly peak demand' and its associated costs, the program empowers customers to take proactive steps to reduce power consumption during high-cost, high carbon intensity periods. Such insights and resulting actions are increasingly pivotal for utilities in managing peak demand and decarbonization efforts.

Through real-world examples, we will showcase how a holistic approach to data not only elevates the outcomes of energy management programs but also lays the groundwork for future-oriented program initiatives like decarbonization, electrification, and grid management.

Introduction

Energy management programs like Existing Building Commissioning (EBCx) and Strategic Energy Management (SEM) generally focus on energy-saving changes that can be implemented with little to no capital cost. These programs often include training, facility-specific energy and cost analytics, energy project identification, and incentives for avoided energy consumption. Two overarching components make the impact of energy management programs expansible to do more than reduce energy consumption. These components are increased familiarity with the facility's energy consumption patterns and engagement with the personnel who most impact facility energy use.

Historically, avoided energy consumption has generally been the primary goal for most utility-sponsored energy management programs. However, there is a recent movement to quantify additional benefits, such as California's total system benefit (TSB) metric. California's Public Utility Commission has transitioned to focusing on TSB instead of avoided energy consumption to encourage conservation at high value times and locations to support grid stability, equity, and greenhouse gas emission reductions (CPUC 2021). In the United States, the vision is to reduce greenhouse gas emissions 50% below 2005 levels by 2030, reach 100% carbon pollution-free electricity by 2035, and achieve a net-zero emissions economy by 2050 (White House 2021). Decarbonizing the grid will increase electrical consumption substantially and the impacts of climate change are forecasted to elevate reliability risks across most of the North American grid (NERC 2023).

Both utilities and their customers, especially larger non-residential customers, particularly commercial and industrial (C&I), are experiencing pressure to decarbonize and to build Emission Reduction Plan (ERP) roadmaps that define their emission reduction measures and implementation timeframes. Criteria needed to define an effective ERP include establishing an emissions inventory, portfolio categorization, assessing emission reduction measures, developing scenarios, and selecting a scenario pathway (Kramer et al. 2023). Common barriers to creating and implementing ERPs are lack of data, difficulty integrating insights into decision-making processes, the logistical burden of data collection and aggregation, and insufficient internal expertise (Saunders and Skinner 2023).

Energy management programs address these barriers by consolidating utility data, which reduces the amount of information the customer must locate on their own. These offerings also provide insight into opportunities the utility is willing to incentivize or promote, which provides information needed for decision-making. And supplementing site-specific information with knowledge of typical technology pillars of decarbonization — energy efficiency, electrification, and renewables — supplements gaps in internal expertise (Eisen and Johnson 2023).

In recent years, interval data has become central to energy management programs with Advanced Metering Infrastructure (AMI) comprising 72% of all electrical meters in the United States (EIA 2023). By providing granular, time-specific insights into energy consumption patterns, interval data enables utilities to design programs that save energy, optimize costs, and support decarbonization efforts (Holmes, Gomatom, and Chuang 2014). This data is particularly valuable in the residential and commercial sectors where extensive datasets already fine-tune program approaches. However, its potential is underutilized in larger commercial and industrial spaces due to challenges like insufficient population size and non-publicly available data. Addressing these challenges can unlock significant value, enabling participant targeting and expanding energy management strategies (Gold, Waters, and York 2020).

Early integration of interval and rate schedule data into utility energy management programs marks a significant advancement, yet the full potential remains untapped in many sectors. To illustrate the potential impacts of data-driven energy management programs, the following sections delve into specific case studies.

Going Beyond Avoided Energy Consumption

A water system in Colorado joined a utility-sponsored SEM program. The facility's on-site leadership and engaged energy team are committed to reducing energy consumption. In summer 2022, the facility's energy team and its SEM implementer reviewed the facility's utility billing structure and their typical load shape, including their peak demand window from 2pm to 7pm on weekdays. During this period, energy is significantly more expensive. Figure 1 illustrates their typical load shape prior to this discussion, which shows a relatively constant power draw.

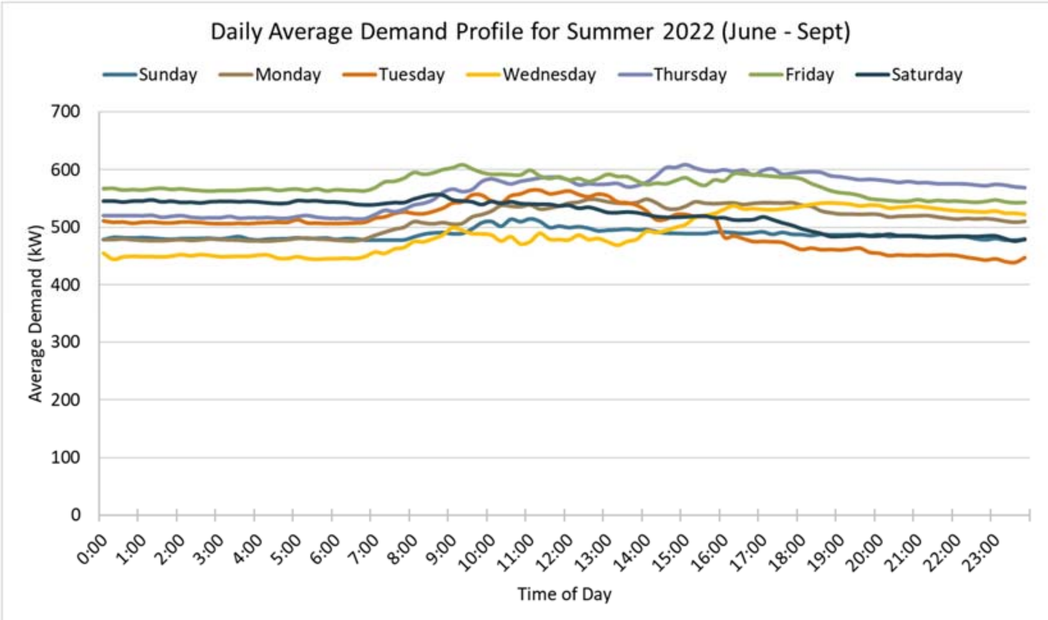

Figure 1. Typical daily load profiles in the summer prior to SEM engagement.

Upon learning that on-peak energy rates are more than 2.5 times higher than off-peak rates, the facility reviewed options and determined they could schedule shutdowns of their reverse osmosis system to reduce peak demand by about 100 kW. The result is a 25 to 35% reduction in peak period energy consumption, as seen in Figure 2.

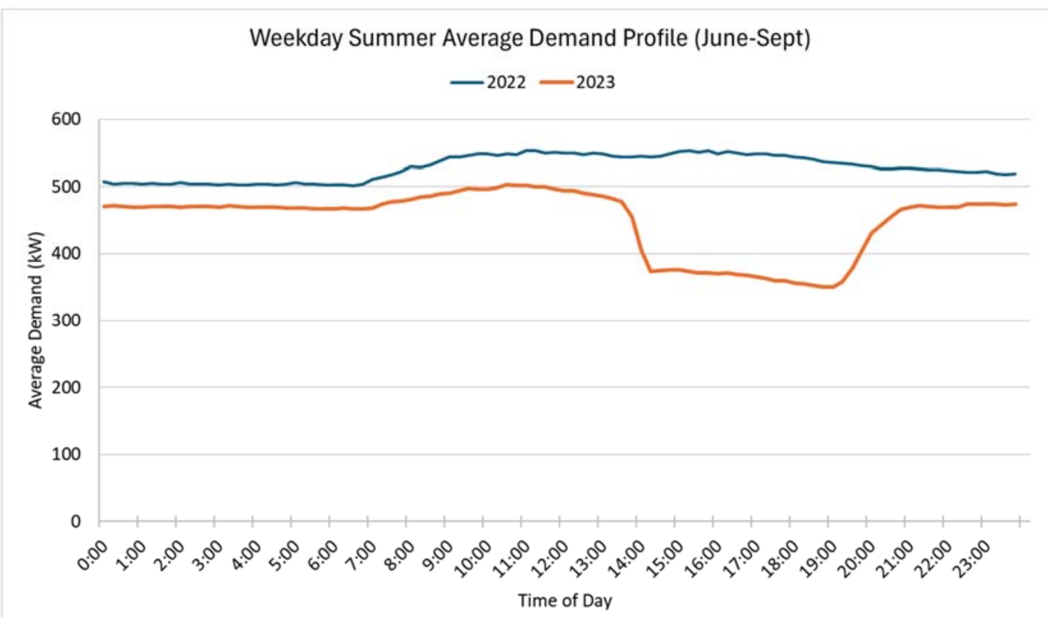

Figure 2. Comparison of pre-program load profile (2022) with load profile after a year of program participation (2023). This figure demonstrates savings from energy efficiency measures and peak demand savings from modifying reverse osmosis operations.

Prior to enrolling in SEM, the facility's energy team was unaware of their rate schedule. The SEM program provided the right combination of energy and cost data to perform a 'what-if' analysis to motivate the team to commit to shifting load to off-peak periods. Without sufficient information to consider cost versus benefit, the facility would likely have never made these operational changes.

Combining Energy, Load Disaggregation, and Energy Costs

As part of a utility energy management program in California, a small manufacturer and their program coaching team mapped the energy consumption of their specific equipment. Disaggregation of energy loads by subsystem is a common practice in energy management programs that helps identify opportunities to optimize energy use. Many energy management programs, including SEM, help participants create an energy map that identifies energy-intensive systems and equipment.

In this case, the energy map identified three grinders as large energy consumers. Because the grinders were operated efficiently and followed a shutdown procedure when not in use, they were not considered when developing initial energy efficiency measures.

Although avoided energy consumption is the core reporting metric for this SEM program, the energy management curriculum includes a module on understanding rate schedules. In this case, the customer and its SEM implementer reviewed the customer's load profiles and rate structure, which included additional demand charges for maximum on-peak power draw. The interval data showing average weekly demand overlaid with on- and off-peak periods in Figure 3 demonstrates a natural ebb and flow of energy consumption. There is no intervention to reduce on-peak power.

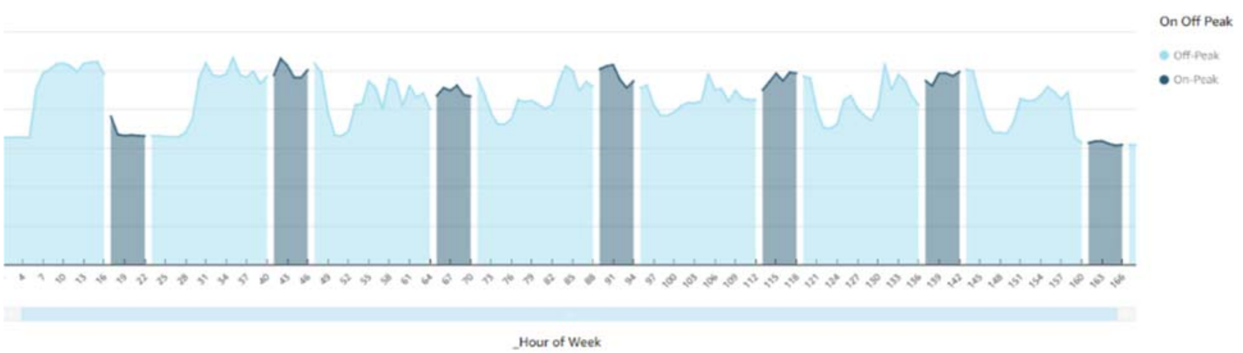

Figure 3. Pre-intervention customer weekly load shape. Darker blue periods are on-peak periods resulting in higher energy and demand rates.

After the SEM implementer provided this analysis, the customer identified an opportunity for cost reduction by shifting grinder schedules. They began shifting their grinding operations outside of the on-peak hours. Figure 4 shows the weekly load profile in the weeks after the customer modified the grinder operation schedule. This facility's production varies substantially week to week, resulting in changes to off-peak period consumption. However, they are able to maintain a weekday on-peak profile similar to the weekend by turning the grinders off during peak periods.

Figure 4. Post-intervention customer weekly load shape. Darker blue on-peak periods have been reduced by about 40%.

The facility now maintains a 40% reduction in on-peak consumption through strategic grinder operation. This result occurred when the SEM implementer provided data analysis showing the potential cost savings from shifting grinder schedules combined with expert coaching to help cement the new schedule as standard practice. In addition to the demand savings, the facility is also on track to save greater than 16% of their total pre-program normalized energy consumption after just two years.

Market Trends that Could Impact Future Evolution

The previous two examples demonstrated how simply visualizing and providing what-if analysis of how load profiles impact electric costs can motivate customers to change their behaviors and operations. This next example demonstrates how one utility is facilitating their customers' decarbonization planning by providing carbon footprint forecasting data and services.

Xcel Energy is conducting demonstration projects in its Colorado and Minnesota service territories. The potential program, called Empower Sustainability, aims to help customers quantify their carbon footprints and leverage Xcel Energy's programs to meet their sustainability goals. The demonstration project includes a variety of customer types including industrial, commercial, and public; with participants to date including a public school district, a university, a wastewater treatment facility, and a manufacturing facility. These customers have previously participated in Xcel Energy program offerings, and about half have participated in SEM.

The demonstration project implementer leads an exploratory meeting with each participant to review ten potential sustainability topics and gauge interest in each. Topics include energy efficiency, electrification, decarbonization, demand response, and renewable energy. Participant staff then attend a tailored workshop that systematically reviews topics of interest, documents high-level opportunities the participants want to pursue, prioritizes these opportunities, and identifies resources for technical and funding support, including Xcel Energy's own demand-side management programs and resources outside of Xcel Energy.

The final deliverable is a report that includes prioritized sustainability projects, resources to support their implementation, the participant's current carbon footprint for Scope 1 and Scope 2 emissions, and forecasted carbon emissions. The forecast is based on estimated project implementation and includes Scope 1 reductions attributable to Xcel Energy's planned grid improvements. Participant feedback on the demonstration project has been positive, especially from those very early in their sustainability planning process.

One reason the demonstration projects have been well received is that Xcel Energy can help participants populate part of their emissions inventory: Scope 2 electrical and Scope 1 natural gas contributions. With those emissions addressed, the participant has less data to collect to complete their inventory, generally the remaining Scope 1 contributions from other fuels combusted on-site and refrigerants. Due to Xcel Energy's own award-winning environmental, social, and governance (ESG) planning, they are able to provide market emission factors through 2032.[1] By simplifying the data collection process and providing long-term information on grid behavior, Xcel Energy is providing a valuable and relevant service for its non-residential customers: understanding their own emission footprint and the actions needed to meet emission reduction targets.

Discussion of Data-Driven Program Recruitment

Most energy management programs measure success based on avoided energy consumption. However, as seen by the examples in this paper, energy management programs are also well-positioned to provide their C&I customers with analytics and coaching to make data-driven decisions related to cost optimization and decarbonization.

The examples discussed previously illustrate the effectiveness of leveraging utility data to promote customer actions that align with utility initiatives. Comprehensive utility data can also be leveraged to address barriers to effective utility program recruitment, including difficulty in constructing cost-effective portfolios and low customer awareness and/or interest in programs (Specian and Bell-Pasht 2023). Population-based targeting analytics are well established in residential and small/medium business programs but are less common in programs serving large C&I customers.

Data-driven program recruitment has been slower to take hold in unique customer sectors where there are insufficient data points to create a homogenous sample. In this case, there is value in looking at the recruitment pool data and considering which customers have the most to gain from program participation. Customers can be prioritized based on higher per kilowatt-hour annual or seasonal rates, load profiles, geographic location (e.g., within a disadvantaged community), historic program participation, and heating and cooling loads. The difference is being able to communicate to a customer the tangible value of what they can achieve through program participation to help overcome awareness and interest barriers.

For example, customers who demonstrate natural load profiles that modulate without reaction to utility grid pricing signals, such as in the second two case studies, are excellent intervention candidates. By using this data in the recruitment phase, the value statement to a potential participant becomes clearer. Being able to say, *"Similar buildings are using and spending 10% less than you during peak periods. Would you like to talk about freeing up that money?"* helps customers understand how their utility consumption ties into their long-term decarbonization and costs.

[1]Xcel Energy is recognized by *Investor's Business Daily* as one of the 100 best ESG companies in 2022, in the top 500 of America's Most Responsible Companies by *Newsweek* in 2023, and as Utility Transformational Leader by Smart Electric power Alliance (SEPA) in 2023 (Corporate Recognition | About Us | Xcel Energy).

Discussion on Energy Management Data and Decarbonization

Energy management programs are effective because they use a framework to meet customers where they are and, over time, educate and build their energy intelligence. Ongoing access to energy data enables customers to track and act when changes occur, reducing the risk of inertia due to complacency or lack of information (Rivas and Kelley 2022). This combination uniquely positions energy management programs to help large C&I customers overcome common barriers to decarbonization efforts, including the following:

- Overcoming Data Barriers: By consolidating utility energy and rate data, energy management programs address the lack of data availability, a significant hurdle in decarbonization planning. Energy management program participants gain access to ongoing data insights, enabling better analysis and identification of improvement opportunities.
- Integrating Insights into Decision-Making: The training and coaching components of energy management programs build customers' energy intelligence over time. Higher energy intelligence assists with evaluating decarbonization strategies that align with their goals and deliver the best return on investment.
- Achieving More per Customer: Customer participation in energy management programs like SEM has also been demonstrated to increase their participation in other utility program offerings (Rubado, Batmale, and Harper 2015), indicating the potential for energy management to serve as a channel to advanced offerings like load flexibility and electrification.
- Supporting Grid Reliability: As the grid transitions towards greener sources, energy management programs can help large C&I customers optimize their energy consumption patterns to minimize spend and emissions.
- Scenario Analysis and Strategy Selection: Energy management programs provide customers with the data and expertise required to compare various decarbonization scenarios. Customers can evaluate the impact of energy efficiency measures, electrification initiatives, and renewable energy adoption on their emissions and operational costs, enabling them to select the most appropriate strategies for their specific circumstances and to reevaluate as technologies advance.
- Aligning Utility and Customer Goals: Energy management programs serve as a bridge, aligning utility goals with customer actions to optimize energy costs, reduce energy use, and lower carbon emissions through utility offerings (Eisen and Johnson 2023). For example, as part of forecasted increases in electric demand, there is programmatic potential to value and advance demand flexibility as a means to promote grid reliability in the United States (Johnson, Fraser, and York 2024).

Through ongoing engagement, data-driven insights, and comprehensive training, energy management programs equip large C&I customers with the tools and knowledge necessary to navigate the complexities of decarbonization. By addressing common barriers and fostering collaboration between utilities and their customers, these programs pave the way for successful decarbonization initiatives that benefit all stakeholders as is already being proven by proactive utilities like Xcel Energy in the third case study.

Conclusion

As energy costs rise and emission reduction targets become more prevalent, large C&I customers must increase their expertise to navigate complex rate schedules, load profile optimization, decarbonization planning, and more. Utility energy management programs are well-positioned to provide data, insights, and coaching to help customers navigate these changes. The prior case studies show how utilities have used energy management programs to deliver insights and strengthen their relationships with key C&I customers.

Utility programs can further help large C&I customers reduce costs and emissions by expanding access to energy data, sharing insights from that data, and offering more energy management coaching services. Energy management programs, with their focus on consumer education and ongoing engagement, are positioned well for this support. These programs offer a progressive approach, starting from understanding annual consumption patterns and implementing straightforward projects, to exploring opportunities for time-of-day and seasonal optimization, and ultimately planning a full decarbonization roadmap.

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