Industrial Customer Case Studies in an Era of Smart Manufacturing

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ABSTRACT

In order to increase industrial customer participation levels in energy efficiency (EE) programs, which often suffer from low participation rates, successful utilities and program administrators have adopted program designs that better meet the unique needs of the industrial customer. This paper provides results from two case studies of the business value brought by ratepayer-funded energy efficiency programs to different industrial energy users. The paper discusses how the business value of ratepayer programs for industrial customers tends to increase as relationships mature and newer continuous energy improvement and smart manufacturing initiatives are taken up, expanding from simpler projects. The paper concludes with recommendations on how other industries might best obtain similar value from their local ratepayer-funded programs, and on how ratepayer program administrators might create better value for industrial customers, expanding their participation.

Introduction

Industrial energy efficiency (IEE) is a low-cost energy efficiency resource that provides productivity and competitiveness benefits to manufacturers and reduces their energy costs.[1] However, IEE ratepayer programs suffer low uptake by industry across many states today, despite the fact the energy efficiency program spending across all customer classes continues to increase.

Significant energy efficiency funds remain on the table for industrial customers. Where effective programs are offered, participating industrial customers can receive significant value and financial benefits, with new energy savings that provide far more financial value in most cases than what they pay in energy efficiency charges.

While the two case studies illustrated in this paper represent different industries and ratepayer program offerings, they show similarities both in terms of the value each customer has derived and in certain elements of ratepayer-funded program design. In both case studies, specific elements of ratepayer programs help to overcome energy efficiency implementation barriers such as corporate upfront capital expenditure payback hurdle rates, insufficient available staff time to devote to developing non-core business operating cost saving projects, and insufficient time and data to clarify cost-saving results. They also reflect success in adopting discrete energy efficiency technologies, nurturing multiple-year relationships, commissioning service providers, and implementing best practices and energy management in the industrial sector.

By delving into these success factors, the paper provides insights for industrial companies considering participating in ratepayer programs, as well as for utilities and third parties looking to maximize IEE potential in their states, encourage greater program participation and develop compelling engagement pathways for their industrial customers.

[1] For a discussion on the importance and benefits of industrial energy efficiency and in-depth background on industrial energy efficiency programs, see SEE Action (March 2014).

Two industries

Two industrial companies: Terumo BCT and Husky Injection Molding Systems participating in two ratepayer programs (Xcel Energy and Efficiency Vermont, respectively) are discussed in this paper.

Terumo BCT's Lakewood facility ("Terumo"), located in Xcel Energy Colorado's service territory, manufactures technologies and devices in manual and automated whole blood processing, collection and cell growth. Husky Injection Molding Systems' facility in Milton, an Efficiency Vermont program participant, manufactures 5,000 injection molding manifolds per year using 48 large metal-cutting machines.

The two companies are relatively large yet energy is still not considered to be a significant cost of production. Terumo counts 2,000 employees but is not energy-intensive, spending just over $1 million dollars on energy per year. Husky has been spending $1-2 million per year on energy but the plant's energy costs are equivalent to only about 1 percent of the company's business volume.

Because energy plays a relatively minor role in operating costs, there is little economic justification for intensive allocation of staff resources for energy management. Efforts to reign in energy costs were therefore nascent before participation in ratepayer programs. However both facilities found value in ratepayer program participation.

Two ratepayer programs

Xcel Energy and Efficiency Vermont provide incentives to encourage adoption of efficient technologies and best practices, and free or cost-shared technical assistance for engineering or feasibility studies, energy management support, and/or project implementation. Both programs rely on support contractors for some aspects of program implementation.

Xcel Energy. Xcel Energy provides prescriptive incentives comprising compressed air, cooling, heating, lighting, and motors equipment and systems. It also has a custom project incentive offering for equipment and process improvements that do not fall within predetermined rebates under prescriptive products. Its main industrial program – the Process Efficiency (PE) program – is a kind of continuous energy improvement program that integrates its technical assistance, energy management support, and incentive programs. Available to industrial customers with energy conservation potential of at least 2 GWh, the program helps industrial customers evaluate both business practices and technical projects, and supports companies to practice energy management as a tool to strengthen existing and ongoing EE activities. The program operates in three phases:

- Phase 1—Identify Opportunities: Xcel Energy offers a no-cost, one-day energy management session (based on the EnVinta One-2-Five® energy management model) to evaluate energy-intensive processes and benchmark energy management practices; Identify energy-saving technical opportunities during a high-level, walk-through audit; and review follow-up assessment report that outlines industrial customers' energy management practices and high- priority action items
- Phase 2—Scope EE Potential: Facilities then develop an energy action plan based on the assessment report. Xcel Energy prepares a customized proposal to help support additional project scoping and provide engineering and technical studies to develop energy-saving opportunities. Xcel Energy funds 75% of the cost of the study. Facility contributions are limited to 25% with a cap of $7,500. If the study costs more than $30,000, Xcel Energy will cover the balance.
- Phase 3—Implement EE Improvements and Qualify for Rebates: After the detailed assessment is completed, Xcel Energy and the customer sign an agreement that

outlines improvements to implement, set a timeline for their installation, and detail customized rebates, bonuses, and support. Xcel Energy encourages the customer to agree to complete projects within a year, but allows longer timeframes if needed.

For the PE program, Xcel Energy account managers rely on a third party energy engineering and data firm, Graphet Data Mining (Graphet), to provide technical support and services for their customers. For custom offerings as well as the PE program, the account manager will also work closely with Xcel's in-house group of efficiency engineers who each have expertise in different areas. The engineering group serves as a resource when necessary to meet and discuss more complex projects with customers. [2]

Efficiency Vermont. Efficiency Vermont's programs for industrial customers involve technical assistance for energy audits, project development, energy management, and employee energy efficiency awareness. Efficiency Vermont offers financial incentives for both customized energy efficiency projects and prescriptive, common-technology applications. Efficiency Vermont also conducted a two-year Energy Leadership Challenge for commercial and industrial customers in 2011, and from there, selected a cohort of industrial customers for ongoing Strategic Energy Management (SEM)[3] assistance through its Continuous Energy Improvement (CEI) program in 2012.

Husky is in the first cohort of businesses participating in the CEI program. The program aims to systematically strengthen internal energy management, using new tools and engaging staff widely to continuously improve energy efficiency.

Efficiency Vermont's program is managed by a team of large-customer account managers centered on assistance with finance and business expertise to support customers' decision making. These account managers team with experienced energy consultants to bring technical expertise to address complex situations and challenges.

Demonstrating success

Working with their respective program administrators/account manager, both Terumo and Husky were able to achieve considerable energy and cost savings through a range of energy efficiency projects (see Table 1). These energy efficiency investments and projects would not have been identified or implemented without technical support, personnel capacity, and planning support provided by the program.

IEE program staff and contractors worked in essence as an extension of both companies' energy teams to provide facility maintenance staff with project identification, packaging, implementation and evaluation assistance.

Table 1. Energy saving results

Customer	Program	Annual energy cost savings (estimates)	Total annual energy savings	Number of projects	Engagement period (yrs)

[2] It also has data center efficiency, new construction, and re-commissioning incentives and a self-direct program.

[3] According to the Consortium for Energy Efficiency (CEE), Strategic Energy Management can be defined simply as taking a holistic approach to managing energy use in order to continuously improve energy performance, by achieving persistent energy and cost savings over the long term. It focuses on business practice change from senior management through shop floor staff, affecting organizational culture to reduce energy waste and improve energy intensity. CEE outlines 14 SEM Minimum Elements to help determine whether its members' programs are SEM programs. Another term used in this paper is "Continuous Energy Improvement", referring to similar programs – i.e. those that aim to continuously improve energy performance – yet do not meet all of CEE's Minimum Elements. For further detail, see CEE (2014) *CEE^{SM} Strategic Energy Management Minimum Elements*.

			through program engagement		
Terumo BCT*	Xcel Energy	$169,000	2,901,057 kWh	18	4
Husky Injection Molding Systems	Efficiency Vermont	$600,000	5,900,000 kWh	46	12

**Includes planned projects in 2015 and 2016*

In both of the case studies, simple or prescriptive projects in the early stages were able to achieve quick gains in efficiency. Longer-term engagements resulted in more complex projects, process efficiency projects and low-cost process optimization and operations and maintenance (O&M) improvements. For example, Figure 2 below shows how Husky's savings accumulate over time with steady participation.

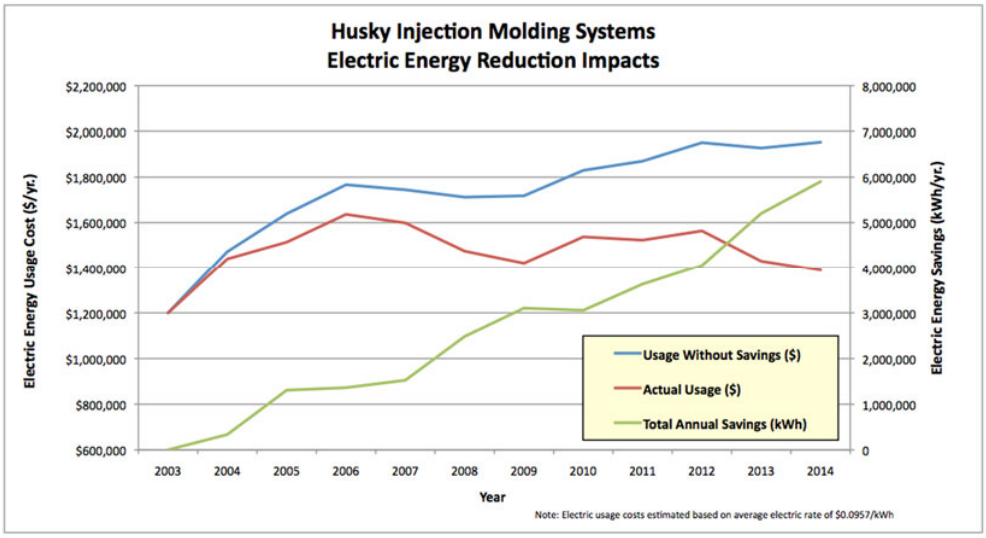

Figure 1. Cumulative energy savings and energy cost savings at Husky's Milton plant, 2003-2014

IEE program value to industrial customers

As illustrated in the case of Terumo and Husky, significant energy and cost savings available to industrial customers when they participate in ratepayer programs. Both companies reported that there were two important value elements they received with program participation: 1) customized technical assistance and support in project identification, packaging development, implementation, and evaluation, and 2) financial incentives to help reduce upfront investment costs.

Financial incentives provided an initial entry point to interest facility and energy management staff, and then served as a tool for facility mangers to obtain internal management support or approval for more energy efficiency capital projects than was possible before. Technical assistance and project planning support provided critical expertise and the time of additional professional personnel necessary to identify and bring opportunities through to implementation. Industrial plant staff said that as the relationship evolved, the technical assistance provided became yet more valuable to them than the financial incentives they obtained.

As relationships grew stronger and benefits accrued over time, customers became more comfortable with the development and implementation of an ongoing EE project portfolio and ventured into smart manufacturing practices, process efficiency projects and low-cost process optimization and O&M improvements. These value elements and program participation evolution are further explored below.

Technical assistance

Technical assistance provided to both customers took various forms, including identification and packaging of project opportunities, both broad and very specific engineering and optimization studies, performance verification of EE projects, assistance in introducing and establishing continuous improvement systems in the facilities, and review of manufacturing processes for efficiency gains through further optimization.

At Terumo and Husky, staff responsible for energy efficiency work are able to attend to energy matters as only one of many tasks they must deliver. As the relationship with their ratepayer energy efficiency program developed, program account managers and key technical contractors helped to fill out the facility's energy team, providing increasingly valued and steady technical expertise to facility managers and others at the plants. The program staff and contractors also helped undertake some of the time-consuming tasks having to do with energy use diagnostics, economic assessment of possible projects, packaging of projects for management approval and contracting, and post-implementation performance assessment.

> *As a manager, I have limited resources. For some of the opportunities I would like to chase, I just don't have the resources to be able to tackle them. When I start a project or ask for money for that project, I may not have as much background as I would like to have. Having added resources provided by Xcel Energy, with the data tagged to it, has helped me present and explain a project. When you are chasing money, you have to tell the story. Having those added resources helped me tell the story. This is* why *we're going to do it, and this is* how *we are going to do it. The program gave us a focus and additional resources that we didn't have on site. That was a huge benefit to our business. We* thought *we were doing the right things, now we* know *we are doing the right things. – Chris Sirbin, Building Operations Manager.*

Terumo has been making full use of Xcel Energy's in-house and contracted experts since their relationship with the utility's energy efficiency account manager began in 2011. The Xcel Energy account manager's initial attendance at one of Terumo's external contractor meetings made all the difference, as Terumo staff were not previously aware of Xcel Energy's program offerings. The continued follow-through, and technical support enabled Terumo to undertake some projects immediately, incorporate others into its three-year scheduling and budgeting processes, and embark on a longer-term, ongoing continuous improvement engagement under the Process Efficiency Program.

Terumo has leveraged Xcel Energy's engineering and feasibility studies as a basis to develop procurement plans and incorporate long-range scheduling and capital investment cycles. When projects were found not to be eligible for rebates (because they had a payback of less than one year), the studies still brought awareness of, and allowed Terumo to go ahead with, these highly profitable EE projects. Terumo would have not otherwise have pursued such projects. The data analytics and real-time tracking of energy use provided by Graphet has also been key to enable the Building Operations Manager to make operations and management changes.

Husky and Efficiency Vermont began their work together in 2001 with simple projects such as electric motor modifications. Dealing with energy use is only one of many responsibilities of the plant's operations staff, and certainly not the most important one. Financial incentives were an important part of the rationale for launching projects. As the plant's maintenance manager put it, "Why not accept the incentives?" Increasingly, however, Efficiency Vermont's account manager assigned to Husky became part of Husky's internal team for developing new projects. Over time, the assistance of Efficiency Vermont in identifying cost-saving projects and helping to package them in ways matching the plant's priorities and budgeting practices became, in the words of the maintenance manager, "even more important than the financial incentives."

The work we have accomplished with Efficiency Vermont is the result of a relationship that has been built over 10 years of collaboration. The consultation services they provide allow us to methodically evaluate potential projects and focus our efforts on the ones that are the most impactful. They have a clear understanding of our business from both an operational and financial standpoint and this allows them to adapt their focus to help us meet our goals. – DeWayne Howell, Husky Injection Molding Systems

Incentives

Financial incentives also have played an important role in the success achieved by the two studied industries in their partnership with their local energy efficiency programs. The incentives offered and paid by the programs in both cases helped substantially in reducing payback periods to below internal hurdle rates (see Table 2).

Table 2. Program incentive effects on project investment payback periods

Customer	No. projects	Total incentive value since engagement ($)	Payback period before (average)	Payback period after (average)
Terumo BCT*	18	$206,917	6.2	4.5
Husky Injection Molding Systems	46	$350,000	2	1.4

**Includes planned projects in 2015 and 2016*

Terumo's Building Operations Manager is thrilled with the ongoing rebates available to his facility. The project incentives, reducing payback periods by 1.7 years on average, were significant in getting more EE projects implemented. The rebates have also been an internal communication tool to obtain corporate buy-in. The facility has monthly departmental update meetings, whereby the Building Operations Manager and his staff report on progress toward their individual cost savings goals. The rebates are an important part of these updates, and occasionally "giant rebate checks" from Xcel Energy have been presented. Written updates also go to the Vice President.

Financial incentives were also helpful to Husky management in reaching decisions about moving forward with energy efficiency projects. The financial incentives Husky received over its 11-year engagement with Efficiency Vermont certainly helped to reduce payback hurdles. The weighted average total investment simple project payback for the entire 2003-2014 46-project

portfolio was 2.0 years, with a project payback for Husky of 1.4 years after incentives were applied (see Table 2).

Smart manufacturing and continuous energy improvement through long-term trusted relationships

For both customers, engagement by their program administrator typically began with prescriptive incentives for simple crosscutting technologies, which were able to achieve quick gains in efficiency. As relationships evolved and benefits accrued over time, however, growing trust enabled more complex custom, continuous improvement projects and process optimizations to be undertaken, generating larger savings.

Smart manufacturing and continuous energy improvement at Terumo. Prior to Xcel engagement, Terumo was already employing various main smart manufacturing practices for reasons other than energy efficiency. The operation uses an automated vehicles line to transport raw materials, products and machines between its various buildings. Its main enterprise software is the Trane Tracer ES, which gives Terumo an enterprise management view into its building control and automation systems. Terumo also uses a power monitoring network of over 150 connected meters and run through the Schneider Electric Square D PowerLogic software and engineering services. The software runs from an application server that provides the visualization of the electrical system for up-to-the-minute energy usage and quality readings as well as long-term trending.

Starting in early 2013, Xcel Energy engaged their PE program support contractor Graphet to work with Terumo in undertaking a continuous improvement engagement. Together, Graphet and Terumo:

- Assembled a cross-departmental team and undertook a self-diagnostic exercise in energy management practices and maturity using the Envinta One-2-Five® energy management model
- Gathered energy and production data, identified key variables, determined an energy baseline and performed a regression analysis using the company's existing metering equipment (2013)
- Completed a full report and energy action plan with energy allocations, a comprehensive list of prioritized opportunities with cost-benefit and payback information (2014)
- This energy action plan is currently being incorporated into Terumo's planning process, with specific projects to begin implementation in 2015.

In November 2014, the Building Operations Manager started pursuing O&M practices according to Total Productive Maintenance (TPM), Kaizen, and 5S principles. For example, he have commissioned design engineering studies to optimize equipment, performed thermal imaging and improved differential pressure across filters for motors. Starting in 2015, Terumo will choose to implement opportunities identified through the PE program, with the potential for an additional 2,112,057 kWh and $ 177,000 in annual energy savings

In parallel, Terumo is integrating its enterprise building automation and power monitoring systems via an integrated dashboard to overlay these systems, and through the PE program and Graphet's assistance, is tying in manufacturing and machine energy into both these systems. Coupled with Graphet's energy data and regression analysis to identify all variables that affect energy use, the continuous meter readings and the overlay dashboard now allows Terumo to monitor equipment energy use and occupancy, measure all its energy use in real time (in

intervals of a few minutes), identify and reduce significant energy uses, visualize its peak demand use curves, identify why those peaks are occurring and can help to smooth those out.

This has allowed Terumo to set energy usage benchmarks within each facility, make system or process adjustments and track possible savings against the original levels. Terumo is now also able to track the impact of energy management practices and projects with increased reliability, and claim substantial energy cost savings.

Smart manufacturing and strategic energy management at Husky. As the relationship and project portfolio between Husky and Efficiency Vermont began to mature, the project portfolio began to change in 2012, with increased attention to the manufacturing process itself and in strategic energy management. Husky and Efficiency Vermont began to review energy efficiency options in the core metal-cutting operations of the plant, installing meters on individual machines and analyzing electricity consumption through the operations schedule.

Husky and Efficiency Vermont devised metering and measurement plans to monitor and compare pump-by-pump electricity use for the Henry machine cutting-fluid pumping system, discovering ways to optimize the operation of plant's pumping system, and to modify machine shut-off protocols, yielding large energy efficiency gains.[4] Husky has since moved to installing permanent meters on its machines.

The costs of these smart manufacturing projects were particularly low, consisting primarily of costs for collection of new information through new metering and data logging, analysis of results, and operational re-design. With investment costs of only about $31,000 and annual savings of approximately 2 GWh of electricity, the strict payback on the dollars invested in the two projects was only about two months.[5] However, the project required substantial technical assistance from Efficiency Vermont, which conducted the initial metering and data analysis work, and worked closely with plant staff on the operational re-designing.

Primarily due to the smart manufacturing projects and compressed air system audit effort, the weighted-average total investment simple project payback for Efficiency Vermont's Husky portfolio from 2012 through 2014 was just 0.7 years. Efficiency Vermont's financial incentives brought the average payback for Husky down to 0.4 years. With the contribution of these economical projects, the weighted average total investment simple project payback for the entire 46-project portfolio was 2.0 years, with a project payback for Husky of 1.4 years (see Table 2).

With the commitment of plant management, Husky's plant has moved further to participate in Efficiency Vermont's relatively new Continuous Energy Improvement (CEI) Program for businesses, a strategic energy management program. Working with Efficiency Vermont, the plant is beginning to use a new energy management information system (EMIS) that can help identify opportunities, especially those involving further system optimization. The plant has also benefited from an application of Efficiency Vermont's new Industrial Peak

[4] The test results showed that there was significant demand on the Henry system and, accordingly, on its electricity consumption—in excess of what the machines actually needed. Further investigation found a key cause to be the fluid diverter valves, located where the Henry system piping enters each machine. The valves enable pressure to be lowered for each machine from the high-pressure system by allowing fluid to exit to the collecting trough. The valves were set with conservative, longtime assumptions and rarely adjusted. Fluid at pressure was being fed into the collecting trough at all times, whether machines were in use or not. Following the test results, Husky's maintenance division decided to plug the diverter valves, allow full line pressure to the machines, and adjust line pressures. In addition, Efficiency Vermont installed variable frequency drives (VFDs) on the pump motors. Subsequently, and also based on metering results, Husky and Efficiency Vermont also discovered that electricity consumption could be significantly reduced by using emergency-stop controls to shut off machines not in use, rather than simply putting machines in idling mode.

[5] This calculation excludes investments in a pressure accumulator, made later by the plant itself, to complete the Henry system operational re-design.

Initiative Tool, which helps identify electricity costs savings through improved management of the timing of its electricity loads. The plant's maintenance manager feels that broader staff engagement is a key part of the initiative, which helps machine operators and others become more aware of how they can help reduce energy costs.

Conclusions and recommendations

This paper has highlighted two success stories of industrial facilities that are deriving considerable value from their ratepayer industrial energy efficiency programs. The two customer case studies in Colorado and Vermont explored how specific elements of ratepayer programs have helped overcome energy efficiency implementation barriers such as corporate upfront capital expenditure payback hurdle rates, insufficient available staff time to devote to developing non-core business operating cost saving projects, and insufficient time and data to clarify cost-saving results.

The studied customers are saving hundreds of thousands of dollars on their energy bills each year.[6] For these facilities, which are not particularly energy-intensive operations and energy is not a central operating cost, these significant financial savings would in all likelihood not have been obtained without the support of the local ratepayer-financing programs. The programs provided facility maintenance staff with needed additional expertise to identify, package and implement the energy efficiency projects. The programs also provided incentives to buy down upfront costs to levels where payback periods met levels acceptable to the enterprises.

Strong interpersonal relationships between efficiency program administrators and contractors and facility staff proved central to the depth and success of engagement, providing the glue that enabled benefits to accrue to their customers. As relationships grew stronger and benefits accrued over time, customers became more comfortable with the development and implementation of an EE project portfolio, and with the program participation process overall.

Although the financial and technical support from the program remained important, especially as projects tended to move towards more system-specific and complex areas, facility staff also became increasingly willing to put in additional internal time and resources towards continued project identification and implementation, thereby achieving ongoing energy savings.

The local ratepayer programs involved exhibited difference in the mix of staff and contractors for program delivery and the ways that program offerings were structured. However there also were key similarities in these two successful cases, including:

- A specific and competent account manager or technical contractor point person was assigned in each case to the industrial program participant. Continuity of this assigned person was key for the development of the steady, multi-year relationships that proved important for success.
- The programs offered custom project incentives, in addition to prescriptive incentives. The custom project incentives were typically part of a broader project development and packaging support effort, and incentives levels specifically considered buy down of specific project payback rates. The prescriptive incentives remain important though as a means to get new customers, leery of these programs, engaged.
- Technical assessment, project identification and packaging, and technical-economic performance assessment support were important element in the program support, in addition to financial incentives.

[6] Productivity improvements, water savings and non-energy benefits, while they have not been monetized in all cases, would likely increase total financial values further.

Programs evolved over time with the changing needs of customers and maturity in the participation relationship. Both program and facility staff developed more sophisticated understanding of the energy use patterns and opportunities for efficiency gains and are moving towards process optimization, smart manufacturing and SEM and/or continuous energy improvements.

Recommendations for industrial customers considering participation

Facility maintenance or other staff at industrial companies considering participating in the energy efficiency offerings might best obtain maximum value from their local ratepayer-funded programs by:

- Requesting an on-site presentation by program staff of incentives and programs offered by the local ratepayer-funded program that may be applicable to the plant. A discussion of the energy issues of greatest importance to the plant might best follow.
- Requesting assignment of a stable program person of contact, and exploration with the contact of incentives and assessment/technical assistance programs of primary interest to the plant. Project payback periods before and after incentives should be calculated.
- Implementing several projects in cooperation with the ratepayer-funded program and using available incentives. Selection of relatively simple or small projects may be a good place to start. Assistance in completing program procedures may be requested. Technical expertise from the program may be leveraged to lessen the burden on staff. Once projects are completed, sound technical and economic performance assessments should be requested, to help the plant as well as the program evaluate results. If satisfied, the plant staff may wish to proceed with:
- Considering integration of energy efficiency projects with program support into the plant's capital budgeting cycle, with the plant availing itself of additional incentives and what technical support may be available and desired.
- Considering participation in SEM or continuous energy improvement programs, if offered, as a continuing mechanism to identify and implement more low-cost projects. Smart manufacturing practices and technologies may also help to further enhance continuous, low-cost energy savings.

Recommendations for program administrators

In many states the industrial sector accounts for a large slice of the cost-effective potential for energy efficiency gains, and hence deserves commensurate attention from ratepayer-funded energy efficiency programs (SEE Action 2014, Aden 2014). However, generating effective participation in industrial program offerings requires a hands-on, more customized approach for these relatively large energy users with differing needs. As demonstrated in the case studies, technical assistance and application of expertise at the plant were a key part of the value of program participation for the industries, complementing financial incentives geared to overcoming the project approval requirements in the industrial companies. Neither of the cases relied on financial incentive support alone, without additional technical support. For the technical expertise to be most valued, program experts needed demonstrate understanding of the specific energy needs and concerns of the given plant and its processes. When the relationship worked well, program staff and expert were viewed as part of the energy team of the facility.

Additional important program value elements that contributing to greater uptake or success in the cases reviewed included:

- Development of multiple-year relationships between the utility/program administrator and industrial company personnel, involving a steadily evolving program of support and efforts to identify multiple projects over time (rather than a single project). Continuity in assigned program staff is important.
- Development of programs that can target energy efficiency gains in manufacturing processes, in addition to energy used in support systems, such as lighting, HVAC, compressed air. However, process improvement investments will almost never happen for the sole reason of increasing energy efficiency. Therefore, program flexibility, accommodating project scheduling and multi-year planning cycles, is needed to allows industrial customers to participate as part of conducting their regular business.
- Development of programs involving Strategic Energy Management (SEM) that support internal company platforms for continual identification and implementation of energy savings measures, high-impact and low-cost behavioral changes, and operational and maintenance improvements
- Promotion of smart manufacturing[7] and enhanced metering practices, such as (1) installing sensors and embedding devices in software that communicate with one another and with other systems through networks; (2) automated control; and (3) improved measurement and management via cloud-based data analytics. Smart manufacturing brings about significantly enhanced and often more granular key data, thus offering efficiencies in process or organization, and a reduction in the energy intensity of manufactured products.

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[7] For a detailed discussion of smart manufacturing, see Rogers (2014).

Detailed case studies of the two industries illustrated in this paper, as well as two additional industrial customer case studies, are included in the SEE Action white paper.