Engaging the Industrial Sector in Efficiency and Renewable Energy Programs

Gary Epstein, ERS, Haverhill, MA
Mark D'Antonio, Chris Smith, Brian McCowan, ERS

ABSTRACT

The industrial sector is the most difficult sector to involve in the implementation of efficiency and renewable energy projects. Although it shares many facility-based end uses (lighting, HVAC) and potential measures with the commercial sector, these areas are not industry's greatest concern. Typically the energy dollars spent on the production of product is dramatically higher than facility end use system expenditure. Approaches to promote energy projects in the industrial sector necessitate an enhanced understanding of the site-specific production process involved and must address potential measures in a way that improves rather than detracts from reliability and productivity.

This paper discusses some highly effective programmatic approaches that have demonstrated considerable success (in promoting both energy efficiency and renewable energy projects in the industrial sector. Such success is realized through motivated participation; supported and guided participants; cost-effective projects; and an expanding base of energy efficiency. In demonstration of these approaches we will discuss program models for both Efficiency Maine and NYSERDA.

For the NYSERDA industrial programs, we will discuss two distinct efforts that have been successful and effective at promoting projects at industrial sites, particularly as they work in concert with each other. NYSERDA's R&D initiative is a technology-focused effort that has an objective of identifying and funding unique projects that can enhance industrial manufacturing processes. The NYSERDA focus outreach efforts have a marketing and outreach basis that is intended to effectively reach out to the larger facilities and present them with the benefits of participation.

Examples of these program approaches and case studies of several unique projects will be discussed in detail. These will include the Steinway & Sons' innovative solar absorption-driven chiller and the Maine ski industry's efficient snowmaking technologies.

Introduction: Energy Use and Needs of the Industrial Sector

The industrial sector has remained one of considerable challenge to energy efficiency program delivery organization. Most of the general prescriptive measures that are applicable and available through efficiency programs, such as lighting, HVAC, and basic controls) do indeed have relevance and applicability at industrial sites. But the majority of energy use at larger industrial sites are associated with equipment that is associated with the manufacturing process. Significant efficiency opportunities have been demonstrated in these process realms, but specialized and focused programmatic approaches are necessary to gain the deeper interest of industrial facility management, and facilitate process-focused measures.

Manufacturing facilities, in addition to basic facility end uses, have a number of very specialized energy systems. Some of these are common to many or most industries, know as cross-cutting technologies, while others are process- or industry-specific. The major cross-cutting technologies include compressed air, steam systems, fan and pump systems, process heating, process cooling, refrigeration, and specialized process space conditioning. Because of the prevalence and energy intensity of these end use system, these have been the subject of considerable interest, and there are even some prescriptive measures that are applicable to these technologies. Still, due to their complexity, measures for these cross-cutting technologies largely fall into the custom category, and savings must be uniquely developed for each specific project.

The process-specific energy systems are incredibly diverse, in fact as diverse as the realm of different manufacturing industry types and different product types. The range of manufacturing processes addresses equipment used for food processing, primary metals development and fabrication, plastics forming, and specialized assembly of countless products. Depending on the industry, process, and product being manufactured, the energy used by these process systems, along with the cross-cutting technologies that serve them, can frequently dwarf that used by the basic facility lighting and space conditioning systems. Examples of some of these energy intensive process systems include injection molding for plastics manufacturing, induction furnaces for metals processing, and process heating systems for chemicals production.

Beyond the diversity and energy intensity of many industrial operations, there are several other characteristics that make working with facility management at these buildings and sites different than basic commercial operations. First, there is always a primary focus on stability and integrity of their production systems. Industrial facility managers will not be inclined to pursue measures which they believe could jeopardize their operation. They will be disinclined to work with energy consultants who do not have sensitivity to these issues. Further, they seek consultants who are understand their processes and will work creatively with them to develop energy projects that do not adversely effect their production.

With all this in consideration, many energy programs throughout the country have been highly successful in engaging the industrial sector. Industrial energy efficiency efforts have resulted in some of the most significant projects, demonstrating considerable energy savings, unique technologies, and great value for the customer. Programs that have been successful have taken care to consider the needs of the sector and to bring value to these end users, from a promotional, technical, and productivity basis.

The subsequent sections of this paper will provide examples of active programs that have had great effectiveness in serving industry. Examples presented, those at NYSERDA and Efficiency Maine, have taken steps towards sector-focused outreach approaches, supporting demonstration and research efficiency projects, have worked with the vendors that support these industrial sites, and have used energy consultants that have a sound understanding of the specific industrial processes and facility needs. Following a basic description of the key elements of the programs that serve the industrial sector, we will provide case study examples of projects that are unique and demonstrate both programmatic success and great value to the customer.

NYSERDA: Programs That Effectively Serve Industry

The New York State Energy Research and Development Authority's (NYSERDA) has a comprehensive array of program offerings and service initiatives that have been very effective at serving industrial customers throughout the state. These program elements partly act as separate initiatives, though they also work in concert, with the objective of optimally serving their significant industrial base.

Existing Facilities Program (EFP)

The NYSERDA Existing Facilities Program (EFP) is the primary incentive program for both commercial and industrial customers in existing facilities. Projects can fall into prescriptive (pre-qualified) or custom categories. The pre-qualified category of incentives primarily addresses more standard commercial facility type projects (lighting, chillers, HVAC, motors, VFDs, commercial refrigeration, and assorted natural gas measures), so most cross-cutting technology or process-specific industrial measures would receive incentives on a custom path.

FlexTech Program

The FlexTech program's primary focus is to increase productivity and economic competitiveness by identifying and encouraging implementation of cost-effective energy efficiency measures. NYSERDA has contracted with engineering firms that were competitively selected through an RFP process, to provide a variety of technical assistance services to New York State companies, custom-tailored to their energy-related needs. These services are provided on a cost-shared basis, and include:

- Engineering feasibility and technical assistance studies
- Detailed analysis of specific energy efficiency projects
- Process improvement
- Rate analysis, load shapes, and energy service aggregation
- Engineering in support of project-financing proposals
- Development of long term capital budget strategies for the upgrade or replacement of energy-consuming equipment
- Retro-Commissioning of energy-efficiency measures in existing buildings

In regards to providing best possible service for New York State industrial customers, the pool of FlexTech consultants consists of many firms that have significant process and manufacturing energy efficiency experience. Many of New York's major industrial operations have developed long-term relationships with the highly qualified industrial consultants under contract to NYSERDA to provide technical support and guidance on development of creative and cost-effective industrial energy efficiency.

Industrial Research and Development

Conducting a multifaceted energy and environmental research and development program has been a central responsibility at NYSERDA since its inception in 1975. NYSERDA's R&D Program supports the development and commercialization of innovative energy and environmental products, technologies, and processes that improve the quality of life for New York's citizens and help New York businesses to compete and grow in the global economy. NYSERDA's R&D Program has been instrumental in attracting new businesses to New York, enabling companies to expand, retain and create new jobs, and increase profitability for many businesses across the State.

NYSERDA's Industry R&D program helps New York State manufacturers adopt or invent energy-efficient, environmentally friendly technologies to reduce cost and improve production efficiency. Several programs are offered to rejuvenate the industrial sector of New York State. The sector currently employs nearly one million people and contributes $80 billion to the Gross State Product. Industry R&D provides opportunities to increase market acceptance and market penetration of clean, efficient technologies as well as facilitating early adoption of emerging technologies such as distributed generation (DG) and high-temperature superconductivity (HTS) cables. Industry Research and Development currently has five programs areas:

- Process Improvement and Product Development
- Distributed Generation/Combined Heat and Power
- Emerging Technologies
- Transmission and Distribution (case studies not available)

NYSERDA conducts active solicitations approximately two to three times annually in support of development of new industrial research and development projects. Projects are selected based on their cost-

effectiveness, innovations, likelihood to benefit New York State, and the reproducibility of the concept for other industrial sites in New York.

Industrial Focus Outreach

Supporting all of the NYSERDA programs that serve the industrial sector is their focus outreach service. The industrial sector is one of several sectors for which NYSERDA has achieved success through contracting with one or more firms to market, promote, and provide technical guidance to potential customers, particularly focused on larger end users. Unlike utility-run programs, NYSERDA's initiatives cannot rely on an in-house cadre of account representatives who have ongoing relationships with larger customers, though only one of their functions is associated with program guidance. To address this issue, NYSERDA has developed this pool of sector experts who can support guide end users towards participation, and technically and administratively assist those customers as they move through the implementation of complex projects.

For larger industrial facilities, it is critical that NYSERDA's selected Outreach Consultants have both marketing/promotional capabilities along with industrial technology and measure expertise. Thus, the outreach team must have knowledge of the industrial site, cross-cutting systems, and the specific processes that are applicable to a given customer. Working closely with the industrial customer, the outreach consultant guides the customer in development of measures, recommends participation in the FlexTech study process (if applicable), and supports the effort as the customer investigates incentives and grants through programs such as the EEP or the R&D initiative.

Efficiency Maine's Programs and Promotional Approach

The Efficiency Maine Business Program, which serves both existing commercial and industrial Maine customers, has been highly successful, in general, but has had great success in working with the Maine industrial base. In fact, while industrial facilities represent just over 5 percent of all businesses in the state, the program participation records show that approximately 32 percent of all participants are in the manufacturing sector. The Efficiency Maine team, a unique combination of the Maine Public Utilities Commission, the Efficiency Maine contractor team (led by ERS), and a network of trade allies, has developed successful, long-term relationships with many industrial customers who not only participate in efficiency efforts on a regular basis, but have made corporate commitments towards greater green practices and higher levels of sustainability. One of the regular participants, Sugarloaf Mountain Resorts, has had continual relationships with the Efficiency Maine team, and has implemented many efficiency measures, just one of their directions in a broad push towards environmental stewardship and sustainable practices. They are outlined later in this paper.

There are several important elements of the Efficiency Maine Business Program that have been highly effective at serving industry. Certainly, the basic incentive structure and offerings have been instrumental in ensuring the success of the industrial efforts, and as with the NYSERDA EFP, most industrial efficiency measures are treated as custom projects. Other key features of the Efficiency Maine efforts that help to best serve the industrial base in Maine include:

Field Staff Network

A significant percentage of the Efficiency Maine contractor staff members are effectively serving in a non-engineering field capacity. Their primary responsibilities including working with customers,

particularly end users, to support their efforts to identify and develop projects, to find the resources to assess savings, and to do basic “hand-holding” as the facility moves through the application and installation process. These staff has also been instrumental in the development and training of the ally network that will be discussed. In effect, the field staff is functionally comparable to a utility-run program’s account executive network, or the outreach contractors that play a vital role for NYSERDA’s industrial sector.

Engineering Staff Network

Another major component of the Efficiency Maine programs are the engineering staff assigned for custom project development and review. These staff works very closely with the major industrial customers. They function with customers to identify projects, scope out best approaches, quantify savings, or review savings estimates developed by others. Later on, they will work with field staff and the customers to support the implementation process, inspecting key projects and deploying monitoring systems to best understand savings achievements. Lastly, the engineering staff serve as technical liaisons to the trade ally network, making sure they understand program technical requirements and specify systems that meet measure qualification criteria.

Trade Ally Network

Efficiency Maine has built up a substantial infrastructure of program allies representing different kinds of firms, targeting different customer segments and covering most regions of the state. Clearly, many of the major trade allies serve and focus on the significant industrial sector. It is noted that relatively few program allies account for the majority of projects.

Efficiency Maine works with two different kinds of program allies. The first, and the majority, are traditional trade allies. These consist of contractors who deliver services directly to customers. The second are non-traditional allies that are market intermediaries such as associations and wholesalers.

The training of trade allies has evolved. Program staff found that breakfast/trade meetings did not work for trade allies. Now program staff are working with several different professional associations (electrical, HVAC, metalworkers, agriculture) to integrate recruiting and training of trade allies in pre-established forums such as annual meetings.

Program staff report that it has taken program allies a while to see the benefit of the Program. They report that now allies are approaching program staff for training and even asking for program staff to go on joint customer calls with them.

With the increased importance of efficiency, rapid advances in technology, and growing demand for expertise with equipment and the programs, Efficiency Maine management has found it now helpful to develop multiple levels of trade ally qualification. Companies earning their new designation, Qualified Partners, must meet some new requirements (minimum number of projects annually, attendance in partner trainings), but will also receive important benefits from Efficiency Maine (such as leads on key projects). A considerable number of the Qualified Partners have been developed to ensure appropriate levels of expertise and service to the industrial sector.

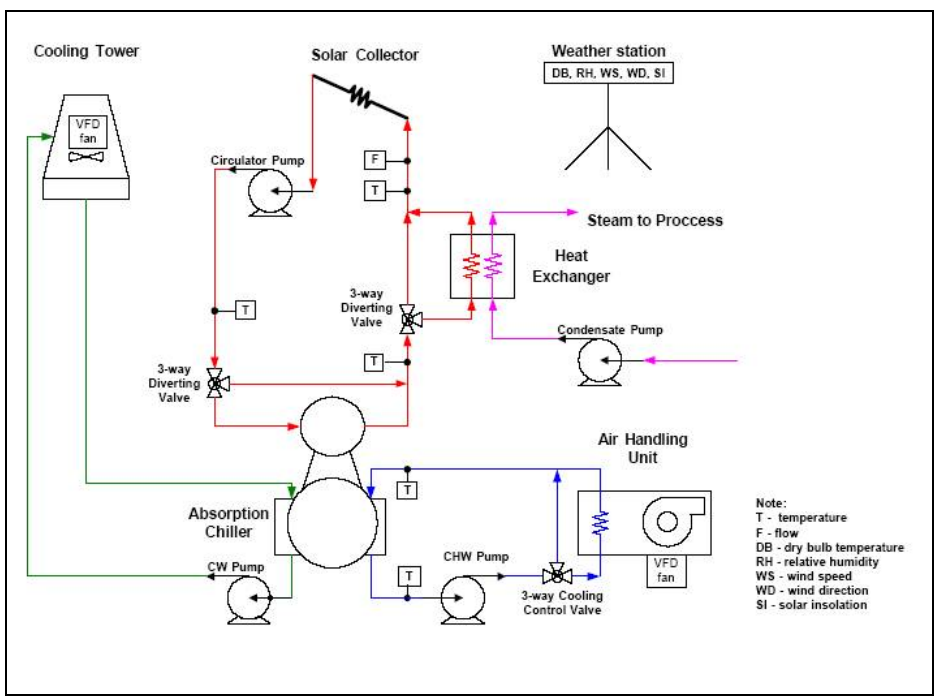
Case Study 1: Steinway& Sons - Solar Industrial Cooling

Steinway & Sons, the famed manufacturer of state-of-the-art, high quality pianos, has had a remarkable history of working closely with NYSERDA, participating in a number of their programs. Steinway has regularly claimed that the vigorous outreach efforts, the network of supportive trade allies, and the industrial-focused array of programs have been instrumental in supporting and motivating their participation. They have participated on a regular basis in the Existing Facility Program, receiving incentives for a variety of projects. In recent years, as they have made an active push to expand their sustainable practices, they have worked on development of new energy efficiency by participating in the FlexTech program. They also have an active pursuit of renewable energy projects. Most recently, they are active participants in NYSERDA's R&D program, working on the development of innovative projects that are both cost-effective and models of sustainable development. The focus of this discussion is on their ongoing implementation of an expansive solar thermal cooling and dehumidification system.

Steinway & Sons manufactures their legendary pianos in the Queens borough of New York City. Their manufacturing facility was built in the 1870s and is not air conditioned. In their second-floor Action Department, employees build the hammer assemblies that strike the piano strings. The department's heating system consists of two 600-hp dual fueled boilers that inject low pressure steam into the space as needed to manage humidity in the winter but has no means of dehumidifying or otherwise conditioning the space in the summer. Maintaining consistent humidity is important in order to control moisture content of the wood components in the assembly.

Steinway has embarked on a dehumidification project factory wide to ensure product quality and decided to begin with the Action department. Installing a conventional packaged rooftop system was an option, but ultimately they decided to install an innovative solar-thermal cooling and dehumidification system in lieu of the more conventional approach. Figure 1 illustrates key components of the system being installed at Steinway.

Figure 1. Solar Thermal System Components



Thirty-eight Abengoa Model PT-1 solar collectors mounted on the roof concentrate heat onto evacuated glass tubes, heating a pressurized water and glycol mixture from nominally 320ºF to 340ºF (the red loop in diagram). Photographs of the collectors are shown in Figure 2. The actual temperature varies with solar availability but is limited to 350ºF maximum. When cooling is needed the diverting valve directs this hot water to a 99-ton double-effect absorption chiller. The chiller has a rated coefficient of performance (COP) of 1.39 and integrated part load value (IPLV) of 1.586. The dual-fuel chiller uses natural gas when solar is not available and cooling is needed. It can use gas to supplement solar-sourced energy or run entirely on gas. The Broad dual fuel design (fossil fuel or hot water-fired) is relatively new, having been introduced in this country in 2005.

Figure 2. Abengoa IST Parabolic Solar Collectors (stowed position)

The absorption chiller otherwise operates like other conventional chillers, cooling chilled water for the air handling unit (the blue loop in Figure 1.) and rejecting heat through a condenser to a cooling tower (the green loop in Figure 1). When dehumidification is not needed and the collectors can generate hot water above 275°F, the hot water circulates through a vertical helical tube and shell steam generator heat exchanger and produces 15-psig process steam to offset a portion of the plant's constant 1,200 kBtu/hr load (the magenta loop in Figure 1). A control system integrates the collector field and field circulator pump controls, chiller controls, and the steam generator diverting valve. The system is fully instrumented with flow-meters, temperature sensors, a pyronometer and weather station to monitor and record the system performance. If there is a loss of power or load during daylight operation, the controls will instruct an emergency power pack to place the collector field in the stow position.

Solar Thermal Project Economics and Programmatic Considerations

The total project capital cost of the solar thermal installation is about $1,050,000. The air-cooled system option would have cost about $250,000, clearly considerably less costly. The project made considerable use of external funding and tax benefits. The NYSERDA Research & Development grant contributed funding for the initial feasibility study and project oversight by ERS, as well as $300,000 towards the capital cost and advanced instrumentation. In addition, federal tax credits pay for 30% of qualifying renewable system costs and is expected to be about $175,000. Federal accelerated depreciation improves the project economics further. The system is not only eligible for the federal 5-yr Modified Accelerated Cost Reduction System (MACRS) but also for a special 50% bonus depreciation, which applies to qualifying renewable systems.

There are also New York-specific property tax advantages to the system and potential renewable energy credits. All of these elements are effectively external funding that improves the project cash flow and present value.

Employee comfort and associated productivity are expected to increase but were not monetized. Sales increases due to higher quality also are possible.

NYSERDA Programmatic Considerations

Steinway & Sons is a valued industrial participant in the NYSERDA portfolio of programs, having participated in a wide variety of initiatives as they progressively adopt energy efficiency and renewable energy projects. For the solar thermal cooling project, clearly the major program that has benefitted Steinway is the R&D program. In this case, the program is ideally suited for this unique and ambitious project, and NYSERDA also benefits since the project has already created considerable attention and good publicity for the program contributions, both financial and technical. It is also noted that a broad network of program contractors and allies, including energy consultants and equipment vendors (of solar and HVAC equipment) were instrumental in the implementation and success of the project.

Case Study 2: Sugarloaf Mountain Resort - Efficient Snowmaking Project

Many industries are important in the state of Maine, including pulp and paper, food processing, ship-building, and agriculture. While not a traditional manufacturing sector, the ski industry falls into the industrial sector due to its unique end uses and the fact that for much of the year they are in the business of manufacturing snow. Many large ski resorts are dominant in the state, with many functioning on an annual basis, and with the snow-making operations progressively lasting for a longer season.

Sugarloaf Mountain Resort in Maine, USA is one of the top year-round destinations in New England. The resort offers many winter activities including skiing, snowboarding, tubing, nordic skiing, snowshoeing, concerts, slope-side lodging and terrain parks. Summer offerings include hiking, mountain biking, moose viewing tours plus facilities to host conferences and weddings. You can also view Sugarloaf snow reports, web cams, photos, videos and everything you need to plan your Sugarloaf vacation.

Sugarloaf is also a leader in environmental stewardship and they work on a continual basis to preserve the natural environment in their region of Maine. Through innovative programs involving waste management, community outreach, bio-fuels, waste water treatment, and low energy snowmaking, Sugarloaf has been recognized and certified as a leader in the resort industry. The focus here is their continual participation in the Efficiency Maine programs, working with the program's trade allies to address all end uses, particularly their energy intensive snow-making operations. While Sugarloaf had been on a path of environmental leadership, their efforts in energy efficiency were initially motivated by vendor trade allies (compressed air, pumping, and snow making vendors) and program outreach and field staff.

Areas for Reducing Energy Use in Snowmaking

There are four fundamental areas to consider for reducing energy use in snowmaking systems that are related to the three basic energy operations involved in all snow production (air delivery, water delivery, and the inherent requirements of the snowmaking equipment). Following is a discussion of each aspect of snowmaking systems that impacts energy consumption. Any snowmaking energy efficiency recommendations must consider the snowmaking equipment, operational control of the system, compressed air operations, and water pumping systems.

Snow Production Equipment. Snowmaking equipment is composed of the actual devices that mix (compressed) air and water to nucleate snow crystals and direct snow to the desired areas. Some systems are inherently more efficient than others, using less air or overall energy to produce a given mass of snow. In addition, each equipment category represents differing performance curves under varying climatic conditions, complicating the task of choosing snow delivery technology.

Control of Snow Production Equipment Operation. Considerable compressed air and water pumping energy and resource savings can be achieved through proper and effective optimizing control of the air and water mixture that is directed to snow production equipment. It is typical that valves controlling these mixtures are not controlled effectively and considerable energy is wasted.

Compressed Air Systems. Compressed air systems for traditional snowmaking operations generally require thousands of horsepower of air compressors. Considerable energy savings can be readily achieved through typical compressed air efficiency measures addressing plant efficiency, air system control, and air loss minimization strategies.

Water Pumping Systems. Snowmaking operations involve hundreds or thousands of horsepower of water pumping. Considerable savings can be achieved through efficient pump selection, pump system and water flow control, and modifications to pumping operations that involve inefficient pumped recirculation back to system reservoirs.

Snowmaking at Sugarloaf

For the past several years, Sugarloaf has been on the leading edge of technological advancements in adopting new snowmaking equipment, which have allowed the resort to greatly expand its snowmaking capacity without a marked increase in its energy consumption.

Since the 06-07 season, Sugarloaf has utilized an ever growing fleet of low-energy HKD snow-guns, which are able to produce the same amount of snow as traditional equipment, while using 40 percent less energy.

Sugarloaf has also acquired 30 Boyne proprietary, high-output, energy efficient fan guns over the past two seasons, which specialize in producing snow at warmer temperatures, while using considerably less energy than traditional snow-guns.

During the 2008-9 ski season, Sugarloaf Mountain again worked with Efficiency Maine field and program staff as they added additional snowmaking capacity. As quantified by the Efficiency Maine team, savings for this latest project were near 400,000 kWh. The efforts at the resort have been a model of the excellent and ongoing Efficiency Maine coordination with their industrial and process operation clients. In this case, field staff, engineering staff, and members of the trade ally network were all

involved in a very substantive way in many aspects of the snowmaking project implementation.

Conclusion

This paper has presented information on the key program elements that effectively serve industrial customers. Two program portfolios, that of Efficiency Maine and NYSERDA, are highlighted to demonstrate the specific offerings they have that have had significant industrial sector participation. Last, two case study projects from these two programs. While both projects are quite distinct and unique representations of process projects, their commonality is the depth of service, the talented network of technical and administrative guidance offered, and the considerable financial incentives for participation. Finally, both of these projects and the programs that have motivated the activity provide high levels of quality control, ensuring that the customer does indeed achieve the savings and that the program does get credit for all of the kWh impacts sought. While the efficacy of these programs has been discussed here, it is the view of the authors that the individual elements of each of the programs are mostly standard. We believe, however, that it is the aggressive and integrated nature of the various program components for NYSERDA and Efficiency Maine that has led to their overall success. We are confident that similar approaches can be readily replicated for programs that are seeking to more effectively reach and serve their industrial base.