Seattle City Light Networks to Develop Industrial Efficiency Projects

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Introduction

Seattle City Light began offering custom grants to industrial customers for the purchase of more energy efficient electrical equipment in 1987, with high expectations based on success in the commercial sector. Eight years later and several training courses wiser, the barriers to succesful projects remain and continually change. A total of 40 grant projects have been completed with 30 different industries, yielding (short term) verified savings of 14.5 gWh annually at an average cost of 10.3 mills per kWh of savings. This amount of experience has not provided us with shortcuts to new project development.

The ideal industrial situation for promoting efficiency improvements would be one in which there are plenty of plant staff who have explicit direction from plant management to make improved energy efficiency a priority and are provided with a noticeable capital budget, sufficient time, and sufficient information. Depending on the particular case, the utility tries to make up for missing factors.

This paper explains some steps Seattle City Light has taken to bring information about energy efficiency improvements to its industrial customers. Often the plant staff are imperfectly informed about efficiency opportunities BECAUSE ENERGY EFFICIENCY IS NOT A PRIORITY. Management priorities affect not only the allocation of staff time and money for project development , but also the amount of time for staff education.

Industrial efficiency projects can take several years to complete, and it is unlikely that a complete solution will come from one plant engineer, one vendor, one energy auditor, or one utility energy analyst. Therefore the contributions of any one source should not be judged alone. The contributions of the various forms of networking cited here cannot be judged in isolation from their context.

Coordination of Energy and Air Quality Management (CEAM)

This three-year project, funded by the Department of Energy through the Urban Consortium, explored ways that the Puget Sound Air Pollution Control Agency (PSAPCA) could work with Seattle City Light to identify and develop industrial efficiency projects which had a beneficial impact upon air quality as well. PSAPCA has responsibilities for controlling air pollution from stationary sources in the four-county region of Puget Sound where almost three million people live.

The major industrial air pollution concerns are particulate matter, sulfur dixoide, and toxic metals. The current federal regulation for particulate emissions of 10 microns or below is an average 150 Micrograms per cubic meter over a 24 hour period. The industrial plant activities undertaken to reduce these pollutants may include the addition of baghouses, modifications of glass melting procedures and equipment, installation of metal furnace covers, new spray painting equipment, enclosure of process lines, duct filters, and other equipment or measures.

PSAPCA staff have visited the industries in Seattle and they keep records of the levels and sources of industrial pollution. The agency publishes monthly lists of construction which requires a PSAPCA permit, enabling City Light conservation staff to learn of impending construction projects which affect air pollution emissions. These can be targetted for discussion with industry staff.

During the CEAM's lifetime the following projects were identified :

(1) Retrofitting a 300 HP baghouse fan motor with an adjustable speed drive to reduce annual electricity use by 274,000 kWh annually. Electricity had been wasted by the fan because a damper was used to slow down the air flow and maintain static pressure upstream at the desired level. The evaluation of savings used actual plant logs. The cost per kWh was 8.9 mills. This project took place in a cement plant which needs to control particulate emissions.

(2) Replacement of a magnetically controlled rectifier and transformer for an electrostatic precipitator with electronic controls. The company wished to reduce the average level of particulate emissions. This measure resulted in a reduction of the average emissions level by 50 % and used 228,000 kWh less than the preexisting equipment would have used to achieve this reduction. The cost per kWh saved was 7.6 mills. Again, the site was the cement plant.

(3) Identification of potential energy savings from the retrofit of covers on two induction furnace bodies in a steel foundry. Savings are estimated at 100,000 kWh annually or more, depending upon which other measures are installed at the same time. The company has recently ordered this equipment. The cost per kWh is estimated at 15 mills.

(4) Identification of potential savings from the replacement of the "lazy flame " ladle preheating practice in the same foundry with an enclosed electric ladle preheater at a savings of 23,000 kWh annually. The major savings come from the reduction in natural gas use after the changeover, and the air quality benefit is a reduction in CO2 emissions of roughly 145 tons per year. This purchase has not yet been made.

The implementation of the three projects depended most of all on the positive attitude of the decisionmakers in these industries. Large quantities of analysis are not a decisive factor in most cases. There are without a doubt other opportunities for reducing air pollution and increasing electrical efficiency simultaneously which could be taken advantage of if plant management were to make cost-effective energy efficiency a priority.

Industries tend to think about air pollution control and electrical efficiency separately rather than in combination. An industry may have to comply with air quality regulations and still not consider the possibility that other benefits such as reduced energy bills or reduced waste will also occur. We had hoped to enlist PSAPCA's support in getting industry to think about conservation opportunities. However, the project was less successful at enabling PSAPCA staff to identify projects in the field. The utility staff were reluctant to visit plants with PSAPCA staff because of the regulatory function of the Agency. Utility staff relied (and rely) upon information from the Agency in meetings and on an as-needed, case-by-case basis. The Agency called our attention to several plants that were planning to respond to PSAPCA requirements including two foundries. For various reasons these plants did not choose electrically efficient options.

Part of the difficulty in working cooperatively with PSAPCA was due to Seattle City Light's inability to influence the agency guidelines within PSAPCA that direct their own staff. City Light conservation staff are judged partly on how many megawatt-hours of "savings" they can claim. PSAPCA staff have long lists of assigned industries and businesses to monitor, pollution tests to make, reports to write and new regulations to interpret to their industries. Energy efficiency is not in the guidelines. Developing energy efficiency projects in conjunction with Seattle is not one of the expectations for PSAPCA staff. PSAPCA staff went out of their way to take on this additional task, but had less time to learn about electrical energy efficiency. Some air quality improvements require more energy rather than less, and one has to know the difference. As a result PSAPCA staff were most useful as additional eyes and ears.

Air pollution in industry can be reduced either by capturing pollutants after they are generated by the plant processes, or by changing the processes in the first place. However, industry is very unlikely to make modifications in its process merely to get a grant for electrical efficiency. We have seen our third largest industrial customer undertake major process modifications in the past year that reduced particulate emissions and saved huge amounts of electricity, but our activities were not a motivator because the company's stakes in the process change were already very high.

Several important spinoffs from our CEAM projects include a long-term grant program participant whose first project was a CEAM project, continuing use of the PSAPCA lists of permitted industrial construction projects, and networking with the Agency staff. When global warming is recognized as a serious problem, these kinds of interagency relationships will become especially important.

The Northwest Industrial Energy Forum

In 1990 Seattle City Light, the Washington State Energy Office and Oregon State University planned the first of a continuing series of biannual meetings that bring industry reps, vendors, consultants, policy staff and utility program staff together to address issues in industrial energy efficiency. In spite of a regional downturn in energy efficiency grant programs, these Forums have been funded for another year by the Bonneville Power Administration.

Until 1994 most of the larger electrical utilities in the Northwest region were offering some type of utility electrical efficiency grant or rebate programs for industrial customers. These programs relied heavily on funds from the Bonneville Power Administration and planning from the BPA and the Northwest Power Planning Council. This funding and concensus created business opportunities for the various groups mentioned above, and a need for sharing approaches to industrial conservation.

The WAshington State Energy Office has been an anchor for the Forum over the years as utility staff and programs come and go. The location and sponsor for the Forums changes each time and sites are selected in Oregon and Washington alternately. Attendance has been consistently at eighty people or more and the most recent Forum in April of this year drew more industry representatives than any other single group. This is gratifying because organizers have always felt industry was underrepresented and because one of the constant themes at the Forums is "How can industry be motivated to participate in Utility efficiency grant programs?".

Project reports and consultant discussions of efficiency projects that involve common industrial electric equipment such as air compressors, refrigeration components, and adjustable speed drives have been popular, while uniques projects such as foundry process changes efficiency improvements have not been particularly popular.

Other presentations concern problems that arise in the practice of energy management in plants such as power quality problems that may already exist or that may occur with installation of efficient equipment. Some installations of adjustable speed drives have increased harmonics to the detriment of power quality , so attendees learn about the types of asd's that generate less harmonics, and how to isolate harmonics generated by the asd's from the plant electrical system.

Energy savings verification is a common problem that has been discussed frequently at these meetings. Verification requires an unusual mix of engineering and statistical skills and research design skills, and presentations have helped to bring up the level of understanding among staff who are trained as engineers. Verification is an important issue in the Northwest since many of the grant funds are administered by the BPA and projects submitted for funding must have verification plans. Verification fits in easily with presentations on metering electrical power in industries, so vendors promote their equipment and engineers needing to analyze systems or needing to verify projects know what is available.

A series of presentations on the relationship between energy efficiency and environmental issues including replacements for CFC's, and air pollution and energy efficiency have generated interest. Both Washington and Oregon have large numbers of fruit processing and seafood processing customers, a few of which uses CFC's. The gradual replacement of CFC's will affect many businesses and some small industries in the last half of the decade. There is a need to educate these customers about refrigerant replacements and associated refrigeration equipment changes.

Regional policy makers have discussed the future availability of electric power resources and the future roles of power suppliers in the Northwest at these meetings, providing an understanding of future resource scarcity and costs. While Utility staff don't control these factors they need to understand what forces control their customers.

Some specific benefits of these Biannual forums to Seattle City Light have included :

(1) Input into the planning of the ACE program for industrial customers, which offers free leak detection and air compressor system analysis to our customers. Staff from B C Hydro were very helpful as this program was developed.

(2) Awareness of and utilization of Oregon State University's Energy Analysis and Diagnostics Center program. Because of contacts made through the Forum, a galvanizing plant and a plating plant received EADC audits in 1994 in Seattle. Recommendations include a replacement air compressor at the galvanizing plant which appears promising and could reduce elctrical consumption by approximately 90,000 kWh a year through reduction of leaks and substitution of a more efficient compressor. Although Seattle lies outside of the geographical area served by this program it was possible to piggyback the audits on an already scheduled audit in the Puget Sound region.

(3) The adoption of small time-of-use metering devices to estimate lighting and motor power use in industrial plants. Two of the most important datasets required in a project verification are equipment run-time and current load.

(4) A rich network of past Forum participants to contact for advice on aspects of industrial efficiency.

(5) An understanding of the tools available to advise customers on installation of premium efficiency motors either as a first installation or as a retrofit. The Motormaster computer program developed at WSEO is an accessible computer package that provides detailed information on costs and efficiency levels of such motors.

One of the goals of the organizers was to develop a regional database of industrial conservation projects that would be available to practitioners. This was never achieved despite numerous attempts, although Oregon State University has modified its EADC database to include some of the features that make a regional industrial database attractive, including documentation of opportunities for waste reduction, and documentation of opportunities for hazardous waste reduction. The reason for the failure is again partly due to the difficulty of getting many different people from many different utilities and agencies to include the goal of a database in their already sizeable list of duties. It is not difficult to imagine the payoffs from having a list of projects that one could review to locate an energy engineer in the region with practical experience relevant to a complex industrial energy efficiency measure. We have seen this work informally but the construction and updating of a formal database seems beyond the region's ability right now.

The Electric Power Research Institute's EPIC Program

The EPRI Partnership for Industrial Competitiveness (EPIC) program has made it possible for Seattle City Light to bring consultants to audit two medium-sized industrial facilities in our service territory. An Energy Management Engineer may have a list of ten or twenty industries he or she is responsible for, and usually they differ markedly from each other. This puts an enormous burden on the engineer who needs to know about a wide variety of industrial processes and the opportunities for electrical

efficiency that exist in each. One solution is to bring in consultants who have experience with certain types of firms to examine opportunities for increase energy efficiency. Seattle City Light used its EPRI Technical Collaborative money to join this program.

Two industries which had installed grant-funded efficiency projects in the past elected to participate in EPIC. The EPIC program provides on-site plant audits lasting a day and a half which are designed to identify options for plant improvement. The audits examine the costs of plant retrofits or modifications, the benefits in increased energy efficiency (and lower energy bills), the benefits in other reduced plant operating costs, the benefits from improved product quality, and the benefits from reduced air pollutant emissions or reduced waste generation.

The EPIC auditor first listens to management's concerns. This discussion is followed up with a day long plant tour /audit which enables the consultant to collect data and see first hand what kinds of solutions might be realistic. Since the consultant has had experience in similar plants he brings ideas from other successful projects.

Our EPIC audit of a local steel foundry which produces castings of stainless steel, manganese steel, 28 % CrFe steel and low alloy steel resulted in the identification of eight options for plant improvement.The consultant, Process Metallurgy International, Inc., identified four options with paybacks under two years, one option with a payback of roughly four years, and three that needed more in-depth study to ascertain the payback levels.

From the foundry's point of view, the most important message was that their induction furnace equipment needed to be replaced and is very inefficient. The audit gave them a specific target to aim for, namely 600 kWh per ton of steel melted. The existing equipment at the time of the visit was using 930 kWh per ton of steel melted. The consultant provided Seattle City Light with additional information that we used to construct a heat loss model for the existing foundry power supply and furnace bodies. Such a model is necessary to estimate how much energy savings might accrue from installation of covers on the furnace bodies, and from improved cooling and insulation. The model uses engineering analyses of heat loss through convection, radiation, and conduction.

One of the options with a very short payback was improvment of ladle pre-heating practices at relatively low cost. The principal benefit to the foundry would be a reduction in gas costs rather than a reduction in electricity costs.

Another quick payback available to the foundry is a management program to analyze and reduce scrap losses. The pre-existing scrap rate is 6 %. which is considered somewhat high by industry standards. Again, the consultant has given the foundry a target to work toward in scrap rate reduction. The consultant noted that "Scrap reduction efforts result in savings in production costs, gas and electricity savings, material savings, improved product delivery and improved customer satisfaction." Following the audit, the foundry has provided the consultant with better data indicating that the three major sources of scrap at this time are shifting, mis-run, and cold chutes. The suggested solution involves adopting a program based on TQM and Statistical Process Control, but designed specifically for foundry casting problems.

We are working with the foundry to help them implement these two measures using information from the audit. A very useful part of the audit report is a list of steps that need to be performed to fine-tune the estimates of cost-effectiveness and undertake the improvement itself.

Another option the consultant identified came from a specific difficulty mentioned by the plant manager, namely unpredictable casting quality with complex castings. Existing computerized modelling of the thermodynamics and fluid mechanics of pouring liquid metal into molds can in some cases identify probable weaknesses beforehand and provide alternate designs for molds. We hope the foundry will make use of this solution in the future.

The consultant was not able to provide detailed solutions to all the identified options. In particular, waste heat recovery from the heat treating furnace and plasma refining will require further engineering and market analysis. This is a disadvantage in that the customer may not want to undertake the extensive effort required to analyze the option in detail.

The success of this audit will depend on whether the foundry eventually pursues projects it would not have pursued otherwise. The audit was completed in December of 1994. Effective use of the EPIC audits requires some followup consultation over the telephone with the consultant. Personal relationships between the EPIC auditor, plant staff and utility staff take time to develop, but they are important because the audit report raises further questions that require answers. Seattle City Light could not have obtained the kind of expertise provided by EPIC for the foundry easily in another way.

The final report has been presented to the foundry and it is up to Seattle City Llght and the customer to work out the details patiently. Since we have been working with this foundry on efficiency projects for six years already the liklihood of a continuing productive relationship is high.

The EPIC audit of a Seattle dairy that uses 6 million kWh of electricity annually discussed five recommendations in depth, and another four options in lesser detail. The work was done by Chem Systems , Incorporated. Three of the five options discussed in detail were judged to have paybacks

ranging from a low of 1.5 years to a high of 7.3 years, and the other two had paybacks that could not be estimated because a great deal of further study is needed. The report was only submitted in May of this year and it is far too early to tell what the ultimate result will be.

The breadth of the options recommended for the Dairy is impressive. The measure with the 1.5 year payback, on-site blowing of plastic milk bottles, has an estimated capital investment of 1.125 million dollars, and the short payback is due to cost savings compared to the cost of purchasing bottles outside the plant. The low payback is dependent on a strong future market since the equipment must be used near capacity to provide the full economic benefit. The electric bills would rise if this equipment were purchased by the dairy.

The next most cost-effective measure, with an estimated payback of four years, is the installation of adjustable speed drives on three rooftop condenser fans at an approximate cost of $ 14,000. Since Seattle City Light has very low electric energy rates at this time, ($ 0.032 per kWh), the energy savings result in lower cost savings than they would in most parts of the country. The measure would have added benefits in lengthened motor life and reduced noise problems which the neighbors complain about now. The benefits from this measure are based largely on electricity savings.

The next most cost-effective measure is an on-site waste water treatment plant using reverse osmosis and ultrafiltration to remove B O D and T S S from the waste water. The estimated payback of seven years is probably an overestimate because base and high strength sewer charges have increased annually in Seattle and are projected to increase this coming year. The benefits from this measure are entirely due to wastewater bill reductions. Electricity costs would rise if this measure is implemented.

The measure that most interests the company now is the suggested purchase of a plate freezer or similar dedicated freezer to harden the ice cream rapidly. The report estimated savings of 1.2 gigawatt hours annually from the installation of such a freezer, but the savings are based on the assumption that since the required storage space for freezing ice cream would drop, the company could increase production of ice cream and this would save a great deal of energy compared to the previous method of freezing so much product. The company badly needs to find a way to increase the rate of hardening.

The company is exploring lower cost means of improving its ice cream hardening facility before it considers purchasing a dedicated freezer. Since industrial efficiency projects typically take a year or more to come to fruition, the ultimate outcome is not clear. Fluctuating market conditions will play a role in any company's decisions to purchase expensive equipment no matter how cost effective it may be.

The results of these two EPIC audits and the ensuing reports are hard to guage at this time. Such reports can influence industry becuase they bring new facts to bear on an old problem, or because they lend credence to positions already taken by plant staff. Both reports emphasized the purchase of industrial process equipment, which always changes the way that industry produces its product. Therefore these changes entail other changes. In the case of the foundry, the ability to melt steel more efficiently means that the plant bottleneck is no longer the furnace, but some other part of the production process. It may be necessary for the foundry to install other equipment to take full advantage of the increased foundry capacity.

The recommended purchase of an ice cream hardener in the dairy would require speeding up the material handling and distribution process for ice cream production, which probably means changing the plant layout somewhat and changing trucking schedules.

Discussion

Each opportunity for improved electrical efficiency in industry is unique. The differences between sectors of industry, the changes in market conditions, and the changing electrical technologies require new informatin from a variety of sources.

The efforts to network and to bring industrial specialists to Seattle industries have helped us to generate customized grant projects and to learn about technologies. There are serious barriers to industrial conservation that cannot be bridged easily by networking, and these have to do with at least the following three factors :

(1) Adverse market conditions make it difficult for industry to invest in new equipment that they would like to purchase. It is often very difficult to communicate with industry when these conditions prevail because they may not be willing to discuss their vulnerability. A breakdown in communication brings any project to a complete stop. We have seen industries wait to install efficient equipment four years after the idea was originally floated. But this is an excellent argument for continuing to network and to store up ideas , technical information or examples of successful projects.

(2) Industries have goals which inhibit the purchase of efficient equipment, either because the real goals take all the capital, or because the real goals require energy inefficient purchases. Some recent evaluation studies of industrial conservation

programs at Puget Power and at Seattle City Light show that reducing labor costs is frequently high on the list of goals. A shortage of plant staff reduces the chances for successful industrial efficiency projects because staff don't have time to coordinate these projects and don't have time to learn about new technologies.

(3) The result of such policies is that industries move to purchasing commodities such as compressed air with maintenance activities assigned to the commodity provider. This reduces the manpower requirements at the plant, but displaces the decisions about energy efficiency to the purveyor of the commodity from the plant management. It also further reduces the amount of time that plant staff have to consider plant operations which can maintain or improve plant equipment efficiency.

Different solutions may be called for if utilities are going to continue to help industry finance electrically efficient equipment. One solution Seattle City Light is pursuing is to work with the vendors that supply utilities to industrial plants. The utilities we have focussed on are compressed air and high purity oxygen. A number of our customers are purchasing oxygen from plants located on their property. We have worked with the companies operating these facilities to encourage them to install more electrically efficient equipment in the oxygen separation facilities. Another company purchases compressed air from a vendor, and we have negotiated a project to make the compressed air plant more electrically efficient.

The message is clear : encouraging industrial plants to install more electrically efficient equipment requires communication and networking and each case is different. The more tools the energy analyst has for solving these unique problems the quicker the problems are going to be solved.