Evaluating Benefits for an Industrial DSM Program

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A Southern California utility has identified that there are over 23,000 manufacturing and industrial customers in its service territory that apply some sort of paint, coating, ink or adhesive. These companies are affected by the strictest air quality regulations in the United States. The intent of the regulations is to reduce formation of ground-level ozone (SMOG) resulting from emissions from solvent based materials.

In response to these regulations and the plight of these businesses, the utility has developed and implemented a demand-side management program to provide technical assistance to help these companies stay in business and be profitable in Southern California. Personnel involved with this program will have provided assistance to 41 businesses in 1992. The assistance has ranged from relatively simple bookkeeping advice to some alternative coatings evaluations lasting over one year.

Data for each customer is evaluated for benefits and negative impacts. This includes evaluation of the resulting change in energy consumption before and after installation of the new process, and accounts for source fuel consumption for electrical processes. And the quantification of environmental impacts at the customer site for reactive organic compounds (ROC), oxides of nitrogen (NOx), and hazardous wastes is measured. This includes the quantification of increases or decreases in emissions from Edison's generation mix as a result of a change in electrical power consumption.

Once the energy and environmental impacts are quantified, cost effectiveness is calculated using traditional evaluation criteria, such as energy consumption, material usage, labor and disposal costs, and the cost associated with controlling pollutants.

Results are presented on the whole for all of the 13 customer sites. Several examples will be discussed to show the diversity of results and to provide information to reflect the cost of these benefits for the level of assistance provided by the program. This paper allows the utility to share valuable information generated because of an aggressive program designed to help industrial and manufacturing customers affected by environmental regulations by quantifying the source fuel, environmental and cost effectiveness benefits to the customer and to the utility.

Introduction

In 1987 and 1988 the utility widened its focus from researching electric energy generation, transmission and distribution to looking for ways for customers to use energy more efficiently and productively. Commercial and industrial customers, in particular, were very concerned with energy costs, and many sought ways to reduce their total energy bills. A number of customers were exiting the utility's territory via cogeneration, fuel switching, or relocation due to environmental regulations and high operating costs in Southern California. The utility believed that new technologies could be used to provide a valuable service to customers by improving process and production efficiency, reducing costs, and complying with environmental regulations.

There was general knowledge that many electrotechnologies could reduce source fuel usage which provides for significant reductions in air emissions and increase manufacturing productivity; but details of the type of technologies and applications were unknown. In the 1988 General Rate Case, Edison petitioned and achieved approval from the California Public Utilities Commission (CPUC) to begin investigating end-use technologies.

The utility conducted numerous analyses that helped to prioritize and shape the research focus in 1989-90 and led to specific research projects in areas of end-use technology, customer air quality and technology transfer activities. Efforts to make these technologies available to customers were not as effective as they might have been because the utility focused on the technology itself and not on a menu of technologies useful to customers. It was deemed necessary to examine alternative ways to better meet the needs of customers and the internal brainstorming sessions that followed identified the need to segment customers into logical groups to better understand their wants and needs.

The idea was simple: rather than asking customers to adopt electro-technologies, a more effective approach would be to focus on customer needs and how available technologies could meet those needs. The approach was a strategy emphasizing customer-pull rather than technology-push. This entire effort, including all of the elements identified above, when taken as a "package" represent an untried, aggressive and innovative approach for the utility industry as a whole, and certainly a way to address rate payer needs.

Concurrent with the end-use technology investigation by the utility, the South Coast Air Quality Management District (SCAQMD) implemented rule 1136 affecting the wood furniture manufacturers in Southern California. The rule limited the amount of volatile organic compound (VOC) emissions from the solvent-borne coatings used by this industry. VOCs, along with sunlight, cause the formation of ground-level ozone or SMOG.

Southern California is considered the second largest producer of wood furniture in the country and the utility by losing this industry, realized there was significant potential to lose a sizable portion of its industrial base. Also realizing that other air quality regulations affecting coatings processes for other manufacturers were soon to be implemented, the utility completed its analysis of the ultraviolet coating technology and designed and implemented its first industrial end-use technology program to assist these customers.

The Clean Air Coatings Technologies (CACT) program was designed initially with goals for conversion to ultraviolet (UV) processes, but the scope was immediately enhanced to involve all technologies associated with coatings. The program goals were to assist the customer with their compliance issues, primarily resulting from air quality regulations, including the following technologies:

- Water-borne, high-solids, powder and UV coatings
- UV and infra-red (IR) curing/drying ovens
- High-volume/low-pressure and electrostatic spray guns
- High transfer efficiency application equipment, such as roll coaters, curtain coaters and flow coaters.

The desired results for the CACT program were to:

- Improve customer service and keep the customer in the service territory
- Improve energy efficiency, promote energy conservation
- Help customer comply with air quality regulations and reduce emissions
- Improve or maintain product quality and improve productivity.

To achieve these results, the utility established partnerships with the customer. One way this was accomplished was through showcases to demonstrate technologies and to measure the impacts. Another way is through its technology center. The technology center was opened in January 1990 to provide a platform for demonstrating new and efficient technologies to commercial and industrial customers. As part of this support function, equipment and expertise was made available to support the CACT program. The technology center offers a location for seminars and workshops for the various coatings processes and a place to demonstrate the technologies and work together with the customer, on their products, to find viable solutions to their problems.

As part of the 1992 General Rate Case, the CPUC indicated that the utility could continue in the development and implementation of customer end-use technology programs, but that we would have to prove the value of the program. In order to do this, the programs would have to pass a three-pronged analysis, consisting of tests for:

- Source Fuel Efficiency
- Environmental Impacts
- Cost Effectiveness.

Analysis

The utility estimates indicate there are more than 23,000 manufacturing and industrial customers in their service territory that could benefit from the Clean Air Coatings Technologies program. In 1992, thousands of our customers were informed of the program either through a utility field representative, surveys or at the technology center through seminars or technology demonstrations.

Two showcases were established, one to examine and demonstrate powder coating with a hybrid gas/infra-red oven and the other to look at an ultraviolet printing process at customer sites. There were 41 projects evaluated at the technology center, of which solutions were found for about 90 percent of them, with results and recommendations provided to these customers. To meet CPUC established test criteria, the utility performed the three-pronged analysis on only those customers that implemented a process change.

Source Fuel Efficiency

The source fuel analysis looks at gas and electrical energy consumption before and after each process change. Electrical energy consumption analysis involved evaluation of site usage on an annual basis. A heat rate of 10,239 Btu/kWh was obtained from the California Energy Commission to estimate the system-wide average energy required to generate this electricity. This heat rate value includes estimates for transmission and distribution losses, as well as the inefficiencies involved with generating electricity. The source fuel analysis for natural gas consumption is at the customer site. There is no consideration made for distribution losses or the energy required to provide gas to the end user.

The thirteen customer projects analyzed for 1992 fell into three categories regarding energy efficiency. A brief discussion of each category follows.

Energy Conservation

Energy conservation means that the customer went from a less efficient electric process to a more efficient electric process. For example, three different types of printing operations went from solvent-borne ink and electric heat set processes to ultraviolet ink and cure processes, resulting in a reduction of electricity demand and consumption for each. Three other customers converted from lower-solids coatings to higher-solids coating and from conventional spray guns to high volume/low pressure spray guns, improving overall transfer rate of pigmented materials from the spray guns to the substrate, reducing the air flow through the guns, and reducing electrical consumption at the air compressor. Three of the process changes were neutral with respect to the source fuel efficiency analysis.

Fuel Substitution

Fuel substitution indicates that the customer adopted an electric curing process replacing a gas process. There were two customer projects for 1992 that were analyzed in the fuel substitution category. One customer wanted to increase production capabilities of an existing powder coating line which used a batch-type gas oven for curing the powder. In working with the technology center personnel, they determined that a conveyorized combination infra-red (IR)/gas convection oven would meet all of their needs and be the most energy efficient process. Source fuel consumption analysis compared the combination oven with a conveyorized all gas convection oven alternative.

The other customer who is in the automotive body repair and painting business actually ordered and received a gas spray booth/oven primarily intended to cure out the water-borne primers mandated by air quality regulations. The installation of the new booth/oven was held up pending installation of a new 4 inch gas line from the street. A utility representative called on the customer and suggested he visit the technology center to look at infra-red as an alternative. The customer decided to retro-fit an existing spray booth with infra-red units and a two-speed ventilation fan. Source fuel analysis compared the IR retro-fitted spray booth/oven with the estimated consumption for the gas spray booth/oven that the customer sent back.

Load Building

Two customer projects were considered to be strictly load retention or load building. While the other customer process changes involved choices in compliant coatings technologies, and choices between gas and electric curing technologies, these two customers made changes in process because to them it made good business sense. In both cases, the customer worked with technology center personnel to evaluate new coatings and curing technologies primarily for increasing productivity and product quality, and secondarily for minimizing VOC emissions.

One customer adopted a water-borne coating process with a gas drying system. This system was the only viable option due to the size and configuration of the product being coated and cured. This system resulted in added load for both the gas company, because of the direct-fired burner, and the electric utility company, because of the associated ventilation motor load for the 4000 square foot spray booth/oven. The other customer adopted an ultraviolet coating and curing system to apply a protective coating to printed circuit boards. For this customer, the ultraviolet process is far superior to the solvent-borne or water-borne coatings used for this purpose. The ultraviolet process minimizes daily clean-up of application equipment and cures in a matter of seconds compared to hours (overnight) for the other coatings. The added load for the utility is for the operation of the curing oven.

Environmental Impacts

Environmental impacts for electrical consumption were estimated from utility generation sources and are calculated on a system-wide basis. Site electrical consumption data is multiplied by a transmission and distribution loss adjustment of 8 percent, and then NOx, SOx, PM10, VOC and Carbon emissions are calculated using the following factors:

- NOx - 1.72 lb./MWh
- VOC - 0.06 lb./MWh
- SOx - 0.91 lb./MWh
- Carbon - 330 lb./MWh
- PM10 - 0.04 lb./MWh.

NOx emissions from gas consumption at the customer site were calculated using the allowable limit for the SCAQMD Rule 1146.1 for small process heaters and ovens. The other four emissions constituents were estimated using the utility's factors for natural gas fired units in the Los Angeles basin. Site gas emissions were calculated using the following factors:

- NOx - 0.037 lb./MBtu
- VOC - 0.08 lb./MBtu
- SOx - 0.008 lb./MBtu
- Carbon - 325 lb./MBtu
- PM10 - 0.02 lb./MBtu.

Site analysis of reduction in VOCs, air toxics (AB 2588) and ozone layer depleting substances (1, 1,1 trichloroethane, for example) due to the adoption of a compliant coating were estimated using the material safety data sheets (MSDS) for the appropriate coating components and quantities estimated by the customer. Amounts calculated for VOC emissions are for non-exempt solvents only. Reduction of hazardous materials due to the implementation of a more efficient process or by adopting coatings with less solvents were also estimated using data from the MSDSs and quantities provided by the customer.

Cost Effectiveness Analysis

Using data estimated and calculated for source fuel efficiency and emissions reductions, a cost effectiveness analysis was performed for each adopted change. For projects involving energy conservation or fuel substitution, a Total Resource Cost analysis was performed. The two load building projects were analyzed using a Rate Payer Impact Measurement analysis.

Energy Cost Analysis. For consistency and comparison of costs of electrical energy, an average value of $0.12/kWh was used for calculations. Demand charges were accounted for by season and according to off-peak, mid-peak, and on-peak rates. Cost calculations for gas consumption were made using an average cost per MBtu of $5.00.

Cost of Emissions. Gaseous emissions resulting from the combustion of gas at a customer site or from the generation of electricity were calculated from values provided by SCAQMD for the cost of controlling those emissions in 19921:

- NOx - $13.46/MWh
- VOC - $0.54/MWh
- SOx - $0.83/MWh
- Carbon - $5.26/MWh
- PM10 - $0.11/MWh.

Total Resource Cost (TRC). The TRC analysis looks at benefits and costs of measures involving energy efficiency or conservation. This test measures the net costs of a demand-side management program as a resource option based on the total costs. This includes both participant costs and utility program costs. The participants' costs include incremental expenditures for the equipment, including installation, operation and maintenance costs. The CPUC has allowed adders, such as environmental, material and labor costs, to be included in the test.

The basic TRC analysis is the total benefits divided by the total costs, and follows the guidelines in the Standard Practice Manual provided by the CPUC and California Energy Commission.

Rate Payer Impact Measurement (RIM). This test evaluates the impact of each project on the customer's bills or rates, and is used to evaluate load building measures. It looks at the changes in utility revenues and operating costs as a result of the program, and includes consideration for incentives and revenue reductions. The CACT program does not offer monetary incentives for customers. The CPUC also allowed the utility to include adders in the RIM analysis. The RIM test also follows guidelines provided in the Standard Practice Manual as discussed in the description for the TRC test.

Results

In order to perform all the analyses discussed above, it was necessary to assume a life cycle for each of these adopted process changes. Initially, we looked at 20 years as a typical life span for a process change. This is a common assumption used for properly maintained mechanical equipment. With coatings technologies changing very rapidly, especially for water-home and high-solids coatings, it doesn't make sense to expect these new processes to last 20 years. New environmental regulations also effect the continued viability of these processes. As a result, the zero VOC processes, such as powder or UV, were evaluated at 20 years. The 1ow-VOC processes were analyzed at ten years and at 5 years, depending on the specific application. In one case, the customer will have to make a change sooner, and it was evaluated for only two years. Obviously, the longer period of analysis, the better the results would have looked for the program. However, throughout the analysis, the intent was to be as conservative and realistic as possible.

Except for the two showcases, which had engineering reports summarizing the energy, environmental and economic benefits, all calculations were made using data collected from the customer, the utility personnel and metered data, equipment and coatings manufacturers, environmental consultants, and the references.

Source Fuel Efficiency Results

There were nine energy conservation projects and two fuel substitution projects, with an adoption of eighteen different process changes, The overall gas and electric source energy savings over the estimated life of the equipment or process change are shown in Table 1.

A ratio of the overall source energy consumption before the process change over the source consumption after the process change must be greater than or equal to one to pass the test. The before/after ratios for all of these customers ranged from 1.13 to 7.80.

The two load building projects, involving four process changes, resulted in a total added energy consumption of 1,268 MBtu, or 16,280 kWh for the utility and 1,104 MBtu for the gas company.

Environmental Analysis Results

The environmental analysis was combined for conservation, fuel substitution, and load building projects. For calculation of the value environmental impacts have over the life of the process changes, the emissions reductions for the 5 primary constituents, trichloroethane (TCA) and air toxics were determined from the amounts below:

- NOx - 738 lb.
- VOC - 116,285 lb.
- SOx - 130 lb.
- TCA - 51,496 lb.
- PM10 - 17 lb.
- Air toxics - 1,377 lb.
- Carbon - 228,238 lb.

The overall environmental benefit for the life span of the process changes are given in Table 2.

As in the energy analysis, the ratio of before costs over after costs must be greater than or equal to one to pass the test. The Total Net Present Value ratio indicates that there is reduction of cost resulting from the process changes over the estimated life of the change.

Cost Effectiveness Analysis Results

The results of the cost effectiveness analysis are broken down between the process changes evaluated using the TRC method and the changes using the RIM method. As in the evaluation of the energy and environmental results, a value of one or greater is required to pass the test.

The program expenditures for 1992 were approximately $870,300 and this amount was divided by the number of adopted changes to arrive at a value for the program cost for the customer process changes analyzed using this method. Table 3 provides a breakdown of all the major costs before and after the change in process, as well as the difference between the two values, used to calculate the TRC.

Table 1. Gas/Electric Source Energy Savings

	Before MBtu	After MBTu	Difference MBtu	Ratio B/A MBtu
Conservation	195,823	49,567	146,257	3.95
Fuel Substitution	387,183	222,331	164,852	1.74
Total	583,007	271,897	311,109	2.14

Table 2. Overall Environmental Benefits

	Before	After	Difference	Ratio B/A
System-wide Generation	$192,190	$189,524	$2,666	1.01
Customer Site	$17,281,647	$6,296,369	$10,985,278	2.75
Total Net Present Value	$17,473,836	$6,485,893	$10,987,943	2.69

Table 3. Associated Costs Before/After Process Changes

Cost	Before	After	Difference
Environmental	$12,390,098	$4,591,958	$7,798,140
Energy	$1,904,800	$1,662,505	$242,295
Equipment	$979,435	$437,494	$541,941
Other	$7,542,756	$4,047,315	$3,495,441
Program		$712,064	($712,064)
Total	$22,817,089	$11,451,336	$11,365,753

The TRC with adders is 1.99 and the TRC without is 1.03.

The breakdown of results of the cost analysis for the load building customers is provided in Table 4. Program costs were calculated in the same manner as described for the TRC results.

The RIM with adders is 2.50 and the RIM without adders is 0.14.

Conclusions

The utility's DSM program for assisting industrial and manufacturing customers involved with the application of coatings has passed the tests and proved to be a cost effective service for the utility and the utility's customer. The interim results presented in this paper continue to be analyzed and re-analyzed to verify the "reasonableness of the numbers." Also, interaction with the CPUC for clarification of certain issues will effect the outcome of the 1992 and future program results.

Quantification of the energy, environmental and cost savings has been difficult and requires the utmost cooperation from the customer. The valuation of adders, such as the environmental benefits, labor benefits, and other cost savings for the customer, has been somewhat subjective and is not comprehensive. The utility will have to include metered data to help verify the impacts of the process change. However, the adders improve the results and provide a more comprehensive analysis of the impacts of a process change.

It is evident that industrial DSM programs with a strong environmental component will be affected by changes in national, state, and local regulations. This requires a dynamic program with knowledgeable personnel that can interact with regulators, and manufacturers and suppliers, and that understand the issues facing the customer.

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Table 4. Cost Analysis for Load Building Customers (RIM)

Cost	Before	After	Difference
Environmental	$4,826,406	$1,762,180	$3,064,226
Capacity & Revenue	$24,165	$19,956	$4,209
Program		$158,236	($158,236)
Total	$4,850,571	$1,940,372	$2,910,199

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