PACIFIC GAS AND ELECTRIC COMPANY'S EXPERIENCES IN ENERGY CONSERVATION IN THE COMMERCIAL-INDUSTRIAL-AGRICULTURAL SECTOR*

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ABSTRACT

The paper presents a discussion of Pacific Gas and Electric Company's Commercial-Industrial-Agricultural (C-I-A) sector conservation programs. Program descriptions and implementation schemes are presented. Problems are also discussed. Load Management activities, in both the C-I-A and residential sectors are also examined. The conclusion is drawn that to implement conservation in the C-I-A sector every effort must be made to convince consumers that conservation measures are cost-effective.

INTRODUCTION

Pacific Gas and Electric Company (PG&E) provides energy to 9 million people in northern and central California. This service area extends from the Pacific Coast to the Sierra Nevada, from the redwood forests to the California deserts.

The company has almost 27,000 employees that help sustain the huge flow of natural gas and electric power. PG&E maintains a network of transmission and distribution lines that could circle the globe five times. Generator facilities serve 3.4 million customers and include 12 thermal electric plants, 64 hydroelectric powerhouses, and a geothermal complex of 14 units. The gas line portion of this network connects 2.8 million customers with production fields in Canada, New Mexico, Texas,

* This paper was prepared in July 1980, and does not reflect developments that have occured within PG&E's conservation programs after that date.

California, Utah, and Wyoming.

For over 100 years, PG&E has been providing reliable service to its customers. In 1979, sales of electricity to customers amounted to over 59.7 billion kilowatt-hours (kWh), and sales of gas to customers came to over 600 million cubic feet (MCF). This resulted in operating revenues of over 4 billion dollars, with a net income of 460 million dollars.

The company's programs to encourage customers to conserve energy are perhaps the most advanced in the nation. Launched little more than five years ago, the programs have grown into a 50-project, $80-million-a-year effort. A general overview of those programs concerned with the commercial-industrial-agricultural (C-I-A) sector follows.

ENERGY UTILIZATION ANALYSIS AND RELATED PROGRAMS

Energy Utilization Analysis: In 1976, PG&E initiated the Energy Utilization Analysis Program: over 100 technical marketing personnel performed more than 2,400 on-site energy audits, focusing mainly on lighting, heating, ventilation, and air conditioning (HVAC). The emphasis on lighting was due to the facts that lighting constitutes approximately 35 percent of C-I-A energy use, and that fluorescent lamps are more energy-efficient than incandescent lamps.

The target population for all C-I-A audit programs is customers that use over 100,000 kWh and/or 50,000 therms per year. PG&E plans to audit all 35,000 such customers by 1985. Energy audits are the single most effective means of reducing energy consumption in this sector. The main objectives of audit programs are:

1. To reduce the customer's gas and electricity consumption
2. To reduce the customer's peak load
3. To reduce PG&E's electric peak demand.

By performing an Energy Utilization Audit (EUA), which is an onsite survey and analysis of the customer's building(s) and equipment, PG&E will try to identify all areas with conservation potential and provide enough information to encourage conservation action without going into

detailed analysis. A typical EUA report identifies ways to reduce energy use by up to 15 percent with low- to moderate-cost techniques and devices.

Commonly recommended measures involve two end-use categories: lighting, and heating, ventilation, and air conditioning. Typical recommendations in each of these categories are as follows:

Lighting

- Use natural daylight when adequate
- Provide switches so unneeded lights can be turned off
- Replace standard incandescents in deep-baffle fixtures with elliptical reflective lamps
- Replace incandescent or fluorescent fixtures with high pressure sodium vapor fixtures when appropriate
- Replace incandescent fixtures and standard fluorescent lamps with energy-saving fluorescents.

Heating, ventilating and air conditioning (HVAC)

- Reset thermostats
- Reset timers
- Lower boiler temperatures
- Purchase controls and systems that allow greater temperature and air volume discrimination
- Use economizers
- Retrofit heat recovery equipment on air conditioning and refrigeration equipment.

In addition, human comfort must be taken into account. The Illumination Engineering Society (IES) encourages conservation but will opt for a slightly less efficient system in favor of higher quality lighting.

The EUA program has had good success in convincing building managers to adjust or modify operation of existing equipment for fuel savings. Having call-backs scheduled for 6, 18, and 42 months after the initial audit helps to remind the customer about conserving energy. At these follow-up meetings with the customer, the effectiveness of the audit recommendations is reviewed as well as the extent to which they have been implemented.

Initially, the EUA program did not get good results, primarily because the auditors would spend approximately four hours walking around with the customer. This usually resulted in a one-page audit which the customer would ignore. In 1978-79 the Audit Program was revised. Improved training was given to the auditors so that customers would be assured of thorough audits. Quality control procedures were introduced to make sure the audits were performed properly. Finally, EUA became concerned with all types of energy conservation and end use.

Marketing research has found that 68 percent of audited customers have taken some action, resulting in an average saving of 10 to 20 percent. Ninety-three percent of those surveyed had positive comments about the program. This programs succeeded in leaving the participants feeling that the audit uncovered cost and energy savings opportunities. These findings also suggested the following:

- Obtaining participation in certain types of conservation activities is relatively easy. This may be because most companies have the appropriate type of equipment or process, or because of the low cost involved, or because the suggested changes are easy to understand, such as controlling temperatures and installing time clocks.

- Those changes that achieved the highest compliance levels were the ones that probably required no investment in capital equipment, such as improving maintenance and eliminating wasteful operational procedures.

The EUA program is concerned mainly with the large commercial and industrial users whose maximum demands exceed 500 kW. In addition to the audit, literature on energy conservation such as HVAC systems and lighting is sent out to customers in the C-I-A sector.

Some additional support programs include a C-I-A Application Engineering Unit, which provides technical support to C-I-A programs. This General Office engineering support group works with Division personnel and C-I-A customers to help conserve energy and reduce electrical demand. The Application Engineering Unit also assists in or conducts energy audits on large complexes, or unique facilities with emphasis on customers with over 500 kW demand. Qualified consulting engineers are employed when appropriate.

To be implemented in the near future will be the C-I-A Energy Conservation Information Center which will offer C-I-A customers a resource center for C-I-A technical assistance on energy conservation issues, and will be reached through a toll-free telephone number. Customers with questions about improving energy efficiency will be encouraged to call. Whereas some questions will be answered directly over the phone, others will require additional research and/or onsite evaluations of customers' equipment.

The Seminar Program, another support program, was started in 1976. Seminars provide information on energy conserving concepts and technology for commercial, industrial, and institutional buildings. The subject material is comprehensive, covering, among other things, the efficient operation and design of HVAC systems, efficient motor applications, new light sources, lighting maintenance, and power factor correction.

To supplement these seminars, PG&E representatives actively recruited manufacturers, engineers, and others with expertise in specific areas for meetings in which PG&E customers could receive and exchange information.

Successes in the EUA program led to the development of the School Plant Program in 1978. The program was created to increase energy awareness and promote energy conservation in public and private schools. Seventeen school plant analysts were trained to implement the program on a full-time basis. Their objective is to decrease overall energy consumption in schools by at least 15 percent before the end of 1985, based on 1977-1978 usages. The School Plant Program is different from the EUA program in that the School Plant Program uses an energy management approach. The Total Educational Energy Management (TEEM) approach includes the following key elements:

- Secure top-level administrative commitments
- Establish district-wide energy conservation committees, led by direct energy conservation coordinators
- Establish school energy conservation task forces
- Analyze energy use
- Establish energy conservation goals and strategies
- Monitor the results of energy conservation programs
- Promote energy conservation through Energy Awareness Programs.

Trained energy analysts are assigned to particular school districts, to allow continuous communication with the customer and to allow the analyst to urge the customer to implement the energy conservation measures that were recommended.

A practical obstacle faced in implementing this program was in convincing people to think and practice energy management from both operations and maintenance points of view. This program, in particular, takes into account technical (mechanical, electrical, etc.) systems and non-technical (human) systems, including faculty and administration. People are continuously reminded to practice energy management. Generally, capital investments are not stressed as much as the individual's role in energy management.

An additional obstacle which had to be dealt with was the two computer programs used: the Fiscal Energy Report (FER) program and the Guideline Analysis Program (GAP). The FER program summarizes gas and electricity consumption for each fiscal year, since the 1977-1978 base

year. This is provided by PG&E for each school district and school participating in the program. The GAP compares a school's actual energy use to the amount it should use if operating efficiently. This program provides recommendations for low-cost or no-cost ways of reducing energy consumption in the schools. It also identifies and analyzes more expensive modifications and suggests which modifications should be cost-effective for the specific school. When initially used in 1978, the GAP program was not yet fully debugged. Consequently, some schools were told (for example) to replace or turn off particular boilers which did not exist. The auditors had convinced the schools that this computer program was their answer to energy conservation. This led school officials to question the credibility of PG&E and, in particular, the auditors. Recently, the audits have been accurate and quite successful. Hence, energy savings in the School Plant Program have increased. At present, published results from the demonstration projects of recommended conservation measures are needed. Most schools will not want to attempt a form of energy conservation they feel is untried.

A study done on the School Plant Program by Marketing Research at PG&E typically found 80 percent of those questioned had favorable comments about a product or service. Eighty-eight percent of the participants had positive comments about the program, and 35 percent mentioned positive attitudes towards the execution of the program, especially the PG&E representatives' knowledge and training. This rather low rate of positive response likely stems from the GAP computer problems discussed earlier.

One criticism was the absence of a good follow-up program, which is important for two reasons. First, a follow-up may be required to "sell" the new conservation ideas to the schools. Second, a number of conservation measures recommended are operational, such as turning off unnecessary lights. Ensuring that these recommendations are adhered to requires a follow-up, to remotivate people and reinforce previous suggestions.

Of the 84 schools surveyed in the School Plant Program, the average reported electricity saving was 11.8 percent, and the average natural gas savings was 9.6 percent.

Plans for this year include the addition of a Monthly Comparison Report Program. This computer program will track actual monthly usages and compare them to the guideline usages generated by the Guideline Audit Program (GAP). Part of the overall energy management program is the development of an energy-conservation ethic that "radiates" to the surrounding community. Energy education, through special programs and energy awareness materials, will be part of the overall program at each school.

The College and University program was derived from the EUA program, in 1979, with major emphasis on developing models for future audits and energy management programs. The goal is to reduce the base year (1977-1978) energy consumption of the 120 colleges in PG&E's service area 20 percent by 1985. To do this, the program adopted the TEEM approach used by the School Plant Program. The TEEM objective is to reduce campus energy consumption while maintaining the quality of educational programs. California State University, Hayward, is a TEEM success. The Trustees of California State University system recently mandated that all 19 state colleges and universities reduce their energy consumption by 40 percent by the 1983-1984 fiscal year. Hayward set a modest goal of saving 10 percent overall energy use for 1979-1980, but starting in July 1979, the first six months, July to December, 1979, showed a savings over 25 percent.

Not every audit is a success. For example, a large university in San Francisco was the subject of a major audit effort by PG&E's San Francisco Division auditors. Over 2.8 million kWh annually could have been saved by adopting all energy saving suggestions. Annual gas savings amounting to 469,000 therms also could have been realized. Yet, six months after the audit, the energy committee formed at the school to implement these changes had dissolved and energy use was actually on the rise. This points out an issue of real concern in any audit program;

without a commitment by the customer, recommendations in an audit are useless.

Still to be implemented in 1980 is an energy audit program designed specifically for hospitals. These institutions have a difficult time trying to conserve energy, since some rooms must be at a certain pressure and temperature at all times. Also, in parts of hospital buildings recirculated air cannot be used due to sanitary requirements.

As a whole, the energy audits performed by PG&E are successful, but in order to be fully effective the company must serve as a catalyst to persuade customers to follow through on audit recommendations. An important point to be made about commercial buildings is the need to take energy conservation into account when new buildings are being designed rather than simply looking at existing buildings and retrofit ideas. PG&E is studying the concept of preconstruction design reviews for energy efficiency.

An additional facet to be added to the audit program is the Solar Technology Assessment and Referral Program (STAR). The STAR Program is designed to work as a follow-up to PG&E's other commercial, industrial, and agricultural energy conservation programs.

During the course of their normal conservation audits, the energy utilization representatives will look for possible solar energy applications. If a customer is interested in solar applications that might pertain to his establishment, then a PG&E solar representative will contact him. The solar representative will assist the customer in identifying particular types of appropriate solar technology. He will estimate the amount of energy that can be saved and the approximate cost of the savings. The customer will also be supplied with a list of qualified solar energy contractors in the customer's area.

ENERGY CONSERVATION ACHIEVEMENT PROGRAM

PG&E's Energy Conservation Achievement Program recognizes and encourages reduction in energy use by business, industry, and government within PG&E's service area. When this program was started in 1976, a certificate was awarded to those participants satisfying the Achievement Program criteria. In 1978 when the EUA program was extended, the award became a plaque acknowledging the participant's reduction in overall energy use.

To be eligible for an award, points are assigned according to the percentage reduction in the categories of kilowatt-hour use, total electrical demand, and gas service since 1976. Points are also given for establishing an active energy conservation program and an active energy management program, with regularly scheduled meetings that generally follow PG&E recommended format. Additional points are awarded for each new or innovative technique that is effectively used in energy conservation.

Applicants achieving the minimum point requirement are given a plaque, certificate, and window decal identifying them as award winners. In 1979, businesses with several branch operations were given special corporate awards if 80 percent of their branch facilities had earned the basic award.

Public reaction to the energy conservation awards program has been positive. Of the 31 participants, 21 did so to save money for their organizations; 23 said they participated to save energy and do their part for conservation; and 4 said they participated for recognition of conservation they had done on their own. Many also said it was not the award that was important but the conservation and money savings.

Revision of the program in needed to take into account expansion of production which might cause a real increase in energy use while the company actually uses less energy per unit produced. At present there is no provision for expansion.

For 1980, the Energy Conservation Achievement Program requires more advertising and greater participation by the commercial sector.

LOAD MANAGEMENT PROGRAMS

The commercial-industrial-agricultural sector accounts for about 60 percent of electrical energy sales and 40 percent of gas sales in the PG&E service area. There are significant opportunities for energy savings and peak demand reductions in this sector. Energy conservation programs directed towards the commercial sector have the following features:

- Operational modification in energy use involved in conducting business and/or maintaining the environment of the building shell
- Long-term capital-intensive retrofits of energy using systems.

PG&E instituted time-of-use (TOU) Schedule No. A-23 during February 1977, the first comprehensive time-of-use rate in California and one of the first in the nation. Rate Schedule No. A-23 addresses large commercial users, those whose monthly maximum electrical demands exceed 4,000 kilowatts.

Customers are continually monitored to evaluate the effect of the TOU rate on consumption patterns. Evaluation of this information revealed that the load pattern for many customers was remarkably consistent with time. For most firms, the shape of the load patterns remained about the same before and after introducing the TOU rate.

Program participants' attitudes toward mandatory electrical curtailments, and information concerning the establishment of an emergency electrical usage curtailment plan during the summer of 1979, were included in a survey done by the Marketing Research Unit. It was found that participants were not particularly enthusiastic about the prospects of a mandatory electrical usage curtailment plan. The main reason voiced for feeling that such plans were "not very" or "not at all" acceptable was that these participants require electricity to stay in

business. Other reasons were: participants were using the minimum amount of electricity already and would not be able to conserve more; and participants did not like public utility control which could curtail or hurt their business. Concerning the establishment of an emergency electrical usage plan during the summer of 1979, only 17 percent of those surveyed responded that one had been formulated.

In addition to Rate Schedule No. A-23, PG&E implemented time-of-use rate Schedule No. A-22 in December 1979. It applies to customers with maximum demands between 1,000 and 4,000 kW. The implementation of this rate significantly expands the coverage of the company's time-of-use rates by including approximately 650 additional customers under TOU rates. An additional new rate schedule, No. A-21, would be applicable to about 1,300 customers with maximum demands between 500 and 1,000 kW. Currently, Rate Schedule No. A-21, is before the California Public Utilities Commission.

Another large group of electricity users consists of small commercial customers with maximum demands of less than 500 kW. Data are being compiled on below-500-kW time-of-use characteristics of this group of customers. This A-20 experiment is collecting information to determine the program's cost-effectiveness. The A-20 experiment has four goals:

- Install metering equipment for 600 customers;
- Develop a data retrieval system for the load profile data;
- Report on the use of a solid state device and a computer to retrieve the load profile data by telephone; and
- Develop a data validation system for load profile data extracted from the solid state devices.

Also, PG&E plans to initiate further activities in this experiment in 1980:

- Implement the control rate on these 600 customers;
- Develop a plan to estimate the elasticity of demand for energy according to the time-of-day; and

- Enhance the load research analysis for the A-20 (small user) customer class, with additional load profile information obtained from the project.

Two of the types of energy management devices used are on-site electronic devices, which manage the electric load, and automatic time clocks. The peak load maximum demand of a building is taken as the average over a set time interval. It is this average that determines an customer's maximum demand.

One device used to reduce a customer's peak demand is a remote load switch known as a "smart thermostat". Since commercial air conditioning uses large amounts of energy, thus reducing the commercial air conditioning demand will decrease customers' peak demands, resulting in economic benefits that cannot be ignored. Such a reduction in a customer's peak demand is important to conserving energy, but it must be remembered that kilowatt-hours should also be conserved, to further reduce a customer's energy costs.

Using the "smart thermostat," PG&E is conducting a customer feasibility test, which started with approximately 400 participants. The smart thermostats used in this test have three modes of operational--normal, temperature-adjust, and emergency off. In the normal mode, the thermostat acts as an ordinary single-zone thermostat. In the temperature-adjust mode, the indoor ambient temperature is sensed and, if necessary, the temperature is increased by up to eight 1.5-degree-Fahrenheit intervals, until 82 degrees is reached. During this period, the customer cannot control the thermostat setting. If this device does not receive a signal from the utility company for 15 minutes, it returns to normal. If necessary, the "emergency off" mode, which is to be used only in extreme situations, allows the utility company to turn off the entire air conditioning system.

Of the 400 customers that volunteered for this test, only 5 percent dropped out the summer of 1979, and 5 percent again in 1980. PG&E is not trying to recruit additional customers to this test at present, although expansion of the test might occur in 1982. PG&E has had particular success in retaining those already participating. (In a similar

test conducted by a utility company in Southern California, 50 percent of the participants either dropped out of the test or tampered with the equipment.) The results of PG&E's feasibility study are still to be determined.

Other limited programs to be initiated in the future include curtailable, interruptable use for time-of-use Rate Schedule No. A-23, the Alternative Power Source (APS) program, and Emergency Electrical Plan (EEP). Under the Alternative Power Source program PG&E would reimburse customers who generate their own power instead of using the company's generated power. The Emergency Electrical Plan program would entail turning off the electricity in pre-planned buildings. These programs would have a limited use and would be put into effect only under extreme circumstances.

Another type of load management program is the Group Load Curtailment (GLC) Program. It provides PG&E's customers with the opportunity collectively to reduce their demand during peak periods, which should occur no more than 15 times per year. The duration of any one curtailment would probably not exceed six hours. The GLC Program was developed and tested successfully in the Los Angeles area by Southern California Edison in conjunction with ESCO, a consulting engineering firm. The program can be thought of as building a "peak-shaving" generation plant, in which the high demand peaks may be reduced by decreasing demand during the peak periods through a voluntary load curtailment program. This would be in lieu of adding additional generating capacity, a capital investment that would result in higher customer costs. Each group would consist of five or six customers representing 10 to 15 accounts. Customer curtailment would be coordinated through a central computer. By supporting PG&E in this load management effort, the GLC cooperative is eligible for significant financial compensation through an incentive rate.

INCENTIVE PROGRAMS

In a PG&E study conducted by Marketing Research, it was found that if the payback period is more than two years, customers usually will not implement that particular energy conservation recommendation. Energy conservation must be cost effective for society, the consumer, and the utility company. If these groups are not satisfied, then energy conservation cannot be properly implemented.

Incentive programs have been developed by PG&E; the California Energy Saver Fluorescent program, in particular, has proved to be very successful. This incentive program was part of an ongoing effort to encourage commercial, industrial, and agricultural customers to reduce electrical demand. Past research has shown that the installation of energy-saving fluorescent lamps by non-residential PG&E customers could reduce electrical demand in the PG&E service area by at least 12.5 megawatts (MW). This program offered incentives to customers with heavy lighting loads to encourage them to switch to energy-saving fluorescents. PG&E offered refunds of 50 percent of unit lamp cost (up to $1.00 per lamp) to customers who switched from conventional to fluorescent lamps.

Of the total 16.8 MW reduction, which exceeded the earlier estimate, 1,600 kW of the load reduction occurred in the summer of 1979. PG&E attributes this to the response time necessary for C-I-A customers to purchase and install the lamps. The full 16.8 MW load reduction should be realized during the summer of 1980.

To qualify for the rebate, between 240 and 4,800 lamps had to be purchased between September 1 and October 21, 1979 and installed by October 31, 1979.

Participants in the incentive program specifically mentioned the PG&E rebate as the primary incentive for lamp replacement. Yet, the drawbacks of this program are the same reasons given by firms that did not participate: it was too expensive; the deadline was a problem; some had too large an inventory of "usable" lamps on hand.

The program also appears to have motivated the majority of participants to relamp completely. Some participants relamped only partially, citing cost as a major factor. An encouraging note is that most of the participants who relamped partially plan to install additional energy-saving fluorescent lamps.

OTHER ACTIVITIES

Looking toward the future, PG&E is involved in a number of solar research and demonstration projects on commercial and industrial buildings. Most involve heating water for domestic purposes, although in El Centro, in a manure digester project, a solar system was installed to provide some process heat. PG&E also has a limited involvement in a solar crop-drying facility in Fresno. PG&E is involved in a number of solar projects from which data will eventually be analyzed to determine the feasibility of solar energy.

Finally, Energy Conservation and Services is conducting an ongoing project to study and investigate new energy-saving technologies such as dry air evaporative coolers, power factor motor controllers, energy-efficient fans, and other space conditioning equipment.

One area we have been studying is the efficacy and proper use of various types of window treatments. Initial results to date have been surprising, showing that in one case application of a solar reflective film actually resulted in a net annual increase in energy use, because the loss of solar heat in winter outweighed the reduced air conditioning load in the summer. This is an area that could benefit from increased research.

CONCLUSION

This paper has discussed PG&E's energy conservation programs for the commercial-industrial-agricultural sector. It is clear that institutional constraints limit the effectiveness of PG&E's conservation efforts. All the audits in the world will not save one kWh or therm if

a customer does not implement suggestions made in the audit. Most customers will not implement a conservation technique unless the simple payback period is two years or less.

Simply stated, what must come out of this study is a plan to maximize consumer awareness of the benefits of energy conservation. Consumers must be made aware that spending money on conservation is cost-effective and is a valid business investment. PG&E is attempting to do this in its service area, but this study is a perfect opportunity to do this nationwide.

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