Sacramento Municipal Utility District

Commercial Lighting & Industrial Program

Profile #13, 1992

Executive Summary

Sacramento Municipal Utility District's Commercial Lamp Installation Program (CLIP) was designed to reduce the utility's summer peak demand and the electric bills for SMUD's small commercial customers. The program was implemented in part because utility audits of small commercial facilities revealed large opportunities to save lighting energy, as well as a fundamental reluctance by these customers to do the recommended retrofits themselves.

A six-month pilot program of CLIP began in July of 1986. Based on the success of the pilot, SMUD went forward with a full scale program in January of 1987. The program continued for two years, moving from one zip code area to the next, at which time SMUD determined that almost all of the potential eligible customers had been contacted at least twice. The participation rate among those eligible was about 45%.

The program saved each customer an average of 937 kWh/yr and the utility captured a peak capacity savings of 0.316 kW per participant. This resulted in a total annual energy savings for the 7,339 program participants of 6.88 GWh and a capacity savings of ~2.32 MW. While SMUD assigned an average life of the measures installed of five years, SMUD also assumed that there would be a 25% "persistence of savings" (continued use of energy-efficient lamps) through the year 2015.

The total cost of the program was $1.24 million for an average cost of ~$169 per participant. The largest cost component was for labor (60.4%) followed by lamp costs (36.2%). The average cost of saved energy for the program was just under 4¢/kWh at a 5% real discount rate for an assumed five-year measure lifetime but was cut almost in half (2.2¢/kWh) if it is assumed that, on average, the customers replace the energy-efficient lamps installed at the time of their burn-out with similar use energy-efficient lamps, at least once.

One of the most interesting aspects of the CLIP are the changes that have evolved as its program managers realized that the program could be implemented more efficiently than they first assumed. Key mid-course corrections are discussed in the Implementation and Lessons Learned sections, as are program design changes for the forthcoming evolution of the program.

All of SMUD's current DSM programs are being implemented in the context of capturing 800 MW of capacity by the year 2000. During this same period they are planning to bring on line an additional 400 MW from renewable energy supply options. By combining the implementation of energy-efficient end use technologies with renewable energy, this utility has become a leader in moving toward the goal of providing its customers with environmentally benign, sustainable energy.

Commercial Lamp Installation Program

Utility:	Sacramento Municipal Utility District
Sector:	Small commercial (less than 50 kW)
Measures:	Energy-efficient lighting
Mechanism:	Utility pays the full cost of relamping including the installation
History:	Pilot in the second half of 1986, system wide program 1987-1988

1988 Program Data

Energy savings:	2.65 GWh
Lifecycle energy savings:	13.24GWh
Capacity savings	860 kW
Cost:	$485,100

1986-1988 Program Data

Energy savings:	12.4 GWh
LIfecycle energy savings:	34.4 GWh
Capacity savings:	2.32 MW
Cost:	$1.24 million
Participation:	45%

Conventions

For the entire 1992 profile series all dollar values have been adjusted to 1990 U.S. dollar levels unless otherwise specified. Inflation and exchange rates were derived from the U.S. Department of Labor's Consumer Price Index and the International Monetary Fund's International Financial Statistics Yearbook: 1991.

The Results Center uses three conventions for presenting program savings. **Annual savings** refer to the annualized value of increments of energy and capacity installed in a given year, or what might be best described as the first full-year effect of the measures installed in a given year. **Cumulative savings** represent the savings in a given year for all measures installed to date. **Lifecycle savings** are calculated by multiplying the annual savings by the assumed average measure lifetime. **Caution**: cumulative and lifecycle savings are theoretical values that usually represent only the technical measure lifetimes and are not adjusted for attrition unless specifically stated.

Utility Overview

Sacramento Municipal Utility District (SMUD) is, as the name implies, a municipally owned utility formed July 2, 1923. It is the fifth largest public utility in the nation with a service area that encompasses 900 square miles within and around the city of Sacramento, California, and serves ~456,800 customers. The District is governed by a five-member Board of Directors elected for four-year terms. The Board of Directors makes policy decisions for the District and appoints the General Manager, who is responsible for the District's operations.

In 1990 SMUD's electricity resource mix was hydroelectric 659 MW, geothermal 138 MW, gas 49 MW, and photovoltaic 2 MW. An additional 1,310 MW of capacity was purchased through four different agreements. The current amount of purchased power is relatively larger than usual because of the recent closure of the SMUD - owned Rancho Seco nuclear plant.

SMUD's resource plan through the year 2000 emphasizes both efficiency and renewable energy and is designed to eliminate the current need for purchased power. By the end of the decade the utility plans to gain ~800 MW of capacity from its DSM programs. This 800 MW is approximately equal to SMUD's projected growth. On the supply side SMUD plans to add 700-800 MW of gas fired cogeneration in the next five years. This will be done in cooperation with existing and new local industries and will utilize some of the most efficient gas fired turbine systems available. In addition to these cogeneration systems SMUD plans to incorporate a variety of renewable supply options. The initial plan calls for the installation of 150 MW of solar thermal, 50 MW of wind and 200 MW of photovoltaics, biomass, fuel cells, and geothermal combined, for a total of 400 MW of additional renewable energy.[R#10] By the year 2000 this integrated resource plan will eliminate the need for any purchased power.

SMUD 1990 STATISTICS

Number of Customers	456,809	
Energy Sales	8,265	GWh
Revenue from Energy Sales	$648.5	million
Summer Peak Demand	2,220	MW
Generating Capacity	848	MW
Purchased Capacity	1,310	MW
Average Electric Rates		
Residential	8.2	¢/kWh
Small Commercial	7.6	¢/kWh
Large Commercial & Industrial	6.0	¢/kWh

[R#8]

SMUD is moving toward independence from purchased power for the customers in its service territory while concurrently moving toward energy sustainability. Many forward-looking energy analysts agree that a workable scenario for moving to a sustainable energy future would include implementing energy efficiency to control the load, supplying the load with a variety of renewable energy supply options, and using natural gas as a transition fuel while the renewable energy options are being implemented. The progress that this utility is making toward a sustainable energy future is commendable, and the long range thinking necessary for achieving it is a credit to SMUD's General Manager and Board of Directors.

Utility DSM Overview

SMUD formally began its conservation effort in 1976 with the creation of a Conservation Department. Initially this department focused on customer education, attic insulation retrofits, rebates for energy-efficient new residential construction, and a test of direct load control of residential air conditioners. SMUD's conservation efforts were expanded in the early 1980's, in part as a response to state and federal mandates. Under the California Energy Commission's "Load Management Standards", SMUD developed the air conditioner cycling test, the swimming pool pump timer program, and commercial, industrial, and residential energy audits.

SMUD decided to expand these and other programs on its own initiative. For example, the residential air conditioner cycling program was moved from test to full operational status in 1980 and is now one of the largest programs of its type in the U.S. Low-interest financing and rebates for energy-efficient retrofit and giveaway measures such as water-heater blankets and weather stripping were added to the audit programs in an effort to induce customer participation and increase program energy savings.

In 1987, SMUD prepared and adopted the "Load Management Business Plan" which described the critical need for additional load management to help meet the summertime air conditioner-created peak load. As a result during the late 1980s there was a significant increase in load management efforts. This increase was especially strong as applied to air conditioner cycling, commercial and industrial curtailable programs, and thermal energy storage incentives and rates.

DSM Overview Table	Annual DSM Expenditure (x1000)	Annual Energy Savings (GWh)	Annual Summer Capacity Savings (MW)
1978	$3,608	negligible	14
1979	$4,501	"	2
1980	$4,758	"	2
1981	$7,189	"	4
1982	$6,772	"	7
1983	$6,561	"	7
1984	$7,548	"	9
1985	$8,503	"	19
1986	$7,155	"	13
1987	$6,903	"	19
1988	$8,839	"	25
1989	$8,432	"	11
1990	$10,000	9.0	85
1991	$37,839	51.0	56
1992	$62,265	51.0	50

[R#4]

In October of 1990 SMUD began implementation of one of the strongest conservation efforts in the country. To achieve their new energy-efficiency goals, three program areas were defined: Energy Efficiency Retrofit, New Construction, and Load Management. Each of these program areas has stated goals for projected annual savings through the end of the decade, and includes a list of specific programs for achieving the goals.

In April of 1992 SMUD released their "Business Plan for Achieving Energy Efficiency Goals 1992-2000." The plan states two general goals:

1). to satisfy projected growth in capacity requirements over the remainder of this decade with demand-side programs, and

2). to reduce SMUD's projected average annual growth in energy requirements from about 2.7% down to 1.0-1.5% -- thus increasing the system load factor while avoiding the need for new supply-side resources over the 1,100 MW proposed in the "Recommendation for SMUD Power System Additions."

The heart of the plan is to "buy" approximately 800 MW of capacity from its customers by the year 2000 with a combination of load management and energy-efficiency measures, thus committing the utility to a continued and aggressive DSM program through the end of the century.

The annual energy savings shown in Table A (pg.4) are negligible because all of SMUD's early DSM efforts focused on load management and not energy efficiency.

CURRENT SMUD DSM PROGRAMS

Dispatchable

- Peak corp -- (residential & commercial)
- Fast dispatch
- Auxiliary power
- Curtailable service
- Water-pump load management

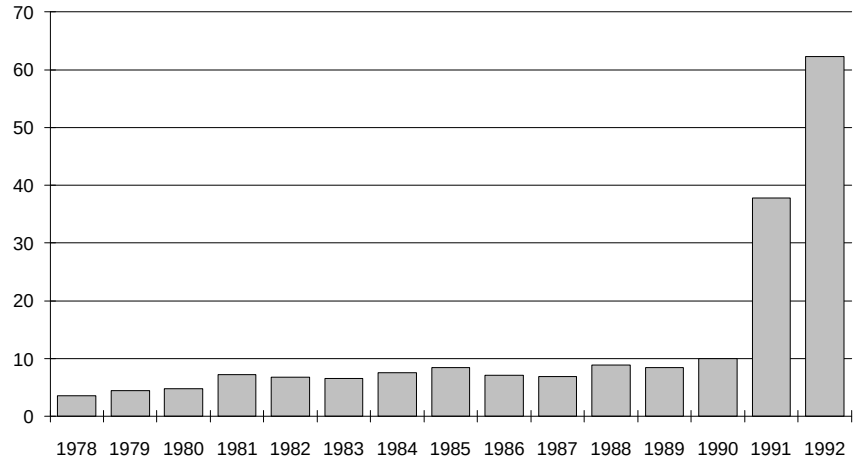
Nondispatchable

- Pool and spa load management
- Conservation power--(residential & nonresidential)
- New construction--(residential & nonresidential)
- Thermal energy storage (residential & nonresidential)
- Direct installation weatherization for limited income
- Incentives for solar DHW

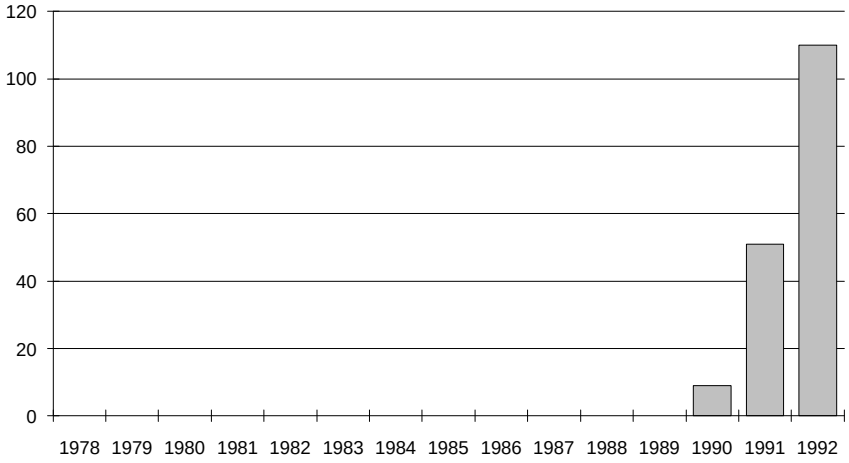
Currently SMUD is running several DSM programs which it categorizes as either dispatchable or nondispatchable. The dispatchable programs allow the utility to directly alter usage to reduce peak demand. The nondispatchable programs are not in the utility's direct control but can both save energy and reduce peaks.

Utility DSM Overview (continued)

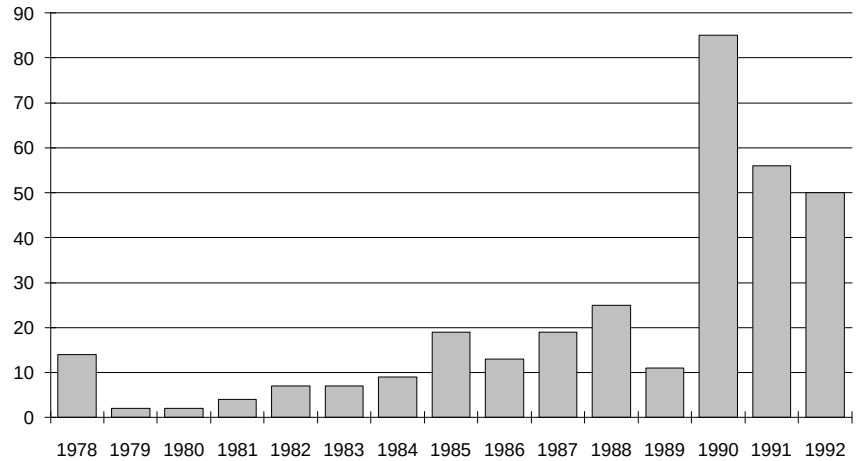
ANNUAL DSM EXPENDITURE ($1,000,000)



ANNUAL ENERGY SAVINGS (GWH)



ANNUAL CAPACITY SAVINGS (MW)



Program Overview

The Commercial Lamp Installation Program (CLIP) was designed to reduce the utility's afternoon peak demand and at the same time reduce the lighting-energy consumption for SMUD's small commercial customers. The program achieved both of these goals in two ways: directly, by reducing the wattage of the lamps; and indirectly, by reducing the air conditioning load contribution of the lights. (Lower wattage lights give off less heat to be removed from an air conditioned space).

The main effort of CLIP was the replacement of standard fluorescent lamps with energy-efficient lamps. More specifically, the standard 4' F-40 and 8' F-96 were replaced with 34-W and 60-W energy-efficient lamps respectively. In addition, there were provisions during the first six months of the system wide program (beginning in 1987) for replacing incandescents with compact fluorescents and for tungsten halogen replacements. However, four- and eight-foot lamps represented about 99% of the lamps replaced and the compact fluorescent and tungsten halogen lamp options were discontinued.

This program was designed to complement to SMUD's small commercial energy audit and rebate program. One reason this complement was deamed necessary was that an evaluation of the energy audit and rebate program revealed that most of the small businesses that were audited were not making the recommended lighting-efficiency improvements. The CLIP direct installation program was therefore implemented as a way of improving small business participation in energy-efficient lighting.

In July of 1986 SMUD began the CLIP pilot program whose stated goals were to:

- Implement the energy-saving fluorescent-lamp recommendations identified by the small commercial audit program,
- Develop cost/benefit information,
- Determine customer acceptance,
- Determine if direct lamp installation increased implementations recommended by small commercial audits,
- Determine vendor and lighting maintenance contractor acceptance, and
- Determine the feasibility of extending the program beyond the 1986 pilot test program.

During the pilot phase of the program 54,362 lamps were installed in 1,278 customer's businesses.[R#2] The pilot phase ended in December of 1986, and based on its results, SMUD decided to move to a full scale implementation of the program. In the two years that followed another 6,061 customers participated with the installation of another 246,638 lamps.[R#4] The total annual savings from the pilot and the full scale program implementation was ~7 million kWh and 2.32 MW of capacity at a total cost of $1.24 million.[R#2] The program ended on December 30, 1988 after two and one-half years of operation.

SMUD's target audience for CLIP was its small business customers, particularly those customers who had received energy audits and had not implemented any of the recommendations. SMUD identified those customers by rate class: customers who have less than 30 kW demand and generally consume less than 48,000 kWh per year. An 18,500-name customer list was developed from the billing master and sorted by zip code and street address. In 1988, customers with a demand between 30 kW and 50 kW were made eligible for the program, adding another ~1,500 customers to the list. The goal was to retrofit energy-efficient lamps into the facilities of all target-group customers that met the following eligibility requirements.

- The facility must be owned or rented by one of SMUD's small commercial customers.
- The account must be classsified as small commercial (less than 50 kW demand).
- Lights must normally operate during SMUD's summer peak period (between 1:00 p.m. and 9:00 p.m.).
- The facility must not already have energy-saving fluorescent lamps.
- Lamps must be in conditioned space, 12 feet or less from the floor, and readily accessible.
- Ballasts must be compatible with energy-saving lamps.
- Previously delamped fixtures were not eligible.
- Lamps must be installed during program operating hours (to simplify scheduling and avoid overtime).
- Inoperable fixtures, fixtures with ballasts in the process of failing, obvious mechanical problems, or F40 single pin lamps were not eligible.
- Customers with existing lighting maintenance contracts were not eligible.
- Customers must allow SMUD to disable their old, standard fluorescent lamps. (Customers were responsible for disposal.)

Other Requirements:

- SMUD was not responsible for pre-existing conditions. These include, but were not limited to, defective wiring, sockets, or fixtures (including brittle or aging diffusers and lenses).
- The customer agreed to hold SMUD harmless from all loss or damage arising from, or in any way connected with, pre-existing conditions.
- SMUD was not responsible for lamp and ballast failures occurring more than 30 days after installation.

MARKETING AND DELIVERY

Despite a minimal marketing budget, SMUD's marketing methods were very effective in recruiting participants. After the target list was compiled, SMUD auditors approached customers, without prior notification, on a zip-code area by area basis. If a customer met the eligibility requirements and agreed to the service offer, the auditor performed a lighting audit on the spot. Initially, SMUD tried a direct mail approach, involving an introductory letter and a "group relamping" brochure, which was followed by a visit from a representative within a week. SMUD found the "cold canvass" approach just as effective in recruiting participants and discontinued the mailings.

Although this identification and direct contact was the main focus of the CLIP marketing effort, two additional steps were taken. First, at the time of lamp installations, a sticker was placed in each fixture, which recommended which energy-saving fluorescents to buy when replacement became necessary, and secondly, an information packet was left with each customer after the installation. The packet included a "thank you for your participation" letter, vendor information, a customer survey, educational material on the benefits of energy-saving fluorescent lamps, and information on other SMUD programs. This packet was designed to help with program evaluation and, along with the installation sticker, to give the program a "persistence of savings" by encouraging the customer to continue using energy-saving lamps even after the original ones burned out.

The successful delivery of this program required a team effort by the auditors, supervisors, and installers. The

auditors methodically approached the customers one zip code area at a time. At the end of each day they compiled a list of businesses willing to participate in the program from which the program supervisors scheduled work orders for the installation crews. Work orders were also included for some customers who had agreed to the retrofit but had no appointment yet for installation. This helped to efficiently fill extra field time. Typically installers arrived several days after the audit to install the lamps. By working one zip code area at a time the team was able to minimize traveling time between job sites. Once the program got underway the installation crews found that they could average four to five installations (250 to 300 lamps) per day.

Before being sent into the field to deliver this program, all staff participated in a CLIP orientation and training program which included basic conservation theory, program policies, sales training, safety and first aid, and the uses of the work-order form. SMUD also conducted a five-day course to train lamp installers in lighting conservation, basic electrical safety rules, and varying aspects of the utility's organization and energy-services program.

By January, 1988 all the zip code areas had been covered once. SMUD then re-canvassed each area contacting new businesses or customers who did not previously participate in the program. After completing a second canvass, additional marketing techniques were used, including bill inserts, messages printed directly on the bill, word of mouth, and targeting franchise headquarters and property managers. However, it became increasingly difficult to find eligible and interested customers. Believing that they had effectively canvassed their service territory, SMUD discontinued the CLIP program at the end of 1988.

INSTALLED MEASURES

The main efficiency measure was the replacement of four- and eight-foot fluorescent lamps with reduced wattage lamps (~85% of the lamps installed were 4' while ~15% were 8' fluorescents). Other types of lamps such as compact fluorescents and tungsten halogens were included in the system-wide program (beginning in 1987) but represented less than 1% of the lamps installed and were discontinue as an option after about six months.

In order to distribute its lamps to all eligible customers fairly, SMUD set a limit on the number of lamps that each customer could receive. A customer was eligible to receive up to 100 four-foot lamps or up to 50 eight-foot lamps, including installation. If a customer needed a combination of both four and eight-foot lamps, SMUD used a point system. Each customer was eligible to receive up to 100 points worth of lamps: F40 (four-foot) energy-saver lamps were valued at one point, F96 (eight-foot) energy-saver lamps were worth two points, tungsten-halogen lamps were worth from three to five points, and compact fluorescents were worth from eight to twenty-five points depending on their wattage. This point system clearly encouraged the replacement of four and eight-foot lamps as a customer could get more of these lamps replaced before running out of points.

STAFFING REQUIREMENTS

When CLIP was in full-scale operation the program used thirteen staff people. Besides the senior program manager there were two field supervisors, three auditors, six installers, and one part-time clerical worker. The two field supervisors divided responsibilities so that one oversaw the auditors and the other worked with the two person installation crews. The program manager and the two field supervisors were chosen from existing SMUD personnel while the rest of the necessary staff except one installer were contract employees.

The SMUD program manager reported that a CLIP program needs a minimum of two auditors and four installers to ensure a smooth working operation. He also believes that a larger version of the same program could effectively use up to five auditors and ten installers.

Monitoring and Evaluation

MONITORING

SMUD support staff used a personal computer and a spreadsheet software program to maintain program records. A data base was established to document demographics, solicitations, installations, installed lamp amounts, installed kW, and ineligible customers. Spreadsheet software was used to keep track of inventory, budget, and labor hours. Monthly reports were produced documenting the number of customers contacted and audits completed, number and types of lamps installed, and an estimate of the kW and kWh savings per installation. Copies of monthly report forms which show how information was organized and reported, are available from SMUD. Also, a "date installed" was recorded on the stickers inside the light fixture to provide some control in the event of premature lamp failures.

EVALUATION

Evaluation was done in two general areas: the quality of work done and the effectiveness toward meeting the program's stated goals. In order to maintain a high quality of installation each crew checked the job before leaving. In addition, post-installation inspections were conducted by field supervisors and auditors, for a certain percentage of the installations. Initially twenty percent of the installations were inspected, but this was reduced to ten percent half way through the pilot phase of the program due to lack of problems, and later was reduced again to only five percent. Whenever problems did occur, corrections were made on the spot if possible, or arrangements were made for follow-up repairs. The post inspection was useful for evaluating the quality of the work done and for soliciting customer feedback. The goal was to be sure that the customer was left with a feeling of satisfaction and respect for the program's concern for quality. Customers also had an opportunity for feedback by filling out the questionnaire included in the packet which was left with each participant when the installation was completed. Approximately 35% of the participants responded to the questionnaire and less than 0.1% indicated a negative response to the program. All of those who did respond negatively were contacted in an effort to remedy whatever problems might exist.

The other area of evaluation was in determining the program's effectiveness in meeting its stated goals. The well organized record keeping systems were the main tools for gathering data for this area of program evaluation. The monthly reports, which included information on numbers of installations, breakdown of costs, and peak kW saved, allowed for evaluation on an ongoing basis. Inspection of these reports was also helpful in determining when program saturation was being approached and helped the program manager to recommend when to end it. After the program ended, this same information was analyzed to determine the program's overall effectiveness.

DATA QUALITY

The reliability of the savings numbers, which are often the least reliable in a DSM profile, was very high for this program. This was true for two primary reasons: the program was discrete in nature (retrofitting fluorescent lamps) and this was a direct installation program. Because the program was discrete the number of variables was decreased. The direct-installation aspect allowed SMUD to perform thorough audits of each building involved in the program and obtain an accurate count of the number of lamps installed. Knowing the number of lamps installed, the difference in wattage between the existing and the retrofitted lamps (6 W for 4' and 15 W for 8'), and the average number of hours the lights were on each day, allowed for a fairly accurate accounting of the initial savings. It was more difficult to determine the long term savings, however, because it required estimating the number of customers who would continue to use energy-efficient lamps after the first ones burned out. SMUD assumed a 25% persistence of savings through the year 2015 for the purpose of calculating a cost-benefit ratio. It is difficult to assess the accuracy of this assumption but intuitively it does not appear to be inordinately high and in an atmosphere of high awareness of the advantages of energy efficiency, 25% may be conservatively low.

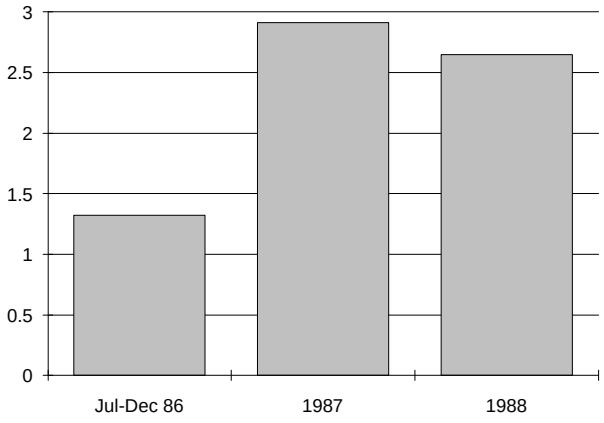
The program costs for the pilot and the first year of the program were well documented. However, the cost records for the program's last year did not seem to be as complete, therefore 1988 cost numbers were estimated by knowing the number of lamps installed and assuming that they cost the same as the average for the previous two years. It was also assumed that the SMUD staff cost in 1988 was the same as for the previous year. The labor contract costs and miscellaneous cost were available from the program Final Report. [R#2] The assumptions used for the last year's cost data have been verified by the CLIP program manager. Despite having to rely on some assumptions, the cost numbers are close to the actual expenditures and are valid for making cost related calculations and assessments.

The measure lifetime for the CLIP which was initially estimated at 4 years, is used for the cost-benefit ratio table in the Cost section. However, a 5-year measure lifetime is more consistent with the program auditor's field estimates of savings and is therefore assumed for the purpose of calculating lifecycle savings and the cost of saved energy. The one year discrepancy exists because SMUD made its initial estimate before the program began and did not update its estimate based on actual program results. However, the CLIP program manager agrees with the use of a 5-year estimate for the measure lifetime.

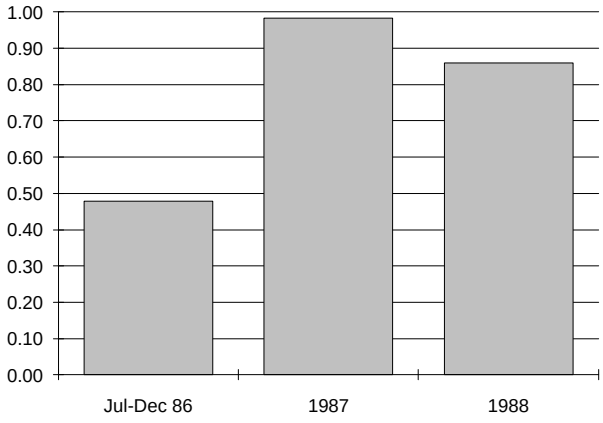
Program Savings

Savings Overview Table	Annual Energy Savings (kWh)	Cumulative Energy Savings (kWh)	Lifecycle Energy Savings (kWh)	Annual Summer Capacity Savings (MW)	Cum. Summer Capacity Savings (MW)
Jul-Dec 86	1,321,257	1,321,257	6,606,285	0.48	0.48
1987	2,911,000	4,232,257	14,555,000	0.98	1.46
1988	2,647,743	6,880,000	13,238,715	0.86	2.32
Total	6,880,000	12,433,514	34,400,000	2.32	

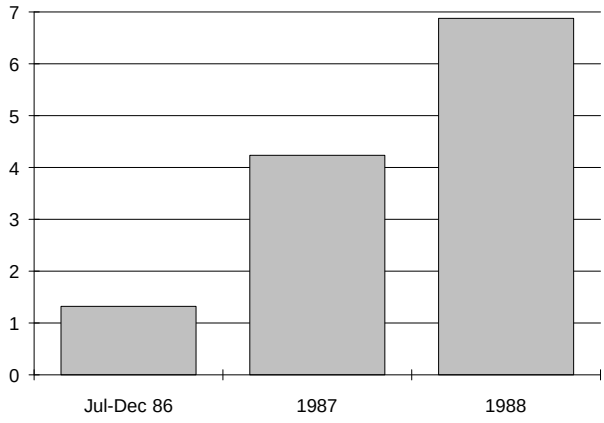
ANNUAL ENERGY SAVINGS (GWH)



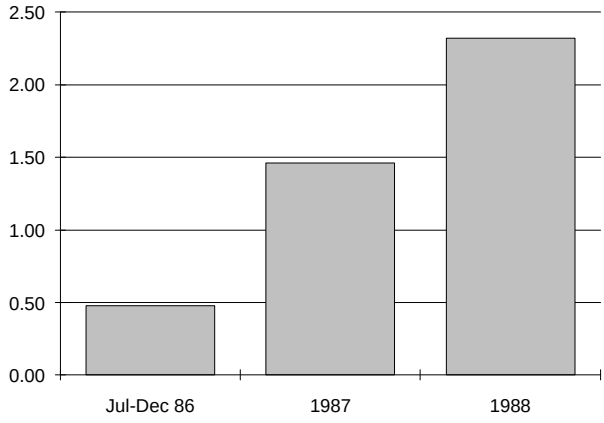
ANNUAL PEAK CAPACITY SAVINGS (MW)



CUMULATIVE ENERGY SAVINGS (GWH)



CUMULATIVE PEAK CAPACITY SAVINGS (MW)



The total annual energy savings from both the pilot and the full program was 6,880,000 kWh.[R#4] Based on this total annual kWh savings estimate and the known number of participants (7,339), the annual savings from the program was calculated to be 937 kWh per participant.[R#2] The lifecycle savings of the program, if none of the customers continued to use energy saving lamps after the originals burned out, was 5 years times 6,880,000 kWh/y or 34,400,000 kWh. Because many customers will continue to use energy-efficient lamps, this can be considered a low-end estimate of the program's energy savings. (See "Projected savings" below.)

ANNUAL ENERGY SAVINGS PER PARTICIPANT (KWH)

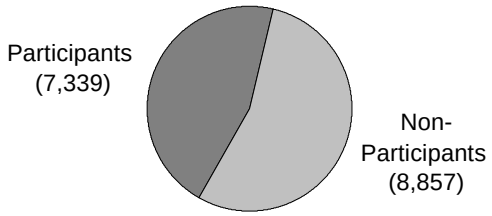
MEASURE LIFETIME

The measure lifetime is based on three factors: average lamp life, duty cycle, and number of lamps replaced with energy-efficient lamps after the original retrofitted lamps burn out. The average lamp life can be calculated by using the weighted average of 85% 4' lamps at a 20,000 hr life and 15% 8' lamps at a 12,000 hr life. If a weighted average 18,800 hour lamp life and a 12 hour per day duty cycle 6 days per week is assumed, then the life of the measure is approximately 5 years. This may be conservative as it does not take into account holidays (thus fewer "on days" per year) or the fact that because most businesses turn lights on and off only once each day the average lamp life will be increased.

Also, it can be assumed that a certain percentage of the customers will continue to use energy-efficient lamps, effectively extending the measure lifetime. Because it is difficult to estimate how many customers will continue to use energy-efficient lighting, the cost of saved energy calculation is done assuming zero, and one replacement which translates into measure lifetimes of roughly 5 and 10 years respectively.

PARTICIPATION RATES

The goal of the program was to involve as many as possible of the 20,000 small commercial customers who were eligible. In the pilot phase of the program 2,350 customers were contacted and 1,278 accepted installation. In the two years that followed (1987-1988) an additional 6,061 participated for a total of 7,339.[R#4] This indicates a participation rate of ~37% of the 20,000 accounts originally identified. However, ~3,838 of these were found to be ineligible for a variety of reasons such as not meeting the eligibility requirements (see Implementation section). Subtracting these from the original group leaves 16,196 for a participation rate of ~45%, as shown in the chart below. This participation rate is still a low-end estimate because the auditors would, on occasion, not even approach a business if they could see clearly that the existing lighting was not a good candidate for a retrofit. Unfortunately, many of these businesses were simply passed over but not recorded as ineligible.



PROJECTED SAVINGS

The projected savings can be stated as either the lifecycle savings just for the lamps installed during the program (34.4 million kWh) or the lifecycle savings plus a "persistence of savings." (This is based on the number of customers that continue to use energy saving lamps). Although it is a difficult number to estimate, SMUD did a cost/benefit ratio calculation in which a 25% persistence of savings was assumed through the year 2015. Therefore, beginning in early 1992 the first lamps installed by the program burned out and the persistence of savings became a factor. If, as SMUD assumed, 25% of the lamps are replaced with energy-efficient ones through the year 2015, the projected savings is ~1.7 million kWh/y after all of the original energy-saving lamps burn out. Assuming 1.7 million kWh/y will be saved for about 23 years, the program will save an additional 39.1 million kWh over the lifecycle savings of the originally installed lamps. This would result in a total program savings of ~73.5 million kWh.

Cost of the Program

Costs Overview Table	Labor Cost (x1000)	Lamp Cost (x1000)	Other Cost (x1000)	Total Program Cost (x1000)	Cost per Participant
1986	$138.1	$86.6	$9.7	$234.4	$183.41
1987	$306.0	$195.2	$21.5	$522.8	$151.40
1988	$305.4	$168.2	$11.6	$485.1	$186.00
Total	$749.5	$450.0	$42.8	$1,242.3	

The total cost of the program including the six month pilot phase in 1986 and the following two years of full program implementation was $1,242,300. Of this amount the largest expenditure was for labor at $749,500 followed by lamp costs $450,000, and all other costs only $42,800. Table C provides a cost overview of this program.

TOTAL PROGRAM COST (x1,000)

COST EFFECTIVENESS

In order to determine the cost effectiveness of CLIP, SMUD used four benefit/cost ratio tests under two scenarios. These benefit/cost numbers, which were generated using Demand-Side program planning software, show that the program was highly cost effective under three out of the four tests. The first scenario assumed a three-year program length, four-year lamp life, 25% persistence of savings through the year 2015, and only marginal benefits during the pilot phase in 1986. The second scenario paralleled the first with the exception that no persistence of savings from the measure was assumed. The four-year lamp life assumption may be conservatively short (see Measure lifetime in the Savings section) and serves to understate the benefits of the ratios given below. It should be noted that if IRL falls below 1.00, program costs can cause rates to rise.

BENEFIT COST RATIO

Stakeholder	Scenario 1	Scenario 2
Program Participants	6.04	10.35
Utility	5.69	3.34
All Rate Payers	3.08	2.55
Impact of Revenue Loss (IRL)	1.09	0.94

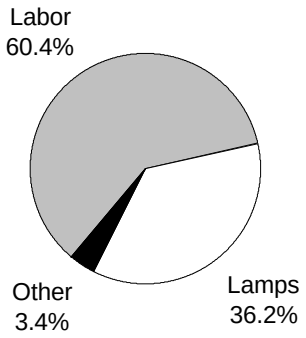
Another measure of cost effectiveness is the cost of saved energy (CSE). Tables D and E show the cost of saved energy for a range of discount rates and a 5 and 10-year measure lifetime. The CSE numbers in Table E, which has an assumed 10-year measure lifetime, are reduced by almost half of those with an assumed 5-year lifetime, and emphasize the advantage of successfully persuading customers to continue to use energy-efficient lamps after the original ones burn out. A useful comparison to make is the CSE and the average small commercial electric rate of ~7.6 ¢/kWh. Regardless of the assumptions made the CSE of this program is well below the 7.6 ¢/kWh rate.

COST COMPONENTS

The costs of this program were broken down into three categories: labor, lamps, and other. Both contract and in-house-staff labor are included in the labor category. The lamps category includes only 4' and 8' fluorescents. The final category, "other", includes materials, vehicle rental, and the

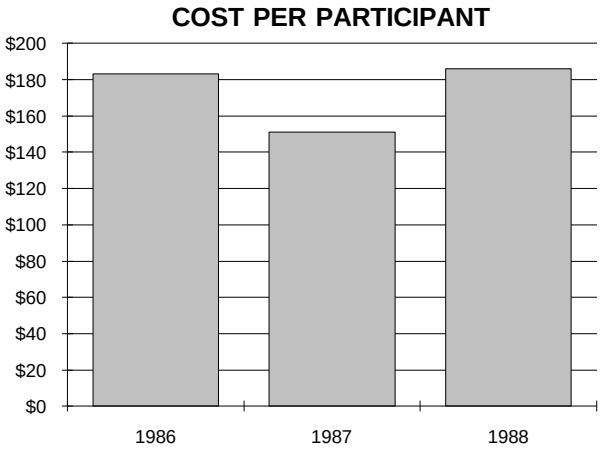
Cost of Saved Energy Table (¢/kWh)	Discount Rates						
	3%	4%	5%	6%	7%	8%	9%
[with 5 year measure lifetime]							
1986	3.76	3.86	3.97	4.08	4.20	4.31	4.42
1987	3.79	3.89	4.00	4.12	4.23	4.34	4.46
1988	3.74	3.85	3.96	4.07	4.18	4.29	4.41
[with 10 year measure lifetime]							
1986	2.02	2.12	2.23	2.34	2.45	2.56	2.68
1987	2.03	2.14	2.24	2.36	2.47	2.58	2.70
1988	2.01	2.11	2.22	2.33	2.44	2.56	2.67

cost of the other lamps used in the program such as compact fluorescents and halogens. Program expenditures by percentage for the three categories are labor ~60%, lamps ~36%, and other less than 4% as shown in the chart below.



COST PER PARTICIPANT

A total of 7,339 small business customers participated in CLIP. With a total cost of the program of $1,242,300, the average cost per participant was $169. During the pilot phase of the project the cost per participant was $183, falling to $151 during the first full year and increasing to $186 in the final year. This is not surprising because start-up costs tend to increase the initial cost per participant and the last year's costs increased as prospective participants became increasingly difficult to locate due to program saturation.



FREE RIDERSHIP

SMUD considered the free ridership for this program to be very low at less than 5%.[#4] This estimate was based on their experience with the small business audit program in which less than 10% retrofitted energy-efficient lamps with the utility providing a free audit. This strongly suggests that very few of SMUD's small business customers were inclined to implement this efficiency measure on their own.

Environmental Benefit Statement

Marginal Power Plant	Heat Rate BTU/kWh	% Sulfur in Fuel	CO2 (lbs)	SO2 (lbs)	NOx (lbs)	TSP* (lbs)
Coal	**Uncontrolled Emissions**					
A	9,400	2.50%	26,807,000	636,000	129,000	13,000
B	10,000	1.20%	28,585,000	246,000	83,000	62,000
	Controlled Emissions					
A	9,400	2.50%	26,807,000	64,000	129,000	1,000
B	10,000	1.20%	28,585,000	25,000	83,000	4,000
C	10,000		28,585,000	164,000	82,000	4,000
	Atmospheric Fluidized Bed Combustion					
A	10,000	1.10%	28,585,000	75,000	41,000	21,000
B	9,400	2.50%	26,807,000	64,000	51,000	4,000
	Integrated Gasification Combined Cycle					
A	10,000	0.45%	28,585,000	51,000	8,000	21,000
B	9,010		25,713,000	18,000	6,000	1,000
Gas	**Steam**					
A	10,400		15,592,000	0	36,000	0
B	9,224		13,540,000	0	85,000	4,000
	Combined Cycle					
1. Existing	9,000		13,540,000	0	52,000	0
2. NSPS*	9,000		13,540,000	0	25,000	0
3. BACT*	9,000		13,540,000	0	3,000	0
Oil	**Steam--#6 Oil**					
A	9,840	2.00%	22,567,000	342,000	40,000	38,000
B	10,400	2.20%	23,935,000	339,000	51,000	25,000
C	10,400	1.00%	23,935,000	48,000	41,000	13,000
D	10,400	0.50%	23,935,000	142,000	51,000	8,000
	Combustion Turbine					
#2 Diesel	13,600	0.30%	29,952,000	60,000	93,000	5,000
Refuse Derived Fuel						
Conventional	15,000	0.20%	35,560,000	92,000	121,000	27,000

Avoided Emissions Based on 12,433,514 kWh Saved (July 1986 - 1988)

In addition to the traditional costs and benefits there are several hidden environmental costs of electricity use that are incurred when one considers the whole system of electrical generation from the mine-mouth to the wall outlet. These costs, which to date have been considered externalities, are real and have profound long term effects and are borne by society as a whole. Some of environmental costs are beginning to be factored into utility resource planning. Because energy efficiency programs present the opportunity for utilities to avoid environmental damages, environmental considerations can be considered a benefit in addition to the direct dollar savings to customers from reduced electricity use.

The environmental benefits of energy efficiency programs can include avoided pollution of the air, the land, and the water. Because of immediate concerns about urban air quality, acid deposition, and global warming, the first step in calculating the environmental benefit of a particular DSM program focuses on avoided air pollution. Within this domain we have limited our presentation to the emission of carbon dioxide, sulfur dioxide, nitrous oxides, and particulates. (Dollar values for environmental benefits are not presented given the variety of values currently being used in various states.)

HOW TO USE THE TABLE

1. The purpose of the previous page is to allow any user of this profile to apply SMUD's level of avoided emissions saved through its Commercial Lamp Installation Program (CLIP) to a particular situation. Simply move down the left-hand column to your marginal power plant type, and then read across the page to determine the values for avoided emissions that you will accrue should you implement this DSM program. Note that several generic power plants (labelled A, B, C,...) are presented which reflect differences in heat rate and fuel sulfur content.

2. All of the values for avoided emissions presented in the table includes a 10% credit for DSM savings to reflect the avoided transmission and distribution losses associated with supply-side resources.

3. Various forms of power generation create specific pollutants. Coal-fired generation, for example, creates bottom ash (a solid waste issue) and methane, while garbage-burning plants release toxic airborne emissions including dioxin and furans and solid wastes which contain an array of heavy metals. We recommend that when calculating the environmental benefit for a particular program that credit is taken for the air pollutants listed below, plus air pollutants unique to a form of marginal generation, plus key land and water pollutants for a particular form of marginal power generation.

4. All the values presented represent approximations and were drawn largely from "The Environmental Costs of Electricity" (Ottinger et al, Oceana Publications, 1990). The coefficients used in the formulas that determine the values in the tables presented are drawn from a variety of government and independent sources.

SMUD AVOIDED EMISSIONS

SMUD does not have a marginal capacity plant that can be displaced by the capacity saved from DSM programs. SMUD has a generating capacity of 848 MW but must buy approximately 1,310 MW to meet its customers' demands. It is this purchased power that is the target for reduction from SMUD's CLIP as well as other DSM programs. By the end of the decade SMUD plans to significantly reduce their amount of purchased power through a combination of aggressive DSM and an increase in SMUD implemented renewable energy supplies. (See Utility Overview section.) However, because this replaced power comes from a variety of sources it is difficult to determine exactly what type of energy source is displaced and thus the degree of the environmental benefits from their programs. Nonetheless, it is certain that there will be some environmental benefits from the implementation of any DSM program because it is sure to have environmental advantages over any of the power that SMUD purchases.

*** Acronyms used in the table**

TSP = Total Suspended Particulates
NSPS = New Source Performance Standards
BACT = Best Available Control Technology

Lessons Learned / Transferability

The two most common reasons for a customer not participating in the program were that the decision maker was not available at the time of the utility's contact and there was a language barrier between the business owner and the utility representative. This suggests that participation rates could have been increased by making appointments with follow up phone calls to the decision makers and by hiring a person with bilingual skills to eliminate language as a barrier to participation.

The CLIP was successful in part because it was a very simple program. However, it might be helpful to examine how the program could be slightly expanded to achieve a greater savings. As is noted in the Cost section of this profile, labor represented a significant percentage of the cost of the program. It becomes a valid question, "What else might an installer do while he's up the ladder changing the lamps?" One option might be to retrofit energy-efficient ballasts at the same time. The advantage is that the ballasts have a longer life than lamps and thus can achieve greater lifecycle savings and the incremental cost is relatively low because the installers are on site anyway to retrofit the lamps. A combined-measure lighting retrofit would clearly be more cost effective than going back for each measure.

There are some energy analysts who have called into question the advisability of swapping lower-wattage lamps for standard lamps. The concern is that because reduced-wattage lamps have a comparable reduction in light output, this is not an efficiency measure but a conservation measure, i.e. a reduction in energy use and service. Despite this, reduced-wattage-lamp retrofits tend to be successful because most small commercial businesses are so overlit that the reduction in light output is usually not perceivable or detrimental to the lighted space. However, if a space has the proper light levels to begin with, it would be necessary to design a retrofit program that maintains the same light levels but uses more efficient lighting technologies to deliver those levels.

The persistence of savings had a significant effect on the cost effectiveness of the program (see Cost of Saved Energy Table pg. 15). Therefore, it is helpful to build into the program, elements that will extend the energy savings beyond the initial installation. For the CLIP program this was done by putting a sticker in the lamp fixture recommending the use of energy-efficient lamps for replacing those that burn out. The packet that was left with the customer contained information that also encourage the continued use of energy-efficient lamps. However, neither of these measures could guarantee that the customer would follow these recommendations. If, on the other hand, a utility installed 4' T-8 lamps (32 W) along with the special ballasts necessary, the customer would have to continue using energy-efficient lamps because the T-8 ballast will not operate a standard 4' fluorescent. Thus, the persistence of savings is virtually guaranteed for as long as the ballast lasts (50,000-100,000 hours or about two and one-half to five additional lamp lifetimes).

When asked "What would you do differently?" CLIP program manager Rich Petersen responded that he would go to the open market to purchase lamps and would not contract labor but instead have the utility hire temporary help. SMUD had problems of prompt delivery of the lamps when they went through a state contract. Eventually they found and used a local supplier and encountered no further trouble with delivery. Mr. Petersen believes that it would be simpler and cheaper if the utility hired the auditors and installers because it would eliminate the considerable time and effort needed to write and have a contract approved. He also believes that it would result in better and fairer working conditions if the contract laborers were hired directly by the utility. And finally, because the laborers were directly supervised by SMUD personnel, the contractor seemed to be an unnecessary middle man.

Because this program dealt with a simple and common retrofit of a common type of business it would be fairly easy to transfer this program to other utilities. If a utility were trying to reduce its peak load it would be important to determine whether or not the savings occurred during the specific utility's peak. Because most peaks, whether winter or summer, occur during business hours, it is likely that a small business lighting retrofit program such as CLIP would help reduce that peak.

Another consideration for a utility wishing to implement a program similar to CLIP, is the disposal of the old lamps. Some states have strict regulations concerning the disposal of fluorescent lamps, while others have no regulations at all. It would be prudent to find out the details of any local regulations, because if there were regulation that involved a disposal fee, the cost effectiveness of the program would be affected.

References

1. Sacramento Municipal Utility District, Annual Report, 1991.

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6. Michael Gettings and Michael MacDonald, "Direct Installation of Lighting Measures in Small Nonresidential Buildings," Oak Ridge National Laboratory.

7. Energy Services Department, Commercial Lamp Installation Program (CLIP)," Sacramento Municipal Utility District, April 5, 1989.

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