
Sacramento Municipal Utility District Comprehensive Municipal DSM Profile #91

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Executive Summary

Sacramento Municipal Utility District (SMUD) is a case study of a significant utility turnaround. Because of problems at its Rancho Seco nuclear power plant in the late 1980s, SMUD was forced to raise rates several times and was suffering from a lack of public confidence and a demoralized staff. Following on the heels of voter referenda to shut the plant and its continuing maintenance problems, SMUD closed Rancho Seco permanently and thus ushered in a new and exciting era at the utility.

SMUD was very fortunate to be able to purchase replacement power from its neighboring California utilities, which gave it time to chart a new course. SMUD's insightful Board of Directors hired David Freeman, a strong advocate of public power, to take the helm. Freeman single-handedly has been credited with turning SMUD around, from a despondent position to a utility with power and vision. Freeman's strategy, reinforced by the Board, was to focus intensely on energy efficiency and to invest proactively in renewable energy resources. Coupled with flexible blocks of purchased power identified in its integrated resource plan, SMUD's vision crystallized and was clearly aimed at providing heightened levels of customer services to alleviate customer bills in the short term and to provide a highly diversified resource portfolio for a long term and sustainable energy future for the Sacramento region.

Today SMUD offers its customers a comprehensive array of energy efficiency and load management programs and their impacts are impressive. After years of annual DSM expenditures in the range of \$3-8 million, in 1991 SMUD's DSM budget grew to \$38 million, reflecting its commitment to the DSM resource. By 1993 the Energy Efficient Refrigerators program, for example, had resulted in purchases of more than 70,000 energy-efficient refrigerators while 63,000 old, inefficient refrigerators had been collected and recycled. The Direct Investment program has provided electric-heat customers with almost 15,000 energy efficiency measures for free. Participants of the Residential Peak Corps program, SMUD's leading load management program, have installed 96,130 air conditioning cyclers. Through the Shade Tree program approximately 109,000 trees have been planted, and 1,200 solar water heaters have been installed through the Solar Domestic Water Heater program, a program that has now been expanded to promote rooftop solar photovoltaics. Equally impressive results have accrued from SMUD's commercial and industrial retrofit programs.

While its DSM programs are on track, SMUD has concurrently been promoting renewable energy resources, from centralized and decentralized solar applications to wind generation. SMUD has proven that it is possible to dramatically change course, and to do so for the better. Not only have rates been stabilized, but citizens in Sacramento are now proud of their municipal utility. SMUD has listened to voters' wishes and invested in the city's future, concurrently setting a powerful model for electric utilities around the world.

SACRAMENTO MUNICIPAL UTILITY DISTRICT Comprehensive Municipal DSM

Sector: Residential, Commercial, Industrial

Measures: A wide spectrum of efficiency improvements from weatherization measures and solar water heating to high efficiency HVAC and lighting.

Mechanism: Rebates for equipment efficiency improvements for all sectors; new construction rebates; a broad range of load management; direct weatherization installation

History: Began conservation efforts with load management in the 1970s; In 1989 began full range of DSM and renewable energy programs

1993 PROGRAM DATA

Energy savings: 96.4 GWh
Lifecycle energy savings: 1,446 GWh
Capacity savings: 35 MW
Cost: \$32,718,000

CUMULATIVE DATA (1978-1993)

Energy savings: 269.3 GWh
Lifecycle energy savings: 4,039 GWh
Capacity savings: 309 MW
Cost: \$196,367,000

CONVENTIONS

For the entire 1994 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 U.S. Federal Reserve's foreign exchange rates.

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 or “the District”) began operations on December 31, 1946. Its service territory encompasses 900 square miles within and around the City of Sacramento, the capital of California, located in the state’s central valley on a trajectory between San Francisco and Lake Tahoe. SMUD is the fourteenth largest public power agency in the United States in terms of energy sales and its 2,411 employees served 467,177 customers in 1993.[R#1]

SMUD is an independent agency governed by a five-member Board of Directors with members elected by the public for staggered four-year terms. (In 1995 the Board will expand to seven members.) There is no formal connection between SMUD and city or county government or any other local government agencies. Its Board is responsible for setting rates, establishing District policy, and appointing the General Manager, who in turn is responsible for utility operations and hiring staff.

Given the hot, dry climate that marks Sacramento’s summers, and its mild winters, it’s not surprising that SMUD is a summer peaking utility. In 1993 the utility experienced a peak demand of 2,145 MW after its load management programs were dispatched. Between purchased power and utility-owned power, SMUD had a peak capacity of 2,162 MW creating a reserve margin of 0.8%. Purchased power comprises the bulk (1,550 MW or 72%) of the District’s capacity. In 1993, the utility had customer electric sales of 8,448 GWh.[R#1]

In 1993, SMUD’s electricity generation was primarily comprised of purchases, at 6,613 GWh or 71% of the total power supply. The closure of SMUD’s Rancho Seco nuclear power plant in 1990 that had supplied 2,812 GWh in 1988 and 1,439 GWh in 1989 forced the utility to increase the use of purchased power. Even prior to Rancho Seco’s closure, SMUD had been forced to dramatically increase its use of purchased power because of repeated problems at the nuclear plant. The remainder of SMUD’s power in 1993 came from hydroelectric sources (2,163 GWh or 23%), geothermal resources (506 GWh or 5%), gas turbines (3.1 GWh or < 1%), and photovoltaics (2.7 GWh or <1%).[R#1,25]

SMUD 1993 STATISTICS	
<i>Number of Customers</i>	467,177
<i>Number of Employees</i>	2,411
<i>Electric Revenues</i>	\$589.6 Million
<i>Energy Sales</i>	8,448 GWh
<i>Summer Peak Demand</i>	2,145 MW
<i>Generating Capacity</i>	2,162 MW
<i>Reserve Margin</i>	0.8 %
<i>Average Electric Rates</i>	
<i>Residential</i>	7.31 ¢/kWh
<i>Commercial / Industrial / Other</i>	6.72 ¢/kWh

California has been in a severe recession for the past several years, in large part because of the decline of the aerospace and defense industry. During 1992, the total population of Sacramento decreased for the first time ever, and SMUD had 1,494 fewer customers at year end 1993 than year end 1992. [R#1,25]

SMUD has not raised its electric rates since January 1990. Residential customers pay an average of 7.31 ¢/kWh, while commercial and industrial and all other customers pay 6.72 ¢/kWh, making the utility’s rates among the lowest in the state. Rates are a major issue at SMUD because the utility believes it essential to keep its rates substantially below PG&E’s for competitive purposes. ■

Utility DSM Overview

SMUD has implemented conservation and load management programs since 1976 when the utility created a Conservation Department. Initially the Department focused on customer education and basic residential efficiency measures such as attic insulation retrofits, rebates for energy-efficient new construction, and a test of direct load control for air conditioners. These programs focused on load management to help curb the utility's summer peak.

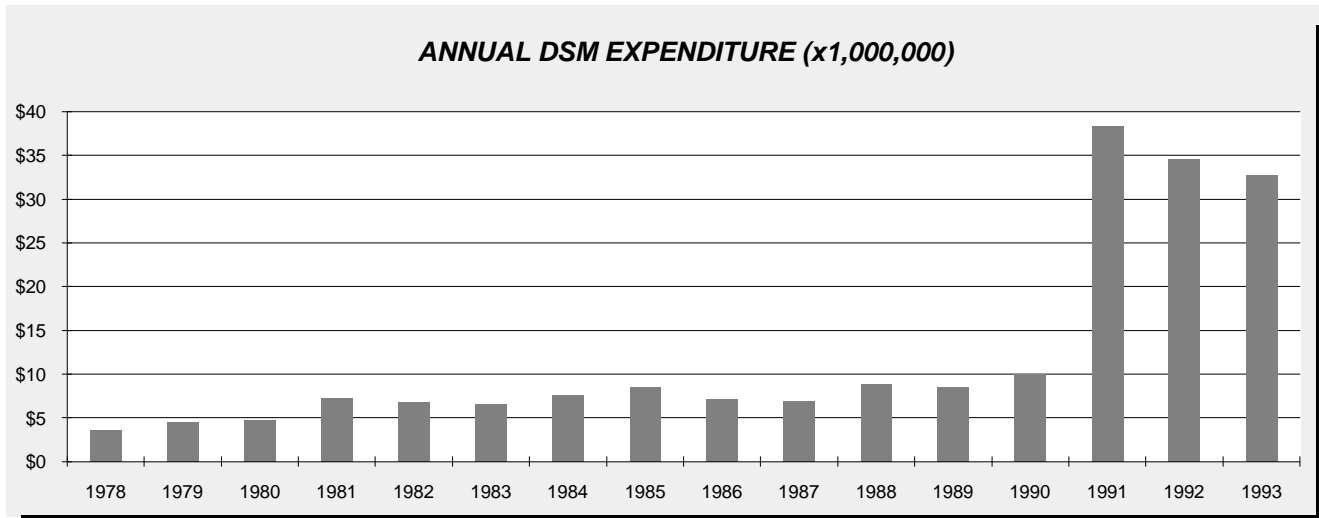
Conservation and load management activities were expanded in the early and mid 1980s in part as a response to State and Federal mandates such as the California Energy Commission's

1993 SMUD DSM PROGRAMS
<u>Residential Retrofit</u>
Direct Investment
Community Partners
Retail Lighting
Shade Trees
Solar Domestic Water Heating
<u>Load Management</u>
Residential Peak Corps
Commercial Peak Corps
Water Pump Load Management
C/I Load Management: Auxiliary Power, Curtailable Service, Fast Dispatch
Pool & Spa
<u>Equipment Efficiency</u>
Energy Efficient Refrigerators
Residential Equipment Efficiency Improvement
C/I Equipment Efficiency Improvement
<u>Commercial / Industrial Retrofit</u>
Small C/I Retrofit
Large C/I Retrofit
DSM Bid
Schools & Public Buildings
Multi-Family Retrofit
<u>New Construction</u>
Residential New Construction
Commercial / Industrial New Construction
Residential Thermal Energy Storage
Commercial Thermal Energy Storage
<u>Education</u>
Total School Energy Management

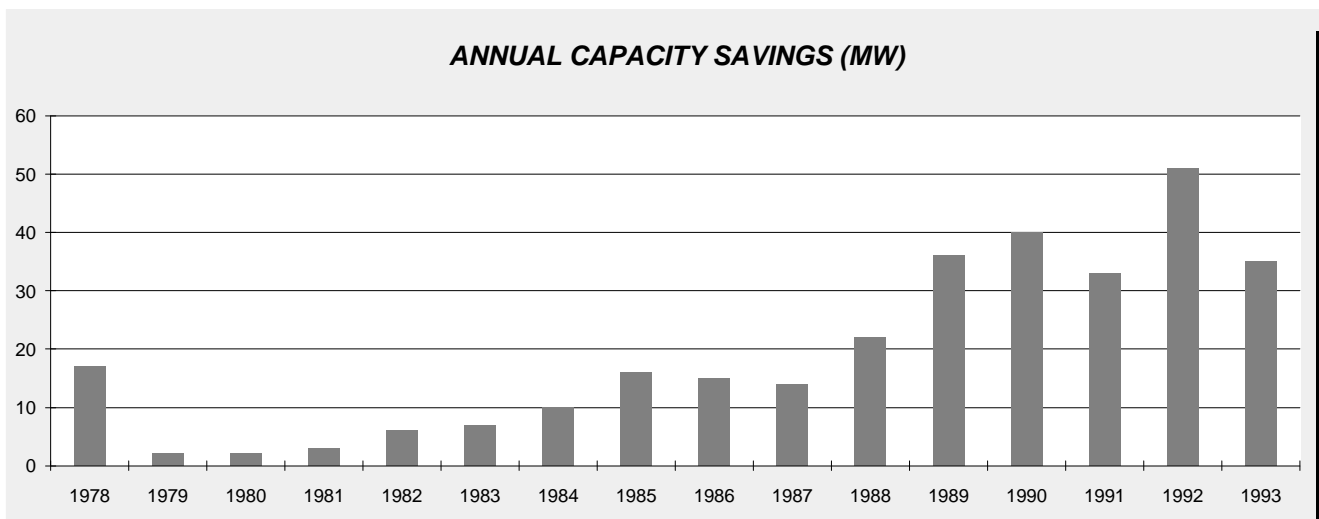
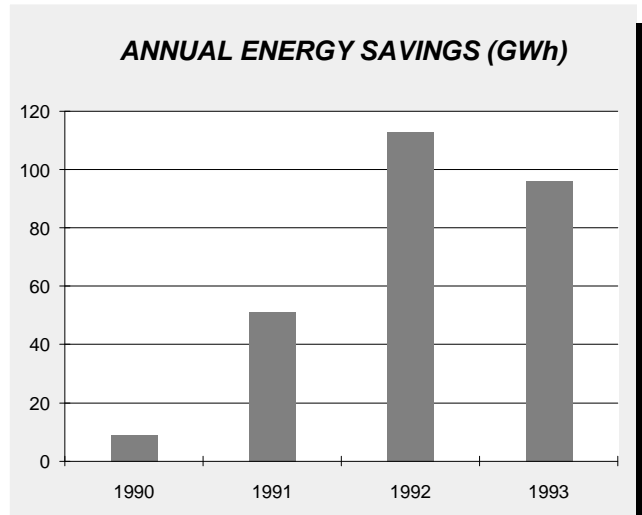
SMUD DSM OVERVIEW	DSM EXPENDITURE (x1000)	ENERGY SAVINGS (GWh)	CAPACITY SAVINGS (MW)
1978	\$3,608	negligible	17
1979	\$4,501	"	2
1980	\$4,758	"	2
1981	\$7,189	"	3
1982	\$6,772	"	6
1983	\$6,561	"	7
1984	\$7,548	"	10
1985	\$8,503	"	16
1986	\$7,155	"	15
1987	\$6,903	"	14
1988	\$8,839	"	22
1989	\$8,432	"	36
1990	\$10,000	9	40
1991	\$38,318	51	33
1992	\$34,562	113	51
1993	\$32,718	96	35
Total	\$196,367	269	309

Load Management Standards and the U.S. Department of Energy's Residential Conservation Service program. As these programs were proven to be successful, popular, and cost effective, participation in the residential air conditioner cycling program was dramatically increased and the overall residential program was expanded to include more measures to induce greater participation and increase savings.

In response to needle peaks resulting from Sacramento's significant air conditioning load when summer temperatures routinely climb above 100 degrees F, SMUD developed and adopted a Load Management Business Plan in 1987. Implementation of this plan expanded the load management programs with a continued focus on residential air conditioning units and a new emphasis on commercial and industrial curtailable efforts, thermal energy storage incentives, and time of use rates.



During the late 1980s the citizens of Sacramento elected three Board members (and thus a majority) who strongly favored conservation. What really catalyzed the Board's direction, however, was the series of events that resulted in the closure of the Rancho Seco nuclear plant. The plant (or "the ranch" as it was called) was closed for slightly more than two years after its fifth significant cooling accident in December 1985. As a result of this outage, SMUD undertook an extensive program of upgrades to plant and personnel to improve the plant's reliability and availability. Plant costs spiralled and utility rates went up. A community action group placed an initiative on the local ballot during this period to close the Rancho Seco plant immediately and permanently. The SMUD Board countered with a referendum to operate the plant for 18 months and then decide its fate based on the level of operation achieved 🖱



DSM Overview (continued)

during that period. The community initiative failed, while the Board's initiative passed. The plant was restarted in March 1988 but continued to suffer breakdowns. A second referendum, permitting continued operation of the plant, was rejected by voters in June 1989 and SMUD was forced to retire the plant.

In January 1990, the Board set forth the goal to make energy efficiency the District's priority resource. To fulfill this mission, the Board selected S. David Freeman as General Manager. By this point in his career, David Freeman had developed a strong reputation as an outspoken advocate of public power in his previous positions at the helm of the Tennessee Valley Authority and the Salt River Project. Freeman was charged with promoting integrated resource planning (IRP), demand-side management (DSM), and renewable technologies at SMUD and to thus chart a new course for the demoralized utility.

All facets of SMUD's DSM activities followed suit. During 1990 and 1991 the Energy Efficiency Department grew from 80 to 240 staff members. Prior to David Freeman's arrival DSM was generally considered a customer service. After his arrival it was more fully integrated as a resource and the Energy Efficiency staff was more fully integrated in the organization. SMUD's expenditures on DSM since 1990 have reflected its aggressive portfolio of programs. For instance, while the industry-wide average for DSM spending as a percentage of gross revenues was 1.2% in 1992, SMUD's 1993 DSM expenditures were 5.55%, one of the highest levels of spending in the United States. [R#1,5]

SMUD'S INTEGRATED RESOURCE PLANNING

SMUD entered a new and aggressive phase of conservation efforts in late 1990 as a result of the closure of the Rancho Seco nuclear power plant and a changing corporate vision of the utility's role as a provider of energy. This new corporate ideology was created and promoted in large part by David Freeman. Staff claim that David Freeman was the real champion of DSM at SMUD. He was not only inspirational to his entire staff, but also worked relentlessly within the community to rebuild the reputation of the utility and garner support for its new directions with efficiency and solar energy.

In 1991, SMUD developed its first integrated resource plan (IRP). The IRP was titled the "General Manager's Recommendations for Power System Additions" and was formally adopted by the Board in its November 20, 1991, "Scoping Report of the Board Policy Committee on Power System Additions." (In 1993 SMUD's Resource Planning Department released its revised IRP and the utility now plans to update its IRP every two years.)

The IRPs have provided a blueprint for SMUD's transition, a transition made especially difficult by Rancho Seco. Through its planning process, SMUD has effectively tapped the DSM resource to offset some degree of power purchases in the short term while providing a greater share of the utility's resource requirements in the mid and long term. The current IRP emphasizes SMUD's goal of building a "conservation power plant" with DSM programs meeting all new load growth. It reiterates the goal of reducing peak load to 2,000 MW by the year 2000, reducing the need for purchased power through emphasis on energy efficiency and renewable energy. By the year 2000 the utility plans to have installed 600-700 MW of summer peak capacity savings through its DSM programs, an amount equal to SMUD's projected demand growth.

In the next few years SMUD must entirely replace the power that is currently being purchased. After a competitive bidding process and extended public discussion, SMUD developed a resource plan featuring three major power "blocks," in contrast with the traditional utility approach of building a large central plant. These increments will provide SMUD with flexibility until all blocks are operational in the year 2000. The first block includes four natural gas cogeneration plants for a total capacity of 465-600 MW plus 50 MW of wind. A second block of power of up to 200 MW will be purchased from British Columbia and generated by natural gas cogeneration. (SMUD views natural gas, the fuel for the first and second blocks, as an important "transition fuel" that can be used until renewable resources are available.) SMUD's third block of power will come from renewables and advanced technologies. This last block will consist of 150 MW of solar thermal and an additional 200 MW from a combination of photovoltaic, biomass, fuel cell, and geothermal sources. If this plan succeeds SMUD will eliminate the need for any additional purchased power. ■

As stated earlier, SMUD's commitment to DSM can be measured by examining its percentage of gross revenues dedicated to DSM. While the industry-wide average for utility DSM spending as a percentage of gross revenues was 1.2% in 1992, SMUD's 1993 DSM expenditures including net customer loans were 5.55% of gross revenues, one of the highest percentages in the nation. In addition, SMUD's conservation staff has almost tripled in size since 1990 and is at a current level of 240 conservation employees who make up approximately 10% of the utility's total workforce.

SMUD's 1993 energy efficiency programs achieved annual energy savings of 96 GWh, equivalent to 1.1% of 1993 total electricity sales and more than one-half again the savings of 51 GWh achieved in 1991. The utility spent \$32.7 million on DSM, and loaned another \$12 million (net of repayments) to its customers for energy efficiency improvements in 1993. Virtually all of SMUD's 1993 energy savings were the result of retrofits, with 48.9 GWh coming from residential retrofits, 43.5 GWh the result of commercial retrofits, and 4.0 GWh from new construction. The utility paid customers a total of \$16 million in incentives, with the average incentive for commercial customers reaching \$6,476 and an average incentive for residential customers of \$126.

SMUD'S LEADERSHIP WITH ADVANCED AND RENEWABLE TECHNOLOGIES


SMUD's lead with solar technologies has been unparalleled in the United States. Its 2 MW photovoltaic generating station was an industry first, as are its solar rooftop programs for both solar domestic hot water and photovoltaics. This leadership must continue if SMUD is to fulfill the goals stated in its resource plan. In fact the plan calls for 350-400 MW of capacity from advanced and renewable technologies by the year 2000. Currently the utility is providing funding for the development and commercialization of solar thermal, fuel cells, photovoltaics, hydrogen, geothermal, biomass, wind, energy storage systems, and high-efficiency gas turbines.

In 1992 SMUD opened one of the first solar-powered charging stations in the country for electric vehicles (EVs). The station can recharge 16 EVs at one time. More than 120 EV charging outlets have been installed throughout the Sacramento area and use of these recharging arrays is completely free. The utility also has an EV loan program for commercial organizations to promote the technology. In addition, largely due to SMUD's EV expertise, McClellan Air Force base has received \$2.5 million in federal funding for researching and developing EV technology. SMUD is also working to establish an EV manufacturing industry for Sacramento and is even considering using Rancho Seco as a site for EV manufacturing.

SMUD'S CURRENT PORTFOLIO OF DSM PROGRAMS

SMUD currently delivers a comprehensive set of load management and efficiency programs to its residential, commercial, and industrial customers. To implement the programs, SMUD's Marketing Department develops an annual marketing plan for each program to spur participation. Types of advertising used include television and radio ads and bill stuffers. Some of SMUD's programs are judged not to need marketing, while others are heavily promoted. [R#22]

RESIDENTIAL RETROFIT

The Direct Investment program: The Direct Investment program is available to all electric-heat customers and is delivered by local contractors working under contract to SMUD. This program was introduced in 1993 and offers, at no cost to these customers, improved insulation; plugging of leaks around ducts, windows, and doors; and other measures such as low-flow showerheads and compact fluorescents. In 1993, nearly 15,000 energy efficiency measures, including over 7,700 compact fluorescent light bulbs, were installed in 2,670 homes following audits of nearly 3,700 electrically-heated homes. 

Implementation (continued)

The Community Partners program: The Community Partners low-income program has been implemented since 1990 and includes direct installation of various weatherization measures. In certain instances refrigerators are provided free, with 886 delivered in 1993 and over 2,300 delivered to date. Program delivery is performed by community-based organizations and local contractors.

Retail Lighting: The 1994 campaign is a joint SMUD/local lighting retailer campaign. Residential customers will be offered two \$10 coupons toward their purchase of two "instant on/flicker free" compact fluorescents at participating retailers. Retailers have agreed to honor SMUD coupons, maintain regular rain check and return policies, offer at least three varieties for customer selection, display promotional and educational material, and keep track of compact fluorescent sales from October 1, 1994 through December 31, 1994.

The Shade Tree program: This program is a joint effort with the Sacramento Tree Foundation and has resulted in the planting of over 109,000 shade trees in the yards of SMUD customers since 1990, of which over 44,000 were planted in 1993. Fully grown, these trees can reduce home cooling costs by up to 40% in the summer.

Solar Domestic Water Heater program: The Solar Water Heater campaign got off to a quick start with approximately 1,200 systems installed from the start of the program in 1992, of which 774 were installed in 1993. Savings for the program totaled 2 GWh and 0.3 MW in 1993. The program replaces inefficient electric water heaters with efficient solar water heaters, is contractor driven, and has high quality assurance standards and control. Rebates averaged \$975 and financing averaged \$2,060 in 1993.(See The Results Center Profile #66.)

SMUD also started a rooftop PV program in 1993 in which customers pay SMUD \$6 monthly to have PV panels installed on their roofs. The power generated by the panels goes directly to SMUD, not the customers. Following limited program marketing, SMUD received 2,000 calls about the program, and 108 PV systems were installed through the program in 1993.

LOAD MANAGEMENT

The Peak Corps Air Conditioner Load Management program: The Peak Corps Air Conditioner Load Management program is SMUD's largest DSM program in terms of capacity savings and allows SMUD to cycle participating customers' air conditioners during selected summer days. Installed summer peak capacity savings were estimated at 102 MW by the end of 1993 with more than 96,000 residential customers and nearly 33,000 tons of commercial air conditioning participating. Cycling occurs on average 10 to 16 days per summer. There are several types of participation options for residential customers, with the most stringent being "the Peak Performer" which cycles AC loads off up to four hours and saves customers up to \$20 monthly from their summer bill. Currently 35% of participating customers have selected this option.(See The Results Center Profile #83)

Participation in the Residential Peak Corps program has benefitted greatly by SMUD's Rule 15 adopted in 1990. Rule 15 is a hook-up condition and requires that all newly-constructed homes with central air conditioning participate in Peak Corps unless the customer requests removal. Less than 20% of new homeowners have requested to withdraw from the program, and new construction currently accounts for about 33% of all new participants. In 1992 SMUD initiated a recorded message updated daily on the Sacramento Bee's (newspaper) BeeLine telephone information system. The recording alerts customers whether the utility will be cycling loads that day. Daily radio messages serve the same purpose.

Water Pump Load Management program: This program provides a 15 ¢/kW incentive to customers who agree to remote cycling of their water pumps for up to four hours at a time on summer peak days. A total of 80 pumps have participated in the program through 1993.

Auxiliary Power, Curtailable Service, and Fast Dispatch programs: For large C/I customers there are three interruptible rate load management options. The Auxiliary Power program takes advantage of the on-site generators that

many large agencies and firms – computer/data, telephone/telecommunication, hospitals – have as a means to maintain service when SMUD power is interrupted. These generators are used in place of SMUD connected power during peak periods as part of the program contract. Customers participating in the Curtailable Service program commit to turning off a prescribed amount of load within two hours of notification on peak days. The Fast Dispatch program participants are able to shed facility electric loads within ten minutes. By the end of 1993, 60 MW of dispatchable load were under contract.

Pool and Spa Load Management program: Started in 1978, the Pool/Spa Load Management program uses advertising, education, and free time clock trippers to encourage owners of pools and spas to shift the hours of operation of filtering pumps to off-peak hours. Through 1993, the District realized approximately 22 MW of capacity shifted off-peak.

EQUIPMENT EFFICIENCY


Energy Efficient Refrigerators program: SMUD's refrigerator program is comprised of two major elements: rebates for encouraging customers to buy the most efficient unit they can afford, and incentives to encourage the removal of older, inefficient models from service. New refrigerators must exceed 1993 Federal appliance efficiency standards by at least 15%. The old units are prematurely removed from the market by dismantling them, removing the refrigerant (which is sold back to a manufacturer), disposing of the capacitor and its oil, and selling the box as scrap. The refrigerator program is operated through a number of local appliance dealers who advertise the availability of SMUD's trade-in incentive and rebates on specified models. By the end of 1993, nearly 70,000 new high-efficiency refrigerators had been purchased, of which over 18,000 were purchased in 1993; and a total of 63,000 old units were turned in and "recycled," of which over 20,000 were recycled in 1993. (SMUD has also participated in the Super Efficient Refrigerator Program (SERP) in which 24 utilities pooled \$30 million in a manufacturer's winner-takes-all design competition coupled with procurement of 250,000 super-efficient refrigerators. SERP is the subject of a forthcoming profile.)

Equipment Efficiency Improvement program: During 1993, the Equipment Efficiency Improvement program provided rebates and/or financing to stimulate the purchase of more than 5,500 efficient heat pumps and air conditioners to replace inefficient electric heating and cooling systems. The program also resulted in over 3,600 ceiling and wall insulation and shade screen installations. Approximately \$7 million in rebates and close to \$16 million in loans were provided to all customer sectors through the program in 1993.

COMMERCIAL/INDUSTRIAL RETROFIT

Large & Small Commercial/Industrial Retrofit: SMUD's C/I Retrofit programs offer C/I customers energy advisory services, energy use analysis and efficiency recommendations, and rebates and financing. Program participation is driven primarily by the 100 SMUD-approved electrical and mechanical contractors and vendors. In 1993, these programs resulted in 9.1 MW and 43 GWh of savings.

DSM Bidding program: Currently SMUD is implementing a pilot DSM Bidding program for C&I customers. The utility received 36 responses to its requests for bids, short-listed eight, and selected three. All of the bids are from energy service companies. Bids were required to come in under 3.5 ¢/kWh and provide at least 30% of savings from non-lighting measures. Approximately 10 MW of capacity savings are expected to be achieved by December 1995.

Schools and Public Buildings program: SMUD's Schools and Public Buildings program offers advisory services, educational services and assistance, direct energy use audits, rebates, and lease/purchase financial arrangements for schools and public buildings (State, Federal, County, and City governments). The program provides comprehensive energy efficiency audits, identifying all cost-effective opportunities in existing schools and other public buildings. To assist schools and public agencies in financing and installing energy efficiency improvements, program staff can arrange for customer payment through a lease/purchase agreement with the District. A SMUD energy specialist may also act as a project manager 

Implementation (continued)

to help a customer select a contractor, arrange installation, and oversee project quality. SMUD completed 73 audits in 1993.

Multi-Family Retrofit program: For SMUD's Multi-Family Retrofit program, residential buildings that have five or more dwelling units are considered multi-family. SMUD energy specialists provide on-site energy audits and recommendations for efficiency improvements. Custom rebates for the commercial accounts (common area lighting, pools, HVAC), prescriptive rebates for residential accounts, and direct installation of weatherization, water heating, and lighting measures are provided.

NEW CONSTRUCTION

New Construction program: A New Construction incentive program for all sectors seeks to make new buildings and homes 25% more energy-efficient than state codes. Builders receive incentives for advanced HVAC systems, efficient lighting, added insulation, and other measures. In the residential sector builders can receive rebates for thermal energy storage systems based on the size of the system, while commercial builders/developers can receive rebates based on peak load reduction achieved through thermal energy storage systems. In general this program focuses on avoiding lost opportunities

by providing design assistance and financial incentives based on incremental costs. The program seeks to transform the construction market by reaching building owners as well as designers and builders. Savings of 4.0 GWh and 2.5 MW were achieved in all sectors through this program in 1993.

EDUCATION

Total School Energy Management program: SMUD has provided educational services to the community and schools for many years, focusing on safety, alternative fuels, generating sources, and energy and the environment. The goal of these programs is to institutionalize efficiency by educating its customers. With the Total School Energy Management program (TSEM) the utility hopes to change the behavior of children in grades K - 6 by educating them about environmental issues and energy consumption. By educating young children the program also hopes to reach their families.

STAFFING REQUIREMENTS

During 1990 and 1991, following the arrival of General Manager David Freeman and the subsequent ramping up of DSM, SMUD's Energy Efficiency Department grew from 80 to 240 staff members with fully eight staff in the evaluation unit alone. Currently Mike Weedall is the Director of Demand-Side Management at SMUD. ■

Monitoring and Evaluation

MONITORING

SMUD produces monthly tracking reports which include energy and capacity savings for each of its DSM programs. The utility uses both a Customer Information System (CIS) and an Energy Efficiency Tracking System (EETS) to track customer, site, and measure specific information. SMUD has recently developed a DSM Planning Database which is the product of a collaborative effort between SMUD's Forecasting, DSM Planning, and Energy Efficiency groups. This database is periodically updated to reflect new data and information, a greater understanding of impacts and costs of existing programs, and the results of Monitoring and Evaluation activities.[R#17]

EVALUATION

In 1991 SMUD placed an increased emphasis on evaluation of all its DSM programs with the creation of a formal evaluation department.

In an effort to refine its DSM activities, the utility underwent a review of its energy-efficiency programs by the Conservation Law Foundation of New England and the Natural Resources Defense Council during 1992. This review resulted in recommendations that SMUD improve its methodology for cost-effectiveness screening to more accurately portray the combined benefits of reducing peak demand and saving energy, to implement direct installation programs for residential customers to improve participation, to encourage retrofits at the time of equipment/appliance replacement, and to expand evaluation efforts.

SMUD's "1993 Demand-Side Management Resource Plan" includes a summary of SMUD's completed and planned evaluation activities as follows[R#17]:

In March 1993, SMUD's Monitoring and Evaluation staff completed a "Comprehensive Evaluation Plan" for all of the utility's DSM programs. This plan outlines the criteria for deciding which programs will be reviewed and the appropriate level of evaluation. The criteria include magnitude of impacts expected from the program, amount of resources spent on the program, degree of uncertainty about program impacts, and amount of resources needed to perform the evaluation.

Based on this criteria, the Peak Corps Residential AC cycling program was a top priority for evaluation. Analysis performed in late 1992 and based on metered data of participants and non-participants found that customers who selected more stringent cycling strategies tended to use their air conditioning less than those customers with less stringent strategies. Based on these results, estimated program impacts were reduced by 40 MW. Other SMUD programs which either have been evaluated or are currently being evaluated for load impacts include: Commercial Peak Corp, C/I Interruptible Service programs, Non-Dispatchable programs, Pool & Spa Load Management program, Efficient Refrigerator program, C/I Retrofit (lighting), and Residential and Commercial Efficiency Equipment Improvements. Process evaluations for the Shade Tree program, Equipment Efficiency Improvements, C/I Retrofit, and Residential Direct Investment programs will be completed by the end of 1994.[R#17] ■

Program Savings

In 1993, SMUD's total DSM roster achieved savings of 96,398 MWh and summer peak capacity savings of 35 MW. From 1990 through 1993 SMUD had total annual energy savings of 269,338 MWh and cumulative energy savings of 511 GWh. (Energy savings from 1978 through 1989 are negligible). Summer peak capacity savings from 1978 through 1993 total 309 MW. [R#20,26,27] Combined, SMUD's Residential Retrofit and Commercial/Industrial Retrofit programs account for 92,407 MWh (96%) of 1993 energy savings. On the peak capacity side, the Residential Peak Corps program accounts for 101.8 MW (33%) of cumulative savings. Programs implemented prior to 1991 account for 49.3 MW of cumulative peak capacity savings. Other programs which have captured significant cumulative peak capacity savings include the Commercial/Industrial Fast Dispatch (25 MW) and Auxiliary Power (26.7

SAVINGS OVERVIEW	1993 ENERGY SAVINGS (MWh)	1990-93 CUMULATIVE SAVINGS (MWh)
Residential Retrofit	48,934	135,352
C/I Retrofit	43,473	126,897
Res New Construction	685	1,471
C/I New Construction	3,306	5,618
Total	96,398	269,338

MW) load management programs, the Pool & Spa program (21.7 MW), and Small & Large C/I Retrofits with 27.7 MW combined. [R#26,27]

PARTICIPATION	1993	TOTAL THROUGH 1993
Direct Investment	15,000 energy efficiency measures	started in 1993
Community Partners	886 refrigerators	2,300 refrigerators
Retail Lighting	0 lamps	0 lamps
Shade Trees	44,000 trees	109,000 trees
Solar Domestic Water Heater	774	1,200
Res. Peak Corps	11,294 cyclers	96,130 cyclers
Comm. Peak Corps	6,216 tons	32,891 tons
Water Pump Load Management	0 pumps	80 pumps
Curtable Service, Fast Dispatch	700 kW	60 MW
Pool & Spa	450 pools	26,145 pools
Energy Efficient Refrigerators	18,000 purchased, 20,000 recycled	70,000 purchased, 63,000 recycled
Eqmt. Improvement (R/C/I)	5,500 heat pumps & AC units	12,200 heat pumps & AC units
Eqmt. Improvement (R/C/I)	3,600 insulation measures	6,200 insulation measures
Large C/I Retrofit	97 participants	318 participants
Small C/I Retrofit	387 participants	952 participants
DSM Bid	3 contracts	3 contracts
Schools & Public Buildings	73	392 participants
Multi-Family Retrofit	14 participants	14 participants
Residential New Construction	1,231 units	1,231 units
Residential TES	5 units	5 units
Commercial New Construction	1,920,000 sq. ft. (32 projects)	1,920,000 sq. ft. (32 projects)
Commercial TES	2 projects	2 projects
School Energy Mgmt. program	20 schools	30 schools

PEAK CAPACITY SAVINGS OVERVIEW	1993 PEAK CAPACITY SAVINGS (MW)	1978-1993 CAPACITY SAVINGS (MW)
<i>Residential Peak Corps</i>	12.6	101.8
<i>Commercial Peak Corps</i>	2.3	13.3
<i>C/I Load Mgt. (Fast Dispatch)</i>	-0.8	25.0
<i>C/I Load Mgt. (Auxiliary Power)</i>	1.6	26.7
<i>C/I Load Mgt. (Curtable Service)</i>	-0.1	8.3
<i>Water Pump Load Management</i>	0.0	1.0
<i>Pool & Spa</i>	0.4	21.7
<i>Res. Retrofit (Dir. Investment / Comm. Partners)</i>	0.9	3.5
<i>Small & Large C/I Retrofit</i>	9.1	27.7
<i>Energy Efficient Refrigerators</i>	3.5	10.6
<i>Equipment Efficiency Improvement (R/C/I)</i>	3.1	10.1
<i>Res. New Construction (incl. TES)</i>	1.0	3.9
<i>C/I New Construction (incl. TES)</i>	1.5	5.5
<i>Solar Domestic Water Heating</i>	0.3	0.5
<i>DSM Bid</i>	0.0	0.0
<i>Pre-1991 Programs</i>	0.0	49.3
Total all programs	35.4	308.9

PARTICIPATION RATES

Because of the diversity in SMUD's DSM roster, there are a variety of definitions of program participation. In terms of number of customers participating in a given program, the Residential Peak Corps program is SMUD's leading program with 96,130 customers who have installed cyclers. The Energy Efficient Refrigerators program has also achieved high levels of participation with customers buying more than 70,000 energy-efficient refrigerators and 63,000 old, inefficient refrigerators "recycled" through 1993. Through the Shade Tree program approximately 109,000 trees have been planted, and 1,200 solar water heaters have been installed through the Solar Domestic Water Heater program. The Community Partners program has provided more than 2,300 energy-efficient refrigerators to low-income customers at no charge. The Direct Investment program has provided electric-heat customers with almost 15,000 energy efficiency measures for free. Through the Equipment Efficiency Improvement program, 12,200 heat pumps and AC units and 6,200 insulation measures have been installed. [R#27]

FREE RIDERSHIP

To date SMUD has not explicitly evaluated free ridership for its DSM programs although it assumes that free riders exist for certain programs. Currently SMUD is looking at the issue of free ridership and an evaluation of free ridership will be included in the District's 1996 biennial report to the California Energy Commission. [R#22]

MEASURE LIFETIME

SMUD calculates measure life for its DSM programs on a measure by measure basis. For the purposes of calculating the cost of saved energy for SMUD's entire DSM roster, The Results Center has used an average measure life of 15 years.

PROJECTED SAVINGS

By the year 2000 SMUD hopes to gain approximately 650 MW of capacity from its DSM programs, a level which is close to SMUD's projected growth. ■

Cost of the Program

SMUD's annual DSM expenditures have increased dramatically in the past few years due to the significant expansion beginning in 1990 of the number and type of programs offered. From 1978 through 1989 DSM expenditures ranged from \$3.6 million to \$8.8 million. In 1990, expenditures increased to \$10 million then jumped to an all time high of \$38.3 million in 1991. Annual DSM expenditures dropped to \$34.6 million in 1992 and decreased slightly again in 1993 to \$32.7 million. [R#20]

COST EFFECTIVENESS

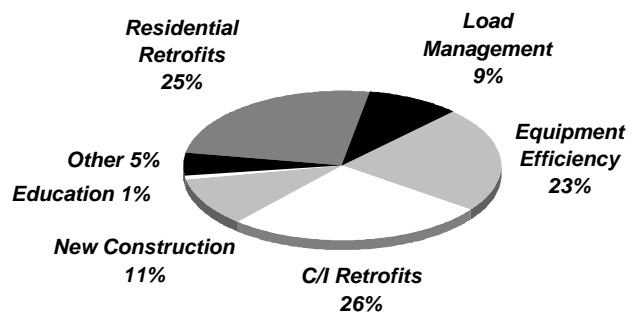
Measures are evaluated by SMUD for cost effectiveness using a simple version of the Total Resource Cost (TRC) test. The pool of measures which passes this screen is further evaluated for cost effectiveness using the Utility Cost Test. The SMUD Board has provided direction on which values to use for capacity and energy savings, declaring that the "initial 600-700 MW block for the Conservation Power Plant shall not exceed the avoided costs for gas-fired generation or the least cost supply-side alternative." However, the Board has also approved the concept that certain energy efficiency programs are to be evaluated using the gas-fired avoided costs plus a "renewable premium" since ultimately the avoided resource will be renewable. This added premium applies to advanced technology measures and special programs such as solar programs, low-income assistance, and measures or programs which constitute a "lost opportunity" such as new construction. [R#17]

Using an average measure lifetime of 15 years and annual program costs and energy savings for SMUD's entire roster of DSM programs, The Results Center has calculated a cost of saved energy for 1990 through 1993. Prior to 1990, energy savings from SMUD's DSM programs were negligible. In 1990, at a 5% discount rate, SMUD's cost of saved energy for all programs was 10.70 ¢/kWh, dropped to 7.24 ¢/kWh in 1991, dropped again to 2.95 ¢/kWh in 1992, and increased slightly to 3.28 ¢/kWh in 1993.

COST COMPONENTS

In terms of individual programs, SMUD spent the greatest amount in 1993 (\$4.1 million) on the Direct Investment program. SMUD also spent \$4.1 million on its Energy Efficient Refrigerators program. Other programs with large expenditures in 1993 include the Residential Equipment & Efficiency Improvement program (\$3.1 million), the Small C/I Retrofit program (\$2.9 million), Large C/I Retrofit program (\$2.8 million), the Schools & Public Buildings program (\$2.2 million), and the Residential Peak Corps program (\$2.1 million). In addition, costs for SMUD's energy efficiency tracking system and administrative costs for loan processing totaled \$1.6 million. [R#27]

1993 COSTS OVERVIEW



When costs are analyzed by program type there are three predominant categories that constituted fully three-quarters of the total DSM expenditure in 1993: commercial and industrial retrofits (26%); residential retrofits (25%); and equipment efficiency (23%). New construction programs represent the next largest category (11%). Load management programs, that once provided the backbone for SMUD's conservation expenditures, represented only 9% of total costs in 1993, an indication of the relative emphasis of DSM program types in SMUD's new DSM paradigm. ■

COST OF SAVED ENERGY AT VARIOUS DISCOUNT RATES (¢/kWh)	3%	4%	5%	6%	7%	8%	9%
1990	9.31	9.99	10.70	11.44	12.20	12.98	13.78
1991	6.29	6.76	7.24	7.74	8.25	8.78	9.32
1992	2.56	2.75	2.95	3.15	3.36	3.57	3.79
1993	2.85	3.07	3.28	3.51	3.74	3.98	4.23

1993 COSTS OVERVIEW	
RESIDENTIAL RETROFIT (x1000)	
<i>Direct Investment</i>	\$4,064
<i>Community Partners</i>	\$990
<i>Retail Lighting</i>	\$132
<i>Shade Trees</i>	\$1,812
<i>Solar Domestic Water Heating</i>	\$1,187
LOAD MANAGEMENT (x1000)	
<i>Residential Peak Corps</i>	\$2,085
<i>Commercial Peak Corps</i>	\$654
<i>Water Pump Load Management</i>	\$90
<i>C/I Load Management</i>	\$256
<i>Pool & Spa</i>	\$20
EQUIPMENT EFFICIENCY (x1000)	
<i>Energy Efficient Refrigerators</i>	\$4,061
<i>Res. Equipment & Efficiency Improvement</i>	\$3,138
<i>C/I Equipment & Efficiency Improvement</i>	\$310
COMMERCIAL / INDUSTRIAL RETROFIT (x1000)	
<i>Small C/I Retrofit</i>	\$2,934
<i>Large C/I Retrofit</i>	\$2,798
<i>DSM Bid</i>	\$228
<i>Schools & Public Buildings</i>	\$2,238
<i>Multi-Family Retrofit</i>	\$440
NEW CONSTRUCTION (x1000)	
<i>Residential New Construction</i>	\$1,486
<i>C/I New Construction</i>	\$1,215
<i>Residential Thermal Energy Storage</i>	\$145
<i>Commercial Thermal Energy Storage</i>	\$606
EDUCATION (x1000)	
<i>Total School Energy Management</i>	\$215
OTHER (x1000)	
<i>Tracking & Administrative</i>	\$1,613
TOTAL (x1000)	\$32,718

Environmental Benefit Statement

AVOIDED EMISSIONS: Based on 511,000,00 kWh saved 1990 - 1993						
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%	1,101,716,0	26,138,000	5,284,000	528,000
B	10,000	1.20%	1,174,789,0	10,118,000	3,412,000	2,529,000
Controlled Emissions						
A	9,400	2.50%	1,101,716,0	2,614,000	5,284,000	42,000
B	10,000	1.20%	1,174,789,0	1,012,000	3,412,000	169,000
C	10,000		1,174,789,0	6,745,000	3,373,000	169,000
Atmospheric Fluidized Bed Combustion						
A	10,000	1.10%	1,174,789,0	3,092,000	1,686,000	843,000
B	9,400	2.50%	1,101,716,0	2,614,000	2,113,000	159,000
Integrated Gasification Combined Cycle						
A	10,000	0.45%	1,174,789,0	2,080,000	337,000	843,000
B	9,010		1,056,748,0	753,000	254,000	51,000
Gas Steam						
A	10,400		640,794,000	0	1,461,000	0
B	9,224		556,479,000	0	3,485,000	165,000
Combined Cycle						
1. Existing	9,000		556,479,000	0	2,136,000	0
2. NSPS*	9,000		556,479,000	0	1,012,000	0
3. BACT*	9,000		556,479,000	0	141,000	0
Oil Steam--#6 Oil						
A	9,840	2.00%	927,465,000	14,053,000	1,658,000	1,574,000
B	10,400	2.20%	983,675,000	13,940,000	2,085,000	1,012,000
C	10,400	1.00%	983,675,000	1,990,000	1,675,000	528,000
D	10,400	0.50%	983,675,000	5,846,000	2,085,000	322,000
Combustion Turbine						
#2 Diesel	13,600	0.30%	1,230,999,0	2,451,000	3,805,000	208,000
Refuse Derived Fuel						
Conventional	15,000	0.20%	1,461,460,0	3,766,000	4,958,000	1,102,000

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 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 accompanying page is to allow any user of this profile to apply SMUD's level of avoided emissions saved through its Comprehensive DSM portfolio 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 both tables include a 10% credit for DSM savings to reflect the avoided transmission and distribution losses associated with supply-side resources.

* Acronyms used in the table

TSP = Total Suspended Particulates

NSPS = New Source Performance Standards

BACT = Best Available Control Technology

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. ■

Lessons Learned / Transferability

LESSONS LEARNED

Quick turnarounds of utilities are possible as proven by SMUD. By the late 1980s SMUD was a demoralized utility spending large sums to keep its beleaguered nuclear plant operational, and having to raise rates to do so. Just as employee morale hit bottom, so did community trust and faith in its municipal utility. But all this changed very rapidly at SMUD thanks to public pressure and ensuing and decisive management changes.

Sacramento is a prime example of how a utility hurt by a faulty nuclear plant can make a radical mid-course correction, abandon its nuclear plant, and invest heavily in energy efficiency and renewable energy, all without additional rate increases.

By gaining the necessary political support, holding rates down, importing a highly charismatic and dedicated General Manager, instigating an aggressive media campaign, and working intensely with trade allies who deliver energy efficiency services, SMUD proved that it is possible to use IRP to chart a new course and to quickly ramp-up DSM with immediate and apparent results, rebuilding the faith both internally and throughout the Sacramento community.

SMUD has also shown that it is possible to change the predominant utility paradigm virtually overnight. Not only has SMUD embraced energy efficiency, but it has become a national model of a utility aggressively promoting renewables. SMUD has experimented with and has demonstrated the potentials for solar energy, both in centralized and rooftop applications with marked success. Perhaps the bottom line of this success is the community's overwhelming support for SMUD's new path. The community is not only pleased with SMUD's lack of rate increases since this new paradigm was put into place, but wholeheartedly supports the utility's initiatives to set itself as a model for utility operations in the 21st century.

SMUD's evolution from a utility plagued by double-digit rate increases associated with its troubled nuclear power plant, Rancho Seco, to a national leader in energy efficiency and the

pursuit of alternative energy resources is remarkable. David Freeman's reputation as a defender and advocate of public power, and someone who can rescue sinking ships, was amplified in Sacramento. Freeman, however, was enabled by two very important supporting casts: SMUD's Board of Directors who were elected by SMUD's customers. In fact, without Board and customer support, Freeman's actions would not have been possible, nor would he have been hired. The Board, however, was conservation-minded and had the foresight to bring in David Freeman. He can be credited with almost single-handedly turning SMUD around in less than four years and boosting community confidence in the utility as well as staff morale, all without additional rate increases.

After a series of malfunctions and expensive repairs, the Rancho Seco nuclear plant was closed by voter referendum in 1989. By doing so, the voters elected to take on the risk of the unknown, rather than pouring additional funds into the plant without the confidence that it would ever perform safely and without continuing expensive and extensive repairs.

In Sacramento, while financial conditions were the driving factor to abandon the Rancho Seco nuclear plant, there was certainly a strong environmental element in the decision as well and particularly in the voter referendum to close the plant. Investor-owned utilities that own reactors don't poll the public to consider whether to close specific plants. Publicly owned utilities, on the other hand, have this form of direct community accountability for all their operations.

Shutting Rancho Seco eliminated a major portion of the utility's generating capacity. Between 1974 and 1985 Rancho Seco's 913 MW provided approximately 55% of SMUD's generating capacity. This power was replaced by purchased power contracts with Pacific Gas & Electric and Southern California Edison. SMUD was fortunate to have sources available but under the terms of these contracts the prices for this purchased power will rise dramatically in 1995 adding pressure to raise rates. Strategically deployed energy efficiency is seen as a cost-effective path to reducing SMUD's dependence on expensive purchased power. Using the Utility Cost Test to determine

program cost effectiveness, SMUD determined that it would cost less to buy efficiency than additional purchased power.

David Freeman took the helm at SMUD in June 1990 and resigned in January of 1994. He left the utility in good shape and in good hands and has now moved on to another challenge. He was not only inspirational with his staff, but staff report that he relentlessly worked with the community to rebuild the utility. He was expert in using the local media to improve SMUD's public image and to garner support for its new directions with efficiency and solar energy. SMUD went on television, offering customers services and basic means of saving money. Freeman's strong, charismatic personality was a key element in SMUD's transition.

One staff member compared the impact David Freeman has had on conservation at SMUD to what "Arnold Palmer is to golf." Under Freeman, DSM programs were ramped up substantially in all respects, especially in terms of the percentage of operating revenues spent on DSM. In 1992 SMUD invested 6.2% of its operating revenues in DSM, one of the highest percentages in the nation and on a par with Seattle City Light. With "net loans" included as DSM expenses, the percentage increases further to 8.0%, the highest rate in the country.

TRANSFERABILITY

While all utilities have unique resource scenarios and some suffer unique power plant complications, SMUD stands at the forefront of examples of utilities that have radically altered their courses for the benefit of all. A sense of urgency, coupled with a set of reasoned and highly inspired management decisions, ushered in a new era for SMUD, rejuvenating demoralized staff and regaining public confidence in the utility. While the speed of change may be alarming for many other utilities, the course that SMUD has charted may be very appealing. SMUD has not only abandoned nuclear power, but it has aggressively invested in customer energy efficiency and renewable energy. These directions likely depict a new utility model, a model of social responsibility that may enable a path to sustainable development. ■

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