

THE LARGE COMMERCIAL ENERGY AUDITING PROGRAM
AT SACRAMENTO MUNICIPAL UTILITY DISTRICT (SMUD)

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ABSTRACT

This report analyzes the results of the Large Commercial/Industrial (C/I) Energy Auditing Program at SMUD over the past five years. Three aspects of the program will be discussed:

- (1) Energy audit recommendations for the different types of facilities;
- (2) Implemented measures for the different types of facilities; and
- (3) The period of time from the recommendation to the implementation.

The program was conducted under California Energy Commission (CEC) guidelines from 1980 through 1985. In that period, SMUD staff conducted 111 energy audits for large C/I facilities with average peak demands over 500 kw. This group of customers uses over 450 million kilowatt hours of electricity annually.

Examining the audit results provides an indication of the most cost effective energy savings in large C/I buildings. The analysis of the achieved savings shows where implementation has actually occurred and if there is a correlation between energy savings and building type. The record of annual visits to audited facilities over 5 years provides insight into the time required to implement C/I audit recommendations. Financial programming, budgeting, and funding barriers may also be important factors for implementing energy conservation measures in large commercial buildings.

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INTRODUCTION

In 1980, SMUD initiated a Load Management Program for commercial electric customers to reduce peak demand and energy use. As part of this program, SMUD offered energy audits to large commercial customers identifying conservation opportunities and encouraging implementation. The original goal of this 5-year program was to achieve a reduction of 9.5 percent of peak demand and annual kilowatt hour use of this target group from energy audits. This report analyzes the success of the program based on audit recommendations and records from 5 years of post audit visits. Findings will focus on the three largest customer groups: Office buildings, retail stores and public schools.

DESCRIPTION OF AUDIT PROGRAM

Under California Energy Commission (CEC) guidelines, SMUD program staff developed load management programs based on the kw demand of the customer's electric service. The Large Commercial Program included customers whose billing demand exceeded 500 kw. The program targeted 124 accounts that were receiving electric service prior to 1980. Excluded from this group were industrial process facilities, pumping plants and mobile home parks.

SMUD Energy Specialists performed audits free of charge that consisted of:

- ° Analysis of energy use history;
- ° Discussion of operating hours and maintenance;
- ° Detailed list of recommendations with associated cost and payback analysis; and
- ° Appendix of equipment descriptions and calculations.

Payback periods varied from immediate to 3 years with a few up to 5 years. (NOTE: During this period, SMUD had very low electric rates with kilowatt hour costs ranging from 1.5 cents to 2.5 cents per kwh.) Staff completed most of the audits by the end of 1983.

Energy Specialists tracked the progress of customer's implementation by offering an annual Post Audit Visit (PAV) to each audited customer. The PAV report consisted of:

- ° Analysis of past year energy use;

- ° Summary of audit recommendations completed;
- ° Estimate of added electrical load; and
- ° Summary of remaining recommendations and revised payback.

By the end of 1985, 299 PAV's has been performed on the 111 audited accounts. Energy Specialists collected data on audits and PAV's and entered results in a simple database computer program. Audit recommendations were summarized as Lighting, HVAC or Miscellaneous. The SIC code, building type and dates of audits and PAV's were also recorded. The original goal for the 5-year program was to achieve a 9.5 percent reduction in peak demand and energy use from energy auditing activities (SMUD 1981). Tables I and II summarize the results of the energy audit program. SMUD staff recommended reductions of 13 percent of peak demand and 19 percent of annual energy use in the audits. The PAV's over 4 years recorded reductions of 9 percent peak demand and 11 percent electric energy use. The building types that received the most audits were offices, retail stores and schools and will be discussed in further detail. Retail buildings provided the quickest implementation of demand and energy reducing measures. The reader is cautioned against drawing conclusions for building types with only a few audits.

As another indication of the effectiveness of the audit program, Figure 1 compares the growth rate of the audited large commercial customers to all commercial customers with billing demand over 30 kw in Sacramento, California (SMUD 1985). While the average electric use of all commercial customers has increased to 9 percent above 1979 levels, audited large commercial customer's average electric use has remained below 1979 levels.

By the end of 1983, SMUD staff audited all but 2 of the large customers. Also by 1983, the average electric use of audited customers was below 1979 levels.

METHODOLOGY

To analyze the effectiveness of these energy audits, we organized PAV data according to the elapsed time after the audit that the measures were implemented. This presentation gives an indication of the rate at which customers implemented the measures over time. This approach also gives planners some insight for predicting the results of similar auditing programs. Because the audits were conducted over several years, this normalization of data also dampens out the effects of short term economic and rate fluctuations.

The audit and PAV results are presented graphically in Figures 2 through 13. Data is displayed as a percentage of the customer's average summer peak demand or their annual electric energy use. Audit recommendations are shown as horizontal lines for Lighting, HVAC and Miscellaneous measures. PAV results (implemented measures) are displayed as a function of the PAV year. The PAV year is the average of the time after the audit that the first, second, third and fourth visits were conducted.

Gas and fuel savings, although identified in the audits, were not the focus of this program and will not be discussed. The overall program results will be presented first, then the audits of offices, retail stores and schools will be discussed.

OVERALL PROGRAM RESULTS

General

In the 111 energy audits, we identified potential reductions of 108 MW of demand 474 million annual kwh of electrical energy. These reductions represent 13 percent of the 1979 average summer demand and 19 percent of the annual 1979 energy use for these customers. Figures 2 and 3 show these results as horizontal lines that represent the audit recommendations for Lighting, HVAC and Miscellaneous reductions.

Lighting

Lighting reductions represent the major portion of the demand recommendations and about 40 percent of the energy recommendations. The most common measures recommended were delamping and upgrading HID conversions, incandescent to fluorescent conversions and outdoor lighting upgrades. Early savings of demand and energy resulted from delamping and installing energy efficient lamps. Energy savings were also associated with switching off lighting during unoccupied periods. The majority of Lighting recommendations were acted on by the fourth year. A rebate program for energy saving fluorescent lamps was offered for a short time in 1983 but did not lead to significant installations.

HVAC

Downsizing fan motors, resheaving fan pulleys and a few recommendations for cycling equipment contributed most of the demand savings. Temperature setpoints and better temperature control were among recommendation which did not result in large savings. Most of the energy savings were the result of reductions in the hours of operation and reduction in the amount of outside air brought into the facility. Most of the demand savings came from reducing outside air and better scheduling of equipment during the demand periods. Few customers made changes to their fan systems even through resheaving pulleys had a payback period of a few months. Reducing hours of operation of compressors, chillers and fans produced the most energy savings. Very few new economizer systems were installed.

Miscellaneous

Recommendations included refrigeration changes, reductions in water heating demand, air compressor system repairs, and some process equipment changes. Actual implementation met or exceeded audit recommendations. Some customers made more changes than were recommended in the audit.

OFFICE BUILDINGS

General

Staff performed audits on 41 office building accounts with a total area of 9 million square feet. Audit and PAV results are shown in Figures 4 and 5. Of these 18 were non-government commercial office buildings. Audit recommendations for the commercial space were 13 percent of summer demand and 29 percent of annual energy use. Figures 4 and 5 show the audit and PAV results for large commercial office buildings. Twenty-three government office buildings (state, county and federal) were audited. Audits recommended 10 percent demand reduction and 13 percent energy use reductions for government offices. This lower potential reflects the results of government energy programs in the 1970's and the use of a central heating and cooling plant on 8 of the state accounts. Figures 6 and 7 show results for government office buildings.

Lighting

Lighting reductions were the major recommendations for government buildings. Delamping, using energy save lamps and ballasts, and turning off unused lighting were recommended. After 4 years, over half of the measures were installed. Barriers to completing the recommended measures included lack of funds, budget lead times and institutional barriers to group relamping.

Lighting reductions comprised a higher percentage of lighting recommendations in commercial offices compared to government offices since there were more opportunities for delamping and switching unused lighting. A lower implementation rate was observed, however. Barriers to implementation here included lack of funding, distrust of energy saver lamps, resistance to group relamping and owner-tenant relationships. Outdoor lighting or HID lighting recommendations were not significant for office buildings.

HVAC

For government buildings, audit recommendations included reducing fan operating hours and resheaving fan pulleys. Most of the energy savings recorded resulted from reduced operating hours. In commercial office areas, reducing operating hours was the major audit recommendation. Many systems were found to run 24 hours a day and maintenance on these systems was generally less than desired.

Recommendations for demand savings include reducing fan kw and better control of chillers. Some of the energy savings later recorded resulted from improved maintenance activities. Because of ongoing controversy and discussions surrounding indoor air quality, office managers were generally not receptive to reducing outside air flow.

Miscellaneous

Audit recommendations for miscellaneous systems in government buildings related to water heating and scheduling of pumps and equipment. Most of the energy savings recorded resulted from turning equipment off during unoccupied periods. Auditors identified a much higher percentage of potential savings in commercial offices than in government offices. Greater than expected demand savings were achieved by removing elements from large water heaters and turning off pumps to decorative fountains. Energy savings also resulted from replacing older computer equipment. Reducing the operation of elevators during peak periods did not occur to any greater extent.

RETAIL BUILDINGS

General

Staff audited 27 large retail stores with a total area of 4.5 million square feet. These were primarily large department and discount stores. Implementation of recommendations occurred much sooner in this sector compared to others. One factor contributing to this could be the higher awareness of the effect of energy costs on net revenues and a better understanding of cash flow. Store managers, whose salary was sometimes tied to the stores profit margin, seemed more willing to make investments in energy conservation. For these accounts, aesthetic lighting and comfort were more important than energy savings. Recommendations that would enhance merchandising were generally well received. Figures 10 and 11 show the recommendations of audits and results of PAV's in this sector.

Lighting

Implementations generally exceeded audit recommendations. Department stores were receptive to relamping with energy saver fluorescent lamps. They were also more likely to use group relamping to maintain even lighting levels and use wattage reducers in their lighting systems. Discount stores were receptive to reducing light levels and delamping in the floor area. Staff also observed reductions in soffit and decorative wall lighting. many of these accounts installed energy management systems (EMS) to control lighting when the store was closed. At least one store used supplemental task lighting for nighttime maintenance. Improvements in outdoor lighting were also implemented. Mercury vapor lighting was converted to HID and shorter hours for parking lot lighting were observed. Overall, this group was more likely to try new lighting products that promised short paybacks.

HVAC

Significant savings were recommended in audits for reducing fan energy and reducing outside air volume. Demand reduction recommendations included resetting chiller controls, resetting temperature setpoints, reducing fan speeds and limited cycling of package unit air conditioning. Energy Management Systems were used to schedule fans, pumps and compressors.

SCHOOLS

General

Twenty accounts comprising 5 million square feet were audited. These were mostly high schools with some college and junior college facilities. In general, this sector took longer to implement measures after the audit. Barriers to energy conservation in schools include: limited funds for facilities improvements, institutional resistance to changing operating procedures, restrictive job descriptions for custodian and maintenance workers and lack of full time energy manager positions. Expenditures had to be planned several years ahead and were usually approved by an elected board of directors. Results of school audits are shown in Figures 12 and 13.

Lighting

There were many opportunities for replacing incandescent lighting systems, both indoor and outdoor. Relamping with energy saving fluorescents was also a major recommendation. There was a definite resistance to group relamping in schools, partially due to existing maintenance procedures (fix it after it burns out) and lack of manpower. Significant savings of energy were identified in audits for better scheduling of lighting systems. Broken timeclocks for lighting were often identified as needing repair in audits of these facilities. Most of the demand reductions implemented were recorded on projects that delamped or relamped fluorescent lighting. Energy savings were due to delamping, relamping and switching off unused indoor lighting.

HVAC

Staff identified very few opportunities for reducing summer demand since many schools do not have air conditioning or do not operate in the summer months. There were good opportunities for saving energy in HVAC systems (12.7 percent), mostly from turning off equipment during unoccupied periods. Checking thermostat settings, calibrating controls, and repairing dampers and economizers were also recommended. Most of the savings documented were the result of resetting timeclocks, installing EMS and better scheduling of classes and HVAC operations. The replacement of older systems with package units has also yielded some energy savings. There still remains a large potential for energy savings in these facilities.

Miscellaneous

This category was insignificant for schools. Audit recommendations were for changes in hot water and pumping systems. Schools have the capability to reschedule some miscellaneous loads to off-peak periods (swimming pool pumps, ceramic kilns, etc.) but these were not recommended in the audits.

OBSERVATIONS AND CONCLUSIONS

- ° The SMUD audit program for large commercial customers met or exceeded program goals and is an effective method of reducing electric summer peak demand and annual energy use.
- ° Post Audit Visits show additional recommendations completed each year and this trend can be expected to continue for several years after the audit.
- ° The retail sector can be expected to exhibit the best rate of audit implementation.
- ° Public schools can be expected to exhibit a slow rate of audit implementation.
- ° Indoor lighting changes provide the best opportunities for reduction of electric summer peak demand.
- ° Reductions in the hours of use of lighting and HVAC systems provide the best opportunities for electric energy reduction in large commercial facilities.

REFERENCES

Nonresidential Load Management Standards Plan for Large Commercial Customers, SMUD, 1981.

Large Commercial Load Management 1985 Annual Report, SMUD, 1985.

Table I. Large commercial energy audit program 1980-1985 electric demand savings.

Building Type	Number of Audits	Audited Area (SF)	Building Demand Kw	Recommended Savings		Achieved Savings	
				Kw	%	Kw	%
1 Office	41	9,031,936	46,587	5,170	11.1%	3,096	6.6%
2 Retail	27	4,562,135	21,769	3,629	16.7%	3,469	15.9%
3 Restaurant	1	55,000	616	35	5.7%	29	4.7%
4 Storage	1	500,000	637	11	1.7%	0	0.0%
5 Hotels	3	699,000	3,685	225	6.1%	82	2.2%
6 Schools	20	5,007,696	18,506	2,267	12.3%	1,361	7.4%
7 Assembly	4	355,010	2,432	253	10.4%	646	26.6%
8 Hospital	7	1,743,913	9,137	857	9.4%	908	9.9%
9 Computer	1	150,000	876	140	16.0%	22	2.5%
10 Automotive	0	0	0	0	0.0%	0	0.0%
11 Misc	6	233,702	3,376	1,291	38.2%	120	3.6%
TOTALS	111	22,338,392	107,621	13,878	12.9%	9,733	9.0%

Source:: SMUD Large Commercial Load Management 1985 Annual Report

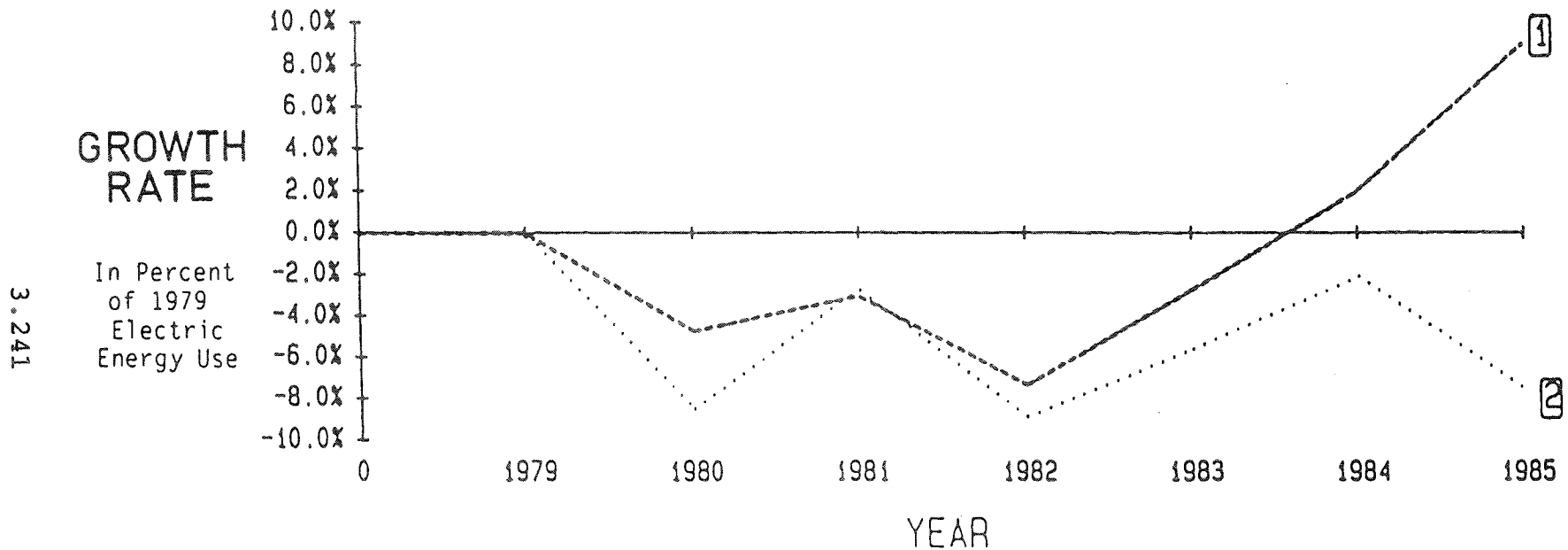
Table II. Large commercial energy audit program 1980-1985 electric energy savings.

Building Type	Number of Audits	Audited Area (SF)	Annual Energy MWH	Recommended Savings		Achieved Savings	
				MWH	%	MWH	%
1 Office	41	9,031,936	201,526	37,756	18.7%	18,177	9.0%
2 Retail	27	4,562,135	92,609	17,738	19.2%	15,663	16.9%
3 Restaurant	1	55,000	3,029	154	5.1%	152	5.7%
4 Storage	1	500,000	4,046	144	3.6%	0	0.0%
5 Hotels	3	699,000	18,172	2,915	16.0%	946	5.2%
6 Schools	20	5,007,696	80,355	17,185	21.4%	7,896	9.8%
7 Assembly	4	355,010	7,320	1,681	23.0%	2,982	40.7%
8 Hospital	7	1,743,913	52,907	9,865	18.6%	6,275	11.9%
9 Computer	1	150,000	4,674	976	20.9%	615	13.2%
10 Automotive	0	0	0	0	0.0%	0	0.0%
11 Misc	6	233,702	9,338	1,559	16.7%	627	6.7%
TOTALS	111	22,338,392	473,976	89,973	19.0%	53,333	11.3%

Source: SMUD Large Commercial Load Management 1985 Annual Report

Figure 1.

Comparison of Growth in Energy Use Audited Customers vs. All Commercial Customers



1. RATE 47 customers are those with demands of 30 kw or greater. This shows the percent change year to year in the average annual electric usage per customer based on billing records. This includes audited customers.

2. AUDITED CUSTOMERS are those commercial customers with demands greater than 500 kw who have been audited since 1979. This line shows the percent change year to year in the average annual electric usage per customer. By the end of 1982, audits had been conducted for 70% of these customers.

Figure 2. DEMAND SAVINGS-ALL BLDG TYPES

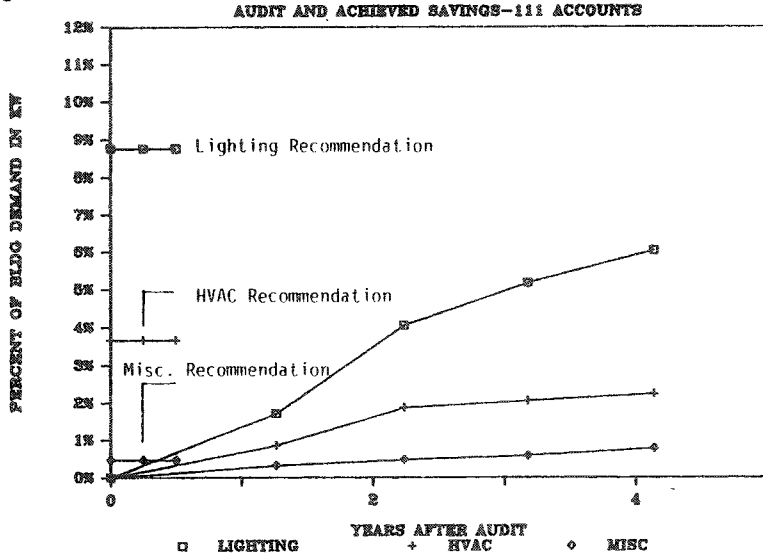


Figure 4. DEMAND SAVINGS-OFFICE BUILDINGS

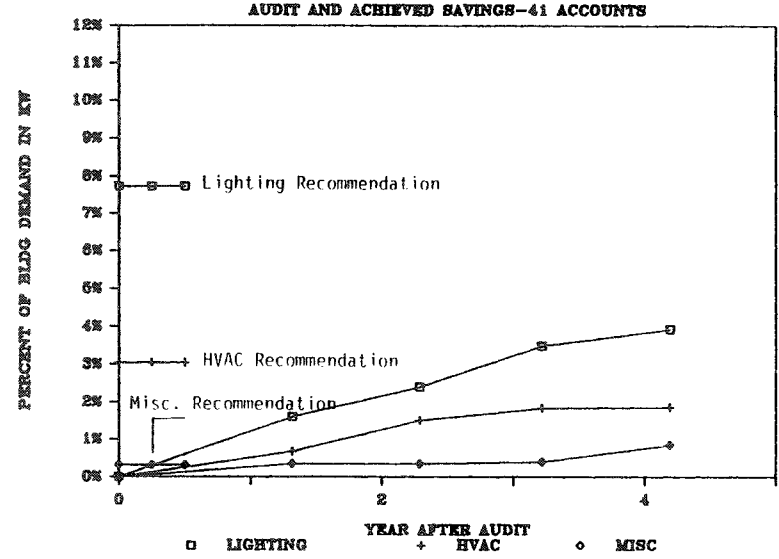


Figure 3. ENERGY SAVINGS-ALL BLDG TYPES

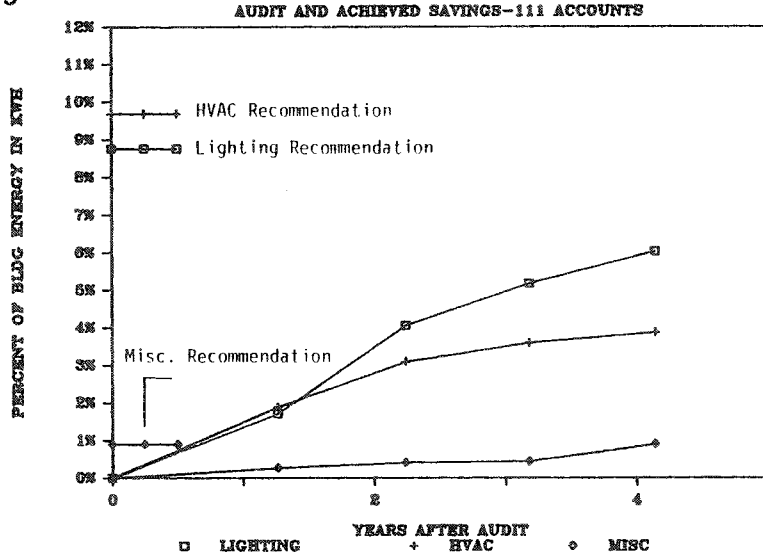
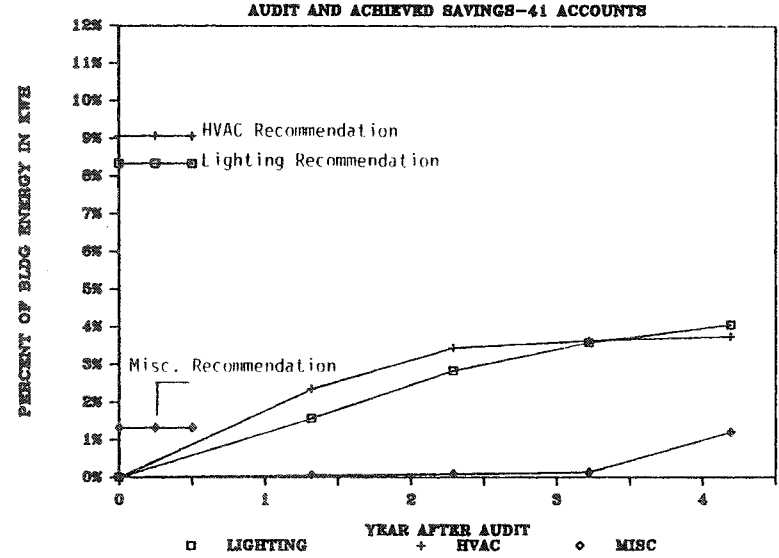


Figure 5. ENERGY SAVINGS-OFFICE BUILDINGS



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Figure 6. DEMAND SAVINGS—COMMERCIAL OFFICES

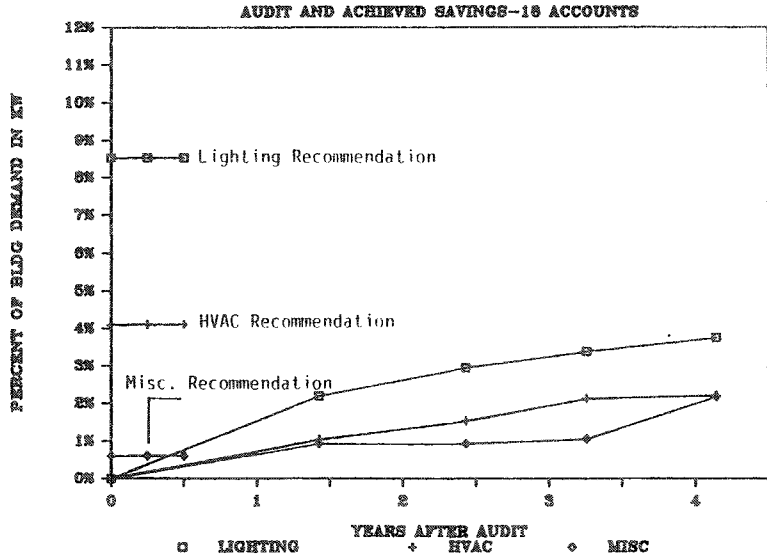
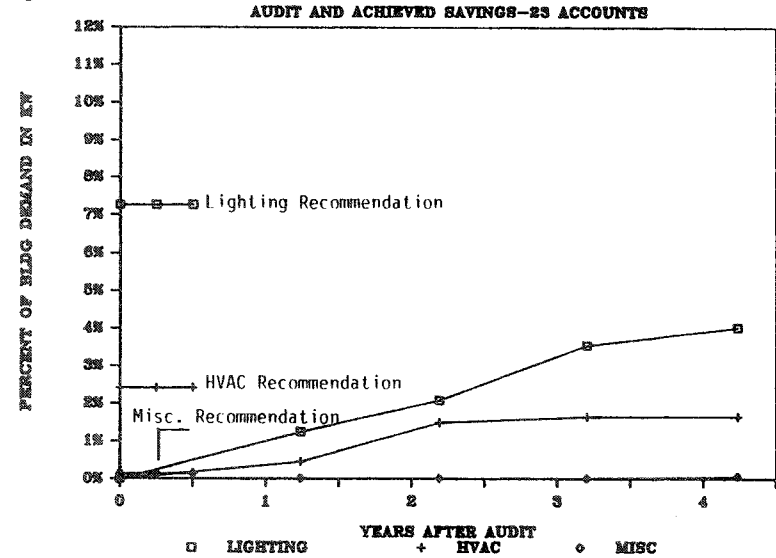


Figure 8. DEMAND SAVINGS—GOVT OFFICES



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Figure 7. ENERGY SAVINGS—COMMERCIAL OFFICES

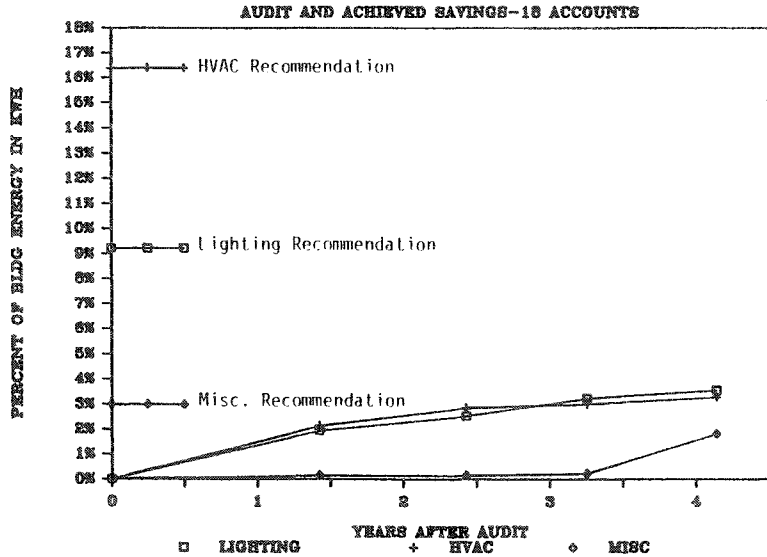
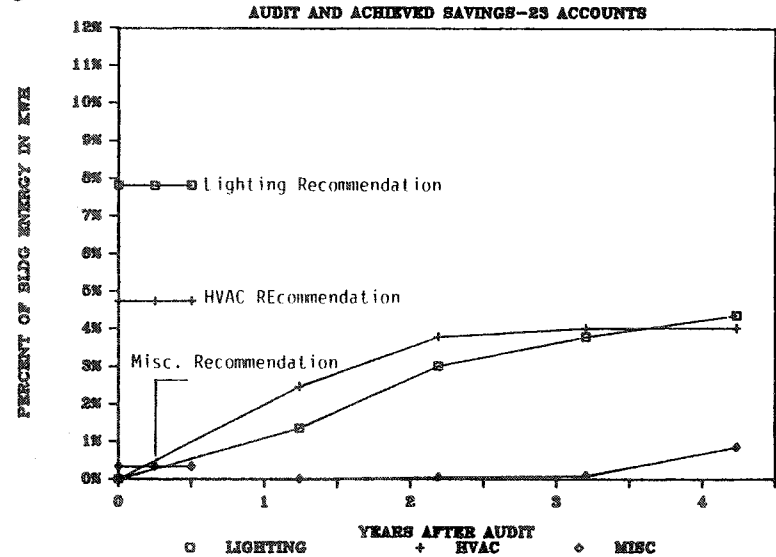


Figure 9. ENERGY SAVINGS—GOVT OFFICES



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Figure 10. DEMAND SAVINGS—RETAIL ACCTS
AUDIT AND ACHIEVED SAVINGS—27 ACCOUNTS

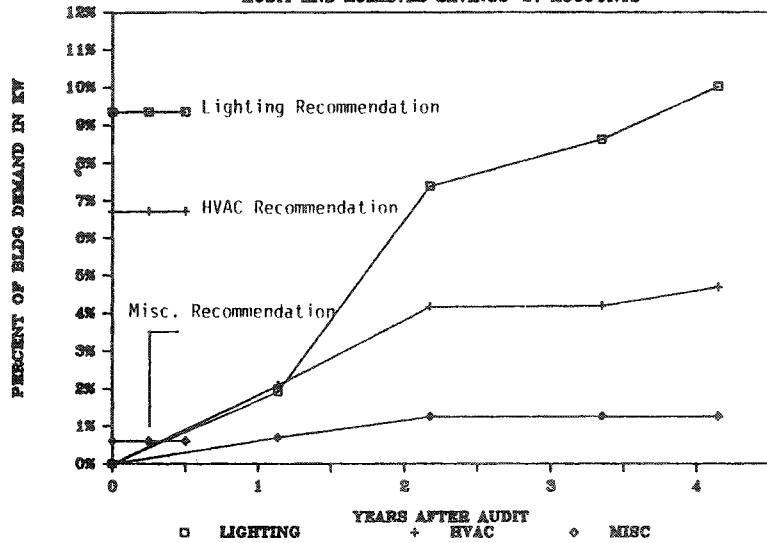


Figure 12. DEMAND SAVINGS—SCHOOLS & COLLEGES
AUDIT AND ACHIEVED SAVINGS—20 ACCOUNTS

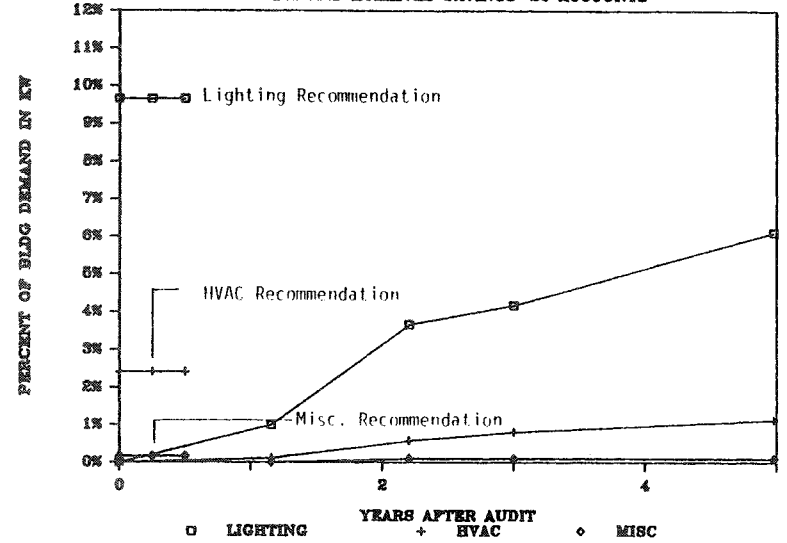


Figure 11. ENERGY SAVINGS—RETAIL ACCTS
AUDIT AND ACHIEVED SAVINGS—27 ACCOUNTS

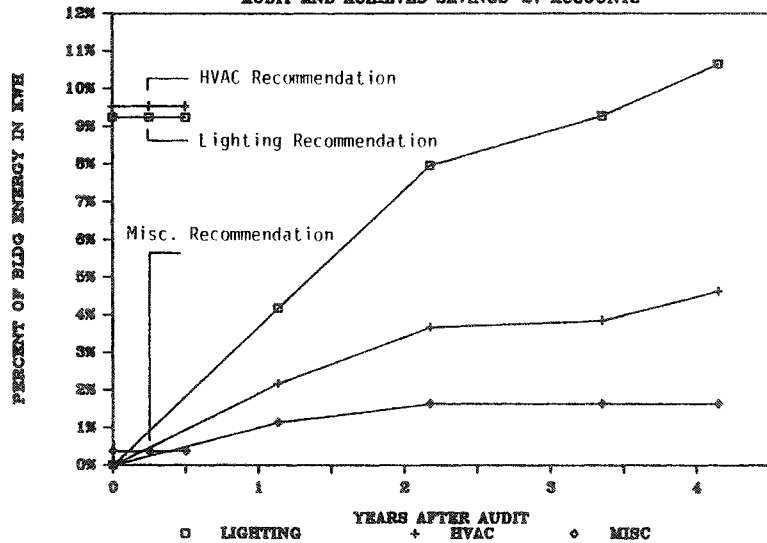
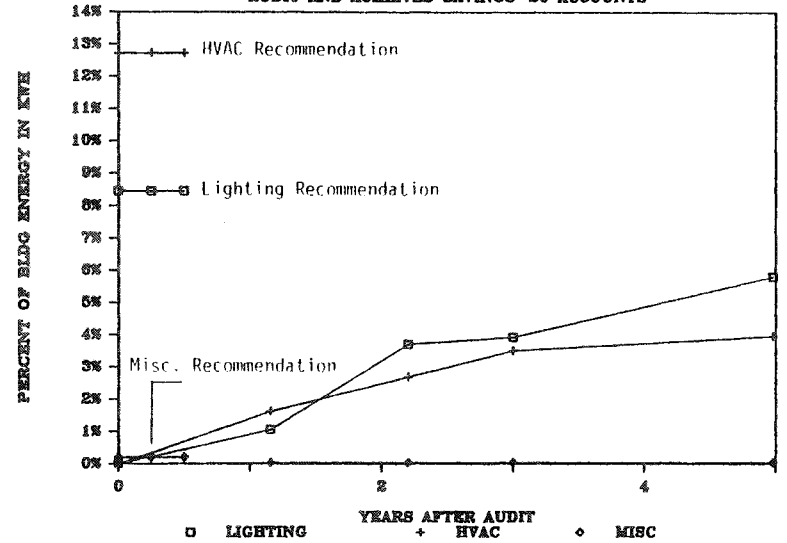


Figure 13. ENERGY SAVINGS—SCHOOLS & COLLEGES
AUDIT AND ACHIEVED SAVINGS—20 ACCOUNTS



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