ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue, Argonne, Illinois 60439

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NATIONWIDE SURVEY OF ENERGY CONSERVATION IN PUBLIC SCHOOL DISTRICTS: INSTITUTIONAL, ORGANIZATIONAL, AND TECHNICAL CHARACTERISTICS

by

N.E. Collins, G.A. Ettinger, L.L. Gaines,
R.C. Kammerud,* P.H. Kier, and K.L. Miller

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*Lawrence Berkeley Laboratory, Berkeley, Calif.

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SUMMARY

This report summarizes the responses to a mail survey sent to superintendents and other administrators of public school districts. The survey was part of an evaluation project for the U.S. Department of Energy's Institutional Conservation Program (ICP). The goal of the project is to identify the most successful energy conservation measures (equipment and activities) available to the institutional buildings sector. To accomplish this goal, four specific research objectives were defined:

1. To determine the impact of the ICP grants program on fostering energy efficiency and saving energy;

2. To determine key characteristics of institutional conservation efforts outside the federal program;

3. To determine the technical, organizational, and institutional conditions that create the opportunity for energy conservation measures (ECMs) to be most effective; and

4. To identify key technology transfer opportunities.

The work includes a retrospective evaluation of the ICP grants program to date and recommendations for future conservation efforts in the institutional sector.

This report focuses on those characteristics of school districts (and the schools within those districts) that might influence the identification, implementation, operation, and impacts of institutional energy conservation efforts. Information about institutional characteristics was gathered through a mail survey of public school districts and private schools. The first mailing resulted in responses from 90 of the 823 public school districts selected through a combination cluster-and-stratification sampling technique and 64 of the 1,700 private schools selected as a stratified random sample. Remaining project resources were used to collect data to achieve a statistically sound sample of a total of 250 public school districts. This goal was accomplished by modifying the mail survey instrument so that data could be collected by telephone interviews. In doing so, some questions had to be dropped. Responses from both the mail surveys and the telephone interviews of public school districts were combined into one data set. This report describes results for all 250 districts.

Institutional and Organizational Characteristics

The districts in the sample are representative of all districts in the United States in terms of three stratifying variables: the grade span of the schools within a district, the type of region (rural, urban, suburban), and the fiscal independence or dependence on the local government. They are not representative for other, nonstratifying variables. Districts that are ICP grantees are over-represented (44% in the sample; 32.5% in the United States); however, the percentage of schools in these districts that benefitted from the grants was 22.4% — not dissimilar from the percentage of ICP-participant schools in the United States, which is 19%. Respondents tended to be larger than average (i.e., more schools per district), and DOE Region 5 was greatly overrepresented. The 250 responding school districts account for 1.6% of all U.S. districts but, due to the sampling strategy, cover 5.3% of all U.S. schools.

The survey was sent to district superintendents; one-third were completed by the superintendent, another 12% by the assistant superintendent. Only 20% were completed by the person directly responsible for the buildings, physical plant, and grounds. However, 40% of the nonsuperintendent respondents reported directly to the superintendent. Therefore, the perspective of the respondents is very much that of management.

Technical and Physical Characteristics

The average age of the oldest building owned by the districts was 59 years. Only 0.4% were constructed after 1977 and therefore ineligible for ICP grants. The average number of buildings per district was 27, but the median was only seven (several very large districts were included in the sample). The average size of a building was 52,600 ft^2; the size of the districts averaged 1.4 million ft^2. About 20% of the districts had no air conditioning in their buildings. ICP participants tended to have older, larger, and more buildings than nonparticipants. A complication associated with describing energy consumption in school districts is that about half reported having temporary buildings. The average number was 17, but one district reported 770.

Energy Management Activities

About 75% of the school districts reported having had comprehensive technical audits since 1980. The proportion of ICP districts that have had audits was much higher than the proportion of non-ICP districts that have had them (87% vs. 62%), as would be expected. Interpretation of these numbers leads to two surprising conclusions, however: (1) some ICP participants (13%) have not been audited at all and (2) even the non-ICP school districts have paid a lot of attention to energy conservation -- only one-third have not been audited.

Non-ICP programs were undoubtedly responsible for much of the audit activity. Twenty-five percent of the districts had participated in or received technical assistance from utility-sponsored programs. Non-ICP state-sponsored programs had provided assistance to 20% of the districts.

For 80% of all districts, ECMs were financed through general operating and capital funds, although 36% of all districts used grants (consistent with national ICP penetration rates, but lower than the percent of ICP districts represented in our sample). Tax-exempt bonds were used by 17%, and 10% participated in rebate and shared savings programs. Future financing plans follow the same patterns.

Decision-making information was not collected from the districts contacted by telephone, so a discussion about motivating factors and about responsibility for general, specific, financial, and daily ECM-related activities (comparable to that collected for hospitals and colleges) cannot be provided for the K-12 subsector.

Energy Conservation Measures

The more "popular" (i.e., measured in frequency of installation) categories of ECMs installed by school districts tend to either be low-cost measures, need continuous maintenance, or require frequent replacement. The percentage of districts that have installed or plan to install ECMs are, by category: building envelope (90%), electrical/ lighting (85%), controls (83%), window treatments (82%), mechanical heating, ventilating, and air conditioning (HVAC) (71%), and domestic hot water measures (60%).

The rate of ECM installation before 1980 (when ICP began to issue grants) was low -- no category exceeded 30% and only two exceeded 20% (building envelope and window measures). Installation of ECMs is clearly linked to climate and building type: air conditioning ECMs have the highest penetration level in the Southeast; envelope and HVAC ECMs are the highest in the North. Urban districts have installed the greatest number of ECMs, followed by suburban, and then rural.

The perspectives of the school districts on which ECM had saved the most energy were examined, using the term "most successful ECM." Building envelope measures and control measures were the answers offered the most often (by 66% and 41%, respectively, of the districts). Far behind in perceived success were lighting (21%), heating measures (19%), fuel conversions (8%), and HVAC conversions (7%). Lighting ECMs may not have been cited as successful very often, despite their popularity, because of their low cost and association with routine maintenance.

Technical problems were reported by 28% of the respondents; 9% reported problems with consultants. Occupant problems were cited by 29% of the districts; 15% of these problems were associated with occupant behavior and 12% with comfort. Thirteen percent of the districts had management problems, mostly due to inadequate staffing. The largest problem area was financing ECMs (42%), which was primarily associated with a lack of funds.

1 INTRODUCTION

1.1 PROJECT OVERVIEW

Argonne National Laboratory (ANL) and Lawrence Berkeley Laboratory (LBL) are conducting an extensive study of energy conservation efforts by schools and hospitals. The study was requested by the U.S. Department of Energy (DOE) in its grant program directed at these institutions (called the Institutional Conservation Program, or ICP). The overall goal of the project is to identify the most successful energy conservation measures (equipment and activities) available to the institutional buildings sector.

To accomplish this goal, four specific research objectives were identified. These were:

1. To determine the impact of the ICP grants program on fostering energy efficiency and saving energy;

2. To determine key characteristics of institutional conservation efforts outside the federal program;

3. To determine the technical, organizational, and institutional conditions that create the opportunity for energy conservation measures (ECMs) to be most effective; and

4. To identify key technology transfer opportunities.

The process of reaching these objectives is driven by two closely related, underlying thrusts. One, related to the first and second objectives, is to accomplish a retrospective evaluation of the ICP grants program to date. The other thrust, related to the third and fourth objectives, is to guide future conservation efforts in the institutional sector.

1.2 RESEARCH DESIGN AND OVERALL DATA REQUIREMENTS

The first task of the project was to develop a research design. In the research design, a three-stage model for institutional conservation decision making and implementation was formulated (Fig. 1.1). In the first stage, "strategic decision making," the early global aspects of the process were addressed; they include (1) an awareness by key individuals of opportunities to conserve energy and of where to get access to information and (2) the creation of strategic conditions conducive to energy conservation and to making the decision to take action. In the second stage, "tactical decision making," the strategy established in the first stage is carried out, and the following critical steps are assumed to occur: (1) access to reliable information regarding energy conservation options is obtained, (2) an understanding of how energy conservation relates to the organization's functions and operations is achieved, and (3) decisions are made that result in the development of an implementation plan for the equipment and activity measures selected by the decision-making process. The third stage, "decision implementation and impacts," is concerned with the design, implementation, and

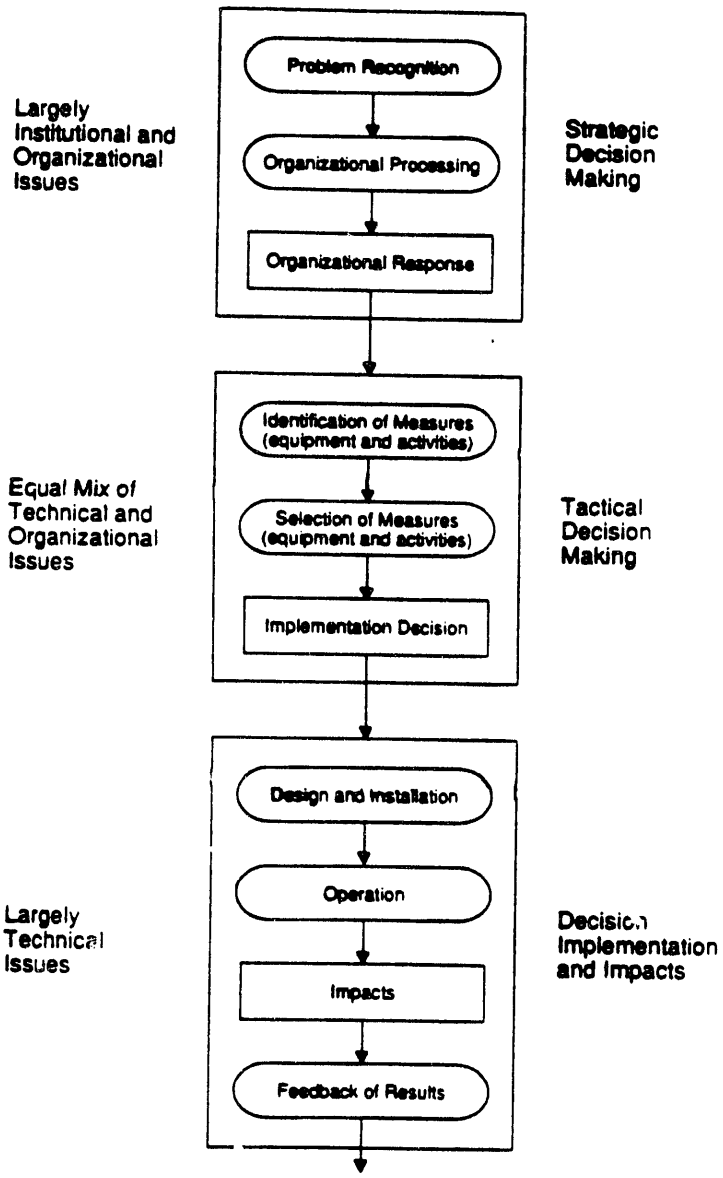


FIGURE 1.1 Three-Stage Model of the Institutional Decision-Making and Implementation Process for Energy Conservation

operation of the technical equipment (ECMs) and with the results measured in terms of energy savings, financial benefits, and unanticipated outcomes. Its primary components are (1) effective program management, (2) monitoring of results, and (3) feedback of results to decision makers.

Associated with each stage in the decision-making and implementation process are many research issues. Overall, 52 research issues were identified. Associated with each research issue are relevant facts or assumptions, hypotheses that may resolve the issues, further research questions, and variables related to the issues and hypotheses. In subsequent portions of this study, testing of key hypotheses becomes a primary concern.

1.3 EXISTING DATA SOURCES AND MERGED DATA BASES

Existing data that relate directly to this project have been analyzed for four purposes:

1. To confirm that the research issues selected for study do, in fact, warrant further study, thereby verifying the direction of the research and providing a basis for refining issues when appropriate;

2. To test the validity of existing data by determining their potential contribution to the evaluation, thereby helping to both define requirements for new data and refine existing data-collection plans;

3. To determine the scope and content of available data on institutions that have not participated in ICP; and

4. To address the research issues being studied whose resolution depends, at least in part, on existing data.

The existing data about public and private schools are of three types. The first type of data can be found in DOE's Grants Tracking System (GTS) data base, the primary source of information about ICP grants and grantees. The GTS data include administrative and technical information. The administrative information allows analysis of participation in ICP; the technical information is used by DOE to monitor actions and ensure adherence to program guidelines. Supplementing the GTS data is information from the National Center for Education Statistics (NCES) on the total population of public and private elementary and secondary schools and public school districts.

The second type of data is contained in printed sources. These open literature sources include periodicals, technical and trade journals, theses, and special-interest reports. These data are used to ascertain the activities of schools and districts that have not participated in ICP. These data have been subjected to a content analysis.

The third type of data on energy use is kept by state energy offices and other major evaluators of institutional programs. The data bases known to the evaluation project team cover Wisconsin ICP participants; Minnesota public schools (including participants and nonparticipants in ICP); Illinois ICP participants; Ohio ICP participants; and institutions in the Bonneville Power Administration service area.

1.4 NEW DATA REQUIREMENTS

Although the existing data contain useful information, they do not completely satisfy the needs of the evaluation project. There is a need for additional information on building characteristics of specific institutions, including information on heating, ventilating, and air conditioning (HVAC) systems and fuels used. The existing data contain very little information relevant to strategic and tactical decision making. Hence, much more information is needed on what factors motivate the undertaking of

energy conservation activities; which individuals and groups have responsibility for making strategic, tactical, financial, and operational decisions; and which information sources are used in making these decisions. In the implementation area, there is a need for more systematic information on which ECMs have succeeded and on what problems may have occurred as a result of ECMs. The subject of this report is the result of efforts to obtain additional data of this type necessary to complete our investigation of the public school subsector.

1.5 DATA COLLECTION OVERVIEW

The research design considered the following three ways to obtain information from institutions:

1. *Mail Surveys* of a nationwide random sample of institutions. Considered as part of the mail survey would be telephone calls to nonrespondents, in which questions from the surveys are asked again to ensure that data are gathered from a representative sample.

2. *Follow-up Telephone Interviews* with a subsample of mail survey respondents. The purposes would be to clarify or amplify the responses, ascertain the availability of energy-use data, and screen for possible site visit candidates.

3. *Site Visits* to institutions represented by a subsample of respondents from both the mail survey and the follow-up telephone interviews, to collect data on detailed building characteristics, technical actions, and energy data. (It is unlikely that site visits will be made.)

1.6 SCOPE AND PURPOSE OF THIS REPORT

This report presents the results of the mail survey directed toward elementary and secondary educational institutions. As discussed later in Sec. 2, the survey data focus on the responses of public school district superintendents and other administrators. Survey data are supplemented by school-level data from GTS and NCES. Where appropriate, the results are analyzed by institutional characteristics (instructional grades; student enrollment; urban, suburban, or rural location; ICP participation) and geographic categories (climate, state, DOE region). Publication of the results of an analysis of energy savings is planned, and a final report analyzes differences in energy conservation efforts among hospitals, colleges and universities, and elementary and secondary schools -- the three subsectors of the institutional sector.*

*Collins, N.E., Kammerud, C., and Kier, P.H., *Energy Conservation in Hospitals, Colleges and Universities, and Public School Districts: Results of a National Evaluation*, U.S. Dept. of Energy report (1987, in press).

The remainder of this report is organized as follows. Section 2 discusses the methods and procedures used in the mail survey. Section 3 describes elementary and secondary schools in the U.S. and presents selected demographic characteristics of the individuals and institutions who responded to the mail survey. Section 4 covers some technical characteristics of school buildings (e.g., fuel consumption data), energy management activities (e.g., energy audits), and other activities that occur in these buildings. Section 5 addresses the financing of energy conservation activities and the roles played by ICP and other sponsors of energy conservation programs. Section 6 discusses ECMs that have been or will be installed and provides their installation dates, describes the ECMs that districts perceive as successful, and addresses the types and frequencies of problems with ECMs. Section 7 summarizes the findings and discusses the relationships of these findings to issues and hypotheses. The school district survey instruments are included in the appendixes.

2 MAIL SURVEY METHODOLOGY

2.1 SURVEY DESIGN

Our review of descriptive data and prior research about the "K-12" (both elementary and high schools) subsector clearly indicated that our sampling approach and data collection methods would need to be substantially different from the survey procedures used with hospitals and higher education institutions. The large number of schools (approximately 80,000 public and 20,000 private) and school districts (16,000), their extreme heterogeneity, and the likelihood of low response rates all suggested a complex sampling design coupled with a lengthy data collection procedure. Our plan relied upon three tapes from NCES — for districts, public schools, and private schools -- and called for the following steps:

1. Cluster public school districts on the basis of key descriptive variables (grade span, number of schools, mean enrollment, community size, total enrollment) to distinguish between homogeneous districts and heterogeneous districts.

2. Eliminate all schools that are only prekindergarten.

3. Combine district clusters where appropriate; eliminate clusters that would not yield any relevant data (e.g., those districts that were only administrative and had no school buildings).

4. Draw a proportional random sample from the remaining clusters, resulting in a sample size that would yield a sufficient number of respondents (based on response rate determined by pretest) to achieve analytic results with a 95% level of confidence and precision of ±5%.

5. From each sampled district, draw a representative random sample of the schools (reflecting grade spans and enrollment) that would allow the responses to achieve the required levels of confidence and precision.

6. Treat the private schools separately from the public schools and districts; draw a stratified random sample, in which the strata would be (a) Catholic schools, (b) religious but not Catholic-affiliated, and (c) schools with no religious affiliation. (We considered drawing private schools from those districts selected from the cluster sampling, but rejected the idea as being too costly, considering the information that would be obtained.)

Although the detailed discussions that immediately follow show that our sampling and data collection varied from our original plan, it is important to describe our intended methodology so that the necessary deviations are understood in the proper context. The

survey instruments were expected to be different for the three subsamples, yet the format to be followed by the schools was to be parallel to that used for hospitals and higher-education institutions. Three survey waves were planned, and considerable attention was paid to mailing dates and how they might mesh with school schedules. The nonrespondent follow-up was to focus on offsetting biases among respondents and ensuring that districts and schools would "match."

2.2 MAIL SURVEY INSTRUMENTS AND THEIR PRETEST

Development of mail survey instruments for schools and districts began in late 1986, after we had completed visits to colleges and universities to pretest a similar mail survey. From the start, we realized that at least two survey instruments would be needed; some questions appropriate for schools would not be appropriate for districts, and vice versa. Thus two survey instruments were developed: one for districts and the other for individual schools, both private and public. Iterative reviews by staff at ANL and LBL and by experts in elementary and secondary education resulted in a version of each survey instrument acceptable to those involved. Teams of two from ANL and LBL visited 17 schools or district offices in the Chicago and San Francisco areas to pretest the survey instruments.

During these site visits, school and district administrators completed and commented upon the survey instruments, showing us that we needed to clarify the wording of a number of questions and instructions. Several issues that could affect the response rate to the final mail survey were brought to light. School administrators were more hesitant to participate than hospital and university engineers. In one district, clearance had to be obtained from a public information officer. Also, the survey instruments, especially the school questionnaire, were longer and took more time to complete than those used for hospitals and universities (because less information was available from other sources). Principals who did not supervise maintenance or custodial personnel could answer only a few questions about the school physical plant.

To address these concerns and estimate response rate so that the final sample could be drawn, we conducted a mail pretest. Three survey instruments were used: one for school districts, a long version for public and private schools, and a shortened version of the school survey instrument to determine if it would result in more responses than the long one. The mail pretest instruments were sent to 81 private schools, 77 districts, and 152 schools within these districts. Districts were drawn at random from each cell in the stratified sampling frame, and two schools within each district were selected to represent all grade levels and enrollments. Private schools were selected on the basis of a simple random sample. Each survey instrument was accompanied by a cover letter that was appropriate for the final survey and did not reveal that this was a pretest.

Within four weeks of mailing, 39 responses had been received, a response rate of 12.5%. The response rate was highest among districts (22%) and lowest among public schools (8%); private schools' response rate was 11%, with 90% of the Catholic schools responding. The short form of the school questionnaire did not elicit a higher response rate. Also, the quality (i.e., completeness and thoroughness) of the responses from the public schools seemed to be lower than from the other two groups. Additional

information on the fate of mailed questionnaires was obtained from telephone calls to 138 nonrespondents. These telephone prompts increased the response rate to 16% after four more weeks.

Based on the results of the mail pretest, we decided to drop the short version of the school survey instrument; it did not encourage responses and it precluded gathering important information about installed ECMs and building characteristics. The mail pretest results allowed us to choose the size of the sample and confirmed the indications from the site visit pretest -- that the district-level survey would probably yield more information about energy conservation activities in public schools than the school-level survey.*

A total of 82 questions appears in the survey instruments. Some pertain only to schools; others pertain only to districts. The district questionnaire contains 60 questions. The survey instruments are divided into five sections. The questions in the first section are concerned with how energy is regarded in the institution, with the persons responsible for energy policy and decisions, and with their motivation and sources of information. The second section deals with energy conservation activities, including technical audits and monitoring, and how these activities are financed. The third section covers the characteristics of the facilities, including their heating and cooling systems and the fuels used. The fourth section addresses participation in energy conservation programs, especially ICP. Finally, the fifth section asks for information about the person primarily responsible for completing the survey instrument.

2.3 SAMPLING PROCEDURE

By the time the date for the first mailing of surveys could be estimated, we were only four months from the end of the project and facing budget constraints. We assessed how much time we would need to accomplish all three mailings of the district and school surveys, match responding districts with responding schools, obtain district-level data where schools had responded and collect school-level data where districts had responded, and conduct telephone interviews. We concluded that our limited resources should focus on collecting data from districts and from private schools. The last step would be to draw samples of school districts and of private schools.

The school district sample would be drawn at random from cells determined using cluster analysis on the entire population of 16,500 school districts. The attributes used to define the clusters were location (urban, suburban, or rural), grade span (only elementary schools, only high schools, only one school, and all grades), and fiscal dependence/independence on the local government. All possible combinations of these three attributes produced 24 ($3 \times 4 \times 2$) cells. Table 2.1 summarizes the average enrollment in the districts found in each cell, the total number of school districts in the

*Collins, N.E., et al., *Institutional Conservation Program Evaluation Project: Results of Elementary and Secondary Education Survey Pretest*, Argonne National Laboratory Report ANL/CNSV-TM-189 (Aug. 1987).

TABLE 2.1 Mean Enrollment and Count Used for K-12 District Survey Sampling

Type of Schools within District	Financial Status	Type of School District Location									Total N
		Rural			Suburban			Urban			
		Mean	N[a]	DOE[b]	Mean	N	DOE	Mean	N	DOE	
Elementary schools only	Independent	345	673	1-5-8	1,973	519	5-9	17,483	32	5	1,224
	Dependent	279	302	1	1,096	293	2-9	478	25	6	620
	Total		975			812			57		1,844
High schools only	Independent	884	57	1-6-9	3,189	82	5-9	-	-	-	139
	Dependent	1,716	8	-	3,278	22	2	-	-	-	30
	Total		65			104					169
Single school (only 1 school in district)	Independent	152	2,651	1-5-7-8	308	617	5-9	516	9	5	3,277
	Dependent	359	363	1-9	473	226	2	429	12	6	601
	Total		3,014			843			21		3,878
K-12 schools (elem. and high schools)	Independent	1,583	6,091	5-6-7	4,207	2,930	0-1-2	25,604	225	5-6	9,246
	Dependent	3,512	692	3-4	6,213	555	1-2	32,982	84	1	1,331
	Total		6,783			3,485			309		10,577
Total											16,468

[a]N = number of school districts.

[b]DOE = Department of Energy region.

cell, and the DOE regions that dominated the cell as a proxy for geographic climate. Inspection of each cell shows some very small N values (e.g., urban, elementary schools only; all districts that are high schools only; and urban, single-school districts) and some highly heterogeneous cells with large N values (i.e., rural and suburban districts in which the schools cover all grades). We reassigned these 24 cells into 9 so that we would have sufficiently large N values from which we could draw a stratified random sample. Table 2.2 shows the distribution of the same across the nine cells, the number of surveys mailed for each cell, and total responses received. Also shown are the cells to which the pretest responses belonged. ICP participation was not a stratification variable but was determined from GTS records after the sample was drawn. Nearly half the questionnaires were mailed to independent, combined elementary and secondary school districts that were suburban or rural.

The private school population was stratified as described in Sec. 2.1 and the sample consisted of 1,700 schools. Their selection was not linked to the specific public school district sample.

2.4 DATA COLLECTION

The first and only wave of the two surveys was mailed in early June 1987 to superintendents of public school districts and principals of private schools. Each packet included a cover letter and a return envelope. A copy of the district mail survey instrument is provided in App. A. Ninety responses (10.9%) had been received from public school districts after approximately five weeks; this was far from the expected 30% response expected based on the pretest results. The highest response rate was from independent, urban districts (cell 0 in Table 2.2) and the lowest rates were from rural districts (cells 4, 5, and 6). Only 64 responses were received from private schools. We decided, therefore, to concentrate remaining resources on augmenting the 90 responses from the public school districts. We added the 20 completed district surveys from the mail pretest, which raised the number of usable surveys to 110, or 44% of the 250 necessary for analysis. Then the remaining 140 questionnaires still needed were completed by means of telephone interviews conducted by Elrick and Lavidge, Inc., the market research firm under subcontract to LBL to carry out the mailing and data entry. The institutions contacted for these telephone interviews were selected so that the statistical integrity of the three stratifying variables (grade span, region, and financial status) would be preserved.

Because of limitations on the length of telephone interviews, not all questions on the mail survey instrument were asked. Most of the questions deleted were in the first section (i.e., related to information sources, energy conservation motivation, and responsibility for decision making). Also, the mail survey question that asked which ECMs had been or would be installed soon was changed; the 36 ECMs were collapsed into 11 broader classes: (1) window treatments, (2) building envelope, (3) controls, (4) air conditioning, (5) cogeneration, (6) heat recovery devices, (7) domestic hot water, (8) fuel conversion, (9) mechanical HVAC, (10) electrical/lighting, and (11) renewable energy. A copy of the telephone interview instrument is provided in App. B.

TABLE 2.2 School District Surveys Mailed and Received

Cell	Cluster Attributes	No. Mailed	Responses Received		No. from Pretest
			No.	%	
0	All grades, urban, fiscally dependent	75	14	18.7	3
1	All grades, urban, fiscally independent	33	6	18.1	0
2	All grades, suburban, fiscally independent	174	25	14.4	3
3	All grades, suburban, fiscally dependent	55	6	10.9	2
4	All grades, rural, fiscally independent	218	16	7.3	9
5	All grades, rural, fiscally dependent	41	3	7.3	1
6	Elementary schools only, suburban, fiscally independent	26	4	15.4	2
7	All other district types, not urban	119	8	6.7	0
8	All other district types, urban	82	8	9.8	0
Total		823	90	10.9	20

2.5 DATA ENTRY AND ANALYSIS

Responses to questions that were asked in both the written survey instrument and the telephone interviews, except for several open-ended questions, were coded and entered into a data file by Elrick and Lavidge. A tape containing this data file was sent to ANL, where the data were merged with data from GTS and NCES and analyzed using specially written Fortran routines, the Statistical Package for the Social Sciences (SPSS, PC+ version), Lotus 1-2-3, and GEM.

In subsequent sections, district information obtained from this survey is analyzed according to the DOE region or climatic region describing the district's location. DOE regions and climatic regions are shown in Figs. 2.1 and 2.2, respectively. States are assigned to climatic regions based on an analysis of the variables (e.g., temperature, humidity, insulation) believed to be important in determining the energy performance of nonresidential buildings. The North is cold; the Southeast is warm and moist, and the Southwest is warm and dry.

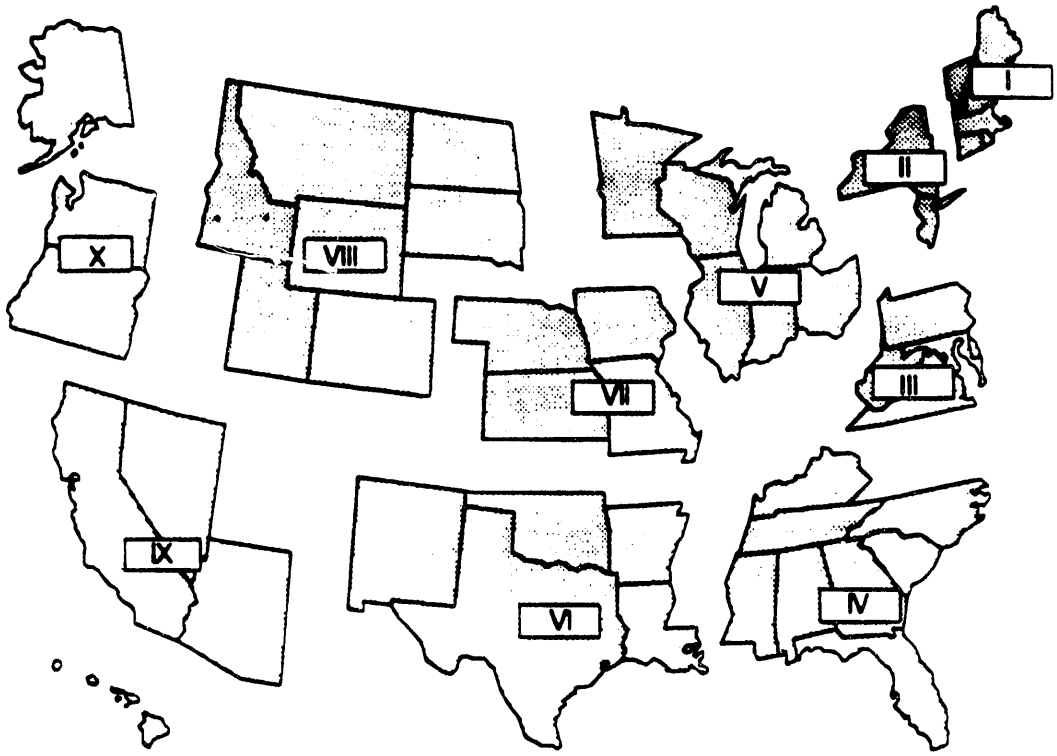


FIGURE 2.1 U.S. Department of Energy Regions

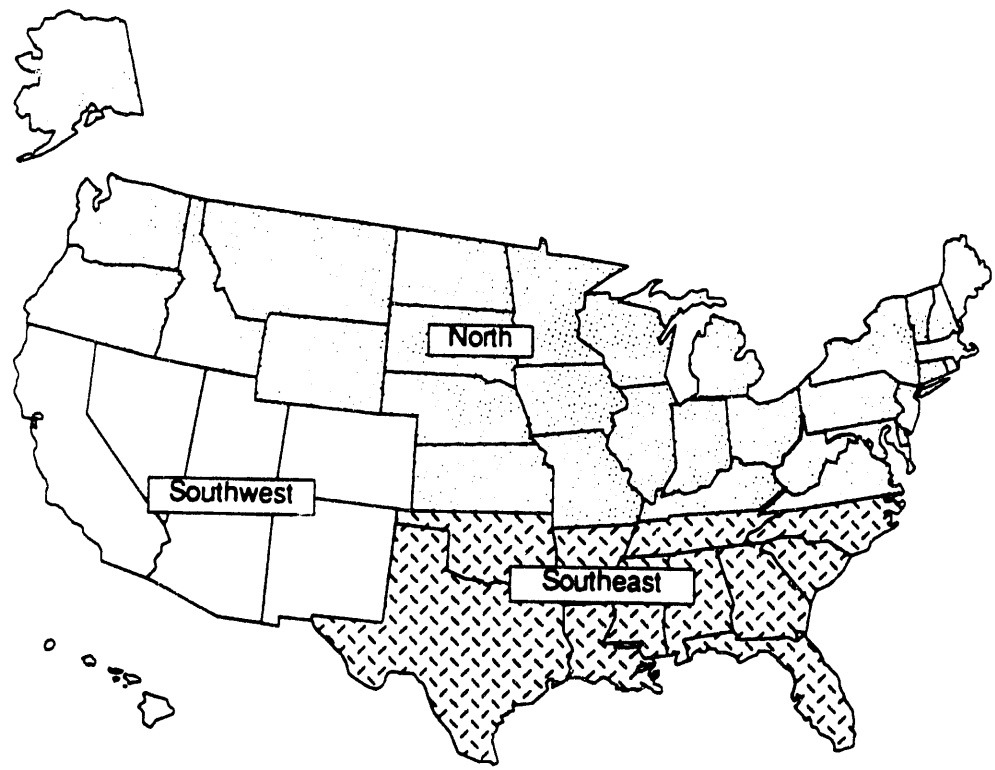


FIGURE 2.2 Climatic Regions Used for Analysis

3 INSTITUTIONAL AND ORGANIZATIONAL CHARACTERISTICS OF RESPONDENTS

3.1 DESCRIPTION OF SCHOOLS IN THE UNITED STATES

Information on the universe of elementary and secondary schools in the United States was obtained from NCES, which is part of the U.S. Department of Education. According to NCES, there are 104,268 schools within the 50 states and the District of Columbia. Of these, 81,241 are public schools and 23,027 are private schools. The public schools are administered by 15,194 school districts.

Most school districts administer few schools, as shown in Fig. 3.1. The average number of schools per district is 5.3; however, more than half of the districts have fewer than three schools, and 80% of the districts have fewer than six schools. Figure 3.2 shows how district size correlates to rural, urban, and suburban locations. Smaller districts (fewer than five schools) tend to be rural; medium districts (5 to 14 schools) are evenly divided between rural and urban/suburban; large districts tend to be urban.

Figure 3.3 shows the distributions of private schools, public schools, and public school districts by DOE region. In absolute numbers, Region 5 has more schools and districts than any other region. There are differences among DOE regions in the ratio of public to private schools. Regions 2, 3, 4, and 9 have above-average numbers of private schools, while Regions 8 and 10 have below-average numbers. The size of school districts, as measured by the number of public schools per district, also shows some variation by DOE region. Large cities and county-wide districts are associated with large districts.

Figure 3.4 shows this information aggregated for climatic region. The North has about half of the schools (both public and private) and districts. Aggregating over climatic region smooths some of the differences in the size of school districts and the ratio of private-to-public schools. However, the Southeast, which contains DOE Region 4 and part of Region 6, has the largest districts, and the Southwest, dominated by DOE Region 9, has the largest ratio of private-to-public schools.

3.2 DESCRIPTION OF RESPONDING SCHOOL DISTRICTS

Figure 3.5 shows the number of districts by DOE region that responded to the mail and telephone surveys. More than twice as many responses were received from Region 5 than from any other DOE region. The number of responding districts by DOE region compared with all districts in the United States is shown in Fig. 3.6. DOE Regions 3, 4, 5, and 10 are overrepresented. The school districts that responded tended to be larger than average in all DOE regions. The range of responses by state is shown in Fig. 3.7. The responses from some states were commensurate with their populations (e.g., Texas and California), while the responses from other states were not (there was only one response from Florida). However, the unevenness of the responses by location should not be unexpected, because state, DOE region, and climatic region were not stratifying variables.

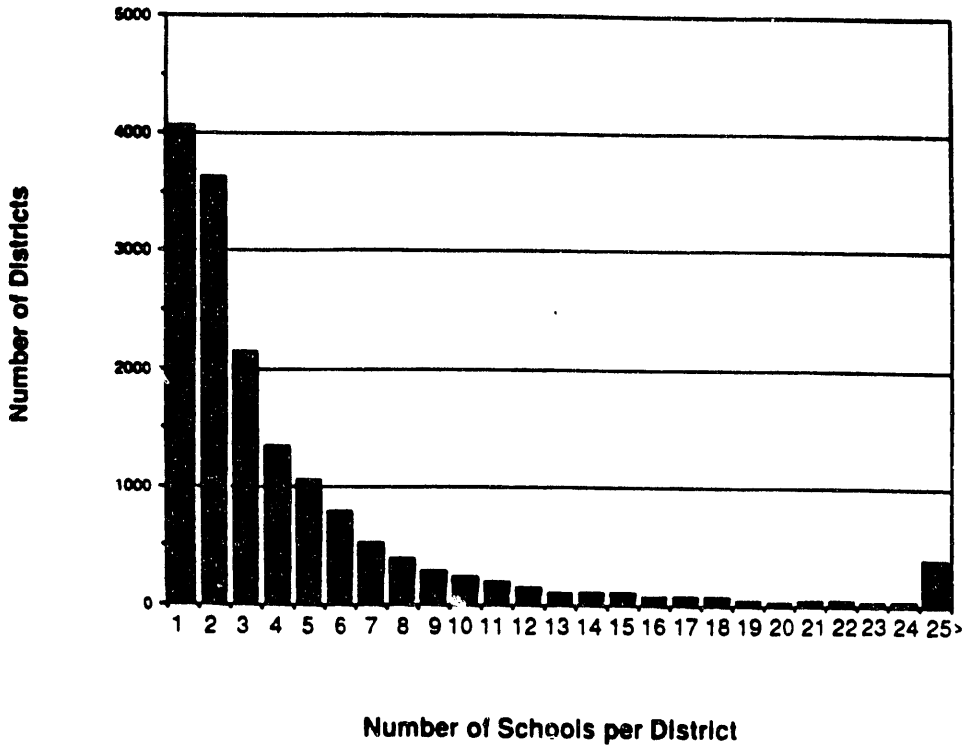


FIGURE 3.1 Number of Public Schools within U.S. School Districts

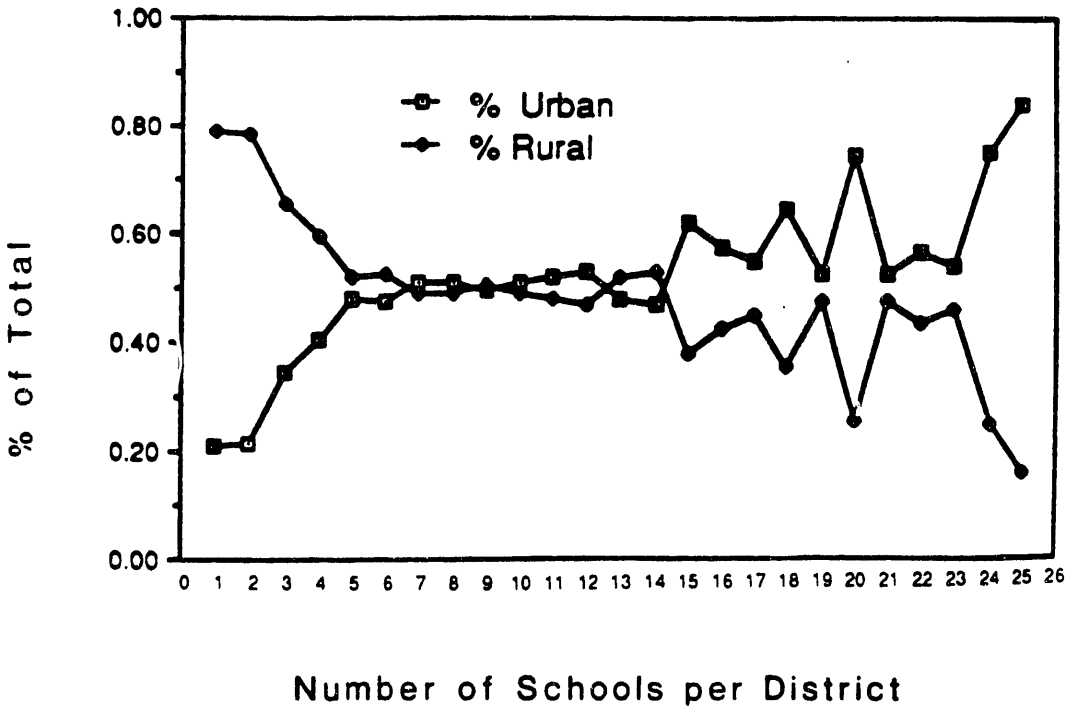


FIGURE 3.2 Description of Public School Districts Based on Their Location and Number of Schools

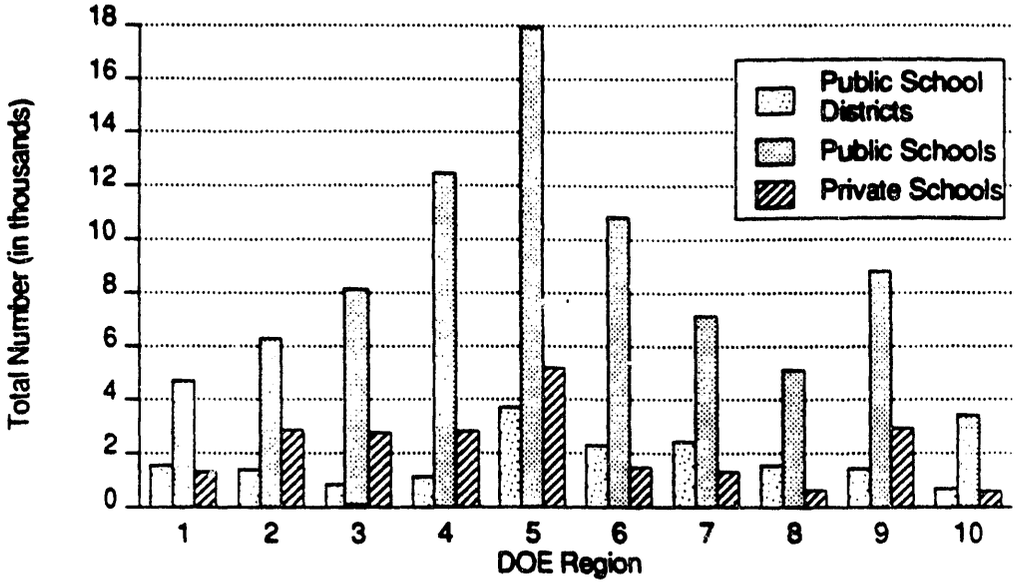


FIGURE 3.3 Number of Districts, Public Schools, and Private Schools in Each DOE Region

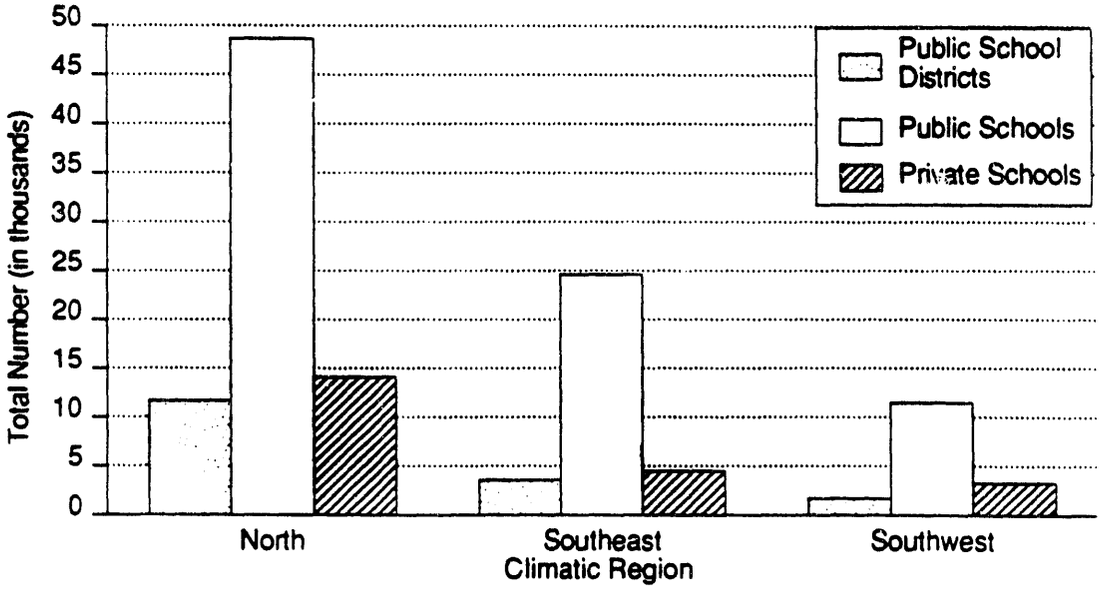


FIGURE 3.4 Climatic Location of Districts, Public Schools, and Private Schools

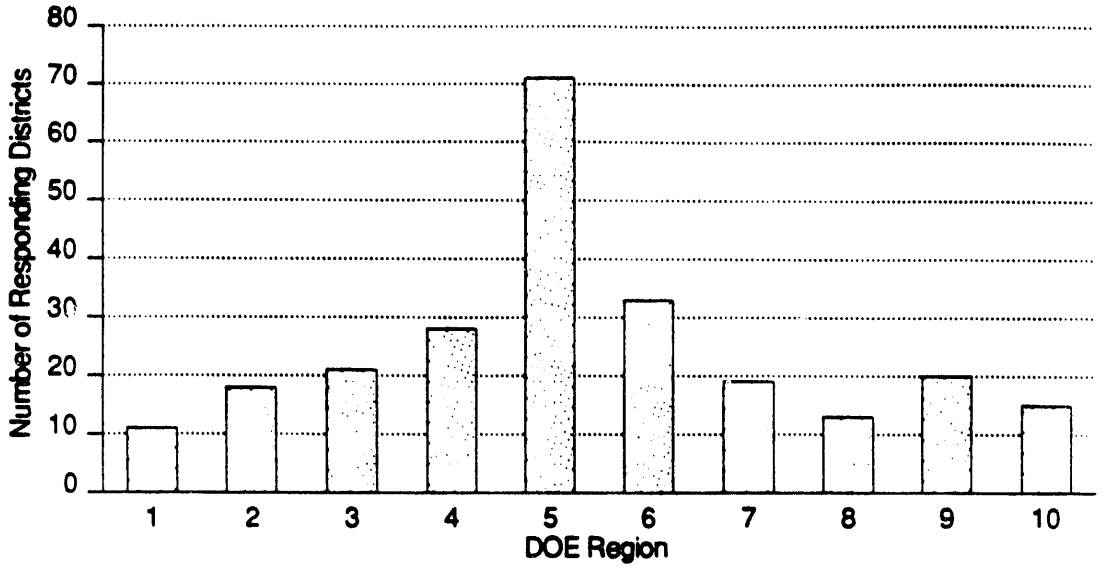


FIGURE 3.5 Number of Responding School Districts from Each DOE Region

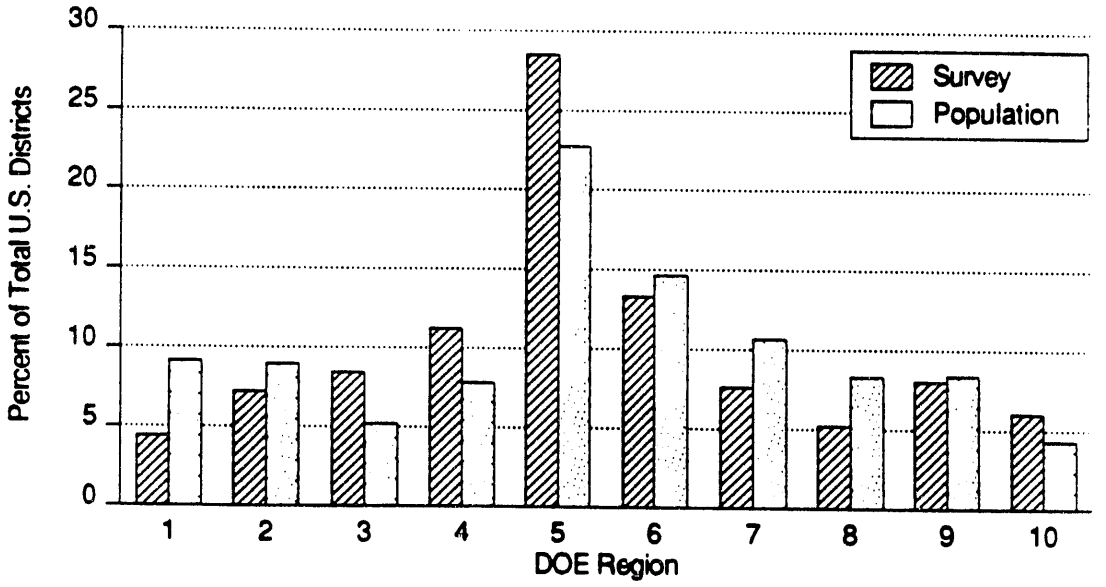


FIGURE 3.6 Comparison of Responding School Districts to All U.S. School Districts by DOE Region

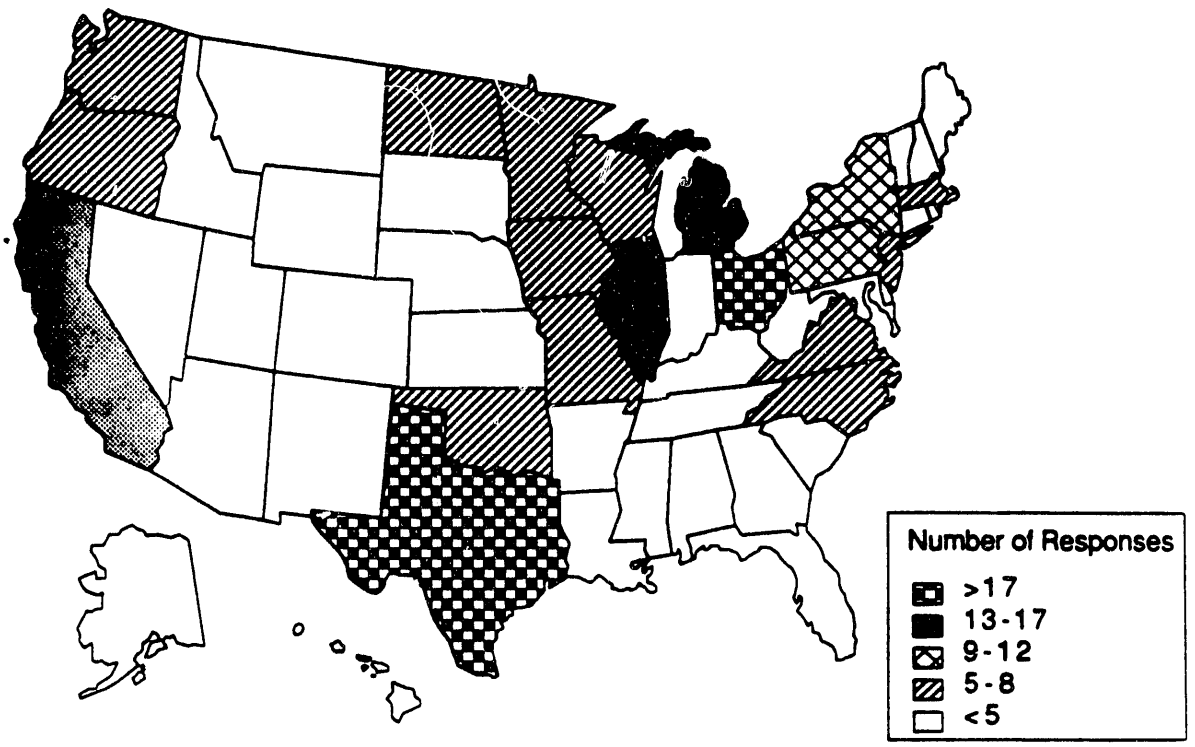


FIGURE 3.7 Number of Responses from Each State

The responding districts also overrepresent the number of school districts participating in ICP. The actual percent of all school districts that have received ICP grants is 32.5%; 44% of the responding districts received them. Figure 3.8 shows ICP participation by responding districts in each DOE region, Fig. 3.9 compares respondents' population to total population on basis of climatic region, and Fig. 3.10 does the same based on urban-suburban-rural location.

Previously in this report, we used the number of schools in a district as a measure of its size. Another measure of size is district enrollment. Figure 3.11 compares, by DOE region, enrollments in districts receiving ICP grant awards with enrollments of nonparticipant districts. Comparison of this figure with Fig. 3.8 gives information on differences between survey respondents and the total population based on enrollment, DOE region, and ICP participation. Dramatic differences in enrollment between respondent ICP grantee districts and non-ICP districts are observed in some, but not all, DOE regions. In Fig. 3.8, the number of districts in Regions 3, 5, 6, 7, 8, and 9 that were nonparticipants in ICP exceeded the number that were ICP grantees; however, the number of students in districts that received ICP grants far exceeded the number in districts that were nonparticipants (Fig. 3.11). The differences are most pronounced in Regions 3, 5, and 7, where the average population of responding ICP grantee districts is at least five times as great as in responding nonparticpants. In Regions 1, 4, and 8, there is no significant difference in enrollment, but in Region 10, nonparticipant districts have larger student populations, on the average, than grantee districts.

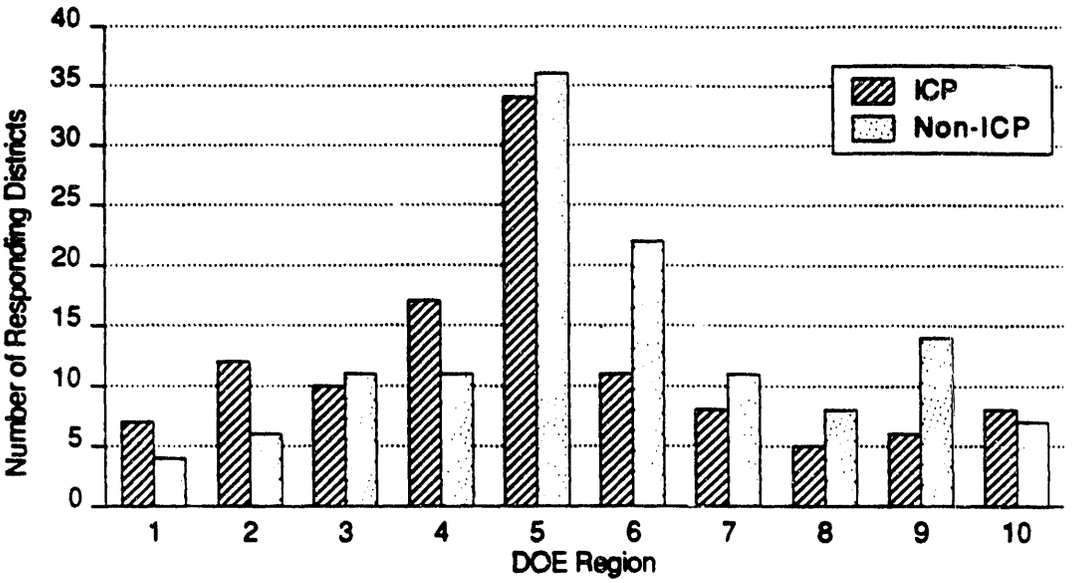


FIGURE 3.8 Number of ICP and Non-ICP Districts Responding from Each DOE Region

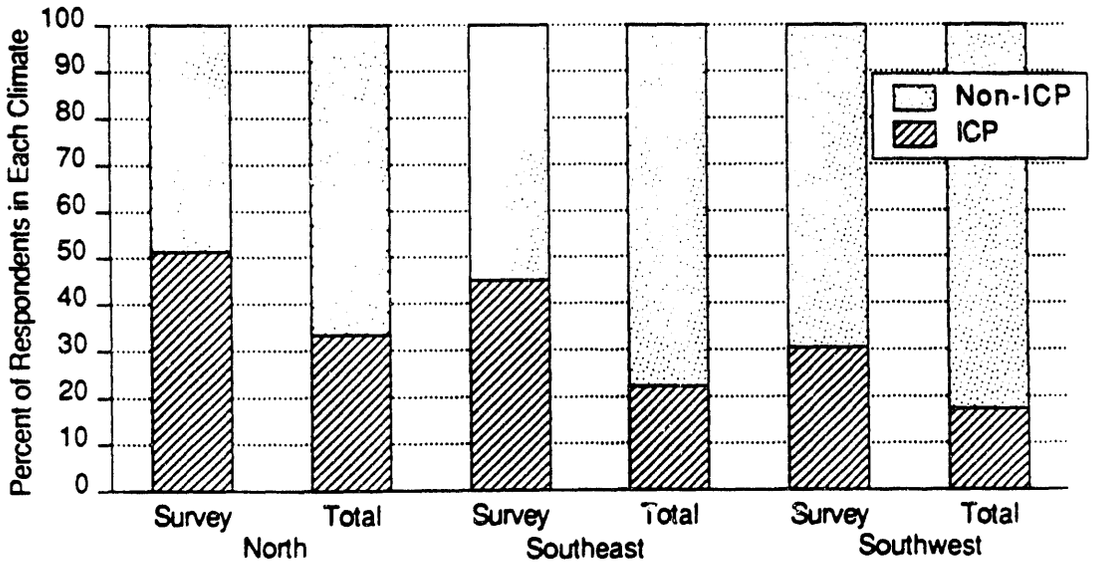


FIGURE 3.9 Comparison of Responding School Districts to All U.S. School Districts by ICP Participation and Climatic Region

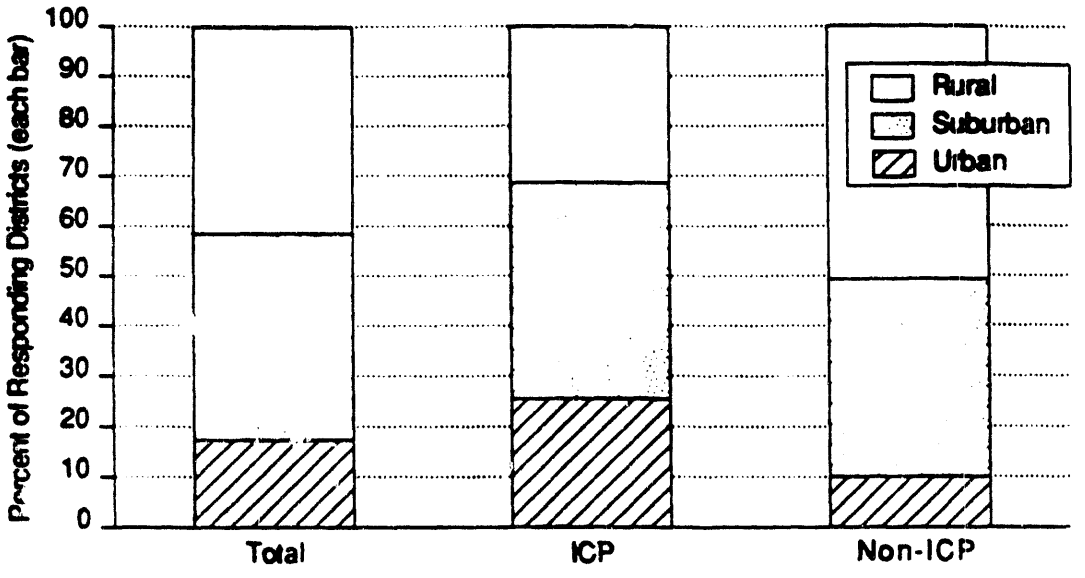


FIGURE 3.10 Description of Responding School Districts in Terms of ICP Participation and Location

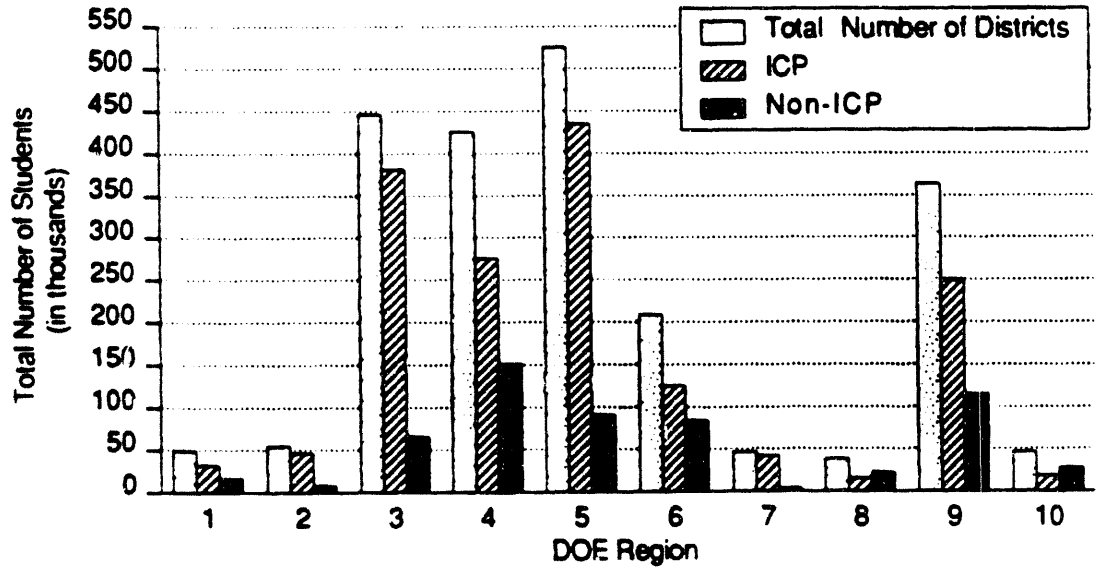


FIGURE 3.11 Enrollment in Responding School Districts by DOE Region and ICP Participation

3.3 CHARACTERISTICS OF PERSONS COMPLETING SURVEYS

The last section of the survey asked for employment-related information about the person completing the survey. This information is useful for determining how knowledgeable the individual might be about historical events in the district and for estimating (based on other answers) the role of the respondent in decision making.

Nearly 90% of the respondents answered the question that asked for the title of the individual completing the survey. These responses are tabulated in Table 3.1. As shown in the table, individuals with a variety of titles completed the survey. The individual who responded most often was the superintendent (33.5%), and the second most frequent respondent was the assistant superintendent (11.9%). Approximately 20% of the surveys were completed by the director of the department that has jurisdiction over operation of the physical plant or the district's buildings (common titles were "Director of Buildings and Grounds" or "Director of Plant Operations"). A comparatively large number of surveys (8.1%) were completed by the business manager of the district. Nearly 4% of the surveys were completed by an energy officer.

The superintendents and administrators, as the chief administrative officers of the districts, reported to the school board (36.5%), shown in Table 3.2. The most likely immediate supervisor of the respondents was the superintendent (40.6%). This fact indicates that most of the respondents were high in the decision-making structure. The next most common immediate supervisor was the assistant superintendent (8.4%).

Nearly all the respondents (240) answered the question on how long they had worked in the district. The responses are shown in Fig. 3.12. Only one-third of the respondents had worked in the district before 1973; 58% had worked there before 1980. As can be seen from Fig. 3.13, there does not appear to be a significant difference in the tenure of respondents at districts based on receipt of ICP grants. The tenure of respondents in their current position was considerably shorter than their tenure in the district. Many respondents (70%) had held their current position one year or less.

TABLE 3.1 Titles of School District Administrators Who Responded to Survey

Titles	Number	% of Total Respondents
Superintendent	79	33.5
Assistant Superintendent	28	11.9
Business Manager/Director of Business Affairs	19	8.1
Administrator	7	3.0
Finance Officer	3	1.3
Energy Officer	9	3.8
Director/Supervisor of Buildings & Grounds/ Building Services/Facilities		
Director of Plant Operations/Physical Plant	6	2.5
Director of Maintenance/Support Services	18	7.6
Other	17	7.2
No answer	26	11.0

TABLE 3.2 Immediate Supervisors of Respondents

Title	Number	% of Total Respondents
Board of Education/School Board/Board Pres.	91	36.5
Superintendent	101	40.6
Assistant/Deputy Superintendent	21	8.4
Business Manager	10	4.0
Director of Facilities/Buildings & Grounds/Operations	4	1.6
Other	10	4.0
None	1	0.4
No answer	11	4.4

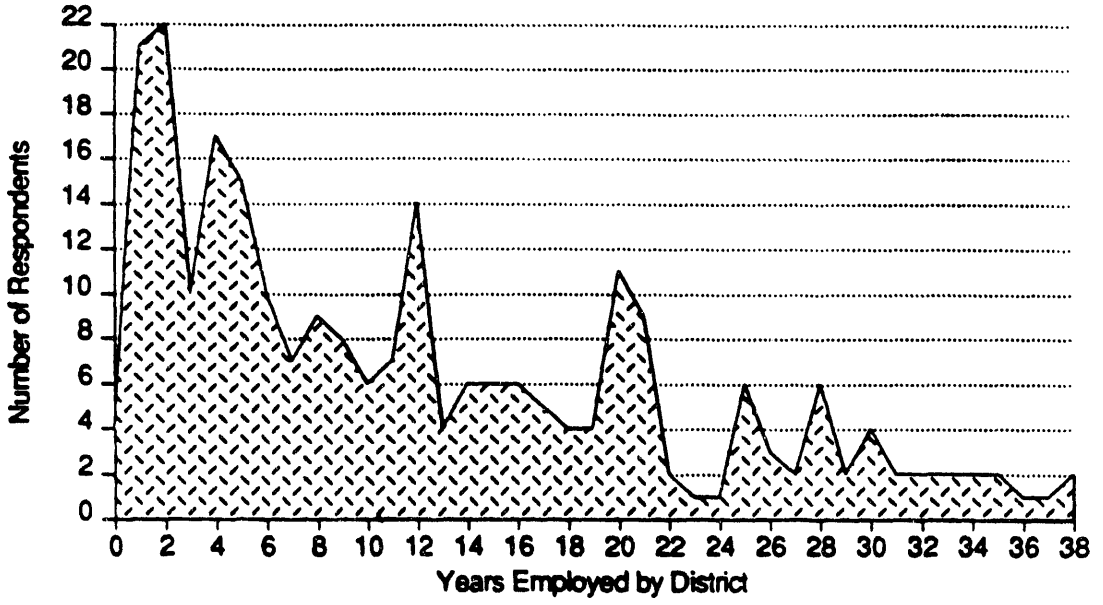


FIGURE 3.12 Number of Years Respondents Had Been Employed by School District

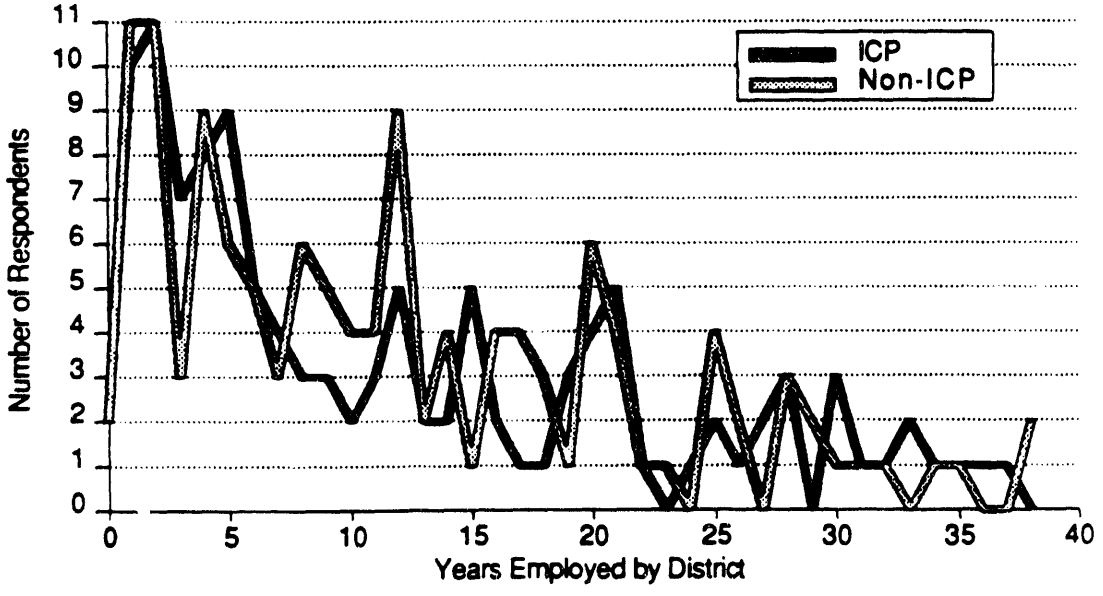


FIGURE 3.13 Number of Years Respondents Had Been Employed by School District in Terms of ICP Participation

4 BUILDING AND ENERGY CHARACTERISTICS OF RESPONDING SCHOOL DISTRICTS

4.1 BUILDINGS AND FUNCTIONS

This section contains information about the gross physical characteristics of the buildings in districts that responded to the survey. This information is correlated with participation in ICP (according to GTS records) and is summarized in Table 4.1. The average age of the oldest building was 59 years, with the oldest building belonging to ICP grantees being 9 years older than the oldest belonging to nonparticipants. Few school buildings, less than 1%, were constructed after 1977.

The average number of buildings (not schools) per responding district was nearly 27. However, the average was greatly affected by the inclusion of a few large districts, evidenced by a median of only seven buildings. ICP grantees tended to have more buildings and larger buildings than nonparticipants. The average area of conditioned space per district (heated and/or cooled) was approximately 1,400,000 ft^2 and the average area per building was 52,559 ft^2. Square footage was also greatly affected by inclusion of a few large districts.

Nearly half of the districts had no purely administrative buildings, although large districts had many such buildings (for example, 25 or 30). Slightly more than half of the districts did not have portable buildings; for those that did, the average number was 17. This average was influenced by a few districts with huge numbers of portable buildings (for example, one ICP grantee had 770). On the average, nearly 20% of the school buildings did not have any air conditioning. When buildings in temperate climates have air conditioning, frequently only a small fraction of the rooms (such as the principal's office) are cooled.

4.2 FUEL CONSUMPTION

Figure 4.1 shows that half (53%) of the respondents decreased their energy consumption since 1980; a quarter (26%) increased their consumption, and 15% had stable consumption patterns. No significant differences were found when the data were correlated to urban/suburban/rural setting, but differences did occur on the basis of climatic region. Consumption increased greatly in the Southeast (by 41%, compared with 18% in the North and 30% in the Southwest), and conversely, consumption decreased more often in the North (63%) than in the Southeast (35%) or Southwest (43%).

We attempted to collect energy consumption data from the districts as part of the mail and telephone surveys. Of the 250 districts in our sample, we obtained consumption data from 51 (20%); 27 were ICP grant recipients and 24 were not. Because nearly 30% of this group did not provide square footage, we could not calculate a standard value (Btu per square foot), which would enable us to compare energy efficiency across the respondents.

TABLE 4.1 Characteristics of Buildings in Responding School Districts

Characteristics	Total	ICP	Non-ICP
Oldest building (yr built)			
Mean (average)	1928	1923	1932
Mode	1930	1930	1939
Median	1929	1924	1936
Built after 1977 (% of total)	0.4	0.9	0
Square feet per district (ft^2)			
Mean (average)	1,412,476	2,057,550	821,158
Mode	100,000	1,000,000	50,000
Median	458,000	878,000	182,000
Minimum	1,600	1,600	1,800
Maximum	20,000,000	20,000,000	8,000,000
Buildings per district (no.)			
Mean (average)	26.9	32.3	21.3
Mode	3	6	2
Median	7	10	5
Maximum	600	426	600
Average square feet per building (ft^2)	52,559	63,607	38,507
Administrative buildings per district (no.)			
None (% of total districts)	48.5	45.2	52.0
Mean (average)	1.3	1.7	.9
Mode	0	0	0
Median	1	1	1
Maximum	30	30	25
Buildings with air conditioning per district (no.)			
None (% of total districts)	19.2	12.7	24.8
Mean (average)	10.6	13.5	8.1
Mode	1	1	0
Median	2.0	3.5	2.0
Maximum	400	400	207
Mobile classrooms per district (no.)			
None (% of total districts)	50.9	48.6	53.3
Mean (average)	17.3	23.7	12.0
Mode	0	0	0
Median	0	1	0
Maximum	770	770	320

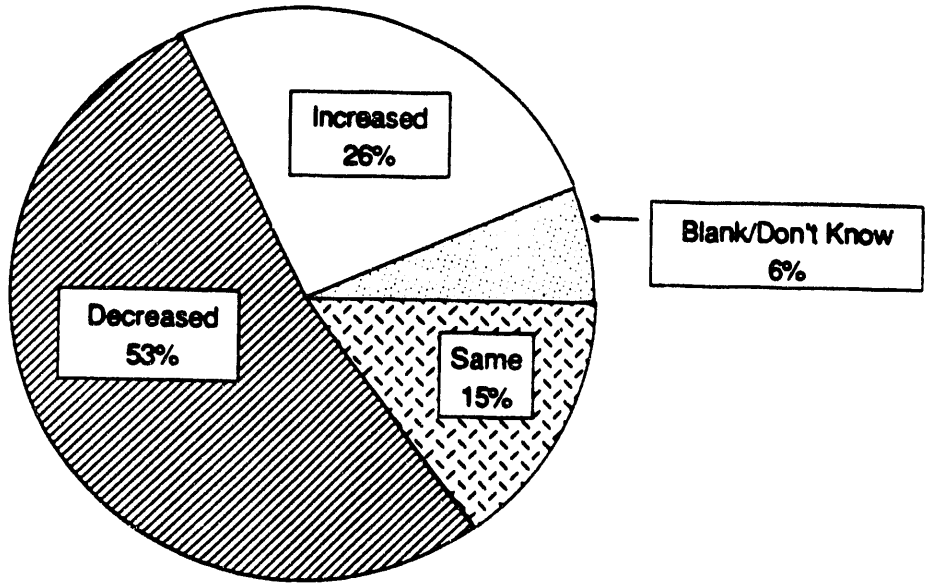


FIGURE 4.1 Changes in Energy Consumption Experienced by Responding School Districts

4.3 ENERGY MANAGEMENT ACTIVITIES

Nearly all the respondents answered the question asking whether their energy conservation activities had increased, decreased, or stayed the same since 1980 (left-most column of Fig. 4.2). As Fig. 4.2 shows, more than 75% indicated that energy conservation activities had increased and about 5% indicated that activities had decreased. Some differences among the responses appeared to be related to climatic region. The northern region reported the least amount of change in the level of activities, while respondents from the Southwest indicated no decrease in energy conservation activities. From Fig. 4.3, it can be seen that nonparticipants were more than twice as likely as ICP grantees to have indicated no change in the level of activities.

The survey included a question asking whether a comprehensive, technical energy audit had been performed in the district since 1980. As shown on the left-most stacked bar in Fig. 4.4, nearly all the respondents (99%) answered this question, and about 75% indicated that at least one technical audit had been performed. Although the proportion of ICP-grantee districts that had audits was much higher than the proportion of non-ICP respondents (87% vs. 62%), we had expected to see that 100% of the ICP districts had had audits. This was not the case. The explanation may be that a few had audits before 1980. On the other hand, only about a third of the non-ICP districts have *not* had technical audits in the last seven years. This fact indicates that even non-ICP school districts have been paying considerable attention to energy conservation.

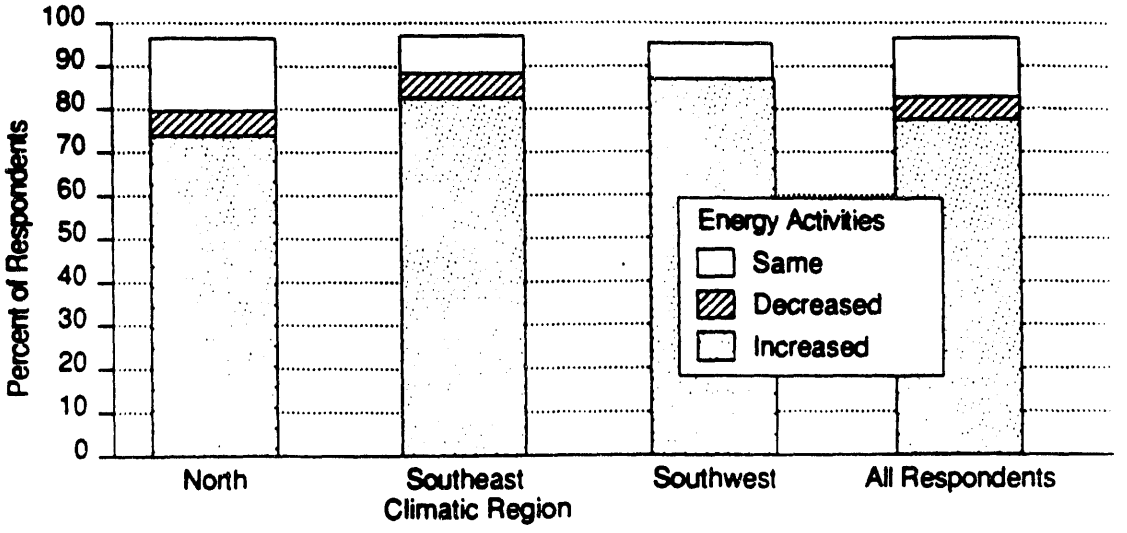


FIGURE 4.2 Change in Level of Energy Activities in Responding School Districts for Each Climatic Region

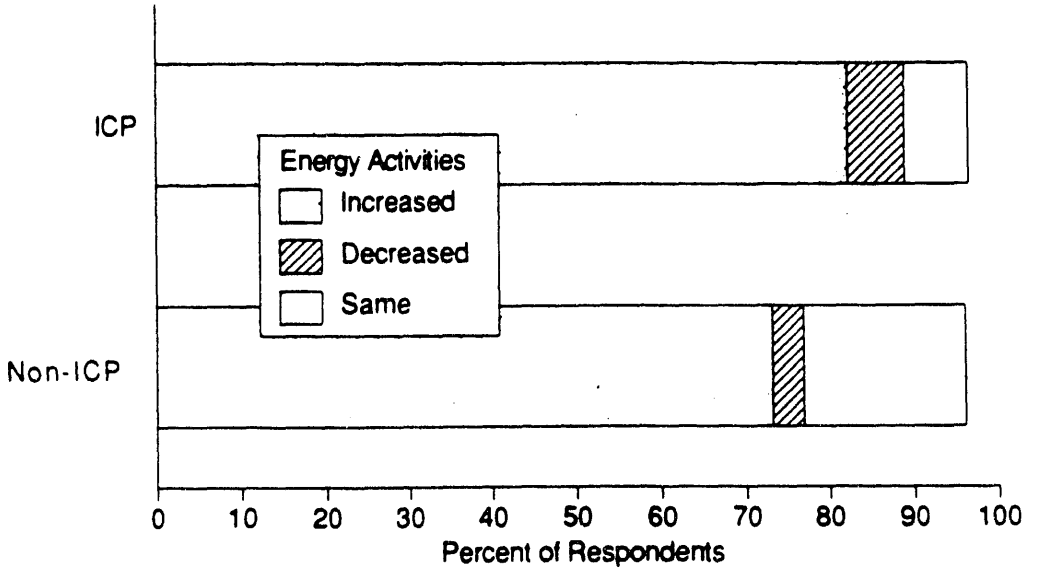


FIGURE 4.3 Change in Level of Energy Activities in Responding School Districts in Terms of ICP Participation

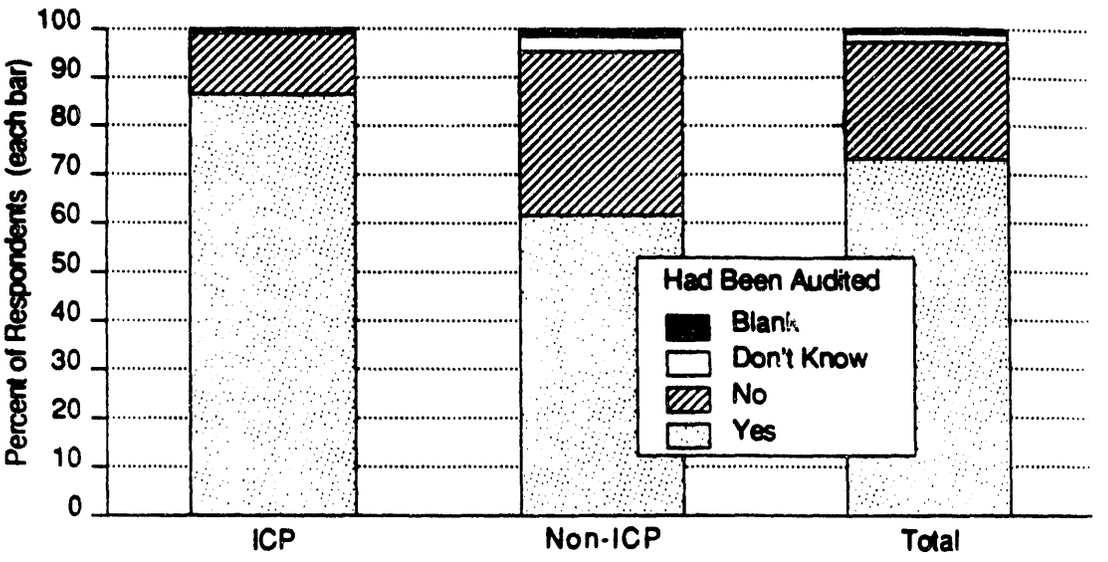


FIGURE 4.4 Technical Energy Audits in Responding School Districts in Terms of ICP Participation

5 SPONSORSHIP AND FINANCING

5.1 SOURCES OF FINANCING

The survey instruments asked which financing arrangements enabled the institution to purchase or lease energy-saving capital equipment since 1980 and which were being considered for the future. The respondents could identify as many of the seven choices that applied as they wanted. The results are summarized in Fig. 5.1. The most common source of financing was the institution's general operating and capital funds (80%). The next was grants (36%), and tax-exempt bonds (17%) were third. The least-used vehicles were commercial loans and lease/purchase arrangements. Rebates and savings-based financing (e.g., shared savings) were used by about 10% of the districts.

In general, the funding trends for energy investments planned in the immediate future were similar to financing arrangements for completed actions, but the frequencies of use were smaller. The lower frequencies could have occurred because fewer respondents answered that part of the question; but they also could have resulted from fewer actions being planned or from uncertainties in future financing plans. The only vehicles that showed increases in planned use were the least popular (commercial loans and lease/purchases), and the gains were very modest.

5.2 FINANCING AND MANAGEMENT PROBLEMS

Respondents were asked to describe problems they had encountered when ECMs were placed in the districts' schools. They could address any or all of four problem types: technical, financing, management, and building occupant. Descriptions of the problems were open-ended; they were categorized and coded by Elrick and Lavidge. The financing and management problems are discussed in this section; technical and building occupant problems are discussed in Section 6.4. Responses were obtained from both the written surveys and the telephone interviews. The absence of problems in an area was determined differently by each method. In the telephone interview, an interviewee could respond that there was no problem (these responses are denoted as "no problem"); on the written survey, a blank denoted "no answer" and indicated the absence of a problem. Also, only in telephone interviews could respondents say that there was a problem in an area, even if they could not articulate its specific nature (these responses are denoted as "not specified"). Except for these differences, responses to the mail and telephone questions were coded in the same way.

Of the four problem areas, financing (Fig. 5.2) received the greatest response rate (42%), and management (Fig. 5.3) had the lowest rate (13%). Financing problems were most often associated with the availability of funding (33%), although some respondents (7%) found investment criteria to be the problem. Problems with investment criteria could indicate that an ECM has a long payback period and cannot meet reasonable investment criteria, or that an ECM has a reasonably short payback period but cannot meet strict investment criteria. Although more than half of the management problems were associated with inadequate staffing, this type of problem was found in only 8% of all responding districts.

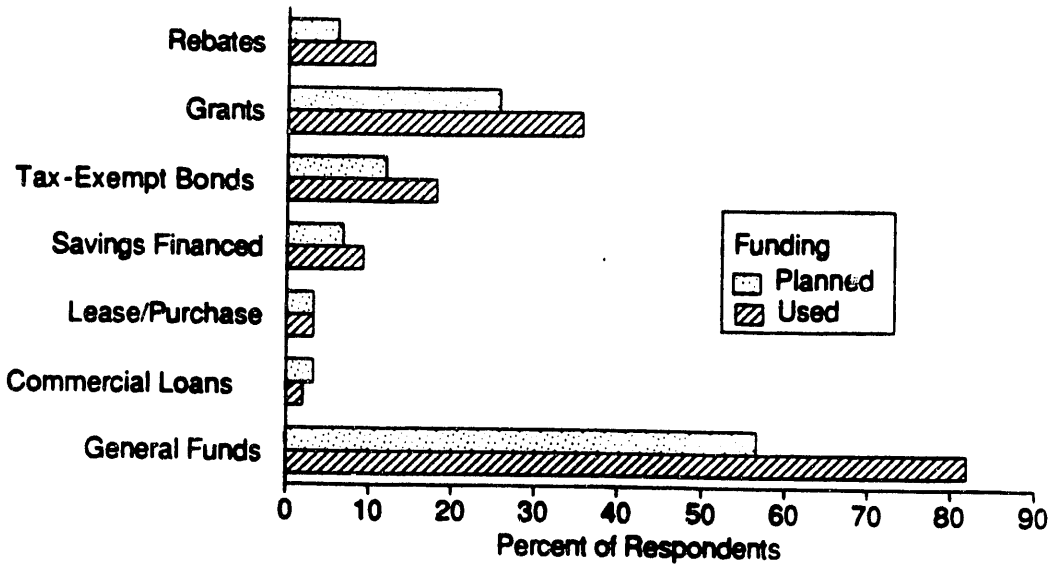


FIGURE 5.1 Sources of Funding, Used and Planned, for Energy Conservation Activities in Public School Districts

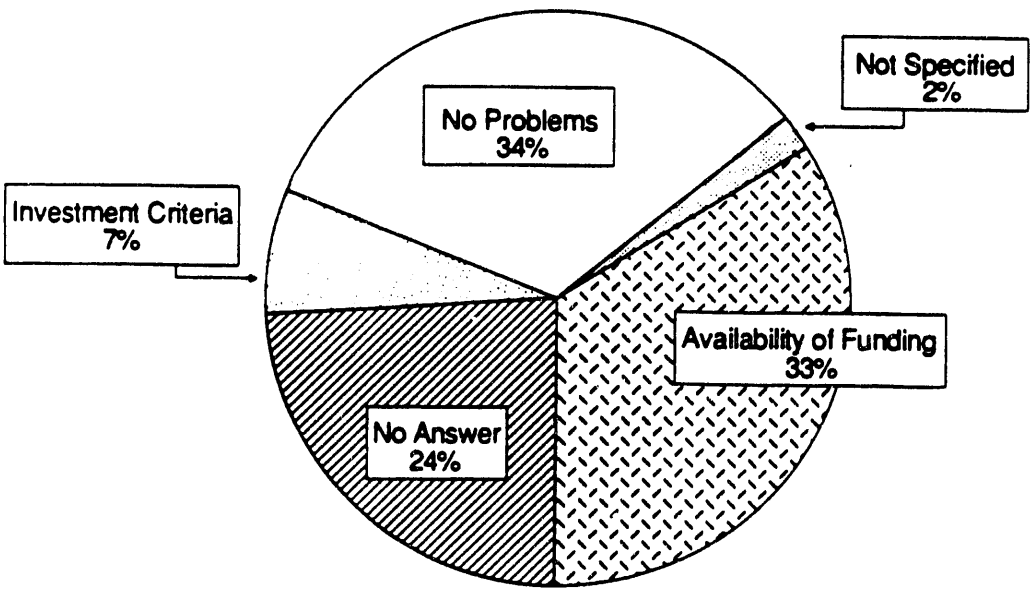


FIGURE 5.2 Financial Problems with ECMs Cited by School Districts

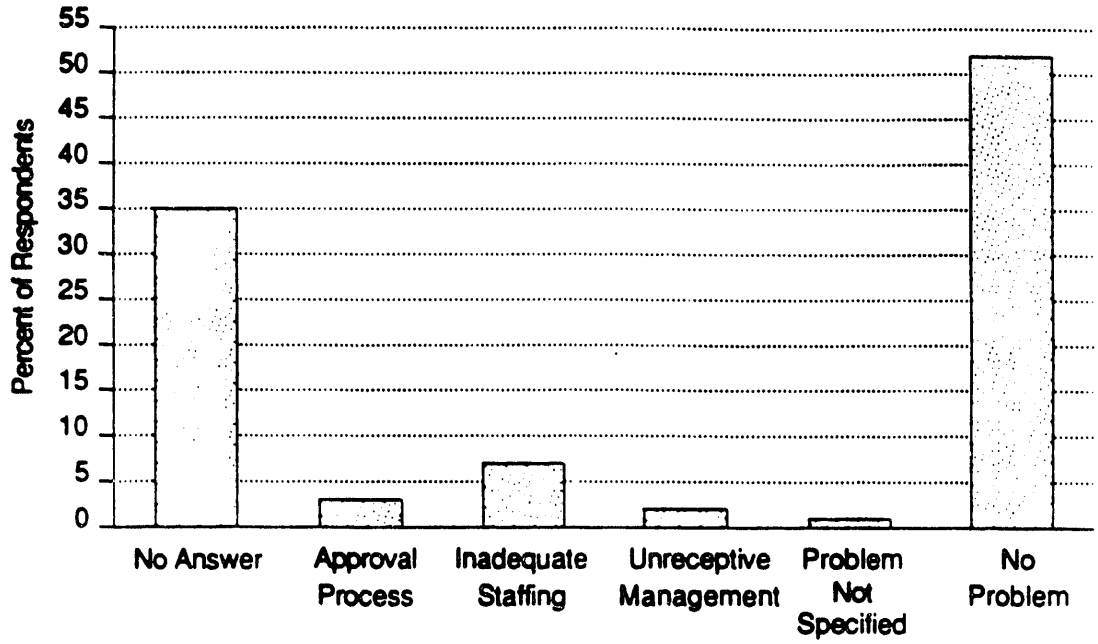


FIGURE 5.3 Management Problems with ECMs Cited by School Districts

5.3 THE ROLE OF ICP

Nearly all the respondents answered the question that asked if they were aware of ICP. Approximately 60% of the respondents were aware (Fig. 5.4). Approximately one-third of the respondents from districts that GTS shows as having received at least one ICP grant were not aware of ICP. Respondents who indicated that they were aware of ICP were also asked if their school districts had ever applied for a grant award. Of districts that received ICP grants, almost 80% knew that the district had applied (Fig. 5.5). An explanation of why 20% of the respondents from ICP districts did not know that their district had applied could be the respondents' short tenures at their districts; recall from Fig. 3.12 that 88 of 240 respondents had worked in the district five years or less. According to the respondents, of the districts that did not receive an ICP grant, nearly half had applied; presumably their applications had been rejected.

5.4 SOURCES OF FINANCIAL AND TECHNICAL ASSISTANCE

To help identify sources of assistance to schools other than ICP, the survey instruments contained a question asking whether the districts had participated in any other energy conservation programs that offered financial assistance or energy audits. The question made clear that federal and state agency programs could not be the ICP programs. Figure 5.6 shows clearly that some non-ICP programs are reaching public schools. Utility-sponsored programs had the highest penetration, nearly 25%. State-sponsored programs were close behind at 20%.

In only 24 of the 43 states from which responses were received did at least one respondent indicate that the district participated in a utility-sponsored financial assistance or energy audit program. In only two states with more than one respondent

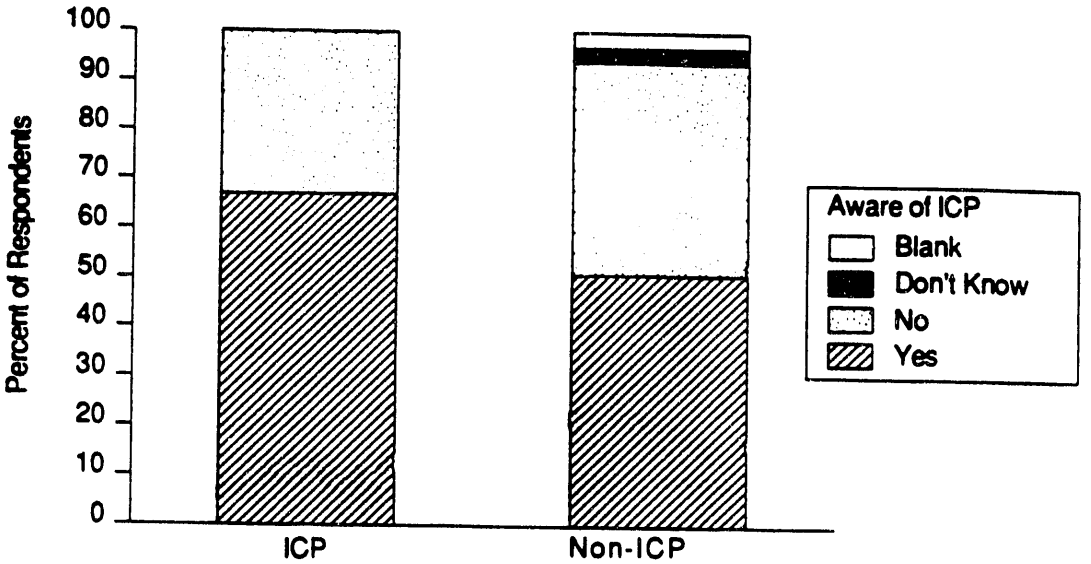


FIGURE 5.4 Awareness of ICP by School District Administrators in Terms of ICP Participation

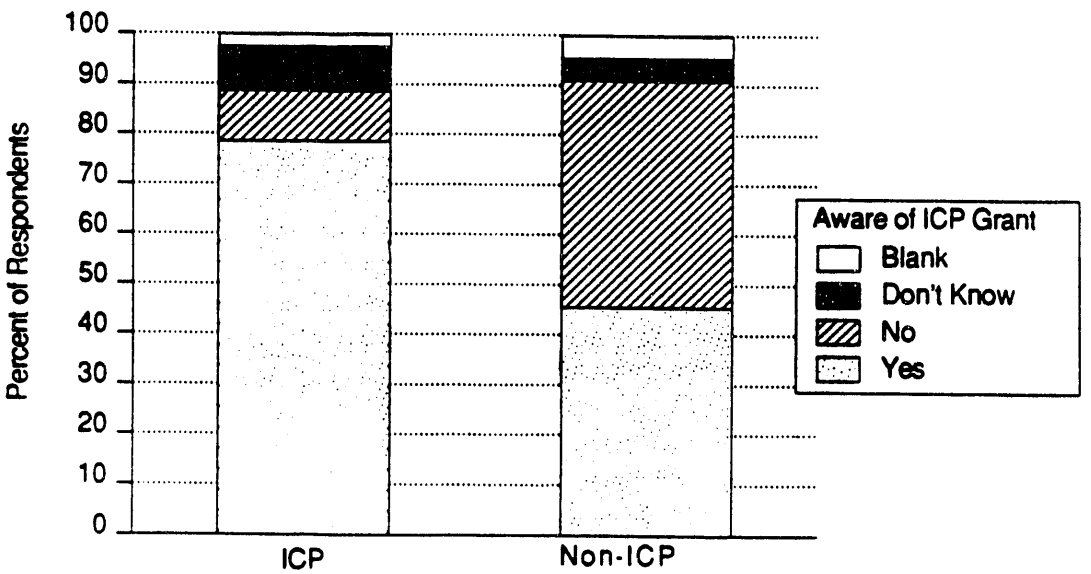


FIGURE 5.5 Respondents' Knowledge of Whether Districts Had Applied for ICP Grants in Terms of ICP Participation

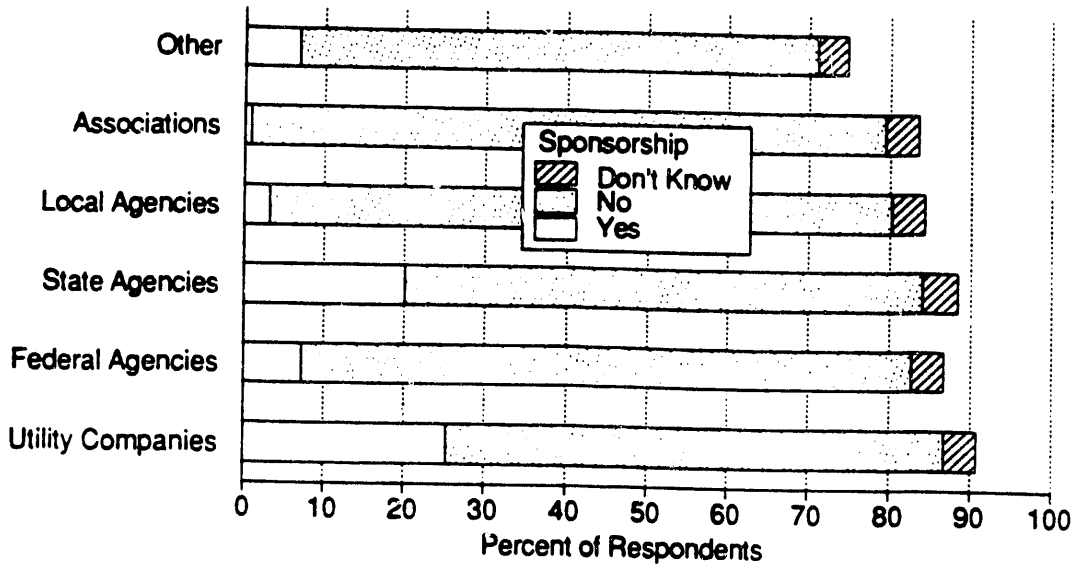


FIGURE 5.6 Sponsors of Energy Conservation Programs Cited by School Districts

did a majority of respondents indicate that they had participated in such a program. These were Tennessee, with 100% participation among respondents, and California, with 75% participation. The Tennessee results indicate the pervasiveness of a Tennessee Valley Authority (TVA) program. Other states with participation rates over 30% were New York and Oklahoma.

As occurred with utility-sponsored programs, in only a bare majority of states (23 of 43) did at least one respondent indicate that the district participated in a program sponsored by a state agency. For states with more than one response, only two indicated that a majority had participated in a non-ICP state program. These were Alabama, with 100% participation, and Minnesota, with 67% participation. Other states with participation rates greater than 25% were Michigan, Texas, Massachusetts, South Dakota, North Carolina, Washington, Iowa, and Virginia.

6 ENERGY CONSERVATION MEASURES

6.1 FREQUENCY OF COMPLETED INSTALLATIONS

The mail survey asked which ECMs had been installed in districts and/or schools during two time periods: 1973-79 and 1980-86. The first period covers the time between the oil embargo of 1973 and the advent of the ICP grant cycles; the second period covers the first eight ICP grant cycles. The same question also asked which ECMs are planned for the immediate future, 1987-90. In the mail survey, 36 ECMs, organized into six categories and defined on the last page of the survey instrument, were listed. When the telephone interviews were conducted, these 36 ECMs were collapsed into 11 new categories so that the telephone interviews would be of reasonable length.

The responses to this question are summarized in Fig. 6.1. In this figure, the bars indicating "never" represent the percentage of districts in which the ECM class has been neither installed nor planned for. The "completed" bars represent the percentage of responses in which the ECM class has been installed in one or both of the past periods but is not planned for in the immediate future. The "planned" bars represent the percentage of responses in which plans to install the ECM class in the immediate future are being made, regardless of whether it was installed in the past. They indicate the size of the immediate market for the ECM classes. When interpreting the results, it should be kept in mind that the ECM classes are of nonuniform breadth. The "mechanical HVAC" class encompasses 9 of the 36 ECMs, while the "fuel conversion," "domestic hot water," "heat recovery," and "cogeneration" classes each represent just 1 of the 36 ECMs. However, because the 36 ECMs are also of unequal breadth, the number of ECMs in an ECM class is not a precise measure of its breadth.

Six of 11 classes have been or will be installed in one or more public schools under the jurisdiction of a majority of the responding districts. The most "popular" ECM classes are building envelope (90%), electrical and lighting (85%), controls (83%), and window treatments (82%), with mechanical HVAC (71%) and domestic hot water (60%) following closely behind. Fuel conversion and air conditioning measures are being installed in only about 40% of the districts and heat recovery devices in about 22%. Renewable energy measures and cogeneration are not installed very often in public school buildings.

Figure 6.1 also gives information on the market for future installation of the ECM classes. It indicates that approximately 50-60% of the districts plan to implement measures in the following ECM classes: electrical and lighting, mechanical HVAC, controls, building envelope, and window treatments.

The survey question also yielded information about the frequency of multiple installations (i.e., those ECMs that have been installed by a respondent in more than one time period). These results are shown in Fig. 6.2. The bars indicating "never" have the same meaning as in the preceding figure; the "single" bars represent the percentage of respondents who have installed or will install the ECM class in only one of the three time periods; and the "multiple" bars represent the percentage of respondents who have installed or will install the ECM class in more than one of the time periods. The figure

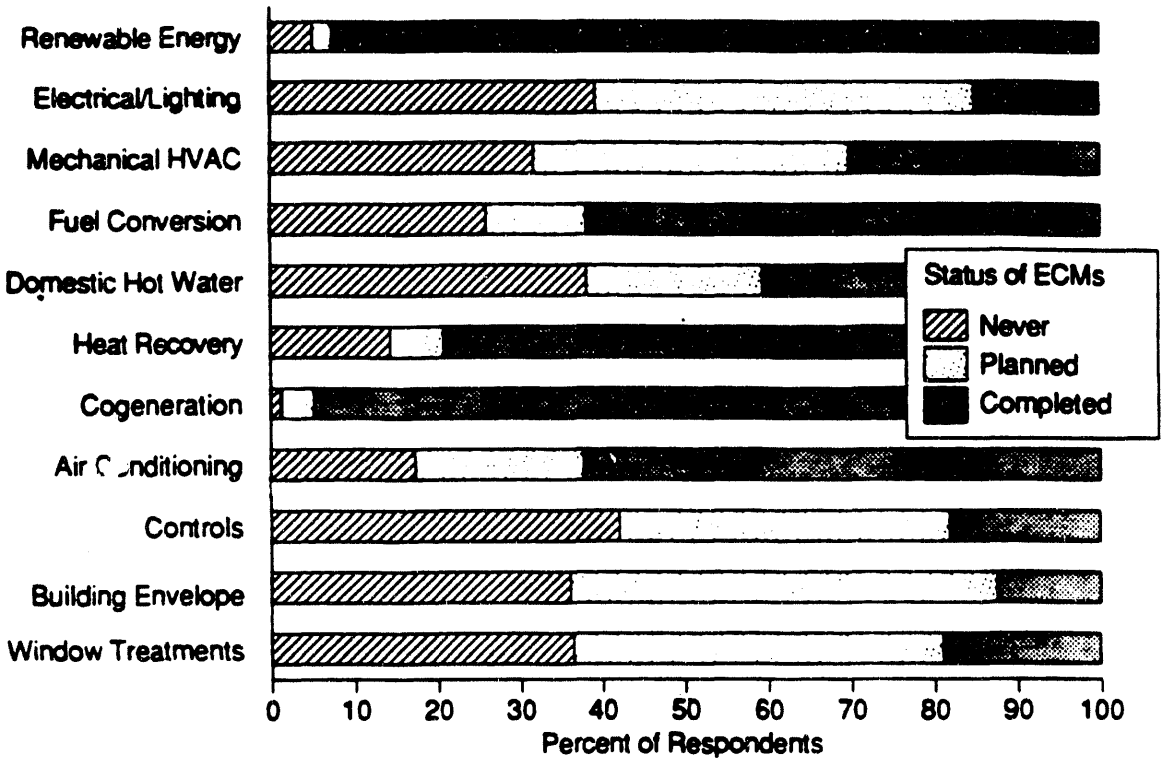


FIGURE 6.1 Completed and Planned ECMs Identified by School Districts

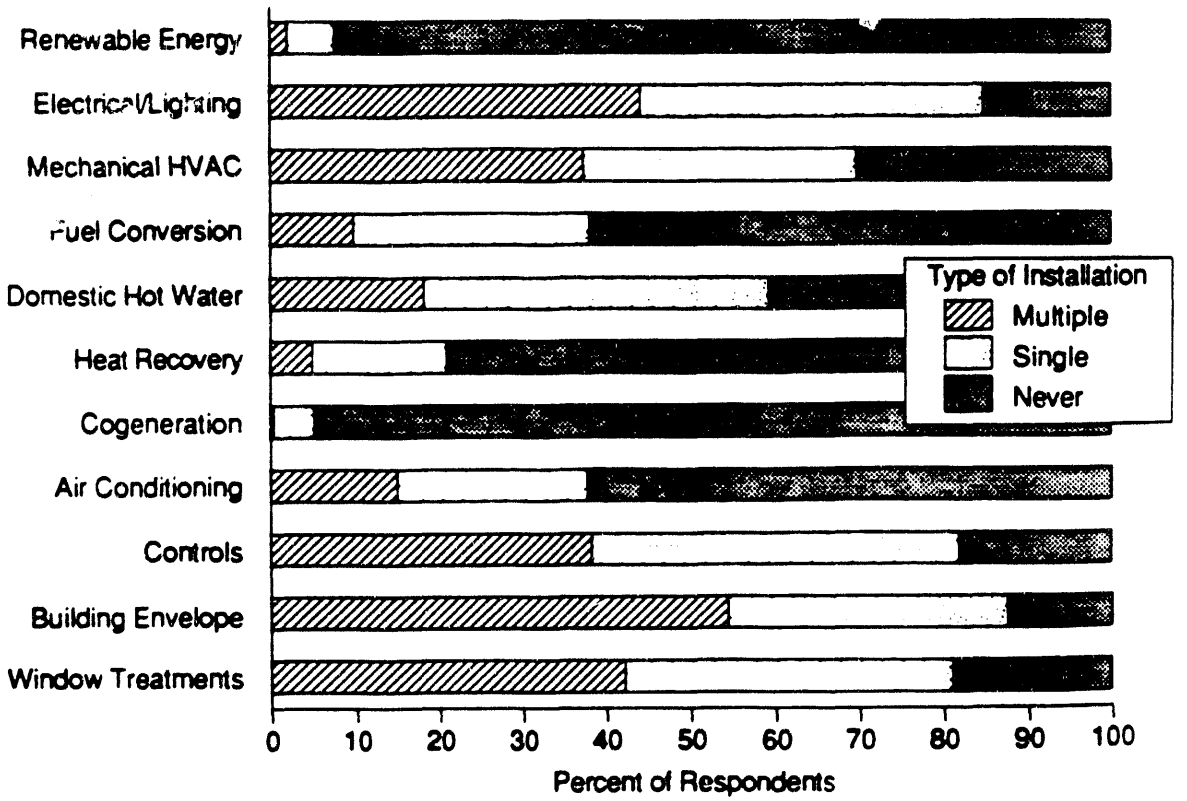


FIGURE 6.2 Frequency of ECM Installations Cited by School Districts

indicates that for the less popular ECM classes (renewable energy, fuel conversion, heat recovery, cogeneration), single installations predominate, while multiple installations are slightly more frequent for the more popular ECM classes (electrical and lighting, mechanical HVAC, controls, building envelope, window treatments).

Several factors affect the popularity of ECM classes: (1) the characteristics of school buildings and activities, (2) the characteristics of the ECMs, and (3) the breadth of the ECM classes. One factor is whether the function performed by the ECM is considered essential. A building envelope and light, from some combination of windows and electric lighting, are essential to the learning environment. In most schools, some kind of heating system is essential; because of summer vacation, a cooling system is not always essential. Heating or, more generally, HVAC systems, need controls. From the figures, it is seen that ECM classes associated with essential functions tend to be popular.

The popularity of ECMs is also affected by cost-effectiveness. Some ECMs may be poor investments for schools. Cogeneration is more cost-effective for energy-intensive, round-the-clock institutions such as hospitals than for schools, which are used part-time, on weekdays only, and seasonably. However, even if an ECM is not cost-effective from the perspective of energy conservation, its installation may be justified if it improves the learning environment (such as building envelope or window measures that reduce drafts).

Two factors that appear to affect the popularity of ECMs are the number of units needed and the frequency of replacement or repairs. Schools usually have many windows, electric fixtures, and lamps that, in the aggregate, need continuous replacement. The need for replacement provides frequent opportunities to select energy-conserving or energy-efficient products. Figure 6.2 shows that envelope, lighting, and window ECM classes are not only popular but are also likely to have multiple installations. They contrast with the ECMs for which a school needs only one or a few units and those that hardly ever need replacement (such as boilers). It should not be inferred that energy-conserving replacements are installed only when the existing equipment has reached the end of its useful life, but remaining useful life may be a factor, especially for high-cost measures.

The popularity of an ECM class as reflected in Fig. 6.2 is also affected by its breadth. The breadths of the 11 classes are nonuniform; for example, the mechanical HVAC class contains 9 of the 36 ECM types, while five classes contain only one ECM type. All the ECM classes that have been or will be installed in a majority of responding districts contain several of the ECM types, except for the domestic hot water ECM class. The only unpopular ECM class that contains several types of ECMs is renewable energy.

6.2 TIME OF INSTALLATION AND GEOGRAPHIC DISTRIBUTION OF ECMS

In this subsection, information on the ECMs is presented according to when they were installed (pre-ICP, ICP, or future) and where they were installed (district's ICP grant status, climatic region, and type of location: urban, suburban, or rural).

Figure 6.3 compares the installation of measures in the 11 ECM classes by ICP grantees and nonparticipants for the three time periods. Figure 6.3a shows that respondents reported relatively little activity occurring in 1973-79 (pre-ICP), but this information could be inaccurate due to faulty memory, because the pre-ICP period precedes this survey by 7 to 14 years and many of the individuals responding are fairly new to their jobs. No ECM class exceeded a penetration rate of 30%; only two exceeded 20% (building envelope and window measures). There was little difference in the installation of measures by districts that later became ICP grantees and those that did not. For five classes, districts that became ICP grantees installed more measures; for six classes, nonparticipants installed more measures.

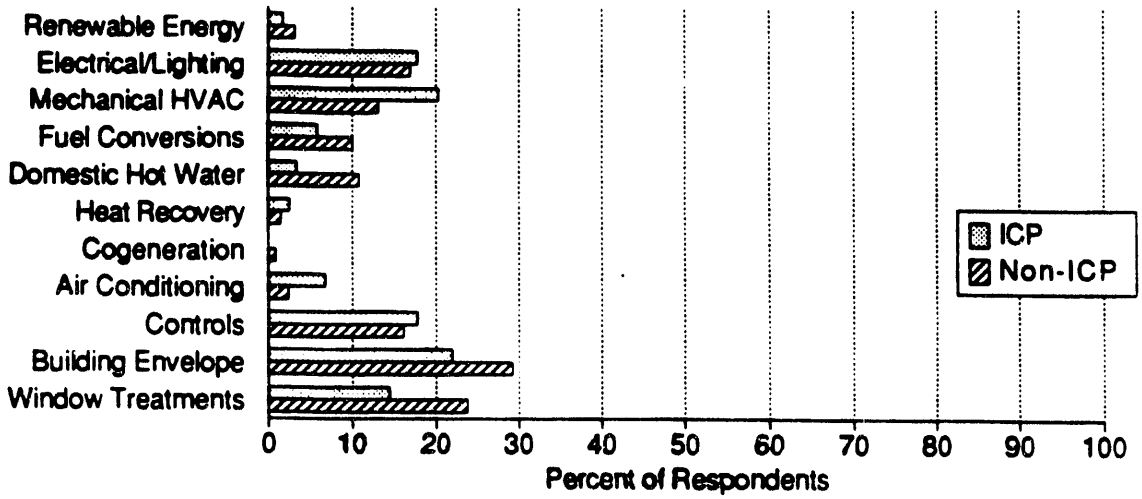
During the ICP grant cycles, 1980-86, the pace of energy conservation activities accelerated according to Fig. 6.3b. There was no noticeable shift in the relative popularity of ECM classes; rather, the penetration of ECM classes, except for cogeneration, increased by factors of 3 to 4. The relative penetration of ECMs among ICP grantees and nonparticipants was much different, as shown in Figs. 6.3a and 6.3b. Before to ICP, the penetration was about the same for the two groups; during ICP, penetration of all ECM classes was greater among ICP grantees, and penetration of most ECM classes was noticeably greater.

Figure 6.3c shows that about one-third fewer measures are expected to be installed in the immediate future, 1987-90, than were installed during 1980-86. Because the immediate future is defined as only four years rather than seven, however, this amount may not indicate a significant slowdown in energy conservation activities. ICP grantees expect to install notably more measures than nonparticipants in all ECM classes except the three least popular. Thus, the frequency of installing ECMs has been greater by ICP grantee districts than by nonparticipant districts during ICP (1980-86) and is expected to be greater in the future. This fact provides some evidence that, for the elementary and secondary public education subsector, ICP grants have resulted in additional installations of ECMs.

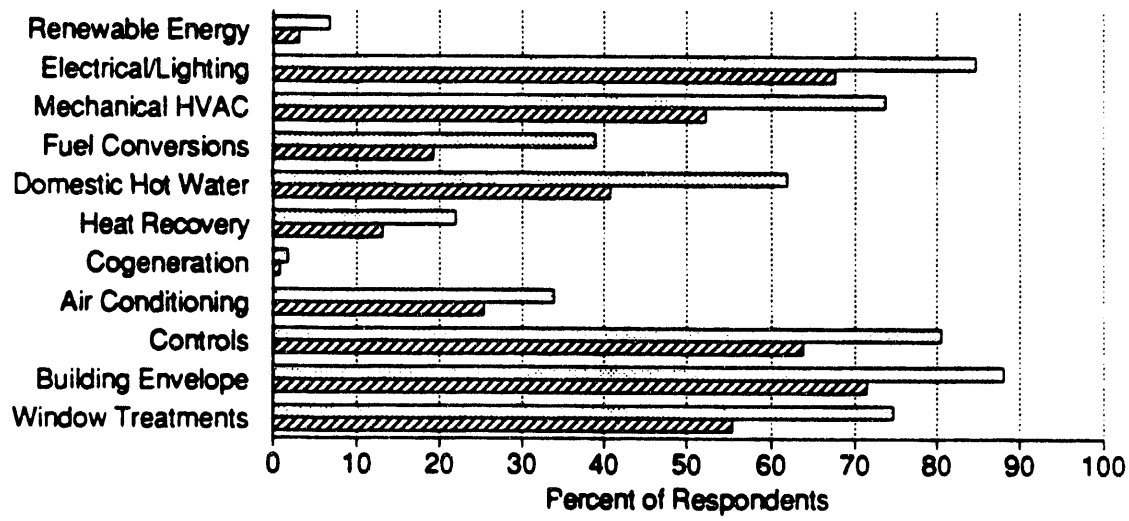
The cumulative penetration of ECMs over time permits us to estimate the boundaries of the near-term market potential for each ECM category. Fig. 6.4 compares ICP and non-ICP school districts. Non-ICP districts clearly expect to install considerably more envelope, control, and lighting measures than ICP districts, which have already taken these actions. Although the gap is slowly closing between the two groups, it will be some time before the school districts that have not received ICP funding achieve the same level of ECM installation as those with funding.

For each of the three time periods, penetration of ECM classes (except cogeneration and heat recovery, which are infrequently installed) in the three climatic regions has been compared (Fig. 6.5). In Fig. 6.6, the same data are displayed differently to show cumulative penetration by ECM class. We see that there are climatic differences in the penetration of some, but not all, ECM classes. The penetration pattern differs most for the Southwest. The penetration of fuel conversions in the Southwest is appreciably lower than in the other two regions, but the penetration for renewable energy measures is greatest. This latter class includes solar measures as well as refuse incineration and use of wood. It is suspected that most installations are solar measures because the Southwest has the greatest insolation. The penetration of

(a) 1973-79



(b) 1980-86



(c) 1987-90

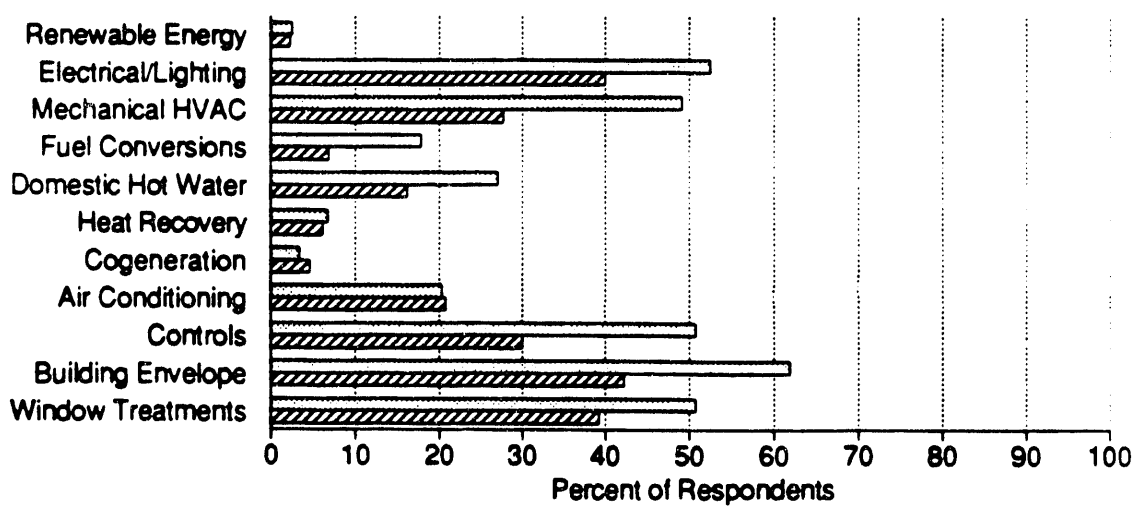


FIGURE 6.3 ECMs Installed or Planned by ICP and Non-ICP School Districts

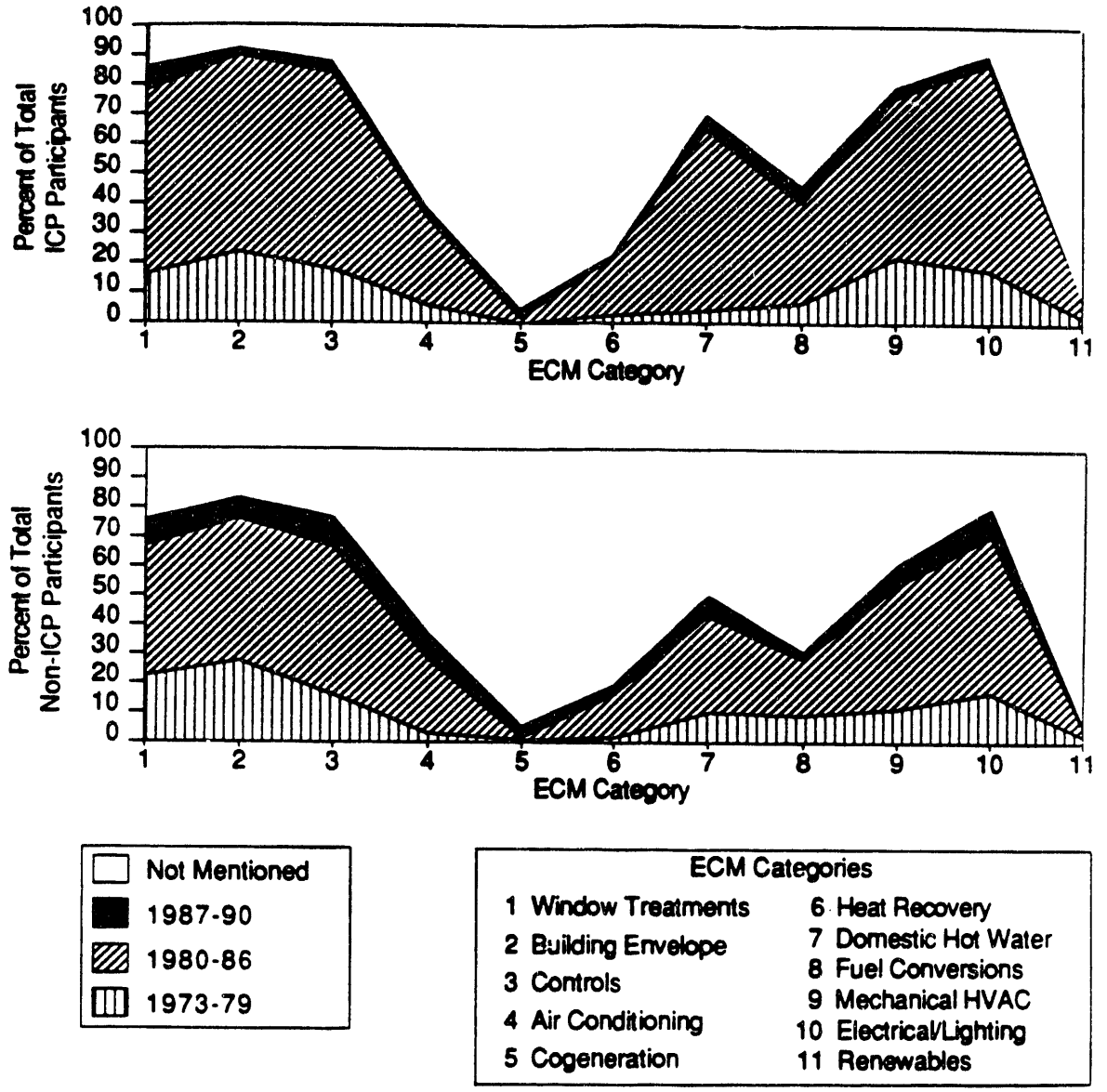


FIGURE 6.4 Cumulative Penetration of ECMs in School Districts with and without ICP Grants

cogeneration is low in all climatic regions, but less so in the Southwest, which may result from relatively high buyback rates offered by electric utilities in California pursuant to Section 210 of the Public Utility Regulatory Policies Act.

The penetration of air conditioning measures is greatest in the Southeast, as would be expected from its warm, humid climate. Conversely, one would expect mechanical HVAC and building envelope measures, which contain heating measures and insulation, to have higher penetrations in the North. Although penetration has been greater, it is not much different than in other regions. One anomaly is the relatively high penetration of electric/lighting measures in the Southwest prior to ICP; this may be the result of utility incentive programs in California. The most conservation activities in the immediate future are planned in the Southwest; the least in the North.

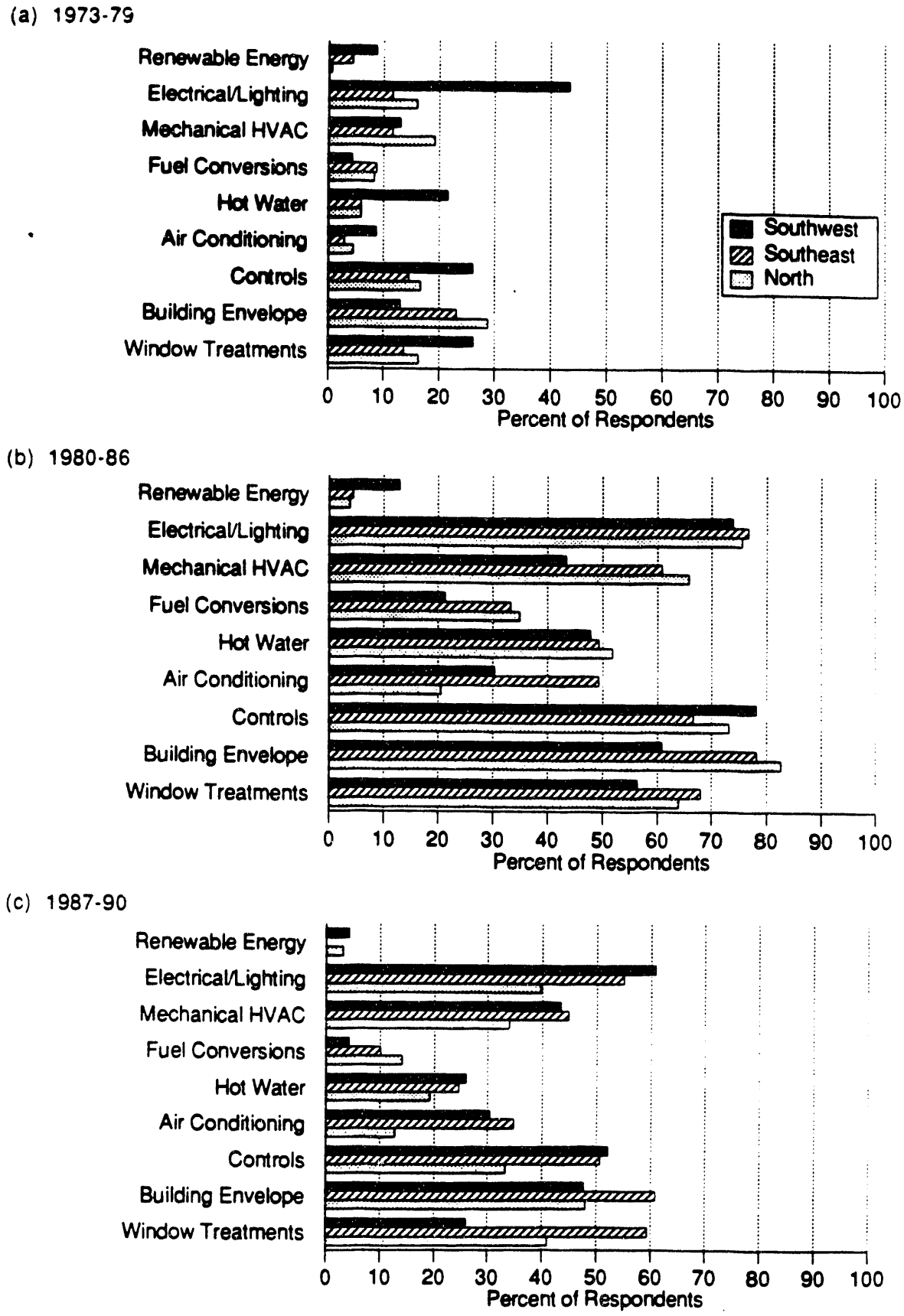
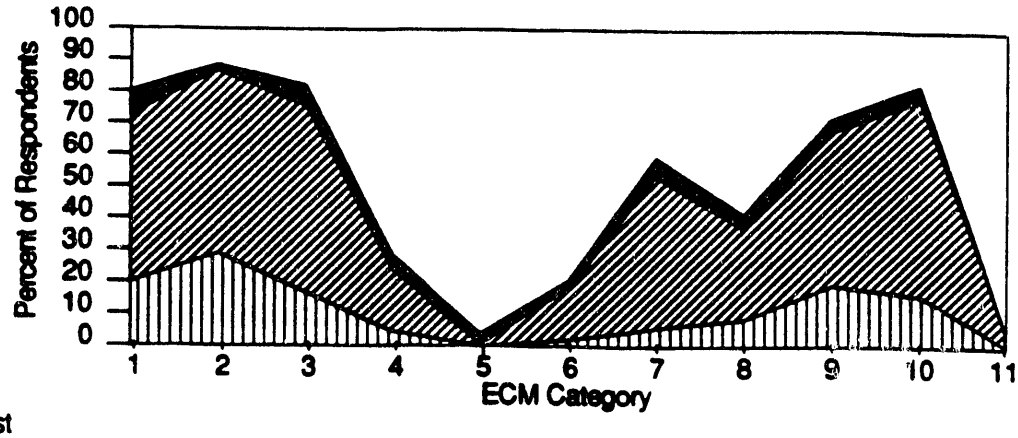
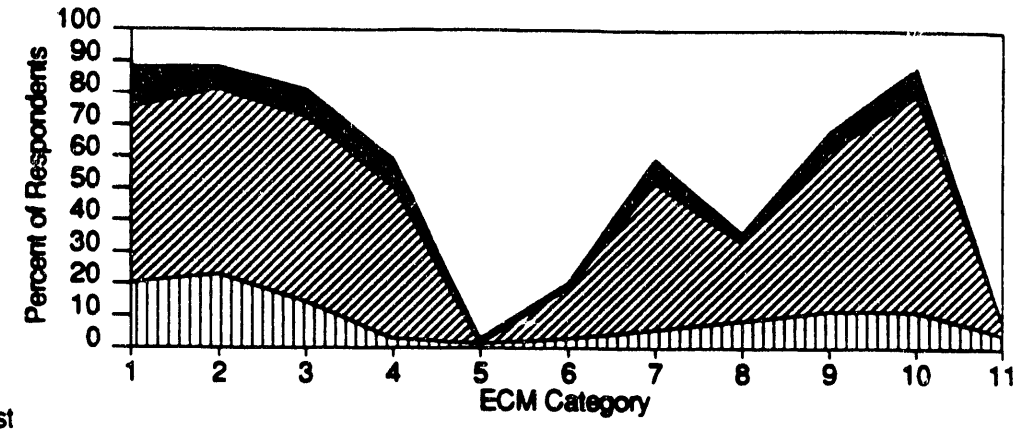


FIGURE 6.5 ECMs Installed or Planned by School Districts by Climate

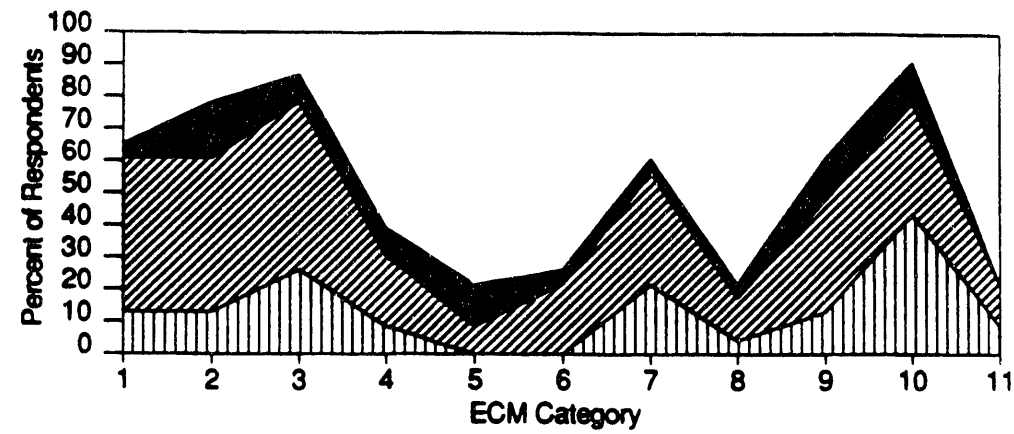
(a) North

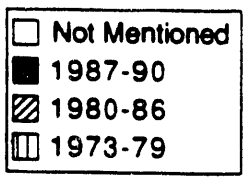


(b) Southeast



(c) Southwest





ECM Categories

1 Window Treatments	6 Heat Recovery
2 Building Envelope	7 Domestic Hot Water
3 Controls	8 Fuel Conversions
4 Air Conditioning	9 Mechanical HVAC
5 Cogeneration	10 Electrical/Lighting
	11 Renewables

FIGURE 6.6 Cumulative Penetration of ECMs Installed in the North, Southeast, and the Southwest

One of the stratification variables in drawing the sample of districts was degree of urbanization. There were three cells: rural for districts outside of MSAs, and suburban and urban for districts within MSAs. Figure 6.7 shows the relationship of this variable to ECM classes, except cogeneration, heat recovery, and renewables, for the three time periods.

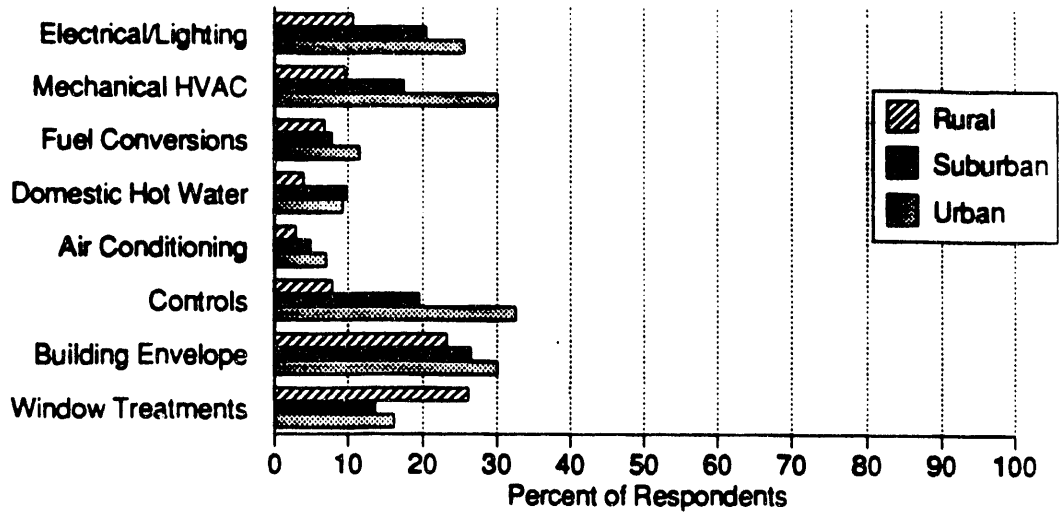
During the period from 1973-79, the penetration of ECMs was generally very low, with measures in no group installed by over one-third of the respondents. This low level of activity applied to urban, suburban, and rural schools districts, but not uniformly. Overall, rural districts reported the lowest penetration of ECMs except for window measures, as can be seen in Fig. 6.7a. For most other measures, urban school districts reported the highest levels, with suburban districts between rural and urban penetration rates. These results indicate that more urban than rural school districts have installed ECMs; however, there are more schools (and, therefore, square footage) per district in urban areas. Therefore, the results do not imply that rural schools are less likely to have installed ECMs than urban schools.

The penetration of all ECMs increased markedly from the 1973-79 period to the 1980-86 period, for urban, suburban, and rural districts. For most types of measures, the highest penetrations were reported by urban districts, followed by suburban districts, and then rural districts, as can be seen in Fig. 6.7b. Urban districts were especially strong leaders in space conditioning activities, including air conditioning and HVAC measures. The highest penetration of any measures in any period was reported by the urban districts, with over 90% installing electrical or lighting measures in 1980-86. The lowest penetration was reported for heat recovery measures. More rural than urban or suburban districts installed heat recovery devices, but even their penetration was under 20%.

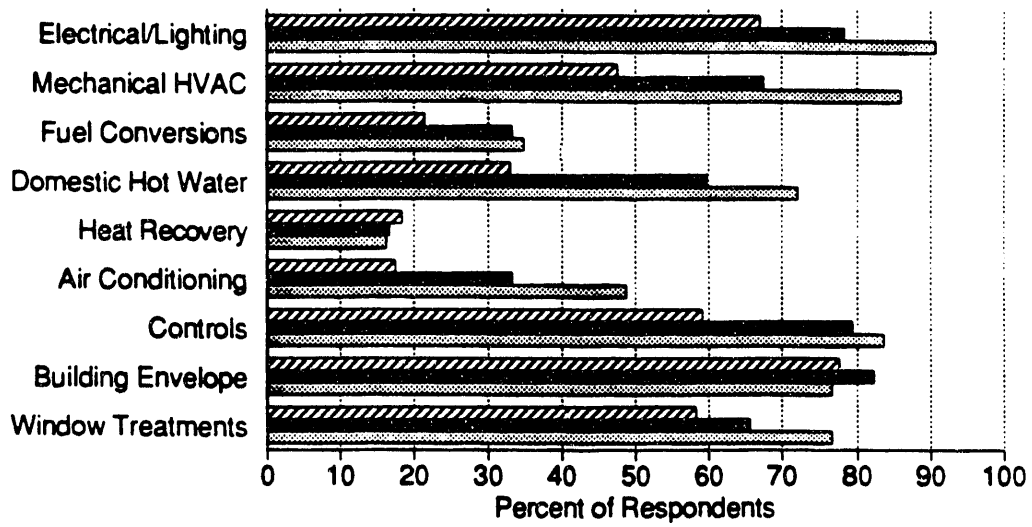
The level of conservation activities planned for 1987-90 is generally lower than the level of activities completed in 1980-86, but higher than 1973-79 levels, as can be seen in Fig. 6.7c. An exception is envelope measures in urban schools, which remain at close to 80% in the future. For all measures, more urban than suburban or rural districts plan to implement ECMs. Over 70% of the responding urban districts plan to install electrical/lighting measures and/or envelope measures, compared with less than 40% of rural districts. Over 60% of urban districts plan controls and/or HVAC measures, compared with less than 30% of rural districts.

The survey revealed some differences in the patterns of installation of certain ECM groups between ICP and non-ICP school districts. These differences can be seen in Figs. 6.8 through 6.13. Each graph shows one ECM class. There is a bar for each time period, and each bar represents all the districts that reported installation of the subject ECM in that period. The fill patterns represent the proportion of those taking the action according to their participation in ICP. Most striking is the large percent (almost 70%) of renewable energy and fuel conversion measures installed in 1980-86 but not before by ICP districts. (See Figs. 6.8 and 6.9.) This preponderance continues into the future for fuel conversions but not for renewables. The rapid increase in these measures appears to have been encouraged by the DOE program. Heat recovery devices were installed by ICP districts more than non-ICP districts in the past, and air conditioning in the 1973-79 period only. Future installation of these ECMs does not appear to be related to ICP participation, as can be seen in Figs. 6.10 and 6.11. School districts that were to get ICP

(a) 1973-79



(b) 1980-86



(c) 1987-90

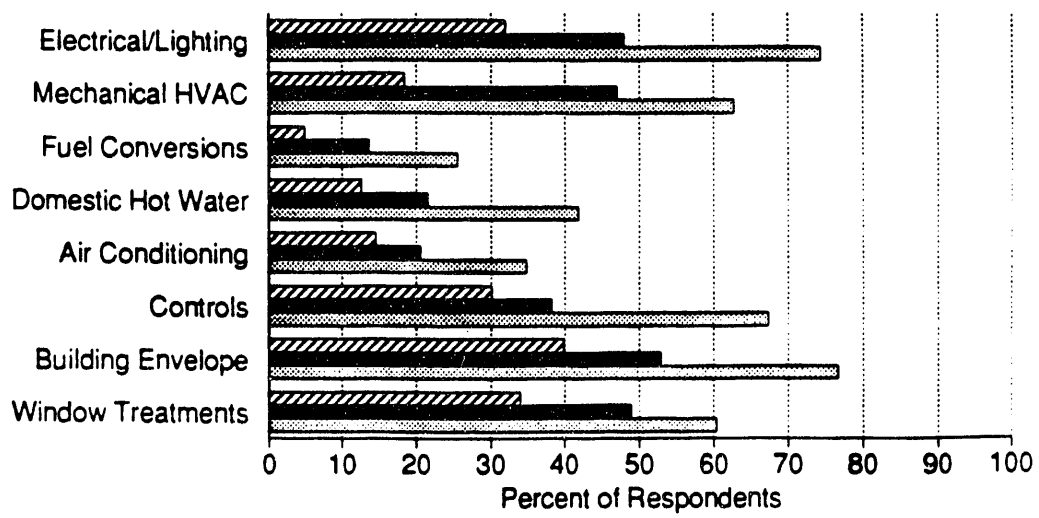


FIGURE 6.7 ECMs Installed or Planned by Urban, Suburban, and Rural School Districts

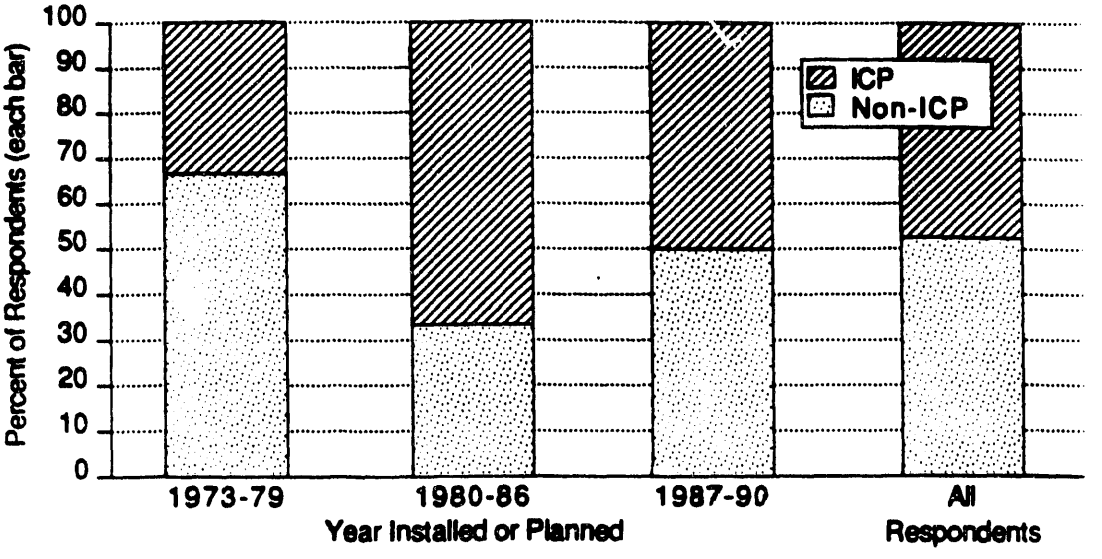


FIGURE 6.8 Participation in ICP by School Districts Installing Renewable Energy ECMs

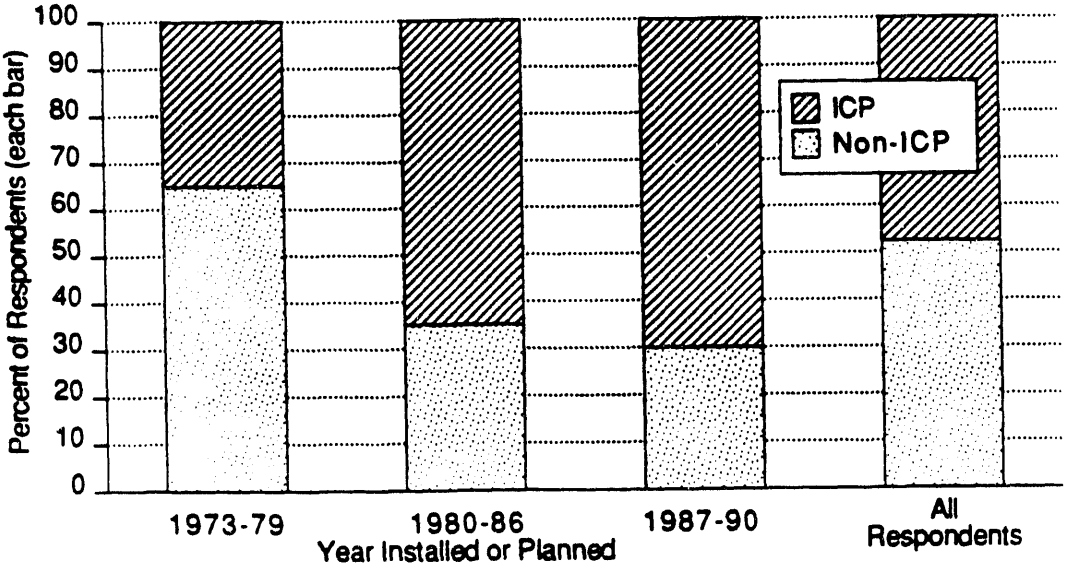


FIGURE 6.9 Participation in ICP by School Districts Installing Fuel Conversion ECMs

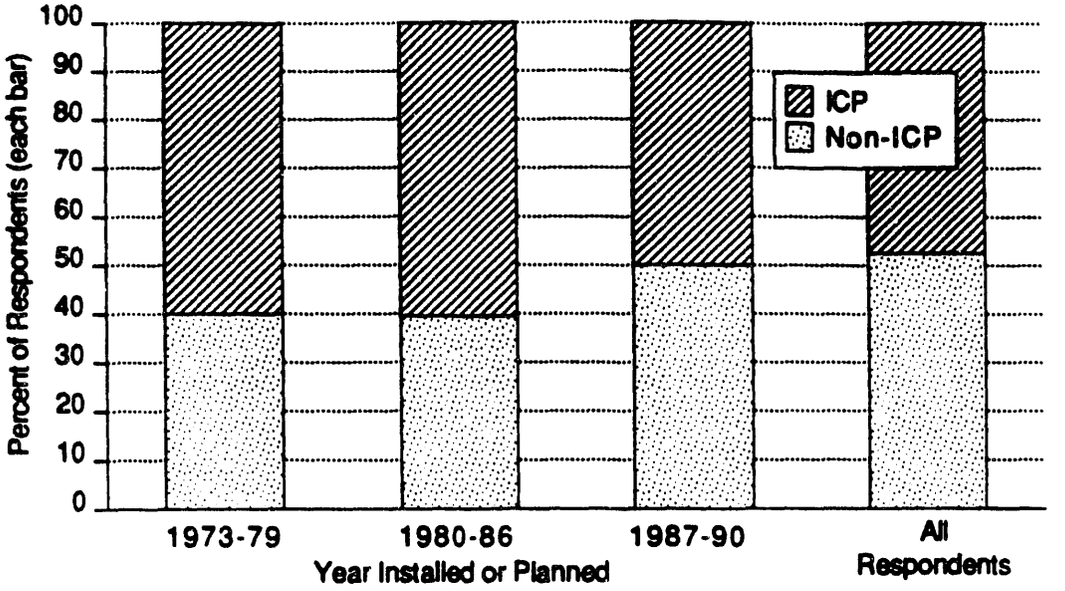


FIGURE 6.10 Participation in ICP by School Districts Installing Heat Recovery Devices

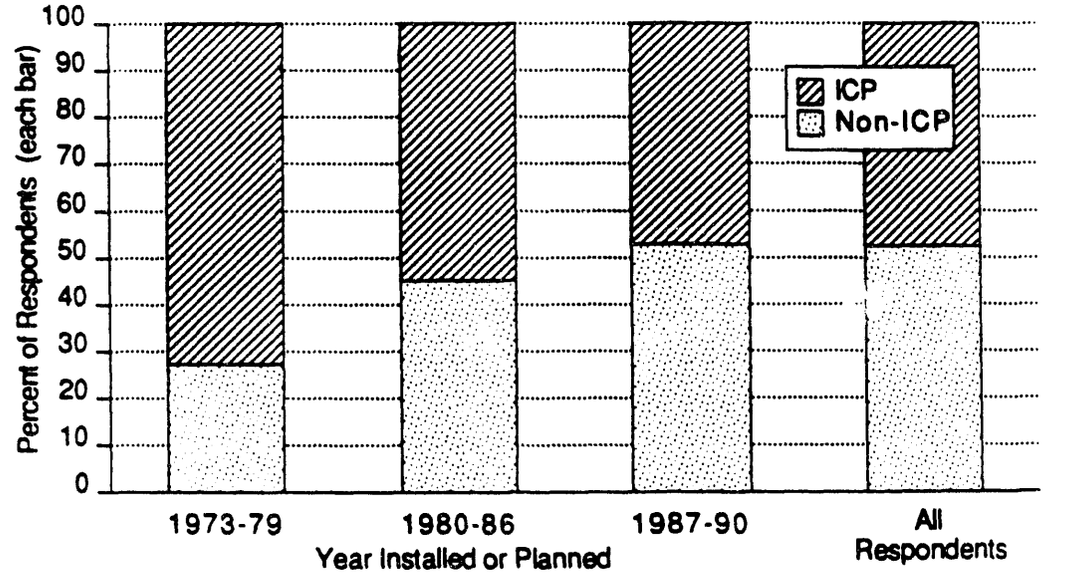


FIGURE 6.11 Participation in ICP by School Districts Installing Air Conditioning ECMs

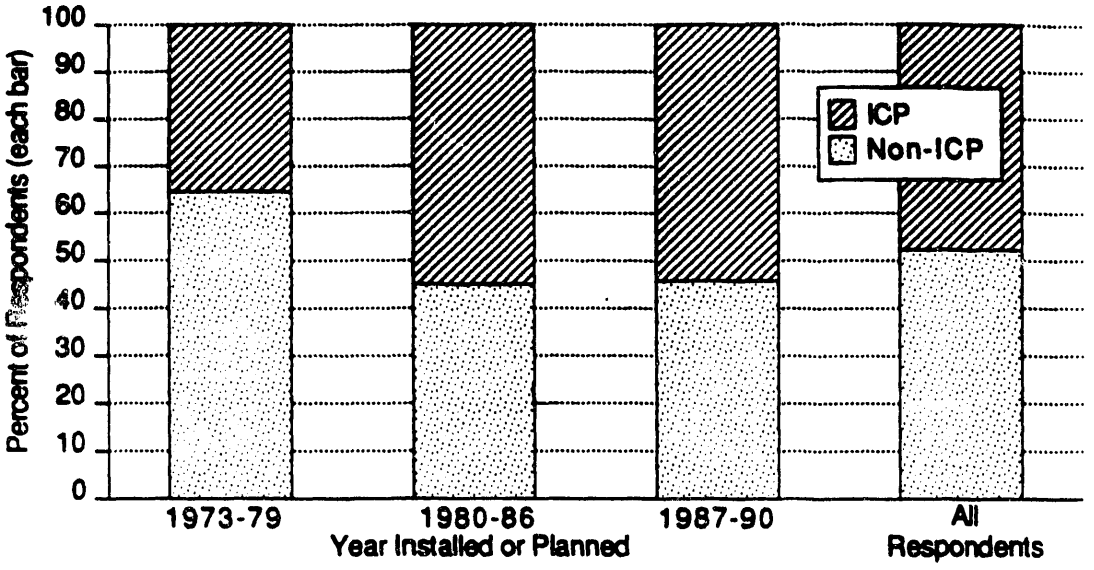


FIGURE 6.12 Participation in ICP by School Districts Installing Window Treatments

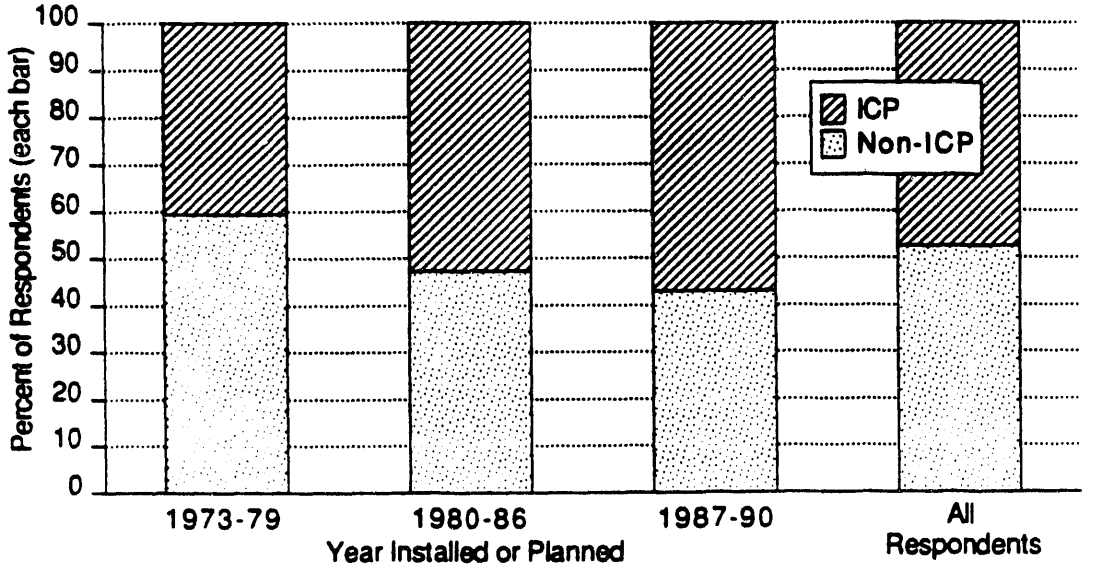


FIGURE 6.13 Participation in ICP by School Districts Installing Envelope ECMs

grants were much less likely to have installed window treatments and building envelope ECMs before 1980 than those that were not to get grants. ICP districts are somewhat more likely to have installed these measures since 1980 or to be planning them. Participation of ICP and non-ICP districts in these measures is shown in Figs. 6.12 and 6.13.

We also divided districts into 18 cells according to the three preceding variables (climate, urbanization, ICP status) and looked for differences in penetrations for the 11 ECM classes for the three time periods. There was considerable variation in the sizes of the cells. Four cells, rural and suburban districts in the North, contained more than half of the responding districts; one cell (rural, Southwest, ICP) was empty. Some of the differences among cells for ECM classes and time periods will now be described.

Pre-ICP installation of building envelope measures by non-participant suburban districts in the North and Southeast was twice that of ICP districts. During ICP, however, installations in ICP districts exceeded those in nonparticipant districts, and twice as many are planned in the immediate future. Districts in the Southeast generally installed more air conditioning measures than districts in other regions during ICP. There was one exception, however — only 3 of 19 rural nonparticipants installed air conditioning. (Overall, rural non-ICP districts installed the fewest ECMs.) Generally, rural nonparticipant districts installed no more air conditioning measures during ICP than they plan to install in the immediate future.

6.3 SUCCESSFUL MEASURES

Respondents were asked to identify the two ECMs that saved the most energy (as measured in Btu) for their school districts. Answers to this question were divided into 13 categories: (1) building envelope, (2) controls, (3) cogeneration, (4) heat pumps, (5) heat recovery devices, (6) fuel conversions, (7) lighting, (8) cooling, (9) heating, (10) ventilation, (11) HVAC system, (12) domestic hot water, and (13) other. This question was answered by 88% of the respondents. Their responses are shown in Fig. 6.14. As can be inferred from the figure, only 6 of the 13 categories generated appreciable responses. Building envelope measures were identified most frequently, by 66% of the districts; control measures were identified next, by 41%. Other categories mentioned were lighting (21%), fuel conversions (8%), and HVAC (7%).

Comparing the perceived success of an ECM in saving energy with its popularity is difficult because of differences in the definitions of the 13 categories associated with "successful" ECMs and the 11 categories used in the "popularity" question (see Secs. 6.1 and 6.2). Building envelope measures are both the most popular and viewed as being the most successful in saving energy; controls are also considered both successful and popular. The greatest discrepancy between popularity and perceived success in saving energy is for lighting ECMs. Success may differ from popularity because of cost. A high-cost item will save more energy than a low-cost item that has the same cost-effectiveness. Lighting ECMs may not often be cited as successful despite their popularity because of their relatively low cost.

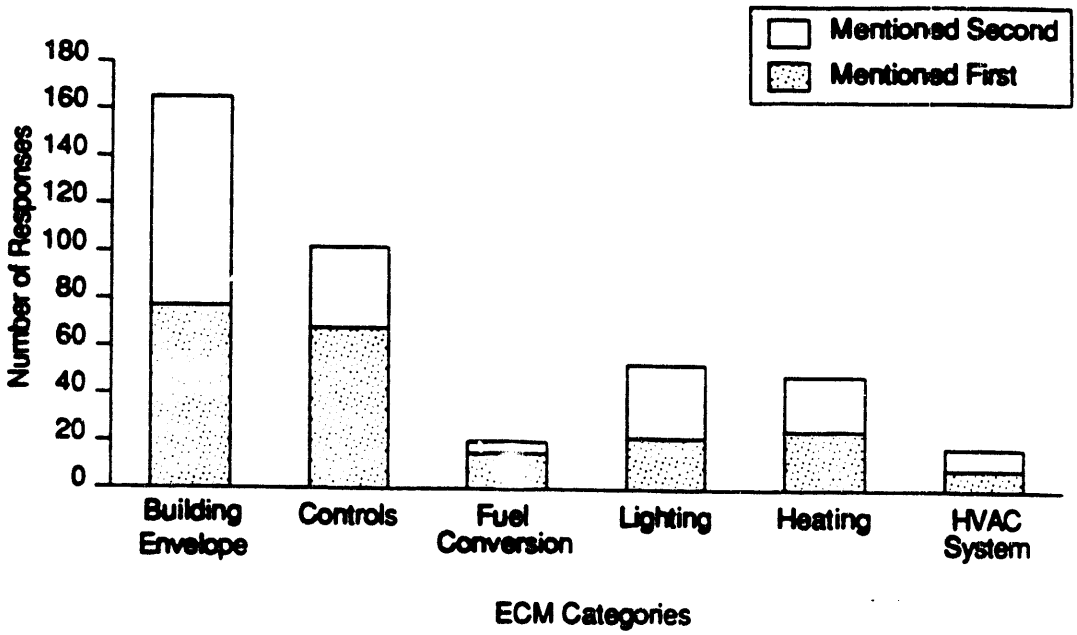


FIGURE 6.14 "Most Successful" ECMs: First and Second Mentions

6.4 TECHNICAL AND OCCUPANT PROBLEMS

Respondents were asked to describe technical problems that they encountered when ECMs were placed in the districts' schools. The technical problems mentioned were coded into five categories: staff training, staff availability, consultant capabilities, energy conservation measures, and not specified. The results are summarized in Fig. 6.15. Slightly more than a quarter of the respondents (28%) identified technical problems. The most common response (15%) was the category "not explained." Problems with the capabilities of consultants were cited the second most often (9%). Fewer than 2% of the survey respondents identified technical problems associated with staff or specific ECMs.

A majority of the respondents to this survey were superintendents, other district administrators, and business managers. They are individuals without direct responsibility for the physical plants of schools and probably do not have technical or engineering training. Thus, although they have probably been informed that there are technical problems (e.g., from the director of buildings and grounds), they may not remember the nature of the problems in an unanticipated telephone interview. In contrast, they would be expected to be aware of the nature of financing, management, and significant occupant problems.

Respondents were asked to describe problems related to building occupants, mainly teachers and students, that were encountered when ECMs were placed in the district schools. The responses were coded into three categories: behavior, comfort, and constraints. Behavior problems refer to ways occupants can defeat energy conservation efforts (e.g., leaving windows open or displaying attitudes of indifference or resistance).

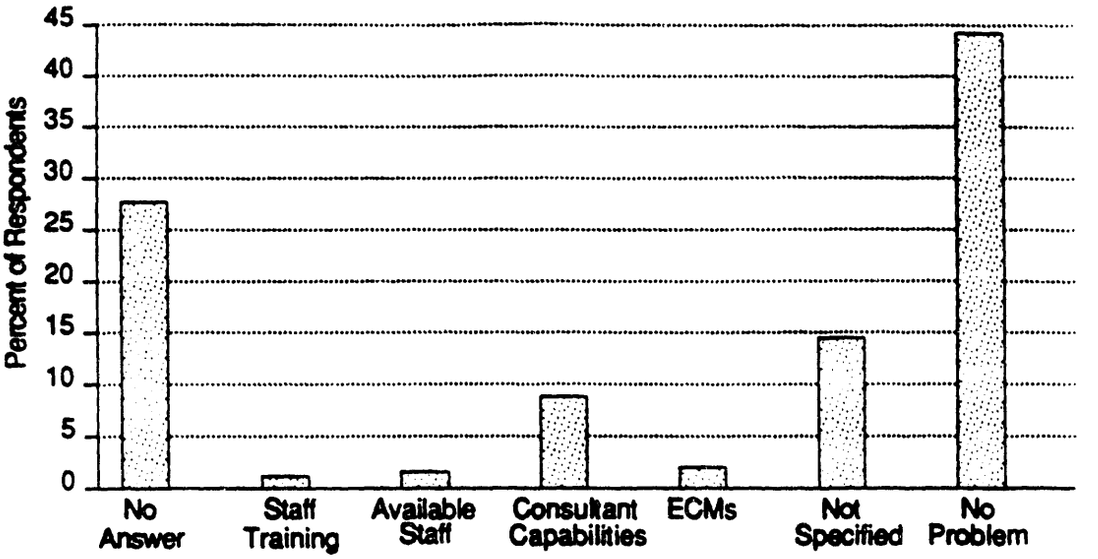


FIGURE 6.15 Technical Problems with ECMs Cited by School Districts

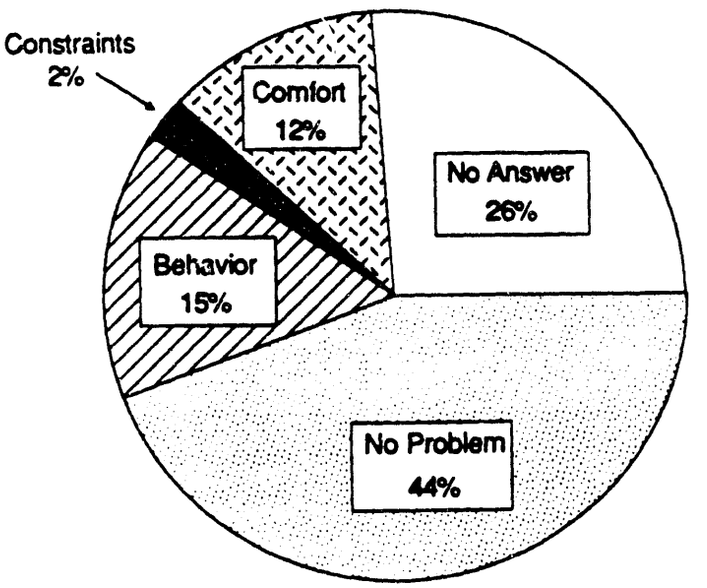


FIGURE 6.16 Occupant-Related Problems with ECMs Cited by School Districts

Comfort problems refer to unpleasant conditions, such as low temperatures, that could result from overzealous conservation efforts. Constraints are problems or special conditions resulting from the educational functions of schools. Figure 6.16 shows the response to the occupant problems question. As with the technical problems question, approximately 29% of the respondents identified problems. Occupant problems were usually associated with behavior (15%) or comfort (12%).

7 RESULTS

Selected findings from the analysis of the survey data are summarized in this chapter, with the focus on ECMs that have been or will be installed by school districts in the near future. Before this discussion, however, we have reviewed the penetration rates of ICP within public school districts, public schools, and private schools. This review updates the earlier letter reports provided to DOE. It is based on the extensive analysis of GTS data that had to be done as part of the survey data analysis.

7.1 PENETRATION OF ICP WITHIN THE K-12 EDUCATIONAL SUBSECTOR

Information on numbers and percentages of districts, public schools, and private schools that have received ICP grants is given in Table 7.1. Overall, 32.5% of the districts and 7.4% of the private schools have received ICP grants. Either through direct application or through the district, 19% of public schools have had technical audits performed and/or ECMs installed as a result of ICP grants. The percentage of schools and districts that have received grants varies greatly among states and among DOE regions.

At the low end of ICP penetration into districts are Arizona (8.1%) and California (12.1%), the two most populous states in DOE Region 9, and Texas (13.1%), which dominates Region 6. It follows, therefore, that Region 9 (12.0%) and Region 6 (19.2%) are substantially below the national average in ICP penetration. At the high end, with penetration rates greater than 50%, are some states that are too small to dominate a region. These are Delaware (94.7%), Utah (65.1%), Rhode Island (57.5%), Wisconsin (56%), West Virginia (54.6%), Minnesota (53.6%), and North Carolina (52.4%). DOE Region 3 (47.4%) has the highest participation rate, followed by Region 2 (42.1%) and Region 4 (40.3%).

ICP penetration rankings for public schools do not deviate greatly from the penetration rankings for districts, but the magnitudes of the penetration rates are smaller. Again, Arizona (4.0%) and California (5.6%) have low penetration rates and DOE Region 9 (5.5%) and Region 6 (12.1%) have the lowest penetrations among DOE regions. Differences between penetration rates for districts and public schools are generally greatest when the average number of schools per district is large. Conversely, these differences are usually smallest when the average number of schools per district is small. For example, Hawaii, with an average penetration rate for districts (28.6%) but a very large average number of public schools per district (55), has the lowest penetration rate for public schools (1.3%). Similarly, Louisiana, with an average penetration for districts (30.6%) but a smaller average number of public schools per district (nearly 22), also has a low penetration per public school (6.8%). Conversely, New Hampshire, with 2.1 schools per district, has nearly identical penetration rates for schools (46.5%) as for districts (48.6%). Vermont, with 1.3 schools per district, has a penetration of 33.5% for public schools and 31.7% for districts.

Penetration of ICP among private schools is not completely dissimilar to penetration among public schools. The variation in penetration by state is smoothed

TABLE 7.1 ICP Penetration Rates among Public School Districts, Public Schools, and Private Schools

State	Code	DOE Region	School Districts			Public Schools			Private Schools		
			Total No.	GTS[a] No.	GTS % of Total	Total No.	GTS No.	GTS % of Total	Total No.	GTS No.	GTS % of Total
Ala.	1	4	130	56	43.08	1,385	377	27.22	297	5	1.68
Alaska	2	10	53	22	41.51	461	46	9.98	72	0	0.00
Ariz.	4	9	210	17	8.10	918	37	4.03	246	0	0.00
Ark.	5	6	344	86	25.00	1,124	164	14.59	131	3	2.29
Calif.	6	9	1,034	125	12.09	7,318	409	5.59	2,752	6	0.22
Colo.	8	8	184	86	46.74	1,246	348	27.93	265	17	6.42
Conn.	9	1	165	60	36.36	985	136	13.81	348	33	9.48
Del.	10	3	19	18	94.74	170	82	48.24	93	25	26.88
D.C.	11	3	8	1	12.50	189	28	14.81	95	38	40.00
Fla.	12	4	93	39	41.94	2,144	633	29.52	1,036	12	1.16
Ga.	13	4	206	58	28.16	1,835	539	29.37	414	17	4.11
Hawaii	15	9	7	2	28.57	233	3	1.29	129	2	1.55
Idaho	16	8	116	48	41.38	547	120	21.94	64	2	3.13
Ill.	17	5	1,026	256	24.95	3,882	736	18.96	1,351	51	3.77
Ind.	18	5	307	109	35.50	1,898	357	18.81	534	41	7.68
Iowa	19	7	436	183	41.97	1,516	455	30.01	291	26	8.93
Kans.	20	7	312	89	28.53	1,467	202	13.77	213	47	22.07
Ky.	21	4	196	84	42.86	1,398	392	28.04	299	35	11.71
La.	22	6	72	22	30.56	1,549	105	6.78	477	3	0.63
Maine	23	1	267	77	28.84	742	108	14.56	149	25	16.78
Md.	24	3	44	16	36.36	1,231	175	14.22	473	88	18.60
Mass.	25	1	408	155	37.99	1,800	400	22.22	618	44	7.12
Mich.	26	5	536	247	46.08	3,326	764	22.97	991	112	11.30
Minn.	27	5	465	249	53.55	1,456	673	46.22	551	89	16.15
Miss.	28	4	159	63	39.62	947	155	16.37	184	7	3.80
Mo.	29	7	548	162	29.56	2,008	366	18.23	552	25	4.53
Mont.	30	8	395	81	20.51	718	125	17.41	100	7	7.00
Neb.	31	7	321	57	17.76	1,413	126	8.92	251	21	8.37
Nev.	32	9	17	8	47.06	289	36	12.46	46	2	4.35
N.H.	33	1	212	103	48.58	439	204	46.47	137	18	13.14
N.J.	34	2	587	216	36.80	2,297	608	26.47	797	72	9.03
N.M.	35	6	92	41	44.57	626	154	24.60	154	2	1.30
N.Y.	36	2	771	356	46.17	3,984	1,028	25.80	1,889	289	15.30
N.C.	37	4	143	75	52.45	1,986	383	19.28	319	6	1.88

TABLE 7.1 (Cont'd)

State	Code	DOE Region	School Districts			Public Schools			Private Schools		
			Total No.	GTS[a] No.	GTS % of Total	Total No.	GTS No.	GTS % of Total	Total No.	GTS No.	GTS % of Total
N.D.	38	8	290	53	18.28	505	76	15.05	65	15	23.08
Ohio	39	5	674	232	34.42	3,846	705	18.33	880	131	14.89
Okla.	40	6	637	137	21.51	1,782	348	19.53	111	9	8.11
Ore.	41	10	303	104	34.32	1,228	236	19.22	276	18	6.52
Penn.	42	3	514	238	46.30	3,304	633	19.16	1,598	89	5.57
R.I.	44	1	40	23	57.50	293	65	22.18	110	16	14.55
S.C.	45	4	113	38	33.63	1145	95	8.30	259	6	2.32
S.D.	46	8	186	53	28.49	605	103	17.02	118	14	11.86
Tenn.	47	4	145	65	44.83	1,637	386	23.58	340	24	7.06
Texas	48	6	1,076	141	13.10	5,427	500	9.21	890	2	0.22
Utah	49	8	43	28	65.12	682	262	38.42	41	1	2.44
Vt.	50	1	290	92	31.72	379	127	33.51	69	20	28.99
Va.	51	3	153	73	47.71	1,786	317	17.75	391	26	6.65
Wash.	53	10	298	96	32.21	1,635	258	15.78	441	25	5.67
W.Va.	54	3	55	30	54.55	1,114	148	13.29	127	8	6.30
Wis.	55	5	445	249	55.96	1,966	594	30.21	949	79	8.32
Wyo.	56	8	49	24	48.98	380	88	23.16	44	4	9.09
		1	1,382	510	36.90	4,638	1,040	22.42	1,431	156	10.90
		2	1,358	572	42.12	6,281	1,636	26.05	2,686	361	13.44
		3	793	376	47.41	7,794	1,383	17.74	2,777	274	9.87
		4	1,185	478	40.34	12,477	2,960	23.72	3,248	112	3.56
		5	3,453	1,342	38.86	16,374	3,829	23.38	5,256	503	9.57
		6	2,221	427	19.23	10,508	1,271	12.10	1,763	19	1.50
		7	1,617	491	30.36	6,404	1,149	17.94	1,307	119	9.10
		8	1,263	373	29.53	4,683	1,122	23.96	697	60	8.61
		9	1,268	152	11.99	8,758	485	5.54	3,073	10	0.33
		10	654	222	33.95	3,324	540	16.25	789	43	5.45
Total			15,194	4,943	32.53	81,241	15,415	18.97	23,027	1,657	7.37

[a]GTS = DOE's Grants Tracking System data base that was used as basis for information on ICP grantees.

somewhat when aggregated over DOE region. In two states, Alaska and Arizona, no private schools have received grants and the penetration is under 1% in California, Texas, and Louisiana. Hence, DOE Regions 9 and 6 have the lowest penetration rates, 0.3% and 1.5%, respectively. States with high penetrations are the District of Columbia (40%), Vermont (29%), Delaware (26.9%), North Dakota (23.1%), Kansas (22.1%), Massachusetts (18.6%), and New York (15.3%). DOE Regions 2 (13.4%) and 1 (10.9%) have the highest penetration rates. The high penetration in the District of Columbia may be attributed to the efforts and technical assistance of the Catholic archdiocese. There is not any correlation between penetration and number of private schools.

7.2 SUMMARY OF FINDINGS ABOUT THE CHARACTERISTICS OF EDUCATIONAL INSTITUTIONS

7.2.1 Building Characteristics

- The average number of buildings per district was 27; the median was seven. The average age of the oldest building in the district was 59 years. Only 1% were constructed after 1977. Half the districts have portable buildings (the average number was 17).

- School districts have an average of 1.4 million ft^2 of conditioned space; buildings average 52,600 ft^2 each. Nearly 22% of the buildings do not have air conditioning.

- Districts that had received ICP grant awards had older buildings, more buildings, and more buildings that were air conditioned.

- ICP-funded school districts reported decreased energy consumption in greater proportion than non-ICP funded districts (64% vs. 43%).

- School districts in the North reported greater decreases in energy consumption (63%) than districts in the Southeast (35%) and Southwest (44%).

7.2.2 Energy Management and Conservation Activities

- About 75% of the school districts reported having had comprehensive technical audits since 1980. The proportion of ICP districts that had audits was much higher than the proportion of non-ICP districts (87% vs. 62%). The fact that only one-third of the non-ICP districts have not had audits within the last seven years indicates that considerable attention is being paid to energy conservation even by non-ICP school districts.

- The most common source of financing for ECMs has been the school districts' general operating and capital funds (80%). The next most used funding source has been grants (36%), with tax-exempt bonds being third (17%). Rebates and shared savings financing were used by about 10%. Plans for funding in the near future follow the same pattern.

- One-third of the school districts had problems obtaining funding for ECMs; 60% did not indicate any financial problems associated with ECMs.

- Only 13% of the districts indicated any management problems associated with ECMs; perhaps this was because 60% of the respondents represented "management" rather than "buildings, maintenance, and plant operations."

7.2.3 The Role of Other Sponsors

- Nearly 25% of the responding school districts had participated in or received some kind of assistance from utility-sponsored programs. State-sponsored programs (specifically *not* ICP) had served nearly 20% of the responding districts.

- States with high percentages of districts participating in utility-sponsored programs are California, Tennessee, New York, and Oklahoma.

- States with high percentages of districts participating in state-sponsored non-ICP programs are Minnesota, Alabama, Michigan, Texas, Massachusetts, South Dakota, North Carolina, Washington, Iowa, and Virginia.

7.3 SUMMARY OF FINDINGS ABOUT ENERGY CONSERVATION MEASURES IN SCHOOLS

7.3.1 Frequency of Completed Installations

- ECMs in 6 of the 11 ECM categories have been or will be installed in schools in a majority of the responding districts. The most "popular" ECM categories are building envelope (90%), electrical and lighting (85%), controls (83%), and window treatments (82%); mechanical HVAC (71%) and domestic hot water measures (60%) follow closely.

- Renewable energy measures and cogeneration are not often installed in public school buildings.

- Approximately 50% to 60% of the districts plan to install electrical/lighting, mechanical HVAC, building envelope, and window treatment measures during 1987-90.

- The more popular ECM categories tend to contain several measures that are either low-cost or require continuous maintenance or frequent replacement and are likely to have multiple installations.

7.3.2 Time Distributions

- Before 1980, no ECM category exceeded an installation rate of 30%, and only two exceeded 20% -- building envelope and window measures.

- During the ICP grant cycles (1980-86), the installation of ECM categories, except for cogeneration, increased by factors of 3 to 4.

7.3.3 Geographic Distribution

- Air conditioning is used more in the Southeast; therefore, it is not surprising that the penetration of air conditioning ECMs is greatest in the Southeast and smallest in the North, except for the pre-ICP period.

- Renewable energy ECMs, including solar measures, refuse incineration, and the use of wood, have been most popular in the Southwest, probably because the Southwest has the greatest levels of insolation. Renewable energy ECMs are not often installed.

- There has been slightly greater penetration of mechanical HVAC and building envelope measures in the North than in other regions, probably because of the type of building construction used and the North's greater potential for heating savings during winter.

7.3.4 Relationship to Urbanization

- For most types of measures for all three time periods, the highest penetrations of ECMs were reported by urban districts, followed by suburban and then rural districts; however, because there are more schools per district in urban areas, the results do not imply that rural schools installed fewer ECMs than urban schools.

- The highest penetration of ECMs in any period was reported by the urban districts in 1980-86, with over 90% installing electrical or lighting measures.

- An exception to the declining installation rates of ECMs in the future is envelope measures in urban schools, which remain at close to 80% for 1987-90.

7.3.5 Successful ECMs

- Respondents most frequently identified building envelope measures (66% of the districts) and control measures (41%) as the ECMs that they felt saved the most energy (Btu) for their school districts. Other categories of ECMs mentioned were lighting (21%), heating (19%), fuel conversions (8%), and HVAC system (7%).

- Building envelope ECMs are not only the most popular measure but are also viewed as being most successful in saving energy; controls are also considered both successful and popular.

- The reason that lighting ECMs may not be cited often as being successful in saving energy, despite their popularity, may be because of their relatively low cost and association with routine maintenance.

7.3.6 The Role of ICP

- There was little difference in the pre-1980 installation rate of measures by districts that later became ICP grantees and those that did not.

- During the ICP grant cycles (1980-1986), penetration for all ECM classes was greater among ICP grantees than nonparticipants.

- ICP grantees expect to install notably more measures in the future than nonparticipants in most ECM categories.

- Almost 70% of the renewable energy and fuel conversion measures installed in 1980-86 (but not before) were in ICP districts. The rapid increase i[illegible]talling these measures appears to have been encouraged by the [illegible]£ program.

- Heat recovery devices were installed by more ICP districts than non-ICP districts during 1980-86.

7.4 INFORMATION AND TECHNOLOGY TRANSFER

- Principals of private schools are more likely to be knowledgeable about the school's physical plant than principals of public schools.

- In some public school districts, principals do not supervise building operations and maintenance staff and/or custodial staff and have little control over energy consumption.

- For public schools, decision making for energy conservation tends to be concentrated at the district, rather than the school, level.

- A Catholic diocese can play an important role in providing technical assistance to parish schools.

- In larger districts where responsibility for repair and replacement is at the district level, school-level personnel often feel that the district is slow in correcting defects that waste energy (for example, replacing broken windows).

- In some schools and districts, energy ranks second to salaries as a cost item; therefore, the incentive to reduce energy consumption and costs is great.

- Superintendents and principals are far more responsive to policies of state departments of education than to policies of other state agencies (e.g., state energy offices).

- In moderate and cold climates, schools are likely to have either no air conditioning or air conditioning in only a few rooms. The installation of air conditioning (sometimes improperly viewed as an ECM by building managers) increases rather than decreases energy consumption.

- Uncertainty about who is responsible for repairing malfunctioning energy management systems is a common problem for schools.

- When school building operations personnel report to a district-level official rather than to the principal, there is a greater likelihood that interior temperatures will be kept uncomfortably low on cold winter days.

APPENDIX A:

SURVEY INSTRUMENT MAILED TO SCHOOL DISTRICT SUPERINTENDENTS

Lawrence Berkeley Laboratory

Berkeley, California 94720

May 14, 1987

Dear Superintendent:

The amount of money spent on energy by school districts remains a serious problem despite the recent drop in oil prices and improved energy efficiency of equipment. The U.S. Department of Energy (DOE) is, therefore, sponsoring a study to identify the most successful energy conservation activities taken by school districts during the past ten years and to determine how school districts decide to undertake these activities.

Two of DOE's national energy research laboratories are conducting this study: Lawrence Berkeley Laboratory, in California, and Argonne National Laboratory, just outside Chicago. A major element in this study is to mail questionnaires to a sample of public school districts, public schools, and private schools in the U.S. to obtain energy-related information. You are one of the superintendents chosen to receive a questionnaire. Some principals in your school district will also receive similar questionnaires about energy use in schools.

We need your help! We would greatly appreciate your completing and returning the enclosed questionnaire. By so doing, you will help us identify the most popular and successful energy conservation activities and technical measures used by school districts, the types of information needed to choose and implement activities and measures, and the best ways to help superintendents.

Please read the instructions carefully as you move through the survey so that we can avoid taking more of your time in telephone calls for clarification. If you are unable to answer a question, please obtain the missing information from the person who can best answer the question. Please feel free to write additional comments in the margin of the questionnaire. We also encourage you to urge the selected schools in your district to respond to the survey.

Answering the questionnaire will take about 30 minutes of your time. A self-addressed envelope is enclosed for your convenience. The questionnaire will be returned to Elrick and Lavidge, Inc., the company handling the mailing of the survey. Your identity (and that of your district) will be kept in strictest confidence, and your responses will be used only for aggregated statistical analyses. If you have any questions, please call the individuals listed below.

We encourage you to complete this questionnaire immediately. The results from this study will be made available to all interested participants. Thank you very much for your cooperation.

Sincerely,

Edward Vine

Philip Kier

Edward Vine
Lawrence Berkeley Laboratory
(415) 486-6047

Philip Kier
Argonne National Laboratory
(312) 972-3989

OMB 1910-1400

ENERGY USE IN SCHOOL DISTRICTS

Please CIRCLE THE APPROPRIATE NUMBER(S) that correctly answers the questions, or write in your response where indicated. Please do not estimate. If you are unable to answer a question, please obtain the missing information from the person who can best answer the question. Please indicate if the information is not available by writing in "not available."

In this first section, we are interested in how energy is regarded by your school district and by the people who are responsible for energy policy and energy decisions.

1. **Overall, has the number of energy-conserving activities in your school district increased, decreased, or remained the same since 1980?**

   1 Increased overall
   2 Decreased overall
   3 Remained the same
   4 Don't know

2. **On a scale of 1 (highly important) to 4 (not at all important), how would you rate the importance of each of the following factors for motivating current energy conservation activities in your school district? Please circle a number as your response for each factor; the same rating can be given to two or more factors.**

Motivating Factors	Importance: Highly			Not at all	Not Applicable
High energy costs	1	2	3	4	9
Expectations of rising energy prices	1	2	3	4	9
Utility demand charges or rate structures	1	2	3	4	9
Cost-containment program within school district	1	2	3	4	9
Tax incentives (credits)	1	2	3	4	9
Awareness of successful experiences of similar school districts	1	2	3	4	9
Availability of information on building energy costs	1	2	3	4	9
Availability of outside funds (grants, private capital, etc.)	1	2	3	4	9
Exposure to marketing of energy conservation products	1	2	3	4	9
Utility company conservation programs	1	2	3	4	9
Energy projects' cost savings credited to institution and/or maintenance department	1	2	3	4	9
Support of administration and staff	1	2	3	4	9
Other (Please specify:)	1	2	3	4	9

3. **Do you have a written energy plan (excluding audits) for controlling energy costs in your school district?**

   1 Yes
   2 No (*GO TO QUESTION 7*)
   3 Don't know (*GO TO QUESTION 7*)

4. Who prepared your energy plan? (Circle a response for each item)

	Yes	No	Don't know
Individual school(s)	1	2	3
Your school board	1	2	3
Your school district	1	2	3
Your state department of education	1	2	3

5. Do you currently use your energy plan?

1 Yes (*GO TO QUESTION 7*)
2 No
3 Don't know (*GO TO QUESTION 7*)

6. If no, does anyone else use your energy plan? _____

7. For energy matters, who is PRIMARILY RESPONSIBLE for setting general objectives, selecting specific actions to reduce energy use, financing capital projects, and the daily management of energy conservation activities in your school district? Private schools should respond to this question only if they report to a higher level organisation. (Circle all that apply)

Responsible Person(s)	Setting General Objectives	Selecting Specific Actions	Financing Capital Projects	Daily Management
State department of education representative (Please specify title:)	1	1	1	1
Governing body at state level (Please specify title:)	1	1	1	1
Governing body at district level (Please specify title:)	1	1	1	1
Superintendent	1	1	1	1
School Principal	1	1	1	1
Chief financial officer	1	1	1	1
School Vice/Assistant Principal	1	1	1	1
School district engineer	1	1	1	1
School maintenance chief	1	1	1	1
School energy committee	1	1	1	1
District energy committee	1	1	1	1
Teachers	1	1	1	1
Parents' group	1	1	1	1
Other (Please specify:)	1	1	1	1
No designated individual	1	1	1	1

8. This question has been purposely omitted.

9. For energy matters, what INFORMATION SOURCES do you use in setting general objectives, selecting specific actions to reduce energy use, financing capital projects, and in daily management of energy conservation activities in your school district? (Circle all that apply)

Information Source	Setting General Objectives	Selecting Specific Actions	Financing Capital Projects	Daily Management
Experience of other school districts	1	1	1	1
Financial status of school district	1	1	1	1
Manufacturers of energy conservation products	1	1	1	1
Energy Service Companies (ESCo)	1	1	1	1
Attending conferences and workshops	1	1	1	1
Technical and trade publications (e.g., *Energy User News*)	1	1	1	1
Literature about saving energy in the home	1	1	1	1
Continuing education courses	1	1	1	1
Preservice and inservice training	1	1	1	1
Professional societies (e.g., *ASHRAE, AASA, APPA*)	1	1	1	1
Contacts with other professionals (e.g., engineers)	1	1	1	1
Personnel in state/federal energy offices	1	1	1	1
Utility companies	1	1	1	1
Consultants and auditors	1	1	1	1
Science teachers and textbooks	1	1	1	1
District/state curriculum specialists	1	1	1	1
Other (Please specify:)	1	1	1	1

The next section asks about energy conservation activities conducted by your school district.

10. Overall, has total energy consumption (NOT COSTS) changed in your school district since 1980? (If more than one fuel is used by your district, answer for the NET change.)

1 Increased overall
2 Decreased overall
3 About the same *(GO TO QUESTION 12)*
4 Don't know *(GO TO QUESTION 12)*

11. If there has been a change in total energy consumption NOT DUE to energy conservation measures, why do you think it has occurred? (Circle a response for each item)

Reason	Yes	No	Direction of change	
			Up(+)	Down(-)
Change in educational services	1	2	+	-
Change in building operations	1	2	+	-
Change in square footage	1	2	+	-
Change in summer schedule	1	2	+	-
Change in daily schedule	1	2	+	-

12. Has anyone performed a comprehensive, technical energy audit (on-site examination of a building and its energy systems, performed for the purpose of recommending ways to save energy) in your school district since 1980?

1 Yes
2 No (*GO TO QUESTION 17*)
3 Don't know (*GO TO QUESTION 17*)

13. How many schools have been audited? _____

14. When was the MOST RECENT audit performed? _____ **(year)**

15. Who performed the MOST RECENT energy audit? (Circle one) (If more than one person, choose the party responsible for preparing the audit report)

1 Utility company
2 Private consultant/contractor
3 A school employee
4 State government employee
5 Local government employee
6 A school district employee
7 Other (Please specify: _____)
8 Don't know

16. How were the results of the most recent audit reported to you? (Circle a response for each item)

	Yes	No	Don't know
Received a computer printout	1	2	3
Received a detailed written report	1	2	3
Received a brief report and/or oral briefing	1	2	3
Reported to someone else (Please specify:)	1	2	3

17. We are interested in finding out what energy conservation measures (including low-cost/no-cost measures) you have undertaken since 1973 or have planned for the near future. Please remove the last page and refer to the definitions of energy conservation measures. Please circle all that apply.

Energy Conservation Measures (ECMs)	Date of Installation		Planned
	1973-1979	1980-1986	1987-1990
BUILDING ENVELOPE			
Insulation (walls, ceilings, roof)	1	1	1
Caulking and weatherstripping	1	1	1
Windows (reflective film)	1	1	1
Windows (replacement)	1	1	1
Windows (all other ECMs)	1	1	1
Other openings	1	1	1
Manual adjustments	1	1	1
CONTROLS - HVAC			
Time clocks	1	1	1
Computer-based energy management systems (EMS)	1	1	1
Other	1	1	1
CONTROLS - ELECTRICAL/LIGHTING			
Time clocks	1	1	1
Computer-based energy management systems (EMS)	1	1	1
Other	1	1	1
MECHANICAL (HVAC)			
Fuel conversions	1	1	1
Air conditioning	1	1	1
Heating modifications (replace burner)	1	1	1
Heating modifications (replace or add boilers)	1	1	1
Heating modifications (insulate boiler)	1	1	1
Heating modifications (steam traps; valves)	1	1	1
Heating modifications (all other ECMs)	1	1	1
Distribution system (insulate pipes/ducts)	1	1	1
Distribution system modifications (all other ECMs)	1	1	1
Domestic hot water	1	1	1
Cogeneration	1	1	1
Manual adjustments	1	1	1
Energy recovery devices	1	1	1
Other	1	1	1
ELECTRICAL/LIGHTING			
Lighting conversion	1	1	1
Lighting modifications	1	1	1
Manual adjustments	1	1	1
Other electrical applications	1	1	1
RENEWABLES			
Solar (passive)	1	1	1
Solar (active)	1	1	1
Solar (all other)	1	1	1
Conversion to renewables	1	1	1
Other	1	1	1

18. **Based on the list of energy conservation measures (ECMs) shown on the preceding page, which TWO ECMs have saved the most amount of energy (BTUs) for your school district?**

Most effective: _____

_____

Second most effective: _____

_____

19. **Please describe the following kinds of problems (technical, financial, managerial, and building occupant) you have had in implementing energy conservation measures:**

Technical (e.g., equipment, operations and maintenance, installation): _____

_____

_____

Financial (e.g., funding, payback, budget): _____

_____

_____

Managerial (e.g., staffing, approvals): _____

_____

_____

Building occupants (e.g., perceptions of comfort, schedules): _____

_____

_____

20. **This question has been purposely omitted.**

21. **Is an energy monitoring or accounting report, which periodically tracks and analyzes energy use and/or energy costs (e.g., monthly, quarterly, annually), prepared by or for your school district?**

1 Yes

If yes, to whom are the results reported? (Circle a response for each item)

	Yes	No	Don't know
School district administrator	1	2	3
School administrator	1	2	3
Board of education	1	2	3
State department of education	1	2	3
Engineer or maintenance staff	1	2	3
Energy committee	1	2	3
Other (Please specify: _____)	1	2	3

2 No

3 Don't know

22. What financing arrangements have enabled your school district to purchase energy-saving capital equipment since 1980, and which financial arrangements are you considering for any planned energy investment? (Circle all that apply)

Source	Used	Planned	Don't know
General operating and capital funds	1	1	1
Commercial loans	1	1	1
Lease/lease purchase	1	1	1
Savings-based financing	1	1	1
Tax exempt bonds	1	1	1
Grants	1	1	1

23. Have energy conservation measures been installed in your school district as part of an asbestos removal program?

1 Yes
2 No
3 Don't know

24. What percent of energy cost-savings is returned to each school? ____%

25. What percent of energy cost-savings is returned to your school district? ____%

26. What percent of energy cost-savings is returned to your state department of education? ____%

****

In the following section, we ask some questions about the size and age of the facilities in your school district.

****

27. How many buildings does your district comprise (excluding unconditioned storage and related buildings)? _____

28. How many of these are administrative buildings? _____

29. When was the oldest building built? _____ (year)

30. How many buildings were built after 1977? _____

31. What is the approximate total square footage of all conditioned (heated and/or air-conditioned) building space in your school district (excluding unconditioned storageand related buildings)? _____ (square feet)

32. Is 51% or more of your conditioned floor area used for nonadministrative purposes?

1 Yes
2 No
3 Don't know

33-47. These questions have been purposely omitted.

The next section asks about your district's participation in energy conservation programs.

48. Are you aware of the U.S. Department of Energy's Institutional Conservation Program (ICP), sometimes called the Schools and Hospitals Program?

1 Yes
2 No (*GO TO QUESTION 55*)
3 Don't know (*GO TO QUESTION 55*)

49. This question has been purposely omitted.

50. Has your school district ever applied for a grant award under the ICP program?

1 Yes (*GO TO QUESTION 51*)
2 No
If no, why not?_____
(*IF NO, GO TO QUESTION 55*)
3 Don't know (*GO TO QUESTION 55*)

51. If yes, how many schools have been recipients, at least once, of grant money? _____

52. Please indicate the number of Technical Assistance (TA) audit grants and Energy Conservation Measure (ECM) grants your school district has applied for on behalf of schools in your district and administration buildings, and the number your school district has received:

	# Applied for	# Received
TA grants		
ECM grants		

52a. How many schools within your district have applied for a TA or ECM grant without going through the district? _____

53. If you received a TA grant but did not apply for an ECM grant, please indicate your reasons for not applying: _____

54. If you were denied (or you rejected) an ECM grant, please indicate the reasons for the denial (or rejection), if you know them: _____

55. List the names and locations of other schools or school districts which have served as models or have been helpful to you in making energy-related decisions:

_____

_____

_____

56. Have you participated in energy conservation programs for financial assistance or energy audits sponsored by the following organizations? (Circle a response for each organization)

	Yes	No	Don't know	If yes, name of organization
Utility companies	1	2	3	
Federal agencies	1	2	3	
State agencies	1	2	3	
Local agencies	1	2	3	
Associations	1	2	3	
Other	1	2	3	

****

For the person primarily responsible for completing this survey, please answer the following questions.

****

57. How long have you worked at this school district? _____ (years)

58. How long have you worked at the school level? _____ (years)

59. How long have you worked at the school district level? _____ (years)

60. How long have you held your current position? _____ (years)

61. What degrees and certificates (including energy-related ones), if any, have you earned?

_____

_____

62. What other positions have you held at this school district?

_____

_____

63. Where did you work immediately prior to coming to this school district?

_____

_____

64. This question has been purposely omitted.

65. How large is the physical facility staff of your school district? _____

66. How many people do you directly supervise, if any? _____

67. How many of these people are engineers? _____

68. What is the title (position) of your immediate supervisor? _____

69. If we have any questions, whom should we contact for clarification of responses in this questionnaire?

Contact Person: _____

Title: _____

School: _____

Address: _____

_____

City _____ State _____ Zip _____

Phone: _____

70. Is the Contact Person yourself?

1 Yes (*GO TO QUESTION 72*)
2 No

71. If no, what is your name, title, address, and phone number?

Name: _____

Title: _____

School: _____

Address: _____

_____

City _____ State _____ Zip _____

Phone: _____

72. If you would like to receive information regarding the findings of this survey, please check the line below, and we will arrange to send you the survey results in about two months:

___ I would like to receive summary results of the survey.

73. Is there anything else you would like to comment on in regard to this questionnaire or energy use in general?

COMMENTS:

THANK YOU FOR YOUR HELP!
WE APPRECIATE THE TIME YOU SPENT HELPING US.

We provided an envelope with an address label for returning this questionnaire. If you do not have the label, please send the questionnaire to the company handling the mailing of the survey: Elrick and Lavidge, Inc., 111 Maiden Lane, San Francisco, Ca. 94108.

USE THESE DEFINITIONS TO ANSWER QUESTIONS 17 AND 22

GENERAL DEFINITIONS

Cogeneration - Cogeneration is the sequential production of heat and power, usually electricity and steam.

District Heating - District heating systems are thermal energy systems which produce heat in the form of steam or hot water, and convey it from one or more central energy production stations to service the thermal energy needs of commercial, residential, institutional, and industrial users.

Energy Audit - An energy audit is an on-site examination of a building and its energy systems, performed for the purpose of recommending ways to save energy.

Energy Service Company - Energy Service Companies arrange "utility service agreements" in which the firm often takes responsibility for paying utility bills in exchange for a portion of the savings attributable to conservation measures installed and sometimes financed by the energy service company.

Lease Purchase Programs - Lease purchase programs require no initial capital investment. At the end of the lease, the building operator acquires ownership of the leased equipment. Under these arrangements you assume the risk of continued lease payments even if there are no energy savings. These programs include "bargain purchases."

Savings-based financing - In these arrangements, a contractor agrees to finance, install and maintain energy-saving equipment in exchange for a portion of the energy savings. As part of savings-based financing, the contractor may provide "turnkey" services such as building energy audits, project design, installation, maintenance and repairs.

DEFINITIONS OF ENERGY CONSERVATION MEASURES (ECMs)

BUILDING ENVELOPE

Insulation

Roof/ceiling insulation (e.g., crawl space), wall insulation, combination of roof/ceiling/wall insulation, or other insulation measures (e.g., berming, soffit, vent caps).

Infiltration control

Caulking and weatherstripping (e.g., tuckpoint).

Windows

Storm windows (inside or outside), double- or triple-glazed windows, replace glass with insulated panel (includes partial panel and glass), reflective window film, wall up or close off windows, or other window measures (e.g , skylight modification).

Other openings

Storm doors, air locks or vestibules (e.g., air curtains, strips), wall up or close off doors, or other door/miscellaneous measures (e.g., insulate, replace with higher R-value, automatic closures, thresholds, sweeps).

Manual adjustments (e.g., pulling shades, screens, opening and closing windows/doors).

CONTROLS - HEATING, VENTILATION AND AIR-CONDITIONING (HVAC)

Time clocks

Computer-based energy management systems (EMS)

Other (e.g., temperature reset devices and enthalpy control).

CONTROLS - ELECTRICAL/LIGHTING

Time clocks

Computer-based energy management systems (EMS)

Other (e.g., additional/selective switching and motion detectors).

MECHANICAL HEATING, VENTILATION AND AIR-CONDITIONING (HVAC)

Fuel conversions

- Convert to oil, natural gas, electricity, coal or another nonrenewable fuel.

Air conditioning

Chiller conversion/efficiency improvement, package unit application, install economizer, adiabatic cooling, or other air conditioning measures (e.g., cross-connect system).

Heating modifications

Replace burner, replace boiler (e.g., more efficient), add smaller boiler, downsize system (e.g., special use), automatic flue damper, install automatic ignition device, preheat heat combustion air/make-up water, turbulators, stack economizer, humidification device, district heating, or other heating modifications (e.g., steam traps/valves, insulate boiler, radiator control valves, oxygen trim).

Distribution system modifications

Reduce air volume, prevent air stratification (e.g., ceiling fans, deflectors), convert to variable air volume, insulate pipes/ductwork, damper modifications (e.g., automatic dampers, seals, controls), zoning modifications (e.g., close off areas, add ductwork), motors (e.g., high efficiency, motor controllers), or other distribution systems measures.

Water

Flow restrictors (e.g., automatic faucet shutoffs, low-flow showerheads), insulate tanks, decentralized hot water heater (e.g., seasonal/booster heater), or other water measures (e.g., flue damper, interconnect system, filter system, pool cover).

Cogeneration

The sequential production of heat and power, usually electricity and steam.

Manual adjustments (e.g., shut off equipment, motors, temperature adjustments).

Energy recovery devices (e.g., boiler blowdown, heat wheel, heat exchanger, heat pipe, runaround system, boiler flue gas, laundry heat).

Other (e.g., humidifiers and dehumidifiers).

ELECTRICAL/LIGHTING

Lighting conversion

Convert to fluorescent lights, high intensity discharge lights (e.g., mercury, metal halide, HP sodium), or other high efficiency lights.

Lighting modifications

Modify fixture (e.g., lenses, reflectors, lower height), reduce number of fixtures, ballast modifications (e.g., electronic ballast, power reducers), or other lighting modifications.

Manual adjustments (e.g., shutting off lights, dimming)

RENEWABLES

Solar

Active solar hot water, active solar heating, passive solar heating (e.g., trombe wall, greenhouse), photovoltaic application, or daylighting.

Conversions

Conversion to wood (e.g., wood chips), biomass (e.g., vegetation, animal waste, agricultural), refuse (e.g., residues), and other renewables.

Other (e.g., wind, tidal, hydro, geothermal, and thermal storage).

APPENDIX B:

TELEPHONE INTERVIEW DATA COLLECTION INSTRUMENT USED WITH SCHOOL DISTRICTS

Elrick and Lavidge, inc.
111 Maiden Lane
San Francisco, CA 94108
(415) 434-0536

Project 882-1332
August 7, 1987

Group # _____

ID [ ][ ][ ][ ][ ][ ]

SCHOOL DISTRICT NON-RESPONDENT SURVEY

SWITCHBOARD INTRO

A. Hello, I'm _____ calling about a Department of Energy survey being conducted by Lawrence Berkeley Laboratory.

B. I'd like to speak with the superintendent.

(IF "NO SUCH TITLE" ASK FOR THE PERSON IN CHARGE OF BUILDINGS.)

RESPONDENT INTRO

Hello, I'm _____ calling about a Department of Energy survey being conducted by Lawrence Berkeley Laboratory.

1. Do you recall receiving a survey in the mail about energy conservation several months ago?

Yes
No

IF YES: Our records show we didn't receive your response so we'd like to ask you just a few questions now . . .

IF NO: Perhaps the questionnaire was incorrectly addressed or it may have gone to someone else in your district. Since we don't have a record of any response from your school district, we'd like to ask you just a few questions now . . .

IF RESPONDENT REFUSES

Why is it that you don't wish to participate in this survey?

Don't have time	-1
Recalled mail questionnaire as being too long	-2
Recalled mail questionnaire and didn't know answers	-3
Not interested in subject	-4
Other: _____	
_____	

I'm going to ask you about energy conservation activities conducted by your district in your permanent buildings.

First, we would like some general information about energy conservation efforts in your school district.

1. Overall, has the number of energy-conserving activities in your school district increased, decreased or remained the same since 1980?

   Increased overall -1
   Decreased overall -2
   Remained the same -3
   Don't know -4

10. Overall, has total energy consumption . . . not your costs . . . changed in your school district since 1980? If more than one fuel is used by your district, answer for the NET change.

   Increased overall -1
   Decreased overall -2
   Remained the same -3
   Don't know -4

12a. Has anyone performed a comprehensive, technical energy audit in your school district since 1980? . . . That is an on-site examination of a building and its energy systems, performed for the purpose of recommending ways to save energy.

   Yes -1
   No -2
   Don't know -3

   b. IF YES: How many schools have been audited?

   _____

18. We are interested in finding out what types of energy conservation measures, including any low-cost/no-cost measures you have undertaken since 1973, or have planned for the near future.

I'm going to read a list of energy conservation measures. As I do, please tell me if you've made any since 1973. Here's the first one . . .

Have you made any changes in your (SAY STATEMENT)

IF YES: Were those changes made between 1973 and 1979 . . . or between 1980 and 1986? RECORD AND ASK PLANNED CHANGES.

IF NO: Do you plan to make any energy conservation changes in your (SAY) between now and 1990? IF YES, RECORD

REPEAT SEQUENCE FOR ALL OTHERS

ENERGY CONSERVATION MEASURES:	DATE OF INSTALLATION 1973-1979	1980-1986	PLANNED 1987-1990
o Window treatments, such as replacing windows and adding reflective film	-1	-1	-1
o Building envelope, such as insulation and weatherstripping	-1	-1	-1
o Controls for mechanical equipment and lighting systems	-1	-1	-1
o Air-conditioning	-1	-1	-1
o Cogeneration, such as the sequential production of electricity and steam	-1	-1	-1
o Heat recovery devices, such as heat exchangers, heat pipes and boiler flue gas	-1	-1	-1
o Domestic hot water, such as low-flow showerheads, insulation of hot water tanks, and booster hot water heaters	-1	-1	-1
o Fuel conversions, such as changes to systems that use oil, gas, electricity, or coal	-1	-1	-1
o Other mechanical HVAC equipment, including boilers, heating equipment or pipe insulation	-1	-1	-1
o Electrical lighting equipment	-1	-1	-1
o Renewable energy, such as solar or other forms of renewable energy	-1	-1	-1

IF MORE THAN TWO CONSERVATION MEASURES INSTALLED SINCE 1973

19. Based on the energy conservation measures we have talked about, which TWO have saved the most energy for your school district?

    1 _____

    _____

    2 _____

    _____

20. Now I'll mention some types of problems you may have had in implementing energy conservation measures . . . as I name each one, please tell me if you've have that problem and if so, please describe what the problem was.

    a. Technical problems such as equipment, operations and maintenance, installation — Yes -1 No -2

    _____

    _____

    _____

    b. Financial problems such as funding, payback, budget — Yes -1 No -2

    _____

    _____

    _____

    c. Managerial problems such as staffing, approvals — Yes -1 No -2

    _____

    _____

    _____

    d. Building occupant problems such as perceptions of comfort, schedules — Yes -1 No -2

    _____

    _____

    _____

IF ANY EQUIPMENT INSTALLED 1980-1986 (Q.18 FOR 1980 TO 1986)

23a. What financing arrangements have enabled your school district to purchase energy-saving capital equipment since 1980?

For example, have you used . . . READ

	USED	PLANNED
general operating and capital funds?	-1	-2
commercial loans?	-1	-2
lease/lease purchase?	-1	-2
savings-based financing?	-1	-2
tax exempt bonds?	-1	-2
grants?	-1	-2
rebates?	-1	-2

b. Which financial arrangements are you considering for any planned energy investment? For instance . . . READ AND RECORD ABOVE

The following questions are about the size and age of the permanent facilities in your school district.

27. How many buildings does your district comprise that are heated and/or air conditioned? _____

28. How many of these are strictly administrative buildings? _____

33. What is the total square footage of all heated and/or air-conditioned space in your school district? _____ (Square feet)

29. When was the oldest building built? _____ (year)

31. How many buildings were built after 1977? _____

32. How many buildings have air-conditioning? _____

34. How many portable buildings . . . that is trailers or relocatable classrooms . . . do you have in your district? _____

50. Now I have a couple of questions about the amount of electricity, gas or other fuels consumed in your district last year in 1986.

a. How many kilowatt hours of electricity did you use?

_____ (kWh)

b. How many therms of natural gas did you use?

_____ (therms)

c. Did you use any other fuels? IF YES, PLEASE SPECIFY AND PROBE FOR QUANTITY

FUEL	QUANTITY

d. What was your district's total energy use in 1986 in millions of BTU's?

_____ (million)

The next few questions are about your district's participation in energy conservation programs.

54. Are you aware of the U.S. Department of Energy's Institutional Conservation Program . . . that is ICP . . . sometimes called the Schools and Hospitals Program?

Yes -1
No -2 ——> GO TO Q.65

56a. Has your school district ever applied for a grant award under the ICP program?

Yes -1 ——> GO TO Q.65
No -2

b. IF NO: Why not? _____

_____

_____

Don't know -3

65a. We're interested in whether you have participated in any energy conservation programs such as financial assistance or energy audits sponsored by various organizations. How about utility company programs?

IF YES: What utility sponsored that?

REPEAT FOR ALL OTHERS

	YES	NO	DON'T KNOW	IF YES, NAME OF ORGANIZATION
Utility companies	1	2	3	
Federal Agencies not including ICP	1	2	3	
State Agencies not including ICP	1	2	3	
Local agencies	1	2	3	
Associations	1	2	3	
b. Any others?	1	2	3	

Now a couple of final questions about you and your job.

66. How long have you worked in this school district? _____ (years)

68. How long have you held your current position in your school district? _____ (years)

73. What degrees and certificates have you earned? _____

77. What is the title (position) of your immediate supervisor?

81. Would you like to receive information regarding the findings of this survey?

Yes -1 ---> SAY: We will arrange to send you the survey results in about two months:

No -2

THANK YOU FOR YOUR HELP!
WE APPRECIATE THE TIME YOU SPENT HELPING US.

END

DATE
FILMED
3/15/93