DOCUMENT RESUME

ED 248 133 SE 044 863

TITLE	An Evaluation of the Institutional Conservation Program: Results of On-Site Analyses. Final Report.
INSTITUTION	Opportunity Systems, Inc., Washington, DC.; Synectics Group, Inc., Washington, DC.
SPONS AGENCY	Department of Energy, Washington, DC. Office of State and Local Assistance Programs.
REPORT NO	DOE-CS-64[illegible]-1
PUB DATE	30 Apr 83
CONTRACT	DE-AC01-81CS[illegible]4571
NOTE	152p.
AVAILABLE FROM	Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.
PUB TYPE	Reports - Evaluative/Feasibility (142)
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	Conservation Education; *Cost Effectiveness; Energy; *Energy Conservation; *Federal Programs; *Fuel Consumption; *Fuels; Nonprofit Organizations; *Program Administration; Program Descriptions; *Program Evaluation; Schools
IDENTIFIERS	*Institutional Conservation Program

ABSTRACT

The Institutional Conservation Program (ICP) is a voluntary grant program designed to help such non-profit institutions as schools, hospitals, local governments, and public care facilities save energy and reduce anticipated energy-related costs. Another primary ICP goal is to conserve oil, thereby reducing the nation's dependence on imported fuels. Secondary ICP goals include fostering energy conservation awareness, advancing energy conservation science by expanding its technical base of knowledge and the expertise of its specialists, and improving the technical capacity for managing energy use in institutional buildings. An evaluation was conducted to determine: (1) how well the ICP has been administered; (2) if the ICP has achieved its primary goals; and (3) what secondary goals have been attained. This report on the ICP evaluation includes an executive summary, introductory/background information, a description of the methodology and procedures used in the evaluation, and evaluation conclusions and findings obtained by means of site visit observations and data analyses. Appendices contain details on ICP history, additional information about the evaluation methodology and the survey instruments used, and an explanation of the assumptions underlying the analysis. In general, ICP was found to be a valuable and well run program that has been achieving its primary goals of helping institutions save energy, money, and oil. (JN)

DOE/CS/64571-1

An Evaluation of the Institutional Conservation Program

Results of On-Site Analyses

Final Report

April 30, 1983

Prepared for:
U.S. Department of Energy
Assistant Secretary, Conservation and Renewable Energy
Office of State and Local Assistance Programs
Under Contract No. DE-AC01-81CS64571

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Price: Printed Copy
Microfiche A01

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DOE/CS/64571-1
Dist. Category UC-95D

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THE INSTITUTIONAL CONSERVATION PROGRAM: ITS PURPOSE AND GOALS

The Institutional Conservation Program (ICP) is a voluntary grant program to help nonprofit institutions--schools, hospitals, local governments, and public care facilities--save energy. "For profit" institutions, unaccredited schools, buildings constructed after 1977, and special purpose units of local government are not eligible to participate in the ICP. Authorized by the National Energy Conservation Policy Act of 1978 (NECPA) and administered by the Department of Energy through State Energy Offices (SEOs), the ICP provides energy audits and grants for detailed energy analyses and for installation of energy-savings capital improvements to eligible institutions. Participation in the grant phase of the program requires a 50% match of funds from recipient institutions (except in hardship cases). Four funding cycles have been conducted between fiscal years 1979 and 1982. More than $368 million has been distributed to institutions to help finance conservation improvements; these funds covered 15,130 buildings through 6,270 grants.

Energy costs constitute significant portions of these institutions' operating budgets. Accordingly, ICP assistance provides an impetus to nonprofit institutions to take steps to conserve energy. Unlike businesses or residential consumers, these institutions pay no taxes and are thus ineligible to apply for conservation tax credits. In addition, many nonprofit institutions have difficulty financing capital improvements because they have limited capital budgets, uncertain income, and limited borrowing capacities.

The ICP established two primary goals and predicted that their achievement and the concomitant publicity afforded the Program would result in the attainment of other, secondary goals. The Program's primary goals were:

- To help participating institutions save energy and reduce anticipated energy-related costs, and
- To conserve oil and thereby reduce the nation's dependence on imported fuels.

Examples of secondary goals arising from these were:

- The fostering of energy-conservation awareness, and the stimulation of energy-saving activities on a national scale;
- The advancement of energy-conservation science by expanding its technical base of knowledge and the expertise of its specialists; and
- An improved technical capacity for managing energy use in institutional buildings.

Has the ICP been successful in achieving its goals? The Department of Energy undertook an evaluation of a portion of the Program to determine the extent to which these goals have been realized.

AN EVALUATION OF THE ICP

Background

In October 1981, the U.S. Department of Energy (DOE) contracted with Opportunity Systems, Inc. (OSI) and The Synectics Group, Inc. (TSG) to evaluate Cycles I and II of the ICP. TSG's evaluation--the subject of this report--focused on site visits to institutions that had completed energy-saving capital improvements before September 30, 1981 and to a small sample of institutions that had undertaken energy audits but no capital improvements. On the basis of analyses of institutional records, on-site assessments, and interviews with State and institution administrators, TSG evaluated the implementation of the program and the impacts of the ICP and estimated the energy savings achieved by participating institutions in its sample.

Evaluation Methodology

Working closely with DOE, OSI and TSG designed and implemented the following methodology for evaluating the program. This description is extremely brief: the report contains methodological details.

- Selection of a sample of 10 States and within those States selection of a sample of institutions participating in Program Cycles I and II.
- Review of grant applications for technical assistance and energy-saving capital improvements.
- Selection of program-related data from interviews with personnel in SEOs and DOE Regional Offices, telephone interviews with ICP participants, and site visits to a sample of institutions.
- Synthesis and analysis of the various data collected.
- Development of findings and conclusions about achievement of ICP goals.

TSG took responsibility for the site-visit component of the evaluation, while OSI--via telephone interviews--pursued evaluation data on institutions that undertook energy audits only (telephone interviews were conducted at 232 institutions in four states: Missouri, Florida, Utah, and Rhode Island). The results of OSI's investigation are presented in a separate document.

Site visits were conducted at 188 buildings in the 10-State sample. The site visit survey design was completed in a scientific manner to allow appropriate statistical analyses and projection of results to the national population of Cycle I and II ECM grantees who had completed their grant-funded capital improvement projects before September 30, 1981 (1,012 grantees).

The findings and conclusions for ECM grantees presented in this Executive Summary and in the attached report are based on that universe of 1,012 institutions. Results from energy-audit-only site visits were not designed to be projected nationally, and so are presented only as descriptive findings:

A BRIEF DESCRIPTION OF PROGRAM ADMINISTRATION

The ICP is administered by DOE through the States. In order to qualify for funding, the States had to prepare State plans that were approved by the Department. States had some latitude in how they administered the Program, but final selection of grants was made by DOE on the basis of State recommendations.

The ICP has been conducted in four phases:

1. Preliminary Energy Audits (PEAs), which provided descriptive profiles of building characteristics.

2. Energy Audits (EAs), which described the energy-use situation in a building, prescribed no-cost/low-cost conservation measures, and assessed whether the institution would benefit from a more extensive engineering analysis (see 3, below).

3. Technical Assistance Analyses (TAs), conducted by licensed engineers or other qualified professionals (as specified in State Plans), recommended further low-cost measures, if appropriate, and identified potential energy conservation measures (see 4, below) for the building.

4. Energy Conservation Measures (ECMs), which involved building modifications or installation of capital-intensive improvements for the purpose of energy conservation.

PEAs and EAs were funded by the ICP either with direct financial support or by providing a DOE-trained auditor to the institution. TAs and ECMs were supported by DOE grants. Institutions had to participate in each of these phases sequentially (or complete a non-ICP equivalent) in order to be eligible for the next phase. Throughout the report the term "ECM grantee" is used to refer to an institution that had completed a capital improvement (ECM) by fall of 1981.

Findings and conclusions about Program administration are presented in the following sections. Although administrative procedures may have an influence on Program performance, the nature of the site visit sample does not allow the correlation of energy savings with program administration.

HAS THE ICP ACHIEVED ITS PRIMARY GOALS?

The ICP Helped Participating Institutions Save Substantial Amounts of Energy and Reduce Their Energy Bills.

EA Institutions Saved Limited Amounts of Energy

Although the site visit evaluation did not look at EAs on a national scale, selected EA sites that were visited saved 6,620 million BTUs or 0.4% of their pre-ICP consumption. Since the EA site visit sample represents less than .04% of the total number of institutions that participated in the EA phase, it is likely that total BTU savings by all EA participants is substantial. However, site visit results suggest that potential savings were somewhat less than projected for the following reasons. Audits often were viewed as a one time commitment of effort and ongoing energy programs were not established. In addition, many local governments conducted EAs at all buildings in their jurisdiction even if they were unoccupied or used very little energy. Furthermore, in some cases program administrators did not review the EA reports or realize they included specific O&M (operating and maintenance) recommendations. Therefore, savings may have been improved if more thought had been given to the sites chosen for audit and if O&M techniques had been emphasized.

ECM Grantees* Saved Energy and Money, and Projects Paid Back Quickly

ECM grantees as a group saved an average of 13.2%** of their pre-ICP consumption. This represented a reduction in annual usage of an estimated 5.17 trillion BTUs. To achieve those savings ECM grantees invested approximately $71 million in energy conservation improvements, 50% of which were Federal grant funds. On the basis of a 10-year ECM life, the cost of saving one million BTUs was $1.37; the equivalent cost of the Federal contribution was $0.68 per million BTUs. Not only were ECM projects found to be cost-effective, but they also paid back more quickly than projections indicated. Paybacks averaged less than two years, compared to more than four years as predicted in ECM applications.

It should be pointed out that specific savings accruing to a particular ECM in a given building cannot be ascertained. During the period over which energy savings of ECM grantees were calculated, institutions took other actions which contributed to the energy reductions achieved. Without additional appropriate instrumentation in grantee buildings it was impossible to separate out the savings from ICP-funded projects from the total savings of all conservation activities conducted there.

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*ECM grantees is defined as Cycle I and II grantees whose ECMs were completed as of September 30, 1981.

**Based on statistical precision tests, the 90% confidence limits range from 9.3% to 17.1%.

Schools and Hospitals Showed Differences in Energy Performance

An examination of energy savings of ECM grantees by institution type reveals that hospitals saved an average of 36,360 BTU per square foot, compared to 23,660 BTU per square foot for schools. Yet, schools saved approximately 21.6% of their pre-ICP energy consumption, while hospitals saved an estimated 8.3%*. In terms of cost-effectiveness, however, schools and hospitals were fairly even, spending $14.45 and $12.50 respectively in ECM costs per million BTU saved. These findings result from the fact that hospitals are more energy intensive than schools, and their energy usage is more dynamic. In many cases, hospitals are expanding or facing increased patient loads. They are continually adding medical equipment that consumes large amounts of energy (e.g., X-ray and laboratory equipment), and they have strict requirements for climate control (e.g., operating rooms, computer centers, diagnostic equipment) in order to carry out their prime mission of providing health care. Therefore, although hospitals may seek to reduce operating costs, energy conservation may not be considered as important an objective as, for example, patient comfort, the addition of new services, security, or convenience. By contrast, energy consumption and costs are more visible in schools and in school budgets, and are more easily controlled by administrators. In addition, energy consumption usually accounts for a larger percentage of school budgets, and it is generally easier to institute conservation measures in schools than it is in hospitals.

Certain Factors Can Override Attempts at Energy Conservation

After the initial fieldwork period, selected follow-up site visits to ECM grantees that experienced apparent increases in energy consumption since participating in the ICP revealed a number of factors that help account for these increases. First, complex facilities (e.g., hospitals) tend continuously to add mission-oriented, energy-consuming equipment without maintaining records; this constantly shifting energy consumption makes it impossible to evaluate ECMs on the basis of total building energy consumption. Second, in most cases, individual metering or instrumentation was not installed at these facilities so that ECM performance could be measured. Finally, it was seen that a lack of an effective energy conservation program directed from the highest management level of an organization can fail to provide the number and type of personnel needed to achieve energy-saving preventive maintenance, equipment fine-tuning, and energy saving hardware experimentation. The findings of this follow-up analysis confirm the observations and findings (described below) made in the basic evaluation.

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*($p<.05$) - Based on statistical significance tests, $p<.05$ indicates a significant difference between the two percentages.

ECM Grantees Made Dramatic Reductions In Their Use Of Oil

The ICP's ranking criteria for ECM applications was designed to give priority to those measures projected to save the greatest amounts of oil, and the Program's oil-saving goal appears to have been realized. Grantees reduced their oil usage by an estimated 11.77 trillion BTUs annually or 2.25 million barrels of oil equivalent. A portion of this savings was due to the fact that a large number of boilers were converted from oil to natural gas.

These conversions resulted in increased natural gas consumption of 8.78 trillion BTUs. However, even when this increase is factored into the oil use reduction a net annual BTU savings of 2.99 trillion BTUs was achieved. Combined savings of electricity, liquified petroleum gas, coal, and purchased steam totaled 2.18 trillion BTUs.

Certain Factors Maximized the Energy Conservation Potential of ICP Funds

The ICP definitely resulted in energy, oil, and dollar savings, but some institution personnel--either through good fortune, dedication, or interested analysis--used ICP funds in a particularly cost-effective way to maximize savings. Those institutions that made the best use of diligent energy managers, undertook accurate and building-specific energy analyses and installed appropriate ECMs, persevered in the conduct of operating and maintenance techniques, and monitored energy usage showed overall greater savings. Findings relating to these factors are discussed below.

Commitment of Personnel Maximizes Savings

While investments in energy-conserving hardware save energy, the ICP experience suggests that the commitment of personnel, particularly institution managers, is critical to maximizing energy savings. Throughout the evaluation it was seen that energy performance was related to the level of commitment of the designated energy manager. During the field survey, managers were rated excellent, good, fair, or poor in terms of their overall involvement in energy management. Institutions rated excellent in this area experienced average savings of 19.8%, compared to 9% for other institutions ($p<.05$). This is a strong indication that administrators who exercise leadership and are involved directly in conservation constitute an important element of successful energy programs. Furthermore, the position of the energy manager within the institution's organizational structure can have an impact on energy savings. When managers had daily contact with buildings' operating personnel, higher savings generally were achieved.

Thorough Analysis Of Energy Conservation Needs And Appropriate Selection Of Capital Improvements Are Critical To Successful Energy Conservation Programs

During site visits it was determined that the quality and use of energy audits and TA analyses varied among institutions. Primarily, analyses often were not building specific. One common pattern observed was that auditors tended to recommend the same O&Ms and ECMs for all buildings. The overall result was that whereas recommendations were successful in some of the buildings, the same recommendations resulted in lower savings at other buildings.

Secondly, EAs often did not serve as educational tools for institutions. Many respondents were unfamiliar with specific EA recommendations and potential energy savings were not realized. Furthermore, on its own, the EA did not guarantee the implementation of O&Ms, as evidenced by the finding that 41% of ECM grantees did not maintain their O&Ms. Where long-term O&M efforts exist it tends to be due to the presence of an effective energy manager.

Similarly, TA reports often did not provide the technical details for a comprehensive energy conservation program. For example, only 42% of the TAs reviewed recommended a full range of possible ECMs, and only 39% of them recommended O&M activities beyond those in the EA. This finding was further supported by the observation that TA analysts often did not coordinate their efforts with institution staff. For such cases, energy savings were reduced by as much as 8 percentage points compared to other grantees.

ECM grantees made four types of conservation improvements: (1) modifications to the building envelope (e.g., structural modifications to windows, doors, roofs and walls); (2) improvements to mechanical systems (e.g., boilers, pumps, HVAC systems); (3) changes (e.g., conversion from incandescent to fluorescent lighting) or reductions in lighting; and (4) installation of special systems (e.g., solar or alternative energy systems). Improvements to mechanical systems tended to be the most common types of ECMs undertaken.

Several factors affected institutions' decisions about which ECMs to install. In addition to cost effectiveness, ECM selection was influenced by the availability of matching funds, the degree to which the building's normal operating schedule would be disrupted by the ECM installation process, the degree to which the ECM might be affected by the institution's ongoing repair and maintenance schedule, and the degree to which the institution planned to install the ECM with its own funds.

Effective and Continued Operations and Maintenance Programs Increased Energy Savings

Field survey teams observed that several ECM grantees were not maintaining the O&M measures recommended in their energy audits. This group saved an average of 3.2% compared to an average of 15.6% savings experienced by grantees observed to be keeping up with the O&M measures recommended in their audits ($p<.05$). Institutions observed to be maintaining O&M measures beyond those resulting from the energy audit experienced 15.9% average savings, compared to an average savings of 7.7% for those who did not pursue O&Ms beyond the energy audit ($p<.05$). This finding is further supported by the energy savings and cost effectiveness of schools and hospitals when examined independently.

Effective Monitoring and Metering Increased Energy Savings

Although the EA, TA, and ECMs were intended collectively to facilitate reductions in energy consumption, very few institutions were found to have the administrative or mechanical capacity for systematically monitoring and controlling the major factors that may cause high consumption. In the cases where monthly, seasonal, or--more often--annual monitoring of consumption is performed, there does not seem to be an effective application of the resulting knowledge for the purpose of reducing energy consumption. Whereas 47 percent of the ECM sites reported some type of monitoring activities, only 18 percent actually metered energy performance. In other words, it is doubtful that timely investigation and correction of inefficient hardware operation results from the monitoring activities.

The ECM grantees that maintained records of energy use and used those records to measure energy performance experienced higher levels of energy savings than those that did not monitor. Data analysis shows that grantees conducting monitoring saved an average of 11.9% as opposed to 7.5% for those that did not monitor ($p<.05$).

WHAT SECONDARY GOALS WERE ATTAINED

The ICP Stimulated Energy-Saving Activities

Seventy-two percent of the ECM grantees reported that they would not have undertaken their ECM projects within 5 years without ICP funding. This information indicates that the Program played a dominant role in the savings that were achieved.

Beyond the actual energy savings achieved, it appears that the ICP has increased the awareness and interest of administrators in energy conservation. For example, 53% of ECM grantees reported that they had no energy conservation program prior to ICP. However, since participating in the ICP, 45% of the grantees had implemented non-ICP funded projects and 65% had specific energy conservation projects planned for the future. Fifty-four percent of the ECM grantees showed evidence of energy conservation awareness in the form of reminder signs and posters throughout their buildings.

Interest And Expertise In Energy Conservation Has Grown Considerably

SEO personnel reported that the benefits of the ICP extended beyond actual fuel savings for participating institutions and included increased training and support of energy conservation specialists (engineers, auditors, and monitors), and generation of basic data bases on building profiles and energy consumption on a State-by-State basis.

In addition, several States have initiated energy conservation programs as a result of the ICP. Although designed around the ICP, these State programs may include alternative funding mechanisms such as low-interest loans, revolving loans, and shared savings, as well as direct grants to institutions. SEO staff attribute to ICP an increased interest in the potential for energy savings in non-eligible facilities.

WHAT WAS LEARNED ABOUT PROGRAM ADMINISTRATION?

Interviews with personnel in the SEOs and with staff at participating institutions provided that extra dimension of knowledge about implementation so valuable to any Federally administered program. The States varied considerably in their administration of the ICP--notably in the areas of methods for procuring matching funds, collecting baseline data on eligible participants, reviewing applications, developing energy audits, and conducting auditor and analyst training--and these variations complicated the evaluation effort. A synthesis of the information gathered about Program administration can be summarized in the following general findings:

The ICP Was Well Received and Attracted Widespread Participation by Institutions.

Throughout the administrative process interviews, SEO officials stated time and again that the ICP was one of the best run and most useful programs of its type. During Cycles I and II more than 65,000 EAs were conducted nationwide. In the 10 sample states EAs of 27,000 buildings or 25% of eligible institution buildings were completed. About 5,300 TA grants covering 14,000 buildings and 2,853 ECM grants covering nearly 6,800 buildings were awarded nationally. In the 10-State sample 779 ECM grants covering 1,642 buildings were made. However, there were more than twice as many ECM applications as could be funded. Reasons cited by SEO personnel for high participation rates included mandatory participation by State Departments of education and widespread publicity and Program monitoring.

Barriers to Implementation Were Revealed.

SEO staff also cited several factors that they perceived as barriers to participation by institutions. The four major ones were:

- excessive paperwork;
- fear of Federal or State intrusion into operations;
- lack of funds to meet the Program's 50% match requirement, and
- lack of financial incentives for local government and public care facilities.

These factors were confirmed as barriers in conversations with institution personnel.

SEO personnel identified several concerns with Program implementation, such as the inherent restrictiveness of all Federal program regulations, administrative inconsistencies in review procedures, recurring changes in Program funding levels and regulations, and the often limited size of their own staffs. These concerns were viewed largely as administrative details, and SEO personnel maintained that they had no substantial impact upon Program results.

Chapter 1

INTRODUCTION

1. INTRODUCTION

OVERVIEW

In October 1981, the U.S. Department of Energy (DOE) contracted with Opportunity Systems, Inc. (OSI) and The Synectics Group, Inc. (TSG) to evaluate Cycles I and II of the Institutional Conservation Program (ICP). The Program provides assistance and matching funds to help four types of non-profit institutions reduce their energy consumption. On the basis of analyses of institutional records, on-site assessments, and interviews with State and institution administrators, evaluators assessed the implementation of the Program, the impacts of the ICP and estimated the energy savings participating institutions achieved using data collected from Cycles I and II Participants. This report presents the findings and conclusions of the ICP evaluation.

THE INSTITUTIONAL CONSERVATION PROGRAM

The Institutional Conservation Program (ICP) is a voluntary grant program to assist nonprofit institutions--schools, hospitals, local governments, and public care facilities--save energy. "For profit" institutions, unaccredited schools, buildings constructed after 1977, and special-purpose units of local government are not eligible to participate in the ICP. Authorized by the National Energy Conservation Policy Act of 1978 (NECPA) and administered by DOE through State Energy Offices (SEOs) the ICP provides energy audits and grants for detailed energy analyses (technical assistance) and for installation of energy savings capital improvements to eligible institutions. Participation in the grant phase of the program generally requires a 50% match of funds from recipient institutions. The initial authorization for the ICP was $965 million, although funds appropriated by Congress have been substantially less.

Non-profit institutions use significant amounts of energy and these energy costs represent large proportions of their operating budgets. Therefore, the ICP was intended to provide incentives to nonprofit institutions to take steps to conserve energy. Unlike businesses or residential consumers, these institutions pay no taxes, and are thus ineligible to apply for the conservation tax credits. In addition, many nonprofit institutions have difficulty financing capital improvements because they have limited capital budgets, uncertain income and limited borrowing capacities.

While the primary goals of the ICP are to save energy and reduce dependence on imported fuels, additional benefits are expected, namely: reduced energy costs for participating institutions, an improved technical capacity for managing energy use in institutional buildings, and an enhanced level of expertise regarding energy conservation among professionals in related industries.

The ICP is administered by DOE through the 50 States, the District of Columbia, Puerto Rico, Guam, the Virgin Islands, and American Samoa. In order to qualify for funding, States had to prepare State plans which were approved by DOE. States had latitude in how they administered ICP, but final selection for grants was made by DOE based on State recommendations. Nevada was the only State that elected not to participate in the first two cycles of the Program.

As required by Program regulations, the ICP has been conducted in four phases: (1) preliminary energy audits (PEAs), (2) energy audits (EAs), (3) technical assistance analyses (TAs), and (4) energy conservation measures (ECMs). Funding was made available for activities in all four phases. Institutions had to participate in each of the phases sequentially in order to be eligible to participate in succeeding phases.

- <u>Phase 1: PEAs</u>--The preliminary energy audit phase involved information-gathering that determined the size, functional use, and energy consumption characteristics of eligible buildings. Eligible institutions completed general energy profile survey forms.

- <u>Phase 2: EAs</u>--Energy audits involved more detailed information gathering on energy consumption characteristics. They also identified low-cost/no-cost energy-conserving operating and maintenance procedures (O&Ms) and assessed whether the institutions would benefit from technical assistance grants. PEAs and EAs were funded by the program either with direct financial support or by providing a SEO-trained auditor to the institution.

- <u>Phase 3: TAs</u>--The detailed technical assistance (TA) analysis, which examines conservation opportunities in detail, is performed by a licensed engineer or other qualified professional. Potential energy conservation measures (see below) and their associated costs are identified and the most suitable are recommended. The TA also seeks out additional O&Ms not identified in the EA phase.

* Phase 4: ECMs--In the fourth phase, energy conservation measures are installed in institutional buildings. ECMs are defined by the ICP as any physical modification or installation of equipment that reduces energy use and that involves a payback period of more than one year. Examples are HVAC system modifications and equipment replacements, insulation, solar systems, automatic controls, etc. DOE funded ECMs on a competitive basis, according to several factors, the most important being the period of time required for the measure to pay for itself through energy savings (the "payback period")*, as determined by the TA analysis.

PROGRAM PARTICIPATION

Table 1.1 summarizes the ICP activity for its first cycles (fiscal year 1979-82). It shows the number of institutions covered, number of grants awarded, and amounts of funding for each program phase. As Table 1.1 indicates, PEAs and EAs were funded only during the first two cycles. Most funds have been used for grants for ECMs. More than $378 million has been distributed to institutions to help finance conservation improvements.

OTHER BACKGROUND INFORMATION

Appendix A contains more details on the Program's history, including information on project selection criteria and the allocation of funding; the regulatory history of the Program; the Program responsibilities of DOE, State energy offices, and institutions; variations within the program; and the events that led to the ICP evaluation.

ICP EVALUATION OBJECTIVES

The ICP evaluation's four primary objectives were to:

* Provide an assessment of Program operations and an analysis of Program results.
* Collect information to prepare a report on ICP that quantifies and correlates field data, and that features case histories, the extent of administrative success, and other such anecdotal information, as appropriate.

*The average simple payback in Cycle I and II ECMs was projected to be about 4.5 years.

TABLE 1.1 ICP GRANT CYCLE DATA

	Cycle I	Cycle II	Cycle III	Cycle IV
PEA/EA				
Number of institutions covered - PEA	117,000			
Number of institutions covered - EA:				
Schools	53,460		NO* AWARDS MADE	NO AWARDS MADE
Hospitals	3,392			
Local Government	5,880			
Public Care	2,428			
TOTAL	65,160			
Actual Awards				
Schools/Hospitals	$ 18,000,000	$ 4,700,000		
Local Government/Public Care	6,400,000	6,400,000		
TOTAL COMBINED (PEA/EA) AWARD	$ 24,400,000	$11,100,000		
IA				
Schools/Hospitals				
Number of Grants Awarded	2,755	1,677	1,125	408
Number of Buildings Covered	6,635	4,985	3,436	1,307
Local Government/Public Care				
Number of Grants Awarded	404	473	254	N/A
Number of Buildings Covered	1,196	1,620	1,299	N/A
Grant Amount ($)				
Schools/Hospitals	$ 20,947,372	$13,590 695	$11,085,063	$3,300,000
Local Government/Public Care	3,061,973	3,029,741	1,968,029	N/A
	$ 24,009,345	$16,720,436	$13,053,092	$3,300,000
ECM				
Schools/Hospitals **				
Number of Grants Awarded	1,306	1,547	2,288	1,129
Number of Buildings Covered	2,540	3,419	6,167	3,004
Grant Amount ($)	$ 90,316,516	$90,377,969	$144,525,284	$43,000,000

Sources: U. S. Department of Energy, Institutional Conservation Programs Division. Title X Sunset Provisions. Prepared by EG&G Corporation, Idaho. Under BRC No. EF0104000

*Although PEA and EA activities are still being carried out in some locations, funded mainly by States with holdover monies, DOE stopped underwriting them at the beginning of Cycle III.

**Grant assistance for ECMs was only available to schools and hospitals during the first two grant cycles.

- Provide a basis for developing a guidebook for future ICP participants, as well as designers and users of similar energy-conservation programs.
- Provide DOE headquarters staff with feedback on Program operations and results.

The evaluation tasks that support these primary objectives and that were used to evaluate various program activities are presented in Table 1.2.

STRUCTURE OF THE REPORT

The chapters that follow describe the evaluation and its results.

- Chapter 2 presents a brief description of the methodology and procedures used in the evaluation.
- Chapter 3 contains evaluation conclusions and findings obtained by means of site visit observations and data analyses.
- The Appendices contain details on Program history, and additional information about the evaluation methodology, the survey instruments used in the evaluation, assumptions underlying the analysis, and a glossary of terms used in the study.

TABLE 1.2 ICP PROGRAM AND EVALUATION ACTIVITIES

Program Actitivies	ICP Evaluation Activities	Meet Evaluation Objectives*
1. Assist SEOs in developing and implementing State plans.	1. Interviewing SEO and Regional officials.	I, IV
2. Conduct EAs at nonprofit institutions to determine operating and maintenance changes to reduce energy consumption.	2a. Sampling, collecting, and "computerizing" of detailed information from EA forms in 10 selected States.	I, II
	2b. Conducting telephone interviews with sampled EA institutions participating in Program Cycles I and II to determine changes in energy consumption resulting from EA activities.	II
3. Provide TA grants for detailed engineering analysis of: - Applicability and completeness of O&M measures recommended in EA phase. - Potential for energy savings through use of energy conservation measures.	3a. Performing brief review of TA reports conducted at EA institutions to compare the O&Ms recommended in TA and EA reports.	I, III, IV
	3b. Performing detailed engineering analysis of a sample of TA reports from institutions receiving ECM grants.	I, III
	3c. Conducting site visits of ECM grant recipients to compare actual conditions to those recorded in the TA reports.	I, III
4. Provide ECM grants to implement conservation measures that will reduce energy consumption at participating institutions.	4a. Reviewing ECM grant applications for technical quality and conformance to program regulations.	I, III, IV
	4b. Conducting site visits of completed ECM grants to determine performance of measures funded.	I, II, III, IV
5. Disseminate and publicize the energy conservation potential at nonprofit institutions nationwide.	5a. Interviewing State, Regional, and Headquarters officials to determine techniques used to publicize the ICP.	I, IV
	5b. Developing detailed guidebook on the successes and problems related to different types of O&M measures, EMCs, TA review procedures, and related administrative approaches taken by SEOs and participating institutions.	III

*Evaluation Objectives Key

I. Assess program operations and results.

II. Gather quantitative data for analysis of energy savings.

III. Compile information for "How-to" guidebook.

IV. Provide DOE headquarters with feedback on Program operations.

CHAPTER 2

THE ICP EVALUATION

2. THE ICP EVALUATION

OVERVIEW OF THE EVALUATION

The ICP evaluation has five major methodological components:

1. Sample Selection--The survey methodology for sampling States and evaluation sites within those States was designed in a scientific manner so that results could be extrapolated to the ICP nationwide for the EA phase, and Cycle I and II ECM grantees with completed projects as of September 30, 1981. However, limitations of the telephone survey efforts ultimately restricted EA findings.*

2. Examination of Administrative Procedures--State energy offices personnel in selected States were interviewed to determine similarities and differences in Program administration.

3. Evaluation and Data Collection at Sample Sites--Data were collected and institutional personnel interviewed at sites that had undergone experience with the EA phase of the ICP and with the EA plus ECM phases. Information was gathered both by telephone and through on-site visits.

4. Analysis of Data--Information on fuel use before and after the ICP was analyzed in conjunction with observations made in the field. A wide range of findings were sought on administrative procedures, institutional implementation of the program, and energy consumption results.

5. Report Writing--The various kinds of quantitative and qualitative data were used as the basis for preparing the report and will be used in preparing the ICP guidebook.

*See Institutional Conservation Program: Analysis of the Impact of the Energy Audit in Selected Institutions, prepared by Opportunity Systems, Inc.

The remainder of this chapter presents a brief description of the following topics:

- The sampling methodology
- The procedures undertaken to collect information and data on implementation of the Program at various study sites
- The problems encountered in the course of the evaluation
- The nature of the evaluation's data base

Details of the methodology are presented in Appendix B.

The evaluation was broadly divided into two components: telephone survey work and site visit investigations. OSI had responsibility for the telephone survey, and TSG was responsible for the site visit evaluation. The primary focus of this chapter, and of the succeeding findings and conclusions, is on the site-visit evaluation, conducted by TSG. The telephone survey methodology and results are discussed in a separate volume prepared by OSI: Institutional Conservation Program: Analysis of the Impact of the Energy Audit in Selected Institutions. However, reference is made to the telephone survey activities when it will to help the reader understand the flow of the evaluation.

SAMPLE SELECTION

A sample of more than 2,000 institutions in 10 States and 8 Federal Regions was selected using the statistical methodology described briefly below (see Appendix B for details). This sampling plan was submitted to DOE/OMB for approval. Approval of the current sampling plan and survey instruments was received in April 1982.

In determining the institutions from which data would be collected for the ICP evaluation, a two-stage sampling plan was developed to maximize both cost efficiency and statistical validity. It was designed to enable reliable generalizations to be made about the Cycle I and II grant recipients and ECM projects completed by September 30, 1981, nationwide. In addition, the sample structure allows acceptably precise estimates of ICP's impacts upon schools and hospitals that progressed through the ECM phase.

Sampling was performed in two stages: first, States were selected; second, sites within States were selected. Both are discussed in the sections that follow.

State Selection

Because ICP grants are administered on the State level, States were chosen as the Primary Sampling Units (PSUs) for data collection. After consultation with DOE, it was determined that 10 States would provide the maximum number of PSUs compatible with time and budget constraints.

The selection of States was partially a function of the ICP population within each State. This determination was made in order to maximize coverage of institution types and ECM installations within the 10-State sample. Thus five of the 54 States and Territories (New York, Illinois, Minnesota, Oklahoma, and Virginia) were chosen with certainty, as they contained the largest number of each of the five target populations (the four institutional types and completed ECM sites). The remaining 49 PSUs were grouped into five strata of approximately equal size and climatic conditions. One State was chosen from each stratum with a probability of selection proportionate to the size of the population of ICP participants. These states are Utah, Rhode Island, Florida, Missouri, and New Mexico.

Site Selection

EA Sample

For details of the EA sample design and selection refer to Institutional Conservation Program: Analysis of the Impact of the Energy Audit in Selected Institutions, prepared by Opportunity Systems, Inc.

ECM Sample

The sampling unit for this phase was defined as an ECM grantee with a Cycle I or II ECM installation completed by September 30, 1981. Telephone inquiries of SEOs provided an estimate of approximately 1,000 such grantees nationwide, 400 of which fell within the 10 selected States. In view of the relatively small size of this ECM universe (DOE had originally proposed a sample of 1,000 ECM grantees), it was decided to modify the sampling scheme in collecting baseline ECM information; background data would be collected from the 400 completed ECM installations within the 10-State sample. The site visit sample included 150 ECM grantees and 50 EA-only sites.

Modification of the Site Visit Sample

The original sample of 200 site visits was modified by respondent refusals to equal a 94% response rate of 188 buildings. The total sample of 188 site visit buildings included 44 EA-only sites and 144 ECM sites. Due to sample design and States' definitions of "buildings," multiple buildings of a complex often were included in the sample. In many cases, on-site investigation determined that central metering at the complex precluded the identification of energy data for individual buildings. Therefore, the 188 site visit buildings ultimately accounted for 168 evaluation sites: 43 EAs and 125 ECMs.

Several problems resulted in a further reduction of the sample. Although every effort was made to collect complete and appropriate energy data from institutions during the site visits, it was not always possible to do so. In addition, at some sites it was discovered that ECM installations had been complete for such a short time that adequate comparison of base and latest year consumption data was not possible. In a few larger school districts and local government buildings, respondents did not have access to energy consumption records that generally were kept by central accounting offices.

Finally, data problems arising during analysis precluded the use of some sites from the data base. Therefore, the final data base include 136 evaluation sites (80% of the total sample): 24 EAs and 112 ECMs.

Because the EA data base includes only 24 institutions, no attempt is made to project the findings to a national population. However, appropriate weighting has been applied to ECM institutions; and results may be projected to represent all Cycle I and II ECM institutions with completed projects as of September 30, 1981, nationwide.

PROCEDURES FOR GATHERING DATA

Administrative Process Interview

An evaluation team visited the State Energy Office (SEO) in each of the 10 States to interview personnel about issues related to administration of the ICP. Background information, administrative histories, and opinions on Program performance were solicited, with an emphasis on distinguishing State-by-State variations.

Gathering Information on Study Sites

While the administrative process interviews were taking place, other team members were microfilming data in the same 10 States. Using the sampling plan, they recorded all documents (PEA, EA, and TA reports and ECM grant applications) filed by the institutions in the sample. Data elements from the microfilmed documents were analyzed, coded, and entered into a computer data base. In the process, missing, incomplete, and/or obviously inaccurate information was flagged. Those pieces of data considered essential to the evaluation were pursued in later contacts with personnel from the institutions.

Telephone Interviews

A sample of participants in the EA phase of the ICP was cho[illegible]r telephone interviews. An interview appointment was set up in adva[illegible]th the most appropriate staff members at each institution. Using [illegible] OMB-approved questionnaire, telephone interviewers at OSI sought information on the results of the Program (e.g., which O&Ms were implemented, effects on energy consumption, administrative procedures, other conservation measures undertaken), as well as other physical changes that may have affected energy usage. At the same time, interviewers attempted to clarify data that were missing or otherwise unsatisfactory in the original EA report.

Site Visits

Site visits were scheduled for maximum efficiency and proximity among study sites. Thus, although the EA and ECM site visits are discussed separately below, the same study teams visited both, as geographically convenient.

TA Review

Before all site visits, TSG's engineering staff analyzed the entire package of documents relating to each institution to be visited. The TA report underwent special scrutiny prior to ECM site visits (see below). The analysis prepared the survey team for what they should expect to see in the field; it also provided insight into the approach taken to the TA, as well as the range of ECMs originally suggested.

EA Site Visits

In order to assess the appropriateness and effectiveness of reported O&Ms, a sample of 44 EA institutions selected for the evaluation was visited by survey teams to perform an on-site inspection. Institution personnel were administered the same questionnaire that was used in the telephone interviews. (The "site visit" institutions were not part of the "telephoned" sample.) As in the phone interviews, missing or otherwise unsatisfactory data were pursued. Because of the more personal nature of the site visits, a significant amount of anecdotal information was proffered, data that are of great utility in developing case studies, in evaluating the results of the ICP, in providing qualitative information to support findings, and in producing the guidebook.

ECM Site Visits

In order to assess the appropriateness, effectiveness, and maintenance of reported O&Ms and installed ECMs, 150 of the pool of completed ECM sites were selected for site visits. The detailed design of the site visit sample was finalized after collection and preliminary analysis of baseline data. ECM institutions were stratified according to size (gross floor area), dollar cost of project, and type of ECM. Cases were selected randomly within strata for each subpopulation to produce a distribution across States and institution types which is proportionate to that described in Appendix B (see "Survey Design"). The results of this selection process are displayed in Table 2.1.

On the basis of sample selection design, approximately half of the institutions that completed Cycle I and II ECMs in the 10 selected States were visited by survey teams. Using an OMB-approved questionnaire, the team members sought detailed information on each conservation measure implemented and on long-term continuation of the O&Ms recommended in previous program phases. Particular attention was given to obtaining accurate pre- and post-installation energy use data. Valuable anecdotal information on Program operations and energy conservation techniques also was collected during these site visits.

Follow-Up Site Visits

All ECM site visit institutions that showed apparent increases in their energy use since ECM installation were analyzed to determine the causes for increased consumption. Activities in this task included: review of both computerized and raw field data for errors; analysis of existing data to determine if

TABLE 2.1 SAMPLE SIZE FOR ECM AND EA SITE VISITS BY STATE

	Original Number of Buildings in Sample			Number of Site Visit Buildings[1]			Number of Sites Visited[2]		
	TOTAL	ECM	EA	TOTAL	ECM	EA	TOTAL	ECM	EA
Missouri	25	15	10	19	15	4	18	14	4
Florida	28	19	9	28	19	9	24	15	9
Utah	13	11	2	13	11	2	13	11	2
Virginia	20	18	2	17	15	2	15	13	2
New Mexico	26	20	6	26	20	6	18	12	6
Oklahoma	19	16	3	18	15	3	17	14	3
Minnesota	20	15	5	19	14	5	19	14	5
Rhode Island	19	13	6	19	13	6	15	10	5
New York	7	5	2	7	5	2	7	5	2
Illinois	24	18	6	22	17	5	22	17	5
TOTALS	200	150	50	188	144	44	168	125	43

NOTES

[1]The difference in the original site visit sample and the number of site visits is as follows:

- Missouri - 1 EA site refused the visit
  5 EA sites were recommended after all other site visits in the State were completed
- Virginia - 3 ECM sites refused the visit
- Oklahoma - 1 ECM site was dropped from sample due to incomplete project status
- Minnesota- 1 ECM site was cancelled due to weather
- Illinois - 1 ECM site and 1 EA site refused the visit

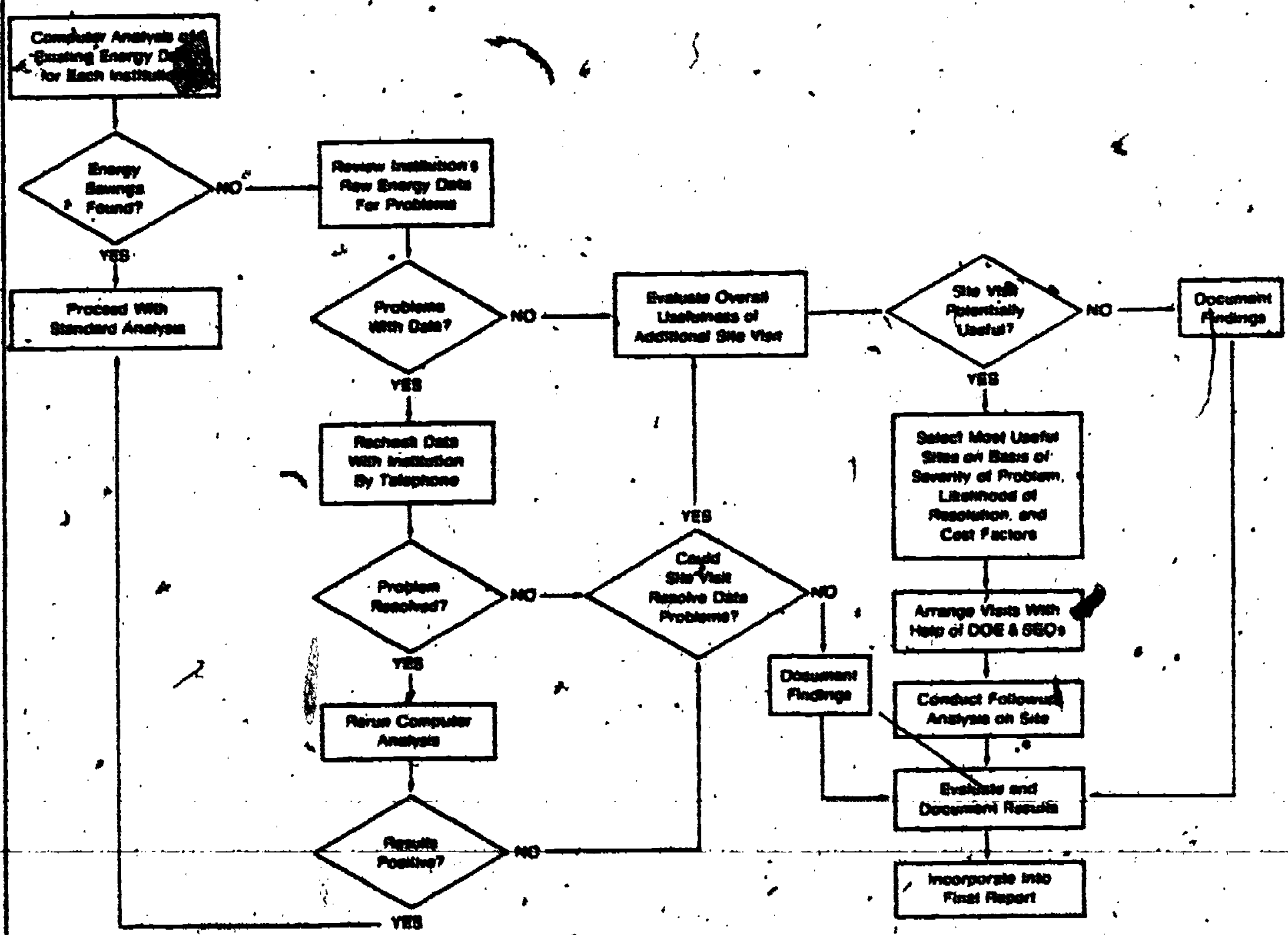
[2]The difference between the number of site visit buildings and actual site visits is as follows: Where more than one building of a complex is included in the sample, but fuel consumption metering was provided only for a complex, the number of buildings was counted as 1 site.

increases were due to changes in weather, institution square footage, building utilization, and/or metering; visits to selected institutions to verify initial analysis and identify internal technical factors that could have contributed to increases; evaluation of the data; and identification of the actions necessary to improve ECM operations and performance. Figure 2.1 presents the analytical procedure used for institutions with apparent increases in energy usage.

This analysis resulted in selection of five ECM sites for return visits. Three of these were hospitals, one was an all electric high school and the remaining one was a chemistry building on a university campus.

The follow-up site visits allowed approximately two days at each institution for the evaluation team's engineer to fully explore the energy systems and reassess the accuracy of the energy data previously used for determining the results of ICP participation by the subject institution.

FIGURE 2.1 ANALYTICAL PROCEDURE FOR INSTITUTIONS WITH INCREASED ENERGY USAGE



One major purpose of the return visits was to determine whether there were specific installation, technical or management/operational explanations for the less-than-expected energy consumption results subsequent to the installation of ECM's at the selected sites.

A secondary product of the return visits was a quality control check on the findings of all site visits performed during the ICP evaluation. The degree of change in overall findings, at this small sample of facilities, between an extended follow-up visit and a relatively short initial visit provides some level of confidence in the adequacy of the shorter visits as an evaluation method for the total of all sites visited.

ANALYSIS

Three types of data have been identified for evaluating the performance of ICP participants. First, quantitative data on fuel consumption identifies the savings of electricity, natural gas, oil, and other fuels that were achieved throughout participation. Second, data on building characteristics, administrative procedures, on-site observations by survey teams, and results of the TA review were included in the computerized data base for the purpose of cross-correlation with the fuel consumption data. Third, ancedotal information is essential to case studies and technical guidance reports, and has been used to amplify and interpret evaluation results.

The analysis consisted of the following principal procedures:

- Raw energy data were processed for each site using VISICALC software; this produced BTU totals by energy type for the base year and latest year.

- Totals for the raw energy data, along with building characteristics and administrative and technical field observations, were coded for entry into the Statistical Analysis System (SAS) software.

- SAS was used as the primary analytic tool. Three kinds of SAS programs were used for various parts of the analysis:

  - Frequency distribution, which displays the number and range of values for each variable
  - Univariate analysis, which calculates sums, means, and other statistical features for each variable
  - Correlation analysis, which is used to calculate and test the significance of relationships between two variables, using linear regression.

- The three SAS programs were used to produce analyses of the following types:

- Energy and cost savings for the entire data base;
- Correlation between ECM cost, institution size, and energy and cost savings;
- Energy and cost savings comparisons between various subgroups within the data base, including:
  - ECM recipients and EA participants;
  - Schools and hospitals;
  - Types of ECMs;
  - Groups based on questionnaire responses (e.g., respondents answering "yes" or "no" to individual questions).

These analyses were conditioned by the following factors:

- Weighting factors designed to amplify results to represent the original sampling universe of Cycle I and II grantees; (see Appendix B, "Sample Design");
- Probability factors which determine the significance of correlations between two variables;
- Tests used to assess the significance of comparisons between subgroups such as ECMs/EAs, schools/hospitals, questionnaire responses, etc.

Figure 2.2 shows the evaluation plan schematically. Please refer to Appendix B for details of the evaluation methodology.

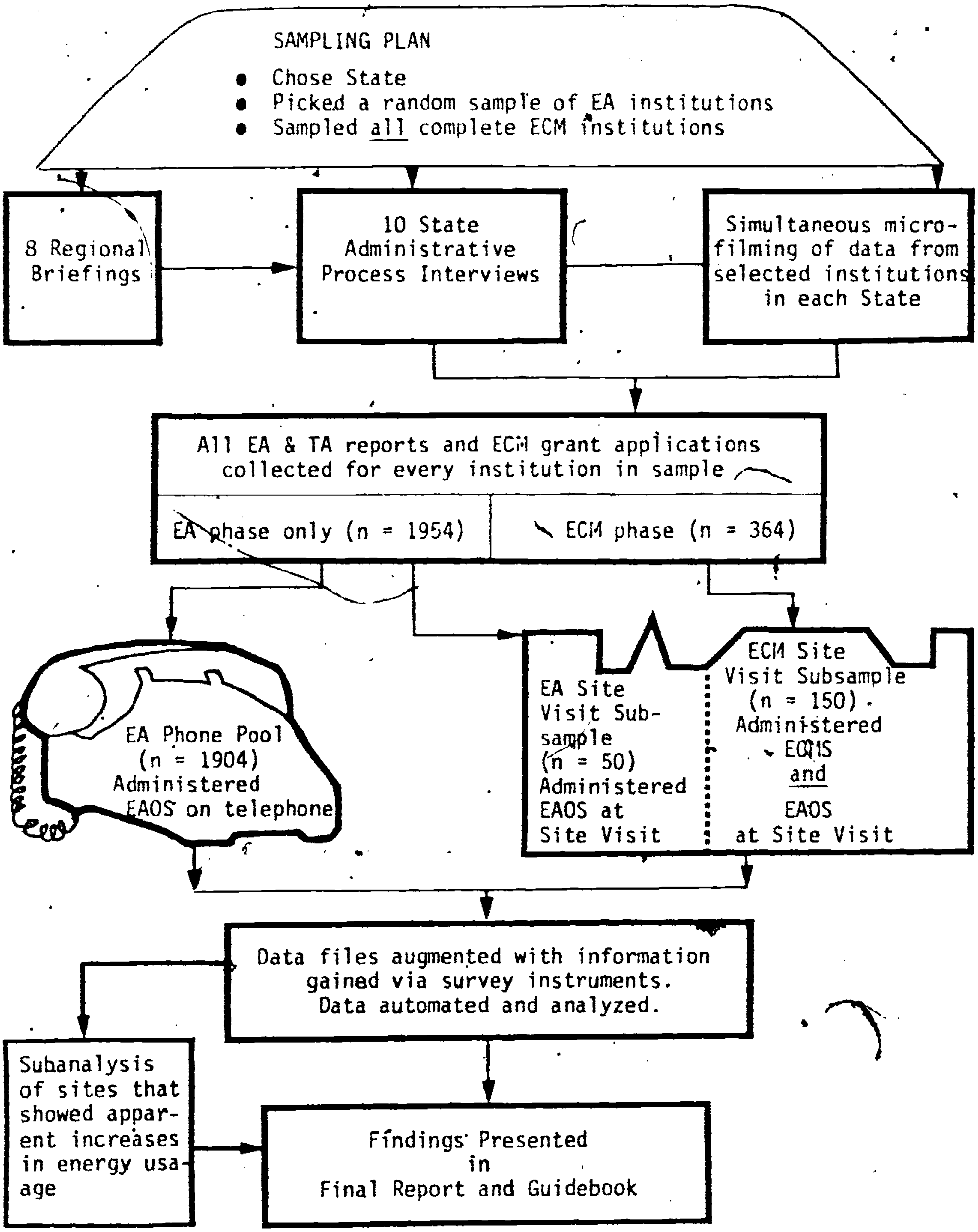
PRACTICAL PROBLEMS WITH EVALUATION IMPLEMENTATION

Certain circumstances had a bearing on the overall formulation and conduct of the ICP evaluation. Many of these problems arose from the wide variation of program administration at both the state and institution levels, and required some minor modification of evaluation strategies on a site-by-site basis as work progressed. Generally, however, these problems had no significant impact upon evaluation results.

Problems associated with the overall formulation of the ICP evaluation included:

- Preliminary evaluation planning during early 1981 determined that the ICP schedule and the length of time required to implement ECMs made evaluation of all cycles of the ICP impractical, since only 20% of funded ECMs had been completed by the start of the evaluation in October 1981. In addition, the majority of completed ECMs were those which had been funded during Cycles I and II. Thus, evaluators were instructed to look at only Program Cycles I and II.

FIGURE 2.2 SCHEMATIC DIAGRAM OF THE EVALUATION



EAOS = Energy Audit Output Survey

ECMS = Energy Conservation Measure Survey

- Records of energy consumption were incomplete and/or unavailable at certain types of institutions (e.g., public schools, small facilities).

- It was often impossible to isolate energy consumption patterns at a single building that was part of a centralized energy system for a larger campus or complex. However, this problem was mitigated during the final weighting of the site visit sample, and therefore, has no impact on evaluation results.

- The nature of energy consuming systems and energy conservation measures at many institutions makes it generally impossible to associate specific O&Ms or ECMs with definite increments of energy savings. As a result, the evaluation has had to focus on general conservation performance by participating institutions.

- In the case of certain fuel types (especially fuel oil), purchases are on a seasonal or irregular (as-needed) basis, causing problems in breaking down fuel consumption to a monthly pattern.

- Personnel at institutions that participated only in the EA phase often evidenced lack of interest in and a limited memory about Program events.

- Some site visits to schools occurred during vacation months when buildings were not in use, causing difficulties in checking on O&M implementation and ECM operating effectiveness.

- States did not use uniform EA or TA formats, and some States used EA checklist formats that do not lend themselves to analysis or field inspection.

- The original design of the ICP makes selection of an ideal control group impossible. As a result, no control group is available to use in comparing energy consumption patterns between participating and non-participating institutions. However, a review of existing data on institutional energy conservation, including various SEO evaluations of the ICP (comparing energy performance of participants and non-participants within States) provides an opportunity to examine energy use trends and to compare the effectiveness of ICP with these trends.

Other problems were specific to the site visits:

- In many cases, site visit time had to be spent clarifying fuel consumption data.

- In about 20 percent of the site visits the respondents had not yet prepared the requested energy data but agreed to do so and mail it. In a few cases, respondents were able, during the visit, to provide data in a format from which evaluators felt they could obtain the necessary information.

- Another 25 percent of the visits required time with the respondent to resolve one or more areas of apparent discrepancy in the data, such as the units in which a fuel was reported, or the reason why use of a certain type of fuel was initiated or terminated during the course of the data period.

- In a few cases, site visit time was used to sort through and copy data from a collection of utility bills or fuel delivery invoices that had not been organized or reviewed by the respondents. Generally, such records lacked important information, or it could not be determined reliably that all the data were present, particularly where fuel deliveries were made on an irregular basis.

- Often, considerable site visit time had to be spent identifying changes in utilization, floor space, or energy-using equipment that might have occurred since the base-year period of energy data.

  - Hospitals were especially difficult to assess in this regard because ongoing modernization changes frequently involved the relocation of equipment into new spaces, as well as the replacement (or addition) of more energy-intensive equipment. The direct change in energy consumption is seldom documented and the indirect effects on heating or cooling are not measured. Therefore, due to their dynamic utilization patterns, many hospitals show changes in energy use that is not evaluated easily.

- At some institutions, the staff had changed since ICP participation began, and information on implementation dates, building modifications, and energy changes was for that reason unobtainable.

- Another frequently encountered difficulty was determining an accurate basis for allocating energy use to specific buildings where central metering and/or a central heating/cooling plant was employed.

  - In cases where both the square footage of the specific building as well as the area of the total metered complex had changed, it was sometimes not possible to be certain of the prorating method applied by the original energy auditor and, therefore, it was difficult to apply an equivalent method to later data. In addition, many institutions simply have not had a previous need to measure their buildings or maintain documentation as renovations, changes, additions, closings, etc. have occurred.

- Few individual ECMs can be validated for their specific energy saving contribution because of the lack of energy consumption monitoring preceding and following implementation.

  - The likelihood of confirming the accuracy of projected results from particular ECMs declines as facility complexity increases. Even in rare situations where only one ECM was installed, a lack of control over all other variables (or at least the documentation of concurrent changes in these variables) makes verifiable results of the ECM difficult. In facilities where usage and equipment are constantly changing (and hospitals are particularly dynamic in this regard), energy consumption patterns are continually in flux. In such cases, it is frequently impossible to separate out the effects of specific conservation activities.

- Changes in building use interact with energy conservation, and true results are virtually impossible to quantify. For example, implementing energy conservation measures in a school gymnasium that also make it more attractive or comfortable may result in more use of the gymnasium, thereby increasing its overall energy consumption.

CHARACTERIZING THE DATA BASE

Definition of the Evaluation Population

This evaluation is based on a sample of ICP participants from Cycles I and II. The sample includes:

- A sample of ECM grantees whose projects were completed by 9/30/81.

- A sample of selected EA-only participants.

In the evaluation's analytic process, the ECM grantee sample was weighted to represent the national total of 1,012 Cycle I and II grantees whose projects were completed as of 9/30/81. Usually there is a one year time period between grant award and ECM completion. For schools, this "lag" time is explained by the fact that any construction and equipment installation generally is scheduled to take place in summer when schools are not in session. Therefore, the number of ECMs completed when evaluation activities began was 1,012, compared to the total of 2,853 ECM grants awarded during the first two Program Cycles. To maintain clarity in reviewing the evaluation findings, the following considerations should be kept in mind:

- The term "ECM grantees" in the report means Cycle I and II grantees whose ECM projects were completed as of 9/30/81, number 1,012.

- Total Cycle I and II grantees number 2,853; hence the evaluation is based on 35% of all Cycle I and II grantees.

- Total ECM grantees in Cycles I through IV number 6,270; hence the evaluation is based on 16% of all ECM grantees to date.

Elements of the Data Base

As mentioned earlier, the ECM sample was stratified by institution type, institution size, project cost, and types of ECMs. This ECM site visit sample, comprised of 125 institutions (adjusted for multiple buildings), included 106 schools (48 elementary, 44 secondary, and 14 colleges/universities) and 19 hospitals. Included in the data base are 96 schools (42 elementary, 41 secondary and 13 colleges/universities) and 16 hospitals. Institution size ranged from 6,162 sq. ft., to 1,365,175 sq. ft., with a median value of 56,245 sq. ft., and project cost varied from $720 to $775,000, with median value of $28,222. The impacts of these factors on energy performance are discussed in Chapter 3. Finally, the ECM sample includes the range and combination of ECM types, which were categorized as building envelope modifications, mechanical changes, lighting modifications, and special systems ECMs. [Special systems include solar systems and other renewable fuels, as well as modifications to energy using systems such as swimming pools, laundries, and kitchens.] Discussions of these systems are found later in the "Findings" and "Case Studies" sections of Chapter 3.

The EA sample was stratified only by institution type; it was composed of 11 schools (4 elementary, 4 secondary, and 3 colleges/universities), 3 hospitals, 6 local government buildings, and 4 public care facilities.

As mentioned above, no attempts have been made to project the findings of the EA site visit survey to a larger population. Rather, analysis of EA sites has been conducted separately, and findings have been used to illustrate the ICP experience at selected EA sites.

Site Visit Respondents

In smaller school districts and particularly in the more rural areas, the most frequently encountered respondent was the school system's superintendent. Most of these administrators were able to handle the discussions by themselves but occasionally called upon other members of their staff, most often their facilities director, financial director, or chief maintenance supervisor. In many cases, the superintendent had personally prepared the documentation during the ICP process and was also reasonably familiar with the technical aspects of the buildings involved. In some cases, his office was either within one of the school buildings or at least nearby in a support services building so that he had essentially daily contact with the facility and an opportunity to observe its patterns of use on a regular basis.

In larger (generally urban) school systems the respondent was more likely to be the director of facilities and occasionally had invited the TA analyst to attend along with this maintenance supervisor. During the walkthrough inspections the respondent usually acted as the main guide but sometimes deferred to the building's key occupant such as the school principal.

In hospital site visits the main respondent was nearly always the facility's maintenance director. Also, he usually conducted the walkthrough with help from his staff if required on specific subjects.

CHAPTER 3

FINDINGS AND CONCLUSIONS

Energy Data Definitions

In general, the energy usage, energy savings, cost-effectiveness, and payback data in this report are based on recorded changes in energy usage at site visit facilities. These data have not been corrected for variations in weather conditions or other factors, such as minor changes in building operation or equipment, due to a lack of the detailed building data needed to establish accurate correction equations for each study site. In selected cases, however, weather correction is applied to help evaluate the performance of individual institutions.

Generally, energy data are calculated by using the 11,600 BTU conversion factor for electricity (the average number of BTUs expended at the generating plant that ultimately produces and transmits a kilowatt hour (kWh) of energy as metered at the user's facility). Therefore, this conversion method reflects the BTU requirements for overall production and transmission of electricity, rather than the BTU consumption of an individual facility. However, in specific cases, when the performance of individual institutions are discussed, energy savings are calculated on the basis of a kWh valued at 3,413 BTU, which reflects the metered kilowatt hour of electricity used by a facility.

The data results in the report are also subject to precision limits because of the weighting methods used for the analysis. In summary, then, data should be viewed with allowance for variations due to:

- Weather conditions.
- Changes in building operation and equipment.
- BTU conversion methods.
- Statistical precision limits.

Based on data available, these factors do not significantly change the quantitative findings in the report.

CHAPTER 3. FINDINGS AND CONCLUSIONS

PROGRAM GOALS

The ICP established two primary goals and predicted that their achievement and the concomitant publicity afforded the Program would result in the attainment of other, secondary, goals. The Program's primary goals are:

- To help participating institutions save energy and reduce energy-related costs.
- To conserve oil and thereby reduce the nation's dependence on imported fuels.

Examples of secondary goals arising from these are:

- The fostering of energy-conservation awareness, and the stimulation of energy-saving activities on a national scale.
- The advancement of energy conservation science: by expanding its technical base of knowledge and the expertise of its specialists.
- An improved technical capacity for managing energy use in institutional buildings.

Has the ICP been successful in achieving its goals? The findings and conclusions presented in this chapter determine the extent to which these goals have been realized. The discussion is presented in the following format:

- How Well Has the ICP Been Administered?
- Has the ICP Achieved its Primary Goals?
- What Secondary Goals Have Been Attained?

REVIEW OF FACTORS INFLUENCING RESULTS

The findings and conclusions of this evaluation must be viewed in light of certain predetermined factors, discussed in more detail elsewhere in this report, that may have an effect on results:

- The ICP funding formula required that 30% of Program funds in each State be set aside for hospitals. This resulted in greater competition among schools for remaining funds, and may have limited schools' grant amounts.
- Designers of the ICP intentionally focused on projects that would pay back quickly and that would promote the saving of oil; the findings are influenced by this orientation.

- The States were given some latitude in the way they chose to conduct Program activities.
- Only Cycles I and II were evaluated. The early phases of any program are typically fraught with start-up problems that become ironed out in later years.
- The evaluation has a very limited focus: it mainly analyzes the 1,012 ECM grantees that completed capital improvements by September 30, 1981. This population is only 35% of all the ECM grantees in Cycles I and II, and an even smaller percentage (16%) of all grantees to date (through Cycle IV). The EA institutions analyzed in this report represent less than .04% of all EA institutions participating in the Program to date.

HOW WELL WAS THE ICP ADMINISTERED?

In general, the ICP was considered by administrators and participants to be a valuable and well-run program. As discussed in the following conclusions, the Program achieved a high rate of participation of eligible institutions. Variations in its implementation, while they made evaluation more complex, sprang from a desire on the part of DOE to allow States as much autonomy as possible in running the Program. Several barriers to participation were identified. Although administrative procedures may have an influence on Program performance, the nature of the site visit sample does not allow the correlation of energy savings with program administration.

CONCLUSION: The ICP Reached a Large Number of Institutions During the First Two Grant Cycles

25% of Eligible Buildings Undertook EAs

During Cycles I and II, over 65,000 EAs were conducted nationwide. In the 10 sampled States, EAs covered almost 27,000 buildings, or 25% of the eligible buildings within the first two cycles of the voluntary energy conservation program.

Many TA and ECM Grants Were Awarded

Approximately 5,300 TA grants and 2,853 ECM grants were awarded nationally during the first two grant cycles, covering 14,436 and 5,960 buildings, respectively. In the 10 sampled States approximately 1,642 buildings were covered by 779 ECM grants, or approximately 2% of the total number of eligible schools and hospitals in those States. However, preliminary review of ICP data indicated that overall, twice as many applications were submitted as could be funded.

CONCLUSION: Administrative Practices and Arrangements Varied by State

The administrative process interviews sought to identify those variations in State program administration that may affect program performance within a State. Table 3.1 highlights these variations in program administration. As may be seen from the table, States used various methods for procuring matching program funds, collecting baseline profile data on eligible participants, reviewing applications, developing energy audits, and conducting auditor and analyst training.

States varied in the number and type of auditors and analysts they trained, as well as in the types of training programs presented. The total number of energy auditors and TA analysts trained during Cycles I and II in the 10 sampled States was more than 11,000. Table 3.2 describes the number and type of auditors and analysts trained by the 10 States during the first two Program cycles. Whereas institution administrators and technical personnel were trained as energy auditors, TA analyst training generally was limited to professional engineers and architects.

TABLE 3.1 ADMINISTRATIVE CHARACTERISTICS OF 10 STATE SAMPLES

FLORIDA

- WORKED IN PARTNERSHIP WITH FLORIDA POWER CORPORATION TO PERFORM EAS, 75% OF WHICH WERE PERFORMED BY INDEPENDENT AUDITORS
- STRICTEST GUIDELINES AND TESTING FOR AUDITOR AND TA ANALYST CERTIFICATION OF 10 STATES
- AUDITORS REQUIRED TO HAVE MINIMUM 5 YEARS OF BUILDING MAINTENANCE/MANAGEMENT EXPERIENCE OR ARCHITECTURAL OR ENGINEERING DEGREE
- RIGOROUS TESTING OF TA ANALYSTS
- FUNDED ECMS ON MEASURE BY MEASURE BASIS SO APPLICATIONS COULD BE MODIFIED TO INCLUDE ONLY THOSE JUDGED APPROPRIATE BY SEO

ILLINOIS

- STATE'S CONTRIBUTION WAS ALL IN-KIND SERVICES; 4 FULL TIME PERSONNEL STAFFED THE SEO.
- INDEPENDENT CONTRACTOR DEVELOPED EA TRAINING, AND DATA COLLECTION FORMS (DIFFICULTIES WITH CONTRACTOR LEFT SEO WITH INCOMPLETE RECORDS).
- ANY INSTITUTION REQUESTING REIMBURSEMENT FOR AN EA WAS REQUIRED TO AUDIT ALL OF ITS BUILDINGS.
- DID NOT PUBLICIZE AVAILABILITY OF HARDSHIP FUNDS. ONLY THOSE INSTITUTIONS REQUESTING ASSISTANCE WERE CONSIDERED FOR HARDSHIP.

MINNESOTA

- INDEPENDENT ENERGY AUDIT PROGRAM IN PUBLIC SCHOOLS PRIOR TO ICP. IN 1978, PUBLIC SCHOOLS WERE REQUIRED TO COMPLETE THE FEDERALLY PREPARED COMPUTER AUDIT PACKAGE, PUBLIC SCHOOL ENERGY CONSERVATION SURVEY (PSECS). IN 1979 FUNDS WERE MADE AVAILABLE TO OTHER NONPROFIT INSTITUTIONS.
- ANNUAL FUEL AND ELECTRIC RECORDS ARE FILED WITH SEO AND MINNESOTA DEPARTMENT OF EDUCATION (THEREFORE, PUBLIC SCHOOLS HAVE BEEN MOST ACTIVE PARTICIPANTS IN THE STATE).
- SEO SUPPLEMENTED ICP GRANT CYCLE FUNDING WITH MATCHING FUNDS FOR PARTICIPATING INSTITUTIONS.

MISSOURI

- INITIALLY STATE HAD DIFFICULTY LOCATING MATCHING FUNDS.
- STRONG STATE SUPPORT OF ICP BEGAN AFTER PROGRAM CYCLE II
- INSTITUTION REPRESENTATIVES TRAINED AS AUDITORS COULD NOT CONDUCT AN AUDIT AT THEIR OWN FACILITY.
- AUDITS GENERALLY WERE MORE GENERIC AND DID NOT ALWAYS ADDRESS AN INSTITUTION'S SPECIFIC NEEDS.

NEW MEXICO

- PSECS AUDITS WERE MANDATORY IN ALL PUBLIC SCHOOLS. THE SEO CITED THIS AS THE MAIN REASON FOR HIGH PENETRATION AND INCENTIVE FOR PROGRAM CONTINUATION.
- STATE SUPPORTED SCHOOLS ARE REQUIRED TO REPORT ON ENERGY CONSERVATION ACTIONS IN ANNUAL BUDGETS.
- STATE USES OTHER SOURCES OF FUNDS TO SUPPORT NON-ICP ENERGY CONSERVATION PROGRAM FOR LOCAL GOVERNMENT INSTITUTIONS.

TABLE 3.1 (CONTINUED)

NEW YORK

- SUBSTANTIAL STATE SUPPORT FOR ICP INCLUDED FULL TIME SEO STAFF OF 25.
- ADMINISTERED MORE ICP FUNDS THAN ANY OTHER STATE
- STATE APPROPRIATED PEA FUNDS PRIOR TO ICP; SEO FELT THAT ICP WOULD CONTINUE EVEN WITHOUT FEDERAL FUNDS.
- SMALL, INEXPERIENCED INSTITUTIONS SHOWED LOW PENETRATION BECAUSE OF EXCESSIVE PAPERWORK.
- LARGE BUREAUCRACIES (E.G., NEW YORK CITY) SHOW LOW PENETRATION FOR LOCAL GOVERNMENT BUILDINGS DUE TO DIFFICULTIES IN OBTAINING INTERNAL REVIEWS AND CLEARANCES.
- MANDATORY PSECS IN PUBLIC ELEMENTARY SCHOOLS CONDUCTED PRIOR TO ICP WERE APPROVED AS EAS, AND THEREFORE THOSE INSTITUTIONS WERE ELIGIBLE FOR TAS DURING CYCLE I.

OKALAHOMA

- STATE LEGISLATURE APPROPRIATED NO FUNDS TO SUPPORT ICP.
- PROGRAM AUTHORITY WAS DELEGATED TO APPROPRIATE EXISTING STATE AGENCIES: DEPARTMENT OF EDUCATION, BOARD OF REGENTS FOR HIGHER EDUCATION, OKLAHOMA HEALTH PLANNING COMMISSION, AND COUNCIL OF LOCAL GOVERNMENTS. PUBLIC CARE INSTITUTIONS WERE OVERSEEN BY ICP CENTRAL OFFICE.
- ADMINISTRATIVE STRUCTURE RESULTED IN DIVERSE TRAINING FORMATS, AUDIT PROCEDURES, AND DATA COLLECTION INSTRUMENTS.

RHODE ISLAND

- ENERGETIC EFFORTS OF ICP DIRECTOR ACCOUNTS FOR HIGH EA PENETRATION RATES, WHICH FOR BOTH SCHOOLS AND HOSPITALS EXCEEDED 95%.
- INDEPENDENT CONTRACTORS DEVELOPED AND CONDUCTED AUDITS AND TRAINING, AND REQUIRED TESTING FOR AUDITOR CERTIFICATION.

UTAH

- SIZEABLE STATE FUNDING FOR ICP DUE TO DIVERSE RURAL CONTINGENCY OF NONPROFIT INSTITUTIONS.
- INITIALLY SEO INVOLVED DIRECTLY IN TRAINING AUDITORS. CURRENTLY SEO EMPLOYS STATE AUDITORS TO CONDUCT AUDITS AT INSTITUTIONS.

VIRGINIA

- SEO SOURCE OF AGGRESSIVE DEVELOPMENT OF NEW TECHNIQUES, TRAINING MATERIALS, AND MONITORING ACTIVITIES
- SEO CONDUCTED COMPREHENSIVE GRANTS MANAGEMENT AND GRANTS APPLICATION WORKSHOPS, PRE-TESTING OF INSTRUMENTS.
- SEO MAINTAINS AN ENERGY CONSERVATION "HOTLINE", PREPARES ICP NEWSLETTER REGULARLY, AND CONDUCTS INFORMAL SEMINARS ON ENERGY CONSERVATION.
- THROUGHOUT ALL CYCLES, SEO MAINTAINED AN ACTIVE ROLE IN MONITORING INSTITUTIONAL PERFORMANCE.

TABLE 3.2 NUMBER AND TYPE OF AUDITORS TRAINED IN 10 SAMPLED STATES

	EA AUDITORS		TA ANALYSTS	
	NUMBER	TYPES OF PEOPLE TRAINED	NUMBER	TYPES OF PEOPLE TRAINED
FLORIDA[1]	413	C[2], D, E, F[3]	319	A, B
ILLINOIS	2750	D, E	350	A, B[5]
MINNESOTA	734[4]	A, B, C, D, E	65[4]	A, B, E
MISSOURI	664	A, B, C, D, E	NA[9]	NA[9]
NEW MEXICO	425	A, B, C, D, E	35	A, B, E[6]
NEW YORK	4600	A, B, C, D, E	NA[9]	A, B
OKLAHOMA	NA[9]	A, B, C[7], D, E	NA[9]	NA[9]
RHODE ISLAND	NA[9]	C, D, E		
UTAH	266[8]	C, D, E	13[8]	A, B
VIRGINIA	1204	A, B, C, D, E	N/A	A, B

CODE:

A. ENGINEER
B. ARCHITECT
C. BUILDING MANAGER
D. MAINTENANCE STAFF OR TECHNICIAN
E. ADMINISTRATIVE PERSONNEL (SUCH AS SCHOOL PRINCIPAL)
F. OTHER (SPECIFY)

FOOTNOTES:

1 75% OF EAS PERFORMED BY INDEPENDENT AUDITORS

2 FLORIDA REQUIRED MINIMUM 5 YEARS BUILDING MAINTENANCE/MANAGEMENT EXPERIENCE

3 FLORIDA ALLOWED ENGINEERING STUDENTS

4 IN CYCLES I & II

5 ONLY FOR CYCLE IV

6 REPORTING REQUIREMENTS ONLY

7 NOT FOR THEIR OWN BUILDING

8 INFORMAL TRAINING; COORDINATING AGENCY PERSONNEL PERFORM AUDITS AS WELL, AND STAFF OF ENGINEERING FIRMS ALSO PARTICIPATE ON TAS

9 N.A. INDICATES DATA NOT AVAILABLE AT THE TIME OF THE ADMINISTRATIVE PROCESS INTERVIEWS.

Auditor and analyst training programs also varied by State. For EA auditors, the length of training ranged from 4 hours of classroom participation to 40 hours of both classroom and building walk-through activities. The average training in the 10 States was 17 hours, and 7 of the 10 States included walk-throughs as part of the training. In 6 States, auditors were required to pass a written test prior to certification.

Training for TA analysts was required in 7 of the 10 States. The length of training ranged from 3 to 40 hours; the average being 12 hours. Only one State included walk-throughs for TA analysts, and only one State required analysts to be tested before they could be certified.

CONCLUSION: SEO Officials Characterized the ICP As a Valuable Program, But They Also Identified a Number of Implementation Problems and Factors Influencing Participation Rates

Throughout the administrative process interviews, SEO officials stated time and again their opinions that the ICP was one of the best run and most useful programs of its type. However, several concerns about program designs and procedures were reported, as discussed in the following sections.

SEOs Identified Several Implementation Problems

Major areas of concern were:

- Time and effort put in to implementing PEAs, when little or no use was made of them.
- Cumbersome nature of the process surrounding development of the State Plans and their review by DOE.
- Restrictiveness of Federal Program regulations.
- Technical and administrative problems (e.g., lack of consistency) involved in the manner by which institutions estimate future energy savings, as well as related quality control problems with EA and TA reports.
- Inability to fund a large enough State staff to perform timely, complete, and accurate technical engineering reviews of reports, grant applications, and ECM project implementation.
- Recurring changes in Program funding levels and regulations without adequate notice to State offices.
- Lack of incentive for participation by local governments or public care institutions (which can not apply for ECM grants).

These concerns were viewed largely as administrative details, and SEO personnel maintained that they had no substantial impact on participating institutions' abilities to meet program objectives.

Certain Factors Influenced Participation Rates

Table 3.3 presents the factors perceived by SEO officials as administrative barriers to participation by institutions. As the table indicates, some factors were evaluated by SEOs to be significantly more limiting than others. SEO officials reported that the three primary administrative barriers to Program participation by institutions were excessive paperwork or administrative requirements, fear of Federal or State intrusion into their operations, and lack of funds to meet the Program's 50% match requirement.

Interviews with institution administrators confirmed these SEO perceptions. For example, several EA-only sites reported that they did not continue with the Program because the efforts involved with the application and reporting requirements would, in their opinion, exceed the benefit of the grant award and/or the resulting savings. At some larger hospitals and colleges that are experienced in grantsmanship, it also was reported that the amount of paperwork was excessive in comparison to the Program's benefits. Finally, it was reported by many institutions that because the ICP funding cycles may have differed from their own budget cycles, they were unable to secure the matching funds required for Program participation.

SEO officials also reported that ineligibility for ECM grants for local government and public care facilities reduced their participation rates, as shown in the data presented in Table 3.4: Cycle I and II EA Penetration Rates and the Reasons for High or Low Rates.

On the other hand, reasons cited for high EA penetration rates included mandatory participation by State departments of education, as well as widespread publicity and Program marketing. Despite the concerns raised by the SEOs, institutions generally commented that the SEOs provided cooperative administrative support whenever it was requested.

TABLE 3.3 ADMINISTRATIVE FACTORS PERCEIVED BY SEO OFFICIALS AS BARRIERS TO PARTICIPATION BY INSTITUTIONS

FACTORS PERCEIVED AS BARRIERS TO PARTICIPATION BY INSTITUTIONS	FL	IL	MN	MO	NM	NY	OK	RI	UT	VA	TOTAL SCORE*
FORMS AND REGULATIONS TOO COMPLEX AND CONFUSING	2	1	3	3	3	3	2	2.5	3	3	25.5
FEAR OF INTRUSION BY STATE OR FEDERAL GOVERNMENT	3	2	2	3	2	2.5	1	2	3	3	23.5
STATE SCHEDULE TOO TIGHT	3	2	3	2	1	1	2	3	2	1	20.0
HARDSHIP INSTITUTIONS COULD NOT AFFORD PROGRAM	2	2	1	2	3	1	1	1	1	2.5	16.5
STATE LACKED PERSONNEL TO ADMINISTER ICP	1	2	2	3	1	1	1	2	2	1	16.0
STATE HAD DIFFICULTY COMMUNICATING WITH ELIGIBLE INSTITUTIONS	1	2	2	2	2	1	1	2.5	1.5	1	16.0
INSTITUTIONS DIDN'T BELIEVE EA/TA WOULD BE PROFITABLE	2	2	1	3	1	3	1	3	1	2	15.0
INSTITUTIONS ATTENDED TRAINING, BUT DIDN'T SUBMIT AUDIT	1	2	1	1	3	1	N/A	1	2	3	15.0
INSTITUTIONS ALREADY ASSESSED/ IMPLEMENTED CONSERVATION OPPORTUNITIES	2	1	2	1	1	1.5	1	1	1	3	14.5
LACK OF INFORMATION ON THE ICP	1	1	2	1	1	1.5	1	2.5	2	1	14.0
INSTITUTIONS HIRED PRIVATE CONSULTANTS TO PERFORM AUDITS	1	2	1	1	1	1	1	1	1	1	11.0
STATE TRAINING TOO FAR AWAY, LONG OR INCONVENIENT	1	1	1	1	1	1	1	1	1	1	10.0
OTHER PROGRAMS CONSIDERED MORE DESIRABLE	1	1	1	1	1	1	N/A	1	1	1	9.0

CODE:

1. NOT A FACTOR
2. MODERATELY IMPORTANT FACTOR
3. SIGNIFICANT FACTOR

*THE HIGHER THE TOTAL SCORE, THE MORE SIGNIFICANT THE BARRIER IS ACROSS ALL 10 STATES SAMPLED.

TABLE 3.4 CYCLE I AND II EA PENETRATION RATES[1] AND REASONS IDENTIFIED BY SEO OFFICIALS FOR HIGH OR LOW RATES

STATE	SCHOOLS PENETRATION RATE REASON	HOSPITALS PENETRATION RATE REASON	LOCAL GOVERNMENT PENETRATION RATE REASON	PUBLIC CARE INSTITUTE PENETRATION RATE REASON
FLORIDA	6%	13%[2]	10%[2]	10%[2]
ILLINOIS	43%	48.6%	0.9% - NO ECM $	0.3% - NO ECM $
MINNESOTA	44%	21%	22% - STATE $ PROVIDED HELP OF LEAGUE OF CITIES	4% - POOR COORDINATING AGENCIES FOR PUBLIC CARE - NO ECM $
MISSOURI[3]	24%	11% - FEAR OF FEDERAL INTRUSION	2% - NO ECM $	3% - NO ECM $
NEW MEXICO	84% - STATE CONDUCTED EAS IN ALL PUBLIC SCHOOLS (MANDATORY) - SCHOOLS MUST REPORT ON ENERGY CONSERVATION AS PART OF ANNUAL BUDGET PROCESS	14% - LACK OF INCENTIVE - PROBLEM WITH MATCHING FUNDS	4% - NO ECM $	2% - NO ECM $
NEW YORK	28%	40%	20% - NO ECM $	10-15% - NO ECM $
OKLAHOMA	52%	10% - HILL-BURTON AND DAVIS-BACON A DISINCENTIVE	12% - NO ECM $	30% - NO ECM $
RHODE ISLAND	96%	100%	25% - LOCAL GOVERNMENT LEAGUE DID NOT FOLLOW THROUGH ON PROMISE TO IMPLEMENT PROGRAM	100%
UTAH	29% - SUPPORT FROM STATE OFFICE OF EDUCATION	29%	3%	N/A
VIRGINIA	7%	7%	6% - NO ECM $	12% - NO ECM $

[1] PENETRATION RATE IS DEFINED AS THE RATIO OF AUDITED BUILDINGS TO ELIGIBLE BUILDINGS.

[2] FLORIDA RATE BY ELIGIBLE BUILDINGS

[3] AS OF JANUARY 31, 1982: SCHOOLS: 57%, HOSPITALS: 53%, LOCAL GOVERNMENT: 24%, AND PUBLIC CARE: 20%.

HAS THE ICP ACHIEVED ITS PRIMARY GOALS?

The conclusions and findings presented below indicate that the Program has, indeed, been achieving the goals of helping institutions save energy, money, and oil. The documentation of these evaluation areas is complex, and so the order of the discussion is summarized below:

- Conclusion: EA Participants Experienced Limited Energy Savings. (A brief discussion of the findings concerning the relatively limited EA sample analyzed)
- Conclusion: ECM Grantees Saved Energy and Avoided Energy Costs.
  - ECM grantees achieved energy savings.
  - ECM projects were cost-effective.
  - ECMs paid back more quickly than projections predicted.
  - Among ECM grantees, schools and hospitals showed differences in energy performance.
  - Certain factors can override attempts at energy conservation (results of the follow-up analysis to the site visits).
  - Other studies support the value of participating in ICP.
- Conclusion: ECM Grantees Greatly Reduced Their Oil Usage
- Conclusion: Certain Factors Maximized the Energy Conservation Potential of ICP Funds
  - The involvement of personnel is as critical to saving energy as are dollar investments or installation of sophisticated equipment.
  - Thorough analysis of energy conservation needs as well as selection of appropriate capital investments are central to successful energy conservation programs.
  - Effective O&M programs increased energy savings.
  - Ongoing monitoring of energy performance is vital.

These topics are discussed extensively in the following sections.

CONCLUSION: EA Participants Experienced Limited Energy Savings

Institutions participating in the EA-only survey experienced minimal energy savings. At EA sites, a total annual savings of 6,620 million BTUs was achieved, or 0.4% of their pre-ICP consumption. Usage of electricity increased by 9,501 million BTU. Most energy savings were achieved in natural gas (21,245 million BTU) and heating oil (3,705 million BTU).

Possible Reasons for Limited Success

Since the EA-only site visit sample represents less than .04% of the total ICP EA institutions to date, it is likely that the total BTU savings by EA participants is substantial. However, during the site visits, the following factors were observed to have an impact on energy savings at EA-only sites.

- At EA sites, audits often had been viewed as a one-time commitment of effort, and ongoing energy programs did not result. This was particularly true at local government and public care facilities, where there were no additional incentives for energy conservation (these institution types are not eligible for ECM grants).

- Many local governments conducted "blanket" EAs at all facilities within their jurisdictions, and consequently EAs were conducted at some buildings (e.g., pumphouses, storage buildings, motorpool garages, and city dump weigh stations) that are neither occupied nor monitored on a regular basis. For example, at one EA site (a community center) that was not regularly occupied, lights were turned on throughout the building. The respondent commented that because of the building's irregular use patterns, lights were turned on in the morning, and then turned off at night, whether or not the building was scheduled for use.

- In other cases, such as school districts, hospital complexes, and local governments, where audits had been conducted by a central office or by an independent auditor not connected with the institution, respondents were unfamiliar with EA recommendations, or the fact that EAs actually had recommendations in them. At one hospital complex, the respondent knew that audits had been completed for some of the larger buildings, but was surprised to learn that the building selected for a site visit had even been audited.

CONCLUSION: ECM Grantees Saved Energy and Avoided Energy Costs

The subsections that follow document the achievement of this primary ICP goal; some provide direct evidence and others contain supportive information and interesting analyses about components of the Program. The topics covered include the energy savings of ECM grantees, the cost-effectiveness of their capital improvements, the achievement of their projected paybacks, the energy savings of schools and hospitals, the findings of the subanalysis that sought to determine the causes of apparent energy increases in certain institutions, and the result of separate studies that present another perspective on ICP achievements.

ECM Grantees Achieved Energy Savings

To meet one of the Program's primary goals of reducing energy consumption in non-profit institutions, schools and hospitals received grants for the installation of energy conservation measures (ECMs). The resulting energy savings from these efforts were the equivalent of 988,461 barrels of oil per year, and reduced their average energy use substantially. Total energy savings are presented in Table 3.5. This table indicates that:

- ECM grantees saved 5.17 trillion BTUs from the pre-ICP to post-ECM period.
- ECM grantees saved an average of 13.2%* of their pre-ICP consumption. The average energy use index (EUI) dropped from 258,255 BTU/ft^2/year to to 229,129 BTU/ft^2/year over this period.
- Among ECM grantees, schools saved a total of 3.13 trillion BTU annually, and an average of 21.6% of pre-ICP consumption. The average EUI for schools dropped from 136,323 BTU/ft^2/year to 112,663 BTU/ft^2/year during their program participation.
- Among ECM grantees, hospitals saved a total of 2.04 trillion BTU annually, and an average of 8.3% of pre-ICP consumption. The average EUI dropped from 441,911 BTU/ft^2/year to 405,551 BTU/ft^2/year during their participation.

TABLE 3.5. ENERGY SAVINGS OF ECM GRANTEES[1]

	Trillion BTU Saved[2]	Average Percent Savings
Schools	3.13	21.6
Hospitals	2.04	8.3
Total	5.17	13.2*

[1]Based on ICP Cycle I and II grantees whose ECM projects were complete as of 9/30/81.

[2]From pre-ICP to post-ECM period, based on evaluation of electricity consumption at 11,600 BTU per kWh.

*Based on statistical precision tests, the 90% confidence limits range from 9.3% to 17.1%.

ECM Projects Were Cost-Effective

ECM projects undertaken by grantees produced substantial energy savings per dollar invested. An analysis of ECM cost-effectiveness for schools, hospitals, and total ECM grantees is summarized in Table 3.6. The following comparisons of total dollars invested and total BTUs saved indicate that on the average, ECM projects were cost-effective:

- Total ECM expenditures for ECM grantees were $70.7 million (including both the 50% Federal grant and 50% institution matching funds).

- Based on total annual BTU savings of 5.17 trillion BTUs, the average cost per million BTU saved annually was $13.68.

- To determine the cost per million BTU saved over the ECM lifetime, an average ECM life of 10 years was assumed.* Based on a 10-year ECM life, the cost per million BTU would be $1.37.

- Since the Federal share of ECM projects was normally 50%, the cost-effectiveness of the Federal share of ECM investments was approximately $6.84 per million BTU. Over a 10-year ECM life, the Federal cost per million BTU would be $0.68 per million BTU. At most evaluation sites, project cost overruns were estimated to be less than 10%, which were absorbed by the institution. When this is taken into account, actual Federal investment was somewhat less than 50%, and therefore actual costs to the Federal government were proportionately less.

- The calculated ECM cost of $1.37/MMBTU compares favorably with 1982 national average prices.** Overall, if it is assumed that total energy savings are attributable to one fuel source, the $1.37 can be compared to: electricity at $20.01/MMBTU, heating oil at $ 9.35/MMBTU, natural gas at $5.23/MMBTU, and coal at approximately $3.57/MMBTU***

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*Ten years is used as an average for an ECM based on engineering judgement rather than statistical or empirical data. ECMs may last fewer than three years or more than twenty, depending upon their nature and upkeep.

**For most ECM grantees, 1981-1982 fuel data have been compared to the institutions' baseline consumption data to calculate energy savings. Therefore, comparison of cost savings and national fuel prices also are expressed in 1982 prices.

***Based on 1982 national average prices from Monthly Energy Review, U.S. DOE/EIA-0035 (83/01).

When 1982 average national fuel prices are adjusted to represent the mix of fuel types used by ECM grantees, the average cost of energy is $7.89/MMBTU. When compared to the ECM cost of $1.37 per MMBTU saved, the result is that for ECM grantees, the cost of energy savings is extremely low compared to the cost of purchasing additional energy.

TABLE 3.6 COST-EFFECTIVENESS OF ECM PROJECTS[1]

	SCHOOLS	HOSPITALS	TOTAL
TOTAL ECM EXPENDITURES (Millions of dollars)	45.24	25.47	70.72
Federal Share[2] (Millions of dollars)	22.62	12.73	35.36
MILLION BTU SAVED (annual)	3,131,907	2,037,746	5,169,653
COST PER MILLION BTU SAVED (annual) (dollars)	14.45	12.50	13.68
Federal Share (dollars)	7.22	6.25	6.84
COST PER MILLION BTU SAVED OVER 10-YEAR ECM LIFE (dollars)	1.44	1.25	1.37
Federal Share (dollars)	.72	.62	.68

[1] Based on Cycle I and II grantees whose ECM projects were completed as of 9/30/81.

[2] Assuming 50% federal match; in some cases, cost increases in project completion resulted in a final federal share of less than 50%.

ECMs Paid Back More Quickly Than Projections Indicated

On the average, the actual time needed to pay for an ECM investment through energy cost savings (the ECM "payback") was less than originally projected. The average projected payback in ECM applications during Cycles I and II was approximately 4.5 years. Data analysis shows that a total of $70.7 million went into ECM projects, and that energy savings totalled 5.17 trillion BTU. Applying 1982 national average prices to the mix of energy types yields an average cost per million BTU of $7.89 for the post-ECM period. At this price level, the annual energy savings of 5.17 trillion BTU would save $40,995,349 annually, resulting in a simple payback of 1.73 years. This is less than half the originally projected payback of 4.5 years. Assuming a 50% Federal share for ECMs, the federal payback becomes 0.86 years. Table 3.7 highlights these findings. The reduced-payback finding may be partially explained by the fact that regulations called for "simple payback" calculations on ECM applications, meaning that energy prices were assumed to stay constant. Since increases in prices for electricity, gas, and other sources have increased the dollar value of BTU savings, the calculated payback is reduced proportionately.

TABLE 3.7 PAYBACK CALCULATIONS FOR ECM INVESTMENTS[1]

	SCHOOLS	HOSPITALS	TOTAL
TOTAL ECM EXPENDITURES (Millions of dollars)	45.24	25.48	70.72
Federal Share (Millions of dollars)	22.62	12.73	35.36
MILLION BTU SAVED (annual)	3,131,907	2,037,746	5,169,653
WEIGHTED PRICE PER MILLION BTU[2] (in dollars)	7.89	7.89	7.89
ANNUAL ENERGY COST SAVINGS (Millions of dollars)	24.83	16.15	40.98
SIMPLE PAYBACK	1.82 years	1.58 years	1.73 years
SIMPLE PAYBACK ON FEDERAL SHARE	0.91 years	0.79 years	0.86 years

[1]Based on Cycle I and II grantees whose ECM projects were complete as of 9/30/81.

[2]Based on average prices for 1982 applied to actual mix of post-ECM energy types, weighted proportionally to BTU consumption. Price data taken from Monthly Energy Review, U.S. DOE/EIA-0035(83/01).

Among ECM Grantees, Schools and Hospitals Showed Differences in Energy Performance

On some measures of conservation performance, schools were more effective in saving energy, and hospitals did better on others. An examination of energy savings by ECM grantees by institution type reveals that schools saved approximately 21.6% of their pre-ICP energy consumption, while hospitals saved an estimated 8.3% ($p<.05$)*. However, hospitals display greater cost-effectiveness for their ECM dollars, averaging $12.50 per million BTU saved annually as compared to $14.45 for schools.

Several factors were observed to have an impact on the differences in energy conservation performance for schools and hospitals. First, hospitals' overall energy usage tends to grow as new equipment and services are added. This results in a rising "baseline" against which energy savings are measured, and thus reduces the apparent effectiveness of a given energy saving measure. Second, hospitals are more energy intensive than schools, due to the presence of a much greater amount of energy consuming equipment in hospitals. This means that the same amount of BTU savings represents a smaller percentage of a hospital's total energy usage than a school's. Third, hospitals experience several restrictions on their operating patterns, dictated by such factors as Federal/State regulatory standards for ventilation, infection control, and patient well-being, and also have strict requirements for climate control (e.g., operating rooms, computer centers, diagnostic equipment) in order to carry out their prime mission of health care delivery. Therefore, although hospitals attempt to reduce operating costs, energy conservation may not be considered as important an objective as, for example, patient comfort, security, or convenience.

Finally, energy consumption and costs are more visible and easily identifiable in school budgets, and are more easily controlled by administrators. In addition, energy consumption may account for a larger percentage of school budgets, and more innovative and non-restrictive opportunities exist for energy savings in this type of institution.

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*$p<.05$ indicates that the difference between the two percentages is statistically significant.

Additions of Unassessable Amounts of Energy-Consuming Equipment, Inadequately Projected Savings and a Lack of Effective Energy Management Can Offset ECM Savings At Complex Facilities

Analysis of the follow-up site visits to ECM grantees that increased their energy consumption from the pre-ICP to post-ECM period reveal that ECM savings can be offset primarily by three major factors: (1) additions of unassessable amounts of energy-consuming equipment; (2) inadequately projected savings, and; (3) a lack of effective management. Findings from the follow-up site visits are described below, and supported by five case studies presented later in this chapter (Case Studies I-M). The return site visits also afforded the evaluation team the opportunity to confirm its original evaluation methodology, which is explained in further detail in the preface to these case studies.

Additions of Unassessable Amounts of Energy-Consuming Equipment

Analysis of the follow-up site visits to ECM grantees that increased their energy consumption from the pre-ICP to post-ECM period showed that complex facilities (e.g., hospitals) tend to continuously add energy consuming equipment without maintaining records. This prohibits an accurate evaluation of ECMs based on the comparison of total building energy consumption over this several year period.

Further, it was observed that individual metering or performance instrumentation on ECM projects which could permit savings measurements is seldom installed. In some cases, changes in operating procedures after ECM installation may actually cause reduced overall system efficiency, which cannot be assessed without instrumentation. Also, the normal degradation of ECM hardware efficiency with age and normal drift of control adjustments frequently cannot be detected without instrumentation.

Inadequate Projected Savings Data

Additional findings from these return visits suggest that inadequate data on projected energy savings also compounds the difficulties of measuring energy savings at complex facilities. Technical analysis reports sometimes fail to present the projected energy savings in energy units for each recommendation so that the savings from a combination of installed projects may be determined. Without this information, the apparent subsequent results cannot be evaluated for accuracy.

Lack of Effective Energy Management

Lack of an effective energy conservation program directed from the highest management level of an organization can fail to provide enough skilled personnel to achieve energy-saving preventive maintenance, equipment fine-tuning, and hardware experimentation. At some facilities, the demonstrated savings potential could more than support the salary of an additional person to achieve the potential result, but this concept is not as readily grasped by management as is the concept of hardware purchases. Perhaps this is largely because management has historically considered the role of maintenance as simply to keep systems running. Now that energy costs are significant, the additional burden on maintenance personnel (and operators/occupants) is to assure that the systems not only run but that they do so efficiently. This calls for a considerably expanded maintenance effort, and frequently for higher skill levels and/or more personnel than management may have come to appreciate.

Other Studies Support the Value of Participating In Advanced Phases of the ICP

The studies summarized below, while they cannot be tied to the evaluation findings of this report, do provide another interesting perspective on the ICP's achievement.

- Maryland Schools--A study by UII, Inc.* of energy and related data from more than 1,400 schools in the mandatory statewide reporting system analyzed energy use data for the 1978-82 period. Their analyses show that:
  - ECM grantees saved a total of 26.94% of their energy use from 1978 to 1982.
  - Non-participants saved 12.5% over the 1978-82 period.
- Minnesota Schools--The State Energy Office** collected data in a voluntary survey of 173 ICP participants in the EA, TA, and ECM phases. While this survey does not compare participants to non-participants directly, it does provide a basis for comparing ECM grantees to other participants. The analysis shows that:
  - ECM grantees saved an average of 14.1% from the 1979 to 1982 period.
  - The group of 173 survey respondents as a whole saved 10.7% over the 1979-82 period.

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*Energy Conservation in Maryland Public Schools prepared for the U.S. Department of Energy by Unified Industries, Inc., March 1983.

**Minnesota Department of Energy, Planning, and Development, Energy Division. Institutional Building Grants Program: Phase Two Preliminary Report (Draft), April 1, 1983.

- AHA Member Survey--The American Hospital Association undertook a survey of various energy-related data from its members. The findings (based on 1980 data) include such facts as:

  - Operating and maintenance improvements occured at a 25% higher rate among ICP-participating hospitals than among non-participants.

  - In-house energy audits were conducted at a rate 64% higher at ICP-participating hospitals.

  - Consultant energy audits occurred at a rate 200% higher among ICP participants.

  - Capital expenditures for energy improvements occurred at a rate 46% higher among ICP participants.

ECM Grantees Greatly Reduced Their Oil Usage

Reductions in oil use were the most outstanding feature of the energy savings analyses; grantees saved more oil than any other energy source. As mentioned at the outset, the ICP's ranking methodology for ECM applications was designed to give priority to those measures projected to save the greatest amounts of oil. This objective was realized by the Program as shown by these findings:

- Oil usage reductions by ECM grantees totaled 11.77 trillion BTU annually, or an estimated 2.25 million barrels of oil per year.

- Natural gas usage by ECM grantees increased by a total of 8.78 trillion BTU; this was observed to be due primarily to a large number of oil-to-gas boiler conversions. However, adding the gas usage increase to the oil use reduction yields a net BTU savings of 2.99 trillion BTUs.

- Savings in other energy types were minor approximately 2.18 trillion BTU for electricity, LPG, coal, and purchased steam combined.

When oil use reductions are viewed separately from other energy sources, it can be said that ECM expenditures of $70.7 million resulted in the reduction of 2.25 million barrels of oil use annually; this average $31.42 per annual barrel. Over a 10-year ECM life, the cost per barrel is $3.14; and the cost to the Federal government (assuming a 50% share) would be $1.57.

Certain Factors Maximized the Energy Conservation Potential of ICP Funds

The ICP definitely resulted in energy, oil, and dollar savings, but some institutional personnel--either through good fortune, dedication, or interested analysis--used ICP funds in a particularly cost-effective way to maximize savings. Those ECM grantees who made the best use of diligent energy managers, undertook accurate and building-specific energy analyses, and installed appropriate ECMs, persevered in the conduct of operating and maintenance techniques, and monitored energy usage showed overall greater savings. Findings on these topics are presented in the sections that follow.

The Involvement of Personnel Is As Critical to Saving Energy As Are Dollar Investments and Sophisticated Equipment

Committed Leadership Saves Energy

Throughout the evaluation it was seen that energy performance was related to the level of commitment of the designated energy manager to the program. During the field survey, respondents were rated excellent, good, fair, or poor in terms of their overall involvement in energy management. Institutions rated excellent experienced average savings of 19.8%, compared to 9.0% for other respondents ($p<.05$). For schools rated excellent, average energy savings was 20% compared to 12% for those rated poor. At hospitals exhibiting high levels of involvement, average savings was 25%, whereas low levels of involvement experienced 10% savings. This is a strong indication that administrators who exercise leadership and are involved directly in conservation constitute an important element of successful energy programs. Figure 3.1 graphically compares the energy savings and cost effectiveness of these ECM grantees. As the figure shows, highly involved energy managers at hospitals can improve energy savings by 250%, since the complex nature of hospital energy systems require constant attention in order to maintain energy efficiency.

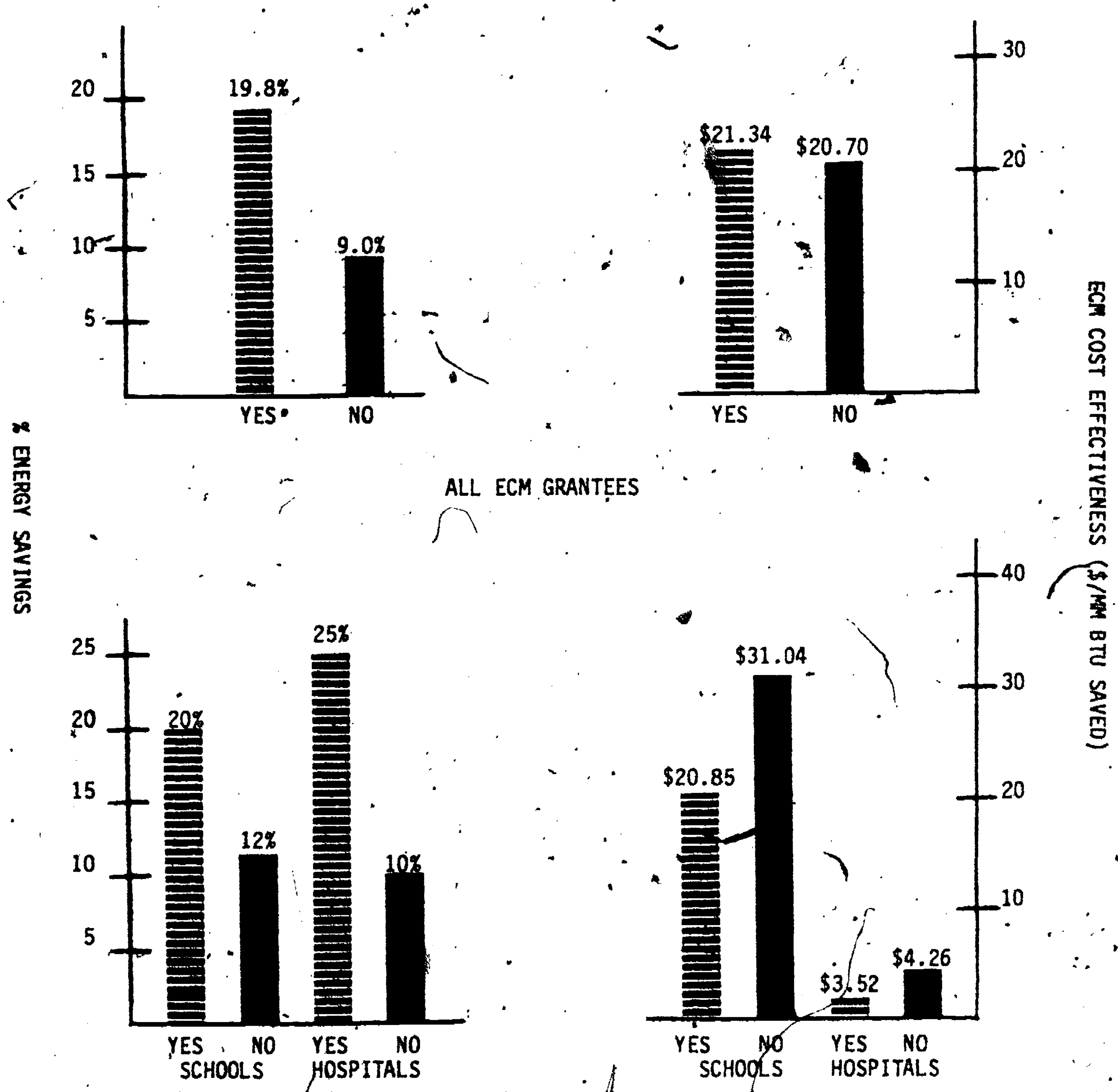
Managers Can Save More Energy Than Some Sophisticated Machines

This finding was particularly visible at those sites where ECMs included the installation of sophisticated energy management computer systems (EMCS). The daily efforts of a very technically competent and effective energy manager to make sure energy equipment functions efficiently can improve the level of energy savings. Much of these savings can be attained by implementing preventive maintenance (PM) practices and improving operational procedures. Large reductions can be achieved initially by such simple means as installing time clocks, or by assigning one maintenance person to a daily patrol of buildings for the purpose of making equipment adjustments, and detecting equipment inefficiencies and malfunctions at their onset.

Once these management efforts are in place, additional energy savings can be achieved by incorporating several ECMs, the most costly being a top-of-the-line computer-based energy management system. In one institution, although a computer system provides desirable features such as control monitoring and remote resetting capabilities, it has not contributed to further energy savings at the same rate that the efforts of the effective manager had achieved over a 4-year period of concentrated conservation efforts (a 75% reduction). This may be accounted for by the fact that the computer system assists the manager in maintaining energy systems, but does not identify additional conservation opportunities.

FIGURE 3.1
IMPACT OF QUALITY OF THE ENERGY MANAGER ON ENERGY PERFORMANCE

Question: Was The Energy Manager Rated Excellent?



COMMENT: High quality energy managers are important to maximizing energy savings.

64

At several other institutions that installed computer-controlled energy management systems, a variety of conditions prevented maximum efficiency and savings from the equipment (e.g., manual override of controls, improperly set timeclocks, cycling of systems in unoccupied areas, and failure to connect some energy systems to the computer).

The Organizational Level of the Energy Manager Can Affect Energy Savings

In addition to the level of dedication by energy managers, the position of the energy manager within the institution's organizational structure can have an impact upon energy savings. Three variations of program management are described below.

On-Site Management

At many rural school districts, the Superintendent was responsible for all aspects of the schools' operations, including energy conservation activities and budget management. In most of these situations, the superintendents had a very good knowledge of the positive effects of energy conservation on operating budgets. Most respondents were pleasantly surprised with the cost savings that resulted from their energy conservation activities when viewed in terms of their avoided energy costs.

The result, in these cases, was generally a sincere and continued commitment to energy conservation. In addition, these respondents often reported that their energy and cost savings prompted their school boards to make firm financial commitments to energy conservation.

Centrally Located Off-Site Management

Many school districts and local governments often [illegible]int a central energy manager to oversee conservation activities in all b[illegible]gs within the jurisdiction. Often the energy manager is a supervisor [illegible]uildings and grounds who has little contact with daily building operati[illegible] Although there are some benefits to this type of management, such as the capability to review vendor proposals and to purchase equipment economically, there are several areas in which this type of management may reduce the savings potential. For example, such a manager has no direct daily authority over personnel who operate a variety of buildings and who have little knowledge or experience in energy conservation. The result is that more energy may be wasted with poor daily control than the energy manager is saving through wise purchasing. Case Study A presents a further example of this situation.

In a similar situation, a school district administrator concerned with ways to save energy dollars was reasonably well informed on general technical methods. However, the management approach was to allow each school principal to handle energy conservation within his own school. The results varied greatly among the schools, as shown in Case Study B.

Internally Delegated Management

Putting the responsibility for energy costs directly into the total operating budget of each department at large hospital complexes and at universities and then returning a portion of conservation savings to that budget the following year was found to be an effective incentive. Many daily procedures account for the bulk of energy results, so that tying responsibility to the manager who has daily authority over his facility's operation can produce good results at relatively low cost. It is likely that this opportunity for the manager to see the direct relationship between energy conservation actions and costs provides additional incentives toward savings.

Thorough Analysis of Energy Conservation Needs as well as Selection of Appropriate Capital Investments Are Critical to Successful Energy Conservation Programs

The Quality and Use of Energy Analyses Varied Considerably

It was discovered during site visits that the quality and use of energy audit information and of TA analyses varied to a great extent from one institution to another. Various aspects of this problem are worthy of discussion, which is presented below.

Analyses Often Were Not Building-Specific

EA and TA reports prepared for ICP participants varied greatly in quality, scope, and effectiveness. One common pattern observed during site visits was that energy auditors and TA analysts tended to recommend the same O&Ms and ECMs at all buildings. In cases of buildings that are very similar this practice may be acceptable, but most seemingly "similar" buildings are in fact quite different in their energy character due to the variations in mechanical equipment, utilization, numbers of users, operating and maintenance conditions, siting, and other factors. For energy audits, this appeared more frequently when an outside auditor conducted EAs in a large number of different types of institutions located in the same geographical location (e.g., the northwest part of a state). In a few cases, improper recommendations (e.g., gymnasium lighting modifications in a library that did not have a gymnasium) resulted.

EAs Often Did Not Serve As Educational Tools

Many respondents were unfamiliar with specific EA recommendations, and it is doubtful that most energy auditors spent any significant time with institution management, much less maintenance management personnel, to effect agreement and motivation for optimum application of the EA recommendations. This situation was seen in several institutions. At some institutions, where the EA had been completed a number of years prior to the site visit, respondents often were unaware of the O&Ms that had been recommended. In some cases, specific changes--such as replacing 40-watt fluorescent bulbs with watt-saver bulbs--had been incorporated into the regular maintenance program. However, lack of attention to many ongoing O&Ms such as recaulking, weatherstripping, turning off lights, and lowering thermostats and domestic hot water temperatures was evident.

EAs Did Not Guarantee the Implementation of O&Ms

Where effective long-term O&M effort exists, it tends to be due to the technical/energy conservation orientation of someone at the facility who is operating in an effective management role. The EA may have accelerated the identification of appropriate actions for this individual, when an energy-conservation advocate existed at an institution. On its own, the EA did not guarantee the implementation of no-cost or low-cost conservation activities. For example, it was observed that at 41% of both EA and ECM sites many recommended O&Ms were not maintained, and that 62% of all sites had not implemented any O&Ms beyond those recommended in the audit. In fact, managers at ECM sites often freely admitted that the need to implement the O&Ms was viewed largely or totally as administrative "hoop-jumping" in order to apply for TA and ECM funding.

TAs Often Failed to Analyze a Comprehensive Array of ECMs

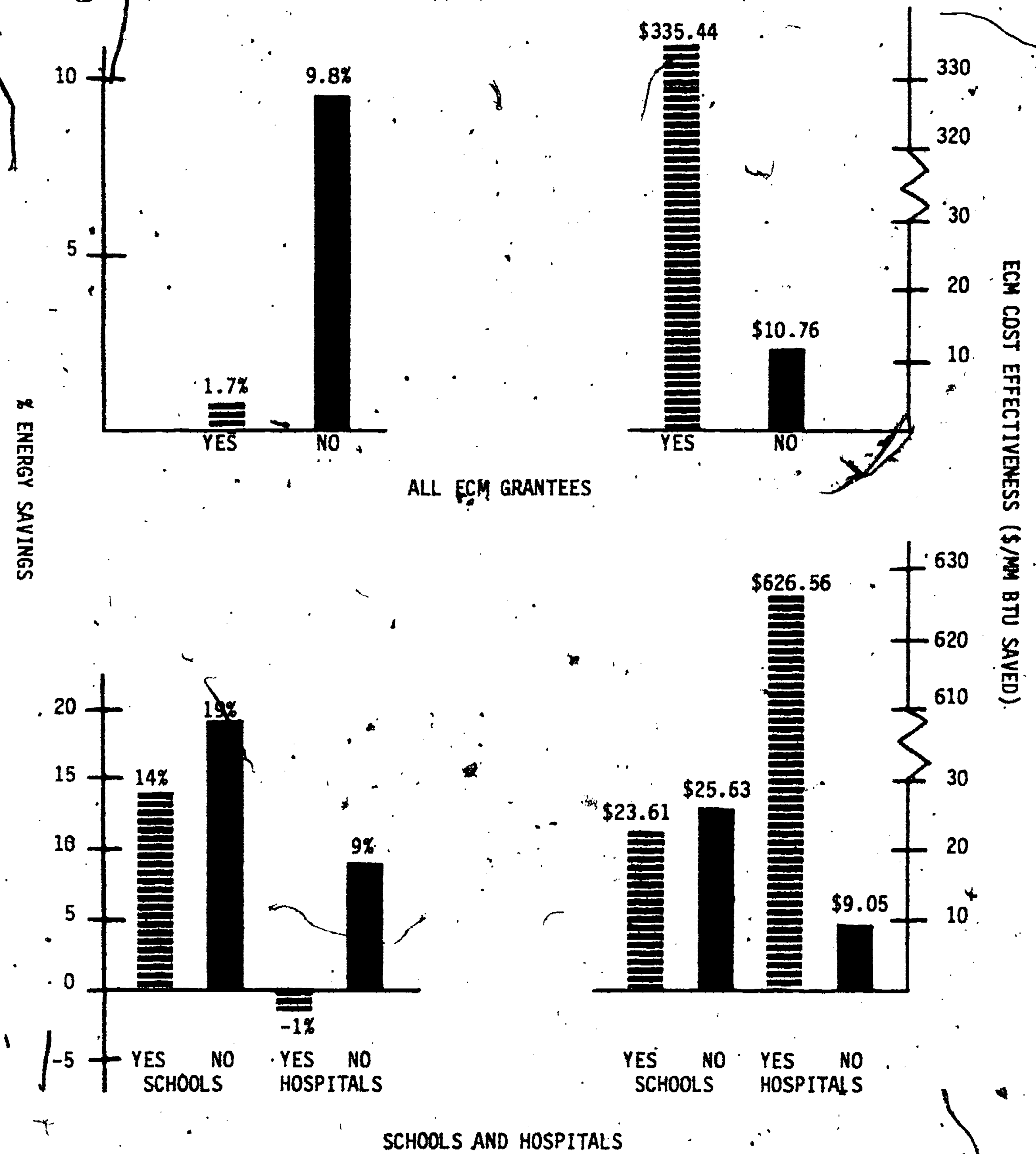
Similarly, TA analysts often either recommended the same ECMs for a variety of buildings, or provided detailed analysis for only a single "favorite" ECM (See Case Study C). For example, it was seen that only 42% of reviewed TA reports recommended a full range of possible ECMs from which to select projects for funding. One SEO official contended that for certain analysts, recommended ECMs could be predicted prior to reviewing submitted TAs. It seems reasonable that at a minimum, the TA for such buildings should examine a relatively large number of possible ECM choices and a demonstration of nonsuitability should be given in the TA for those ECMs ultimately rejected, as well as detailed documentation on the rationale for selected ECMs.

Many TAs Neglected the O&M Aspect of Energy Management

Finally, many institutions perceived the purpose of the TA as qualifying the institution to apply for ECM grant money. Thus, the overriding emphasis of the TA analyst in such cases was apparently to identify capital improvements that could save energy, rather than to present institutions with comprehensive energy management programs. Although the primary purpose of the TA was not to identify O&Ms, the most effective TAs were those that presented an energy analysis of the "total" facility. For example, while some or all of the ECM expenditures theoretically were productive, approximately 50% of the ECM grantees provided evidence to the evaluation team that additional O&M efforts may have been more appropriate than the implemented ECMs. Overall, these grantees showed average energy savings of 1.7% at a cost of $335.44/MMBTU saved. On the other hand, at ECM grantees where the need for additional O&M efforts was not evident, average savings were 9.8% at a cost of $10.76/MMBTU saved. Energy savings for schools and hospitals in these categories, as presented in Figure 3.2 further support the finding that there is a continual need for more and consistent O&M attention. Such attention might result in

FIGURE 3.2
IMPACT OF OVEREMPHASIS ON ECMs vs. O&Ms ON ENERGY PERFORMANCE

Question: Was There Evidence That Additional O&M Efforts Would Have Been More Appropriate Than The ECMs Implemented?



COMMENT: Overemphasis on ECMs vs O&Ms seems to be associated with lower energy savings and poor ECM cost-effectiveness.

the O&Ms "outsaving" the more costly ECM expenditures. This is further illustrated by the fact that only 39% of the reviewed TAs recommended O&Ms beyond the EA. In addition, sites whose TAs identified additional O&Ms showed an average of 16.4% savings, while those TAs not recommending additional O&Ms showed an average of 10.3% savings. At hospitals, where daily O&M attention is essential to the efficiency of complex energy systems, TA analysts may have had too little contact with on-site operating personnel to provide those personnel with technical assistance that would improve their energy conservation skills. This was evidenced during the TA review by the evaluation team which indicated that where TAs did recommend O&Ms beyond the EA, energy savings were almost double the energy savings achieved by hospitals whose TAs did not consider additional O&M actions (see Figure 3.3).

TAs Often Were Not Examined Analytically By Institution Staff

The site-visit teams learned that few TAs were carefully studied, challenged, or made widely available within institutions for coordination and review before ECM grant applications were submitted. This was particularly true at schools where TA analysts submitted their reports directly to DOE, and also were responsible for preparing and submitting grant applications. At some schools, TA analysts failed to seek pertinent information from building occupants and maintenance personnel or to review the recommended ECMs with them. Not only did some respondents disagree with certain recommendations that were made without their knowledge, but also, this lack of communication led to incorporating ECMs that contributed little to energy conservation, or required extensive corrective action. Examples of this situation include: installation of vestibule doors at entrances that had a history of non-use due to the area of the school at which they were located; incorporation of a time clock on a domestic hot water recirculation pump, even though maintenance personnel kept the pump permanently turned off; and recommendation of a boiler stack damper that could not be installed due to safety considerations. At schools where it was observed that alternative ECMs could have been more appropriate, energy savings averaged 12%; where appropriate ECMs had been installed at schools, the average savings was 20%. Therefore, it is likely that had some TA analysts coordinated their efforts with institution personnel, energy results could have improved.

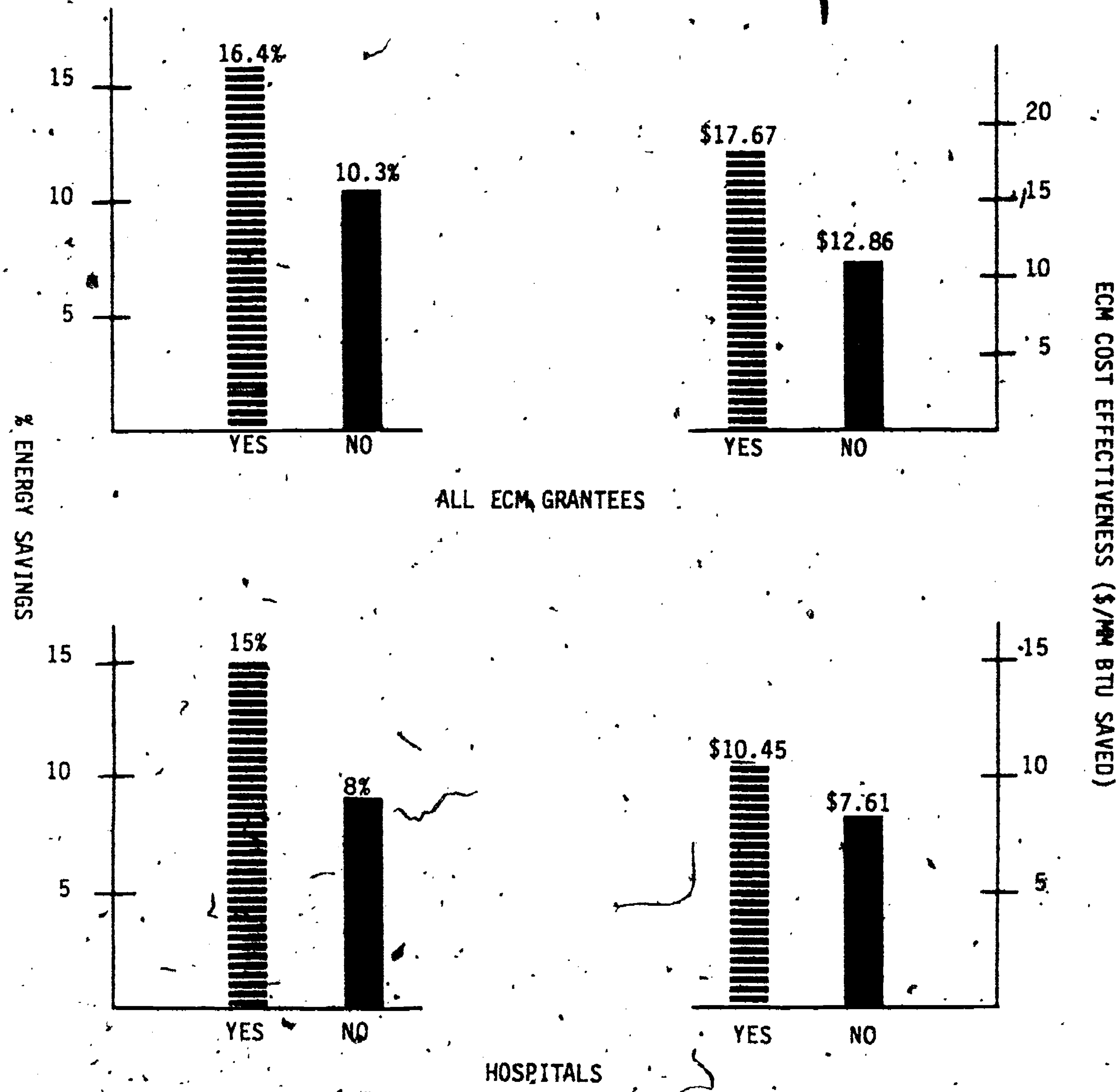
Factors Besides Conservation and Payback Influenced ECM Selection

In addition to the payback limitations for ECM projects, respondents reported a number of other factors that influenced their selection of ECMs for ICP funding. These factors included:

- The availability of matching funds,
- The degree to which the building's normal operating schedules would be disrupted for ECM installation,
- The operating condition of existing energy equipment and the degree to which some equipment would require major repairs or replacement within the near furture, and

FIGURE 3.3
IMPACT OF O&M FOCUS IN TAs

Question: Were O&Ms Beyond The EA Recommendations Included In The TA Report?



COMMENT: TAs with strong O&M focus seem to lead to high energy savings.

- The degree to which the institution would consider installing the ECM with their own funds.

ECMS Observed Were Classified by Type

ECMs observed during site visits were characterized by type, and included:

- Modifications of the building envelope (structural modifications to windows, doors, roofs, and walls),
- Mechanical systems (boilers, pumps, HVAC systems),
- Lighting (reductions and conversion from incandescent to fluorescent), and
- Special systems (solar and other alternative fuels, kitchens, laundries, and swimming pools).

Certain ECMs Were More Popular Than Others, But Were Not Necessarily the Most Effective

Combinations of these four ECM types form 15 categories. Of the institutions that installed only one ECM, 21 were mechanical ECMs, 8 were envelope ECMs, and 1 involved lighting modifications. However, most ECM grantees installed multiple ECMs. The most popular combinations of ECMs were envelope and mechanical measures (27 sites); envelope, mechanical, and lighting (18 sites); and mechanical and lighting (12 sites).

During site visits, it was observed that automatic controls for boilers and HVAC systems were the most popular mechanical ECMs. These included time clocks for automatic cycling of energy systems and conversion of oil burners to natural gas with oil for backup. Envelope modifications often involved the reduction of window areas with insulated panels. Some respondents at schools commented that an initial fear of a lack of visual access to the outdoors from these ECMs was quickly replaced by more attentive students and more comfortable classrooms. Other envelope measures included vestibule installation and ceiling and wall insulation. Lighting modifications included the conversion of incandescent to fluorescent lighting and the reduction of lighting through delamping or replacing existing bulbs with watt-saver bulbs. One common problem identified with delamping was that although bulbs had been removed from fixtures, ballasts had not been, and therefore, potential savings were not being achieved. Examples of special systems ECMs were solar swimming pool heaters, exhaust heat recovery units, and a sawdust fueled boiler.

It Was Often Impossible to Pinpoint the Savings Generated by a Specific ECM

Since the structure of ICP promoted multiple conservation activities throughout an institution, the contribution of either O&M procedures or multiple ECMs recommended in EAs and TAs both federally and non-federally funded, made it impossible to identify savings due to specific ECMs. During the ECM site visits, more than 50% of the respondents reported that O&Ms were ongoing and 45% of the sites were involved in additional energy conservation activities concurrent with ICP. However, only 18% of the sites had specific metering capabilities. Therefore, in most cases, it was not possible to determine the actual savings of a specific ECM. However, it was possible to evaluate the improvements in building efficiency during the ICP participation period.

At schools, the 4 most popular categories of ECMs were (1) envelope and mechanical, (2) envelope, mechanical and lighting, (3) mechanical, and (4) mechanical and lighting. A summary of energy savings and cost-effectiveness is presented in Figure 3.4. These data show that for schools, ECM popularity and resulting energy savings have an inverse relationship (e.g., schools installing the more popular ECM categories achieved the least savings). However, for hospitals, ECM selection shows a direct relationship with overall building energy savings, which suggests that hospitals may have had more technical insight into the energy efficiency of selected ECMs prior to installation. ECM selection for both schools and hospitals shows no correlation with cost effectiveness which is due primarily to the fact that actual cost-effectiveness cannot be assessed prior to installation and operation of ECMs.

ECM Quality Was Good

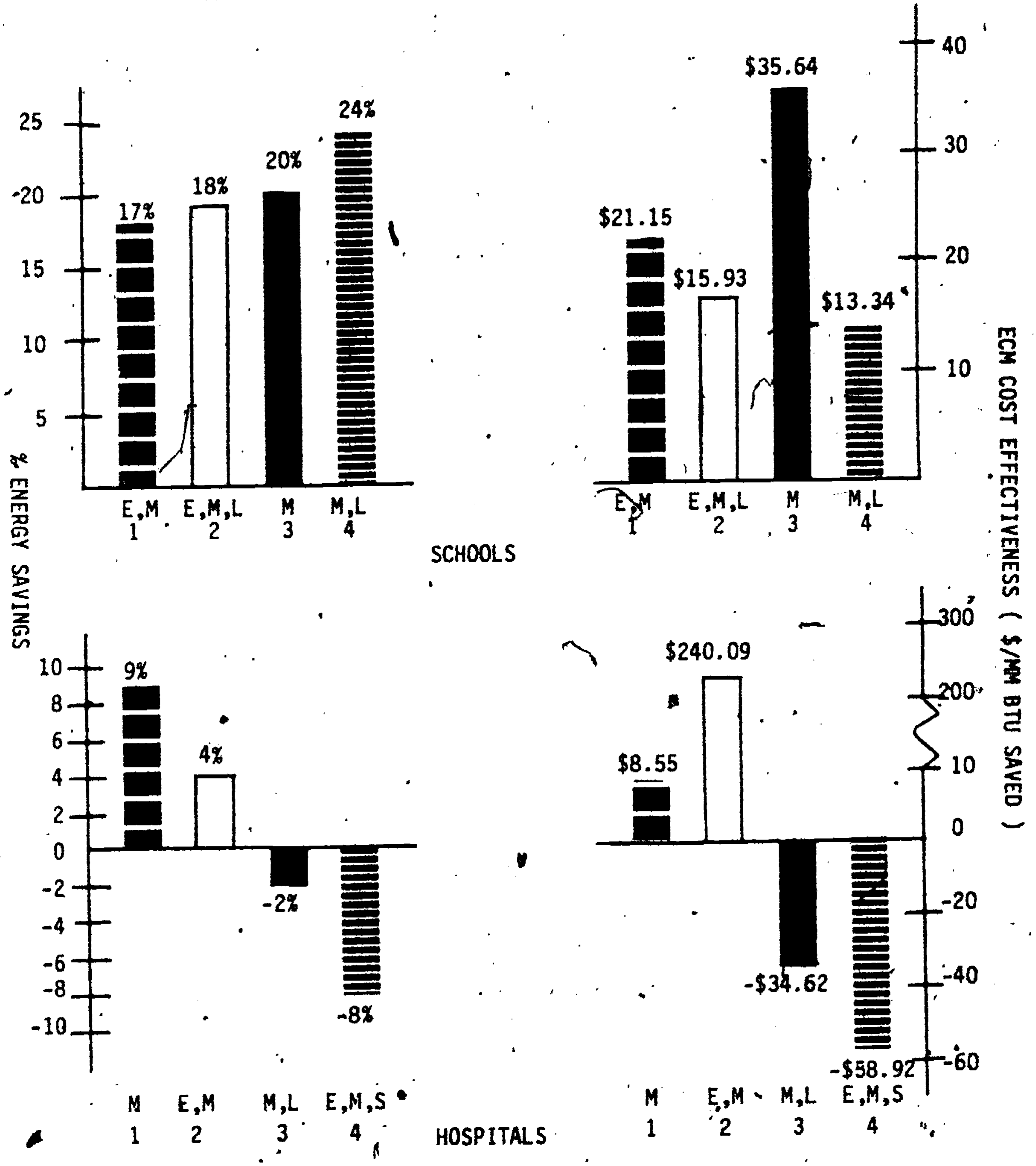
Generally, the quality of ECMs was observed to be very good. Sixty-four percent of the projects were rated excellent or good in terms of their operation and upkeep, whereas only 4% were rated poor. Only 12% of the respondents reported any problems, although the evaluation team observed operational and upkeep problems at approximately 20% of the sites. This difference can be accounted for by the lack of technical and/or engineering knowledge on the part of the respondent. Problems most often occurred at those sites where advanced technologies and innovative ECMs had been installed, and both contractors and maintenance staff were unfamiliar with them. The effects of these problems usually was evidenced by energy savings that were far below the projected savings. For example, at schools where ECM operations and upkeep were rated excellent, average energy savings were 22%, as opposed to those sites where problems were observed, which averaged only 11% savings. For hospitals rated excellent, energy savings were 21%.

Use of Advanced or Unusual ECM Benefits From Prior Proof of Performance

Where advanced or unusual ECMs are installed, their performance may better be assured by using a contractor with previous experience with the ECM, or by requiring prior proof of the ECM's energy performance. If this "track record" is not available, then the institution involved should be adequately cautioned that such an undertaking is a research and development project and that they should have follow-on funds identified and available to assure eventual success. In cases where new and innovative ECMs have been installed, design and operational problems often have been encountered. For example, at one site, a sawdust boiler had been installed to replace the school's fuel oil boiler. It was determined subsequently that the combustion rate in the sawdust boiler limited the output to about one-third of its capacity. Insufficient consideration had been given to the problems associated with moisture

FIGURE 3.4

Energy Performance of Commonly Selected ECM Categories*



COMMENT: Whereas the more popular ECM categories achieved the least savings at schools, ECM selection and energy savings for hospitals show a direct correlation.

*ECMS were characterized by the following types and their combinations:
E = Envelope M = Mechanical L = Lighting S = Special Systems

** ECM categories are identified numerically;
1 = most popular, 4 = least popular

content of the sawdust. Although preliminary analysis projected total replacement of fuel oil, the school had reduced its fuel consumption by only 50%. At the time of the site visit, the school was in the process of investigating the costs for optimizing the system's efficiency. Even though school officials had no specific estimates at that time, it was concluded that the cost effectiveness of the ECM was greatly reduced. Other innovative ECMs encountering problems included incinerator heat recovery, exhaust heat recovery, and some solar applications.

On the other hand, one school was visited that installed a boiler interconnect system which, it was estimated, could eliminate simultaneous operation of half of the school's boilers. Although initial problems were experienced, the TA analyst worked closely with the contractor to correct the system, and within the first year of operation the school showed a 36% reduction in energy consumption and had saved $35,000 (see Case Study E).

Effective Operations and Maintenance (O&M) Programs Increased Energy Savings

Field survey teams observed that several ECM grantees were not maintaining the O&M measures recommended in their energy audits. This group saved an average of 3.2% compared to an average of 15.6% by ECM grantees observed to be keeping up with the O&M measures recommended in their audits ($p<.05$). ECM grantees observed to be maintaining O&M measures beyond those resulting from the energy audit experienced 15.9% average savings, compared to 7.7% average savings for those who did not pursue O&Ms beyond the energy audit ($p<.05$).

This difference is also visible in the area of cost. Grantees maintaining their energy audit O&Ms spent $27.79 per MMBTU saved by their ECM projects, versus $147.52 per MMBTU for those that did not maintain their O&Ms. Those that pursued O&Ms beyond the energy audit spent $27.60 per MMBTU saved.

This relationship between strong O&M programs and energy savings also holds true when schools and hospitals are examined independently. Energy savings and cost-effectiveness data displayed in Figures 3.5 and 3.6 indicates the extent to which neglect of O&Ms reduces energy savings as observed by the evaluation team.

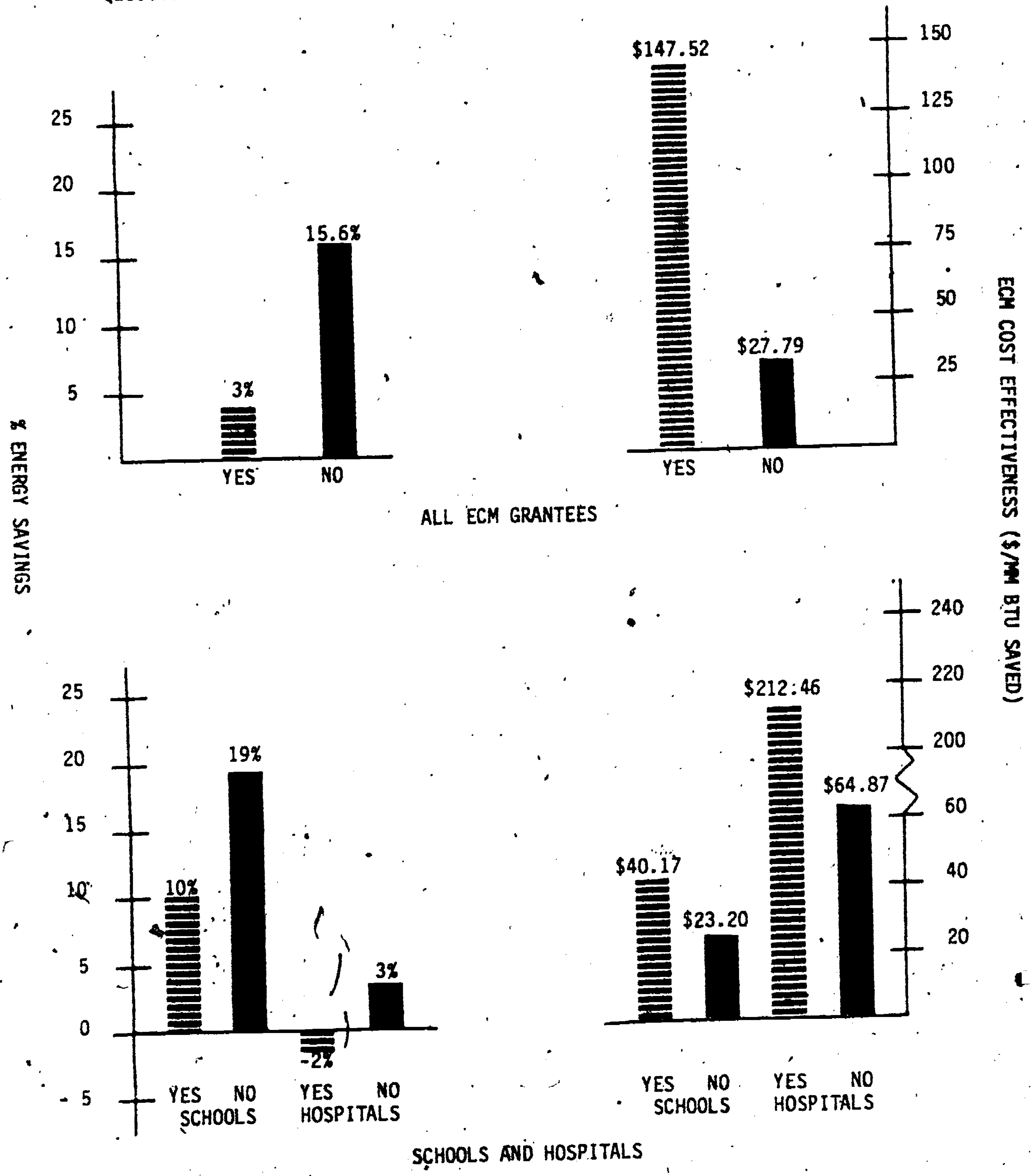
It is clear that thorough, ongoing O&M efforts are associated with greater energy savings, and that ECMs can be more effective when supported by a strong O&M program. ECM grantees selected certain ECMs for various reasons, and the most popular were not always the most efficient. However, selection and maintenance of ECMs are essential to the achievement of a successful energy conservation program.

Ongoing Monitoring of Energy Performance Is Vital

Ongoing monitoring of energy consumption provides the basis for evaluating the success of an institution's energy conservation program. Reviewing and comparing monthly fuel bills and adding equipment metering are two effective methods for identifying the areas of potentially greatest savings as well as quickly pinpointing consumption-increasing problems.

FIGURE 3.5 IMPACTS OF MAINTAINING O&Ms

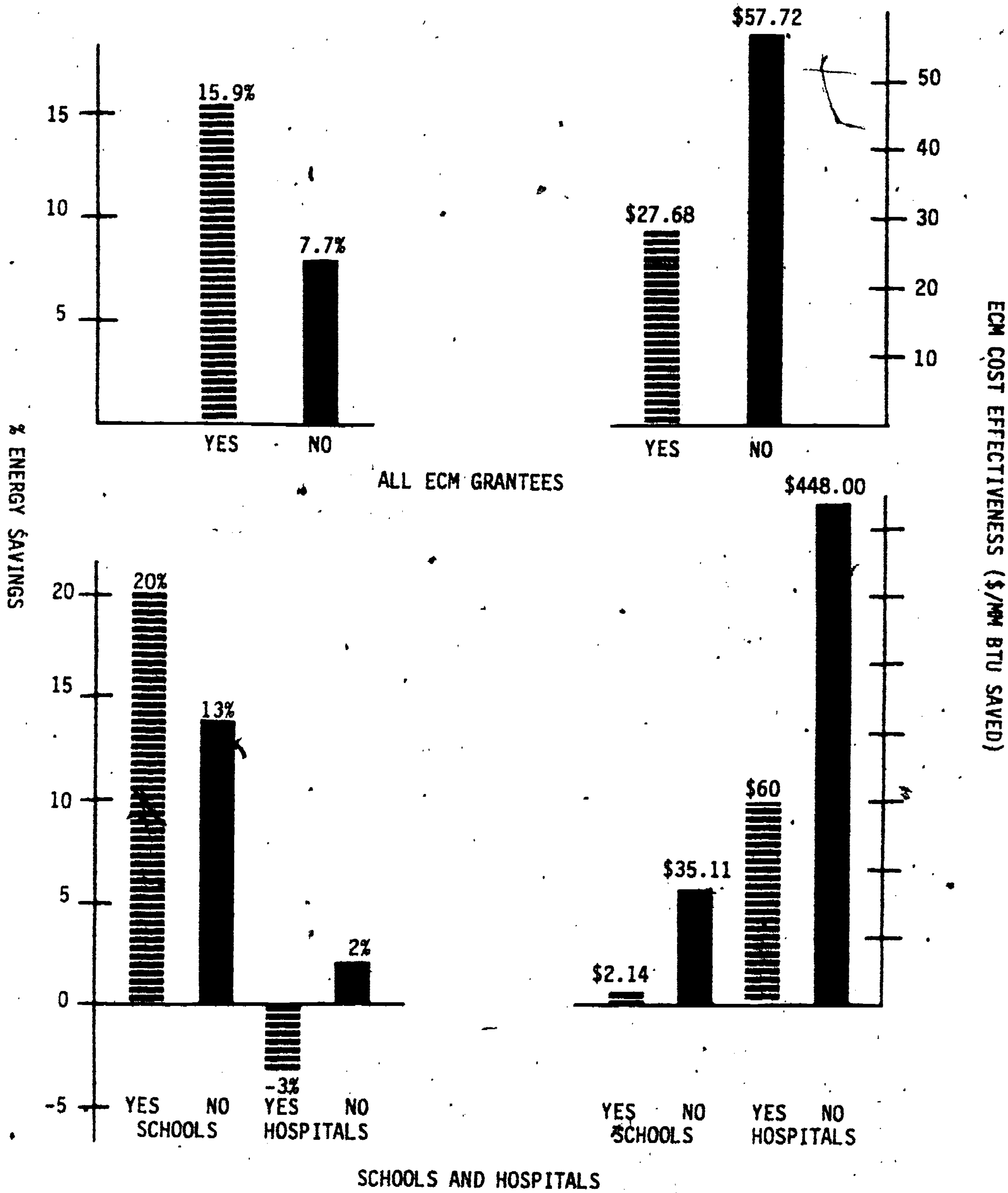
Question: Is There Clear Evidence That O&Ms Are Not Being Maintained?



COMMENT: Actual implementation of O&Ms as verified by evaluation team had a major effect on energy savings.

FIGURE 3.6 IMPACT OF THOROUGH O&M PROGRAMS ON ENERGY PERFORMANCE

Question: Was There Evidence of Additional O&M Activity Beyond the EA Recommendation?



COMMENT: O&Ms exceeding EA recommendations contribute to higher energy savings and better ECM cost effectiveness.

Monitoring and Metering Save More Energy

The ECM grantees that maintained records of energy use and used those records to measure energy performance experienced higher levels of energy savings than those that did not monitor. Data analysis shows that grantees conducting monitoring saved an average of 11.9% as opposed to 7.5% for those that did not monitor ($p < .05$). Monitoring activities also had an impact on costs, as evidenced by costs of $13.52 per MMBTU for institutions with monitoring and $97.74 for MMBTU for those without monitoring.

Grantees with special metering showed an average savings of 20.1%, compared to 9.4% for grantees without special metering ($p < .05$). Energy costs at institutions with special metering were $13.05 per MMBTU saved, compared to $24.44 per MMBTU saved at institutions without special metering. Figures 3.7 and 3.8 summarize the impacts of monitoring and metering on energy performance for all ECM grantees, as well as for schools and hospitals.

Schools that monitored energy performance saved an average of 20% at a cost of $17.56/MMBTU saved. Schools that did not monitor saved an average of 10% at a cost of $60.89/MMBTU saved. At schools where special metering was evident, energy savings were 20%, and 14% at schools without special metering. At hospitals, where energy consumption was monitored regularly, savings averaged 9%, as compared to .1% savings for hospitals that did not monitor.

Results Must Be Analyzed and Applied

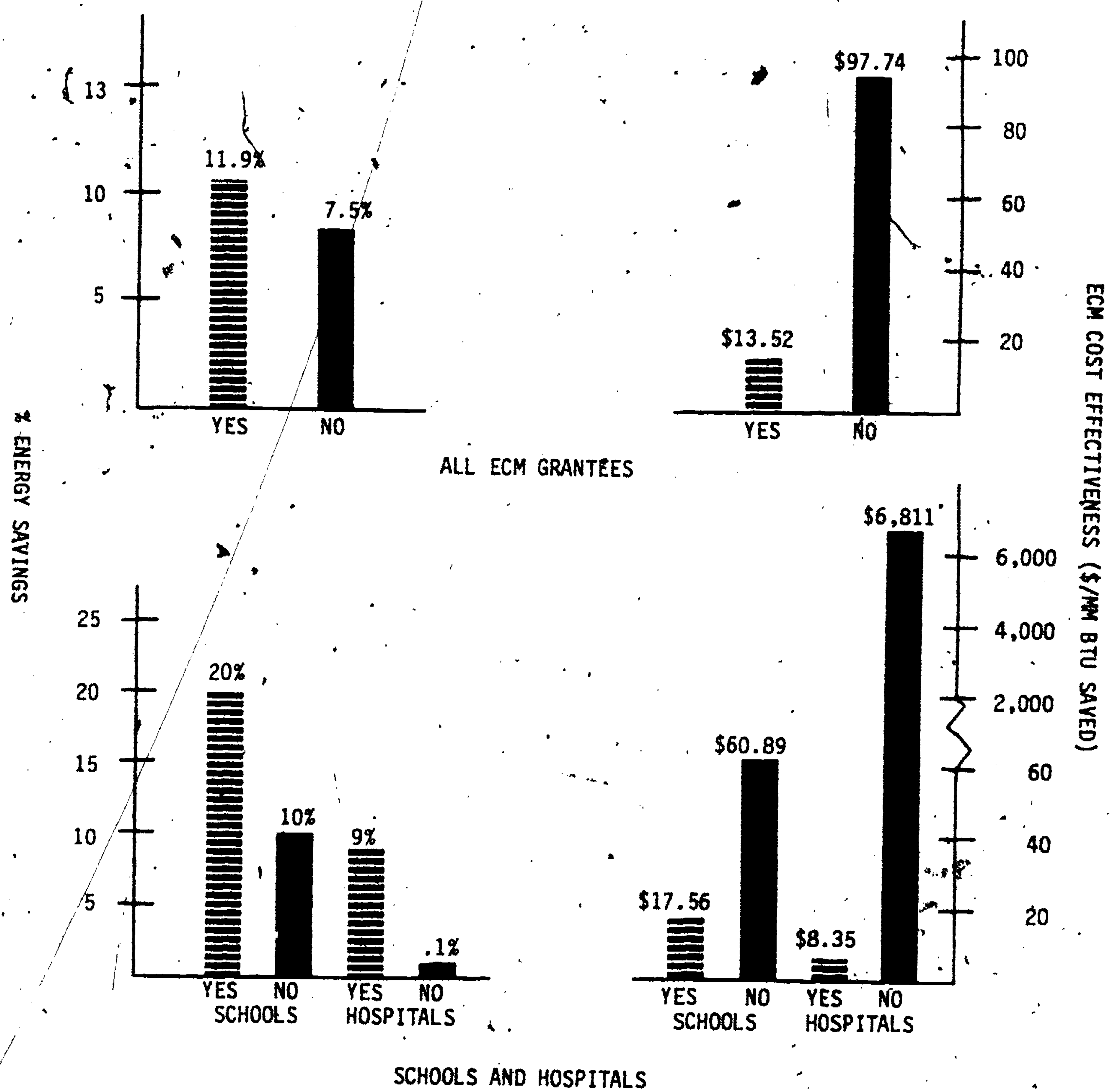
Although the EA, TA, and ECMs were intended collectively to facilitate reductions in energy consumption, very few institutions have the administrative or mechanical capacity for systematically monitoring and controlling the major factors that may cause high consumption. In the cases where monthly, seasonal, or more normally, annual monitoring of consumption is performed, there does not seem to be an effective application of the resulting knowledge for the purpose of reducing energy consumption. Whereas 47% of the ECM sites reported some type of monitoring activity, only 17% actually metered energy performance. It is doubtful that timely investigation and correction of inefficient hardware operation is resulting from the monitoring activities. For example, one hospital that included daily monitoring of electricity consumption, peak demand, and temperatures on an hourly basis simply stored the results in a desk drawer. No attempt was made by the maintenance staff to use the monitoring reports for energy conservation.

Theoretical Savings Often Are Not Challenged

Many managers, operators and maintenance personnel feel comfortable that energy is being saved after ECM activity solely because the theory and paper calculations said it should be so. Lack of interest in confirming the existence/or exact level of savings and in identifying potential ways to fine-tune performance is fairly widespread. During site interviews, when respondents were asked how much energy they thought was being saved, only 14% of the respondents were able to report a percentage of savings without referring to records. Where automatic devices or systems have been installed to manage energy consumption, this "blind faith" is even more prevalent. In the few

FIGURE 3.7
IMPACTS OF MONITORING ON ENERGY PERFORMANCE

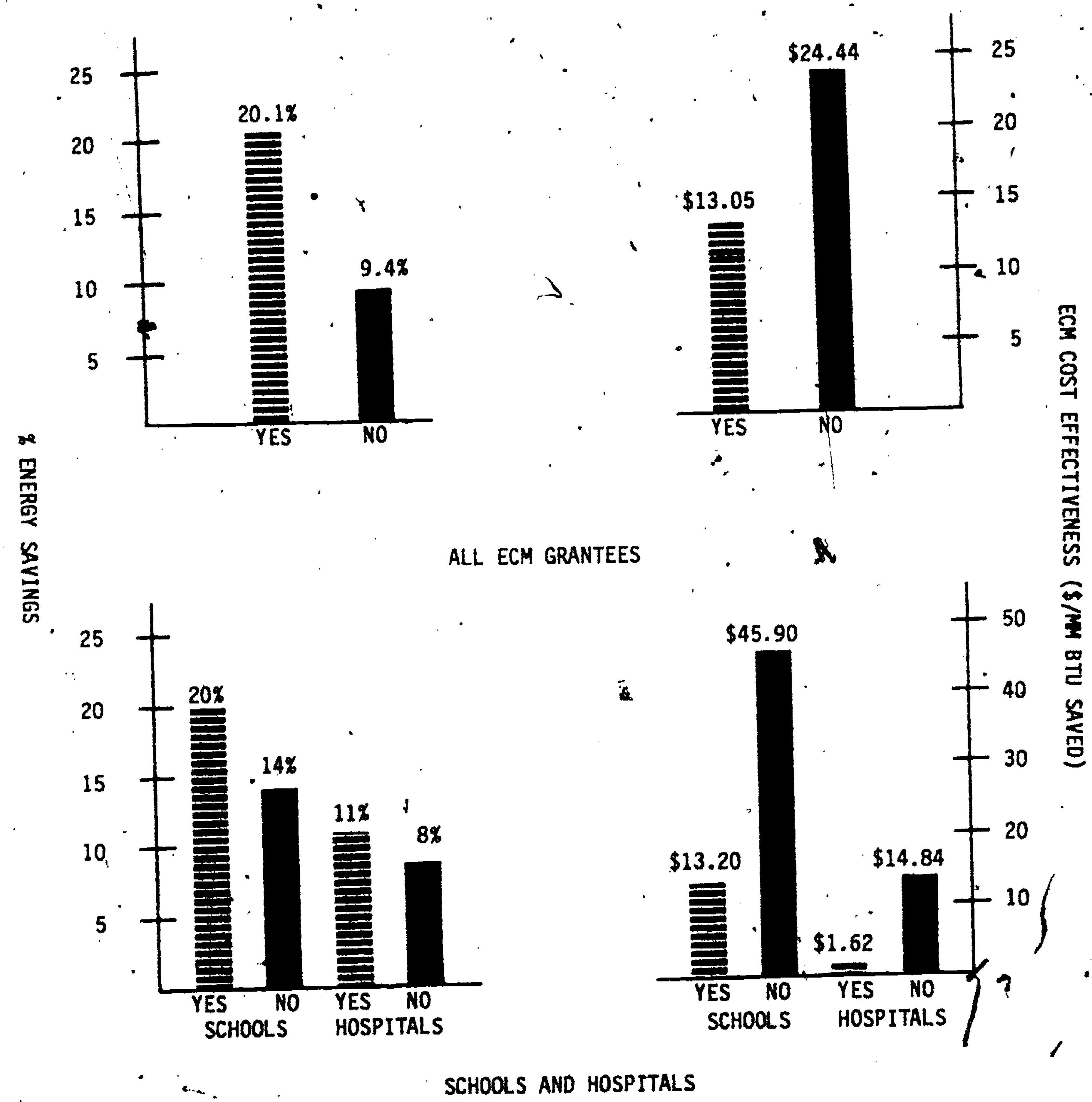
Question: Was There Evidence Of Ongoing Energy Data Monitoring?



COMMENT: Monitoring clearly contributes to both total energy savings and cost effectiveness

FIGURE 3.8
IMPACTS OF METERING ON ENERGY PERFORMANCE

Question: Was There Evidence Of Special Energy Metering?



COMMENT: Special metering contributes to energy savings in a very cost effective manner cases where energy budgets have been decentralized and management authority has been placed in the same hands as the operating and maintenance responsibility, there appears to be more dynamic monitoring which produces better results. This topic is discussed further in Case Study F.

Maintenance and Monitoring Contracts Can Entail Pitfalls

Long-term maintenance/monitoring contracts for ECMS involving changes to (or addition of) mechanical equipment controls can not always assure proper functioning and optimum tailoring to the facilities' needs. Observations and discussion of the functioning of such ECMs has disclosed that improper maintenance and/or monitoring can cause significant difference between theoretical and actual performance. For example, in one case controls that function only in the winter were installed and set in the summer. Problems reported during the winter were adjusted the following spring. The next winter the same complaints still existed and were observed during the site visit to be of a nature that probably could not be corrected properly except during winter operation with actual heat load conditions prevailing. The result was poor energy conservation results existing long after savings should have occurred.

In some cases, the on-site personnel are not considered sufficiently capable and/or are specifically directed not to concern themselves with the mechanical equipment and controls. The incentive to observe and report apparent inefficiencies, let alone take any action, is thus directly affected. In other cases where the on-site personnel appear to be nominally qualified by experience and position, there are still questions of how efficiently hardware is controlled due to lack of analytical instrumentation and/or insufficient willingness and time to obtain the optimum settings experimentally.

One school that contracted with a local maintenance service company to perform periodic preventive maintenance throughout the school did not assign anyone to monitor or judge the contractor's work, or to coordinate appropriate equipment operating procedures and control set-points with the school personnel and mission of the facility. As a result, money was being paid for ineffective service, as evidenced by the following seven items noted during the site visit: dirty filters, overflowing cooling tower basin, classroom gas unit heater pilots left on throughout the summer, domestic hot water heater set at maximum temperature, cooling of unoccupied areas to 65° F, empty refrigerator set to lowest possible temperature in summer, and water coolers operating during unoccupied summer periods.

The implication is that management of an organization must be motivated and knowledgeable in order to select a professional maintenance service that will do more than react to broken equipment. Managers must either know how to select a suitable contractor, or must provide well-defined performance requirements and continuously follow up the contractors' actions until assured that work is being done in a manner that will maximize energy savings.

A viable solution to increasing energy efficiency from complex control ECMs is to recognize the need for more highly trained personnel to conduct follow-on measurements and corrections than is normally needed when only operation of the equipment, not efficiency, is the objective. This requirement can be met in several ways but all have a cost. The cost/benefit ratio should be carefully assessed before such ECMs are incorporated. If no solution can be provided, it may be better to divert the proposed ECM money into even longer payback projects that require no close follow-on attention.

WHAT SECONDARY GOALS WERE ATTAINED?

The ICP achieved several of its secondary goals. In general, they fall into two categories: (1) the stimulation of energy awareness and conservation activities, and (2) a widening of interest in energy conservation and a concomitant growth in technical expertise. The pursuit of a third goal--consideration of solar and other renewable resources--yielded uneven results.

The ICP Has Stimulated Energy Awareness and Energy Conservation Activities

Throughout the site visits it was observed that the ICP has been effective in promoting energy conservation programs in schools and hospitals. Evaluation data that support this finding are shown in Table 3.8.

As Table 3.8 indicates, 72% of the grantees would not have been involved in energy conservation without the ICP. When ECM cost effectiveness data are examined for schools and hospitals (see Figure 3.9), it appears that for institutions that would not otherwise be involved in energy conservation, the Program provided a necessary financial incentive. However, the energy savings data suggest that those ECM grantees who would have installed their ECMs without the ICP may have had a better understanding of the more energy efficient ECMs, since overall, this group achieved higher energy savings.

In summary, the ICP is effective in reducing energy consumption in schools and hospitals, and in assisting these institutions develop energy conservation programs that are likely to be sustained with their own resources.

ICP Has Resulted in a Widening of Interest In Energy Conservation and a Concomitant Growth In Technical Expertise

In addition to the energy savings associated with the ICP, evaluation data reveal that the Program is attaining a number of additional goals and objectives. At the administrative level, State Energy Office (SEO) personnel reported that the benefits of the ICP extended beyond actual fuel savings for participating institutions. Additional benefits cited include: training and support of energy conservation specialists (engineers, auditors, and monitors), and generation of basic data bases on building profiles and energy consumption on a State-by-State basis.

In addition, several States have initiated energy conservation programs as a result of the ICP. Although designed around the ICP, these State programs may include alternative funding mechanisms such as low-interest loans, revolving loans, and shared savings, as well as direct grants to institutions. SEOs also noted stimulation of interest in the energy savings potential in non-eligible facilities.

TABLE 3.8

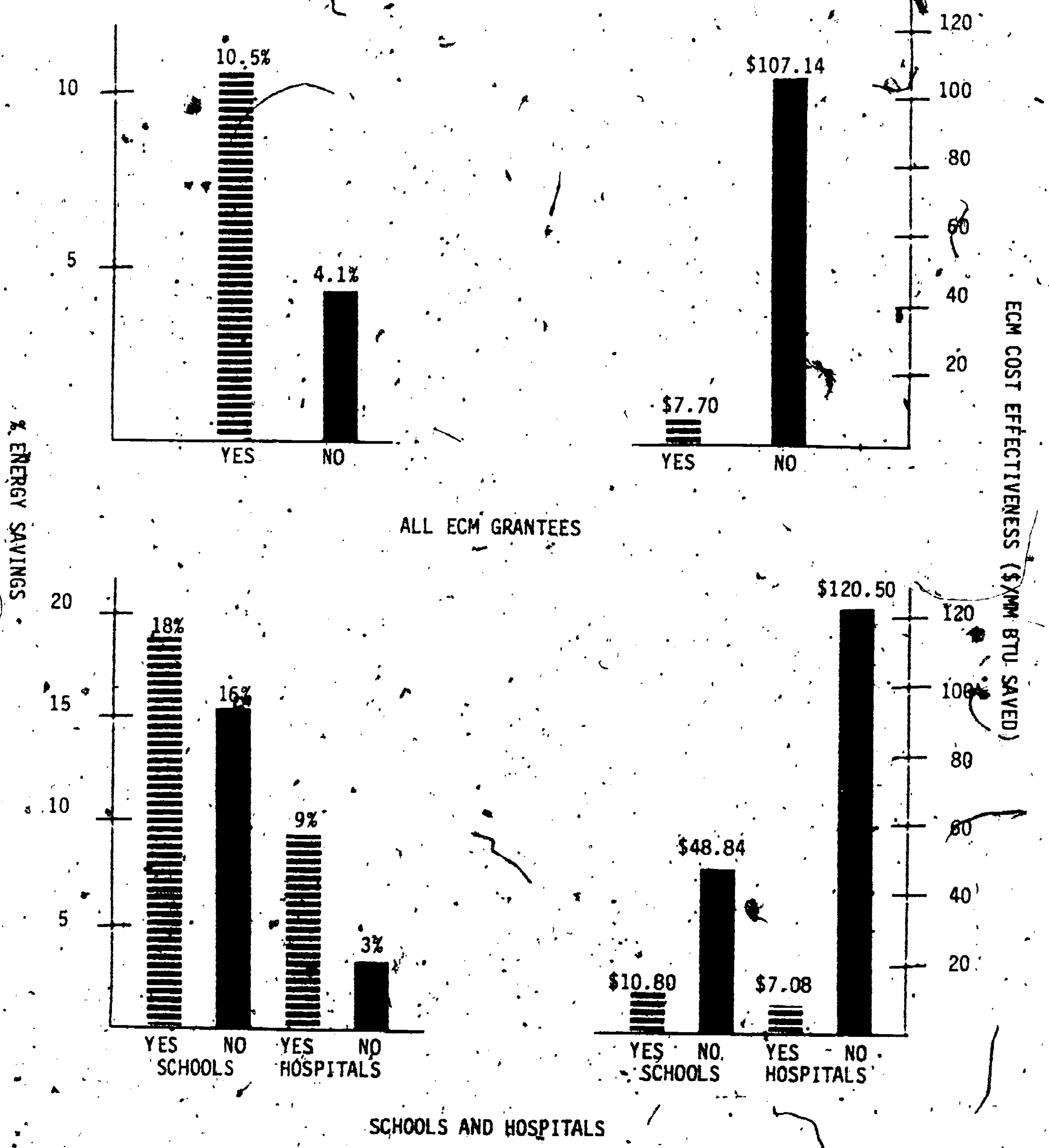
INSTITUTIONAL ENERGY CONSERVATION INVOLVEMENT

ACTIVITY	% INVOLVEMENT All Institutions*	Schools	Hospitals
ECM grantees with no involvement in energy conservation prior to the ICP	53	65	18
ECM grantees that implemented non-ICP funded energy projects since participating in the ICP	45	44	45
ECM grantees exhibited awareness of energy conservation through reminder signs and posters throughout the building.	54	60	18
ECM grantees reported that projects would not have been undertaken within 5 years without ICP funding.	72	76	36
ECM grantees reported specific conservation activities planned for the future.	65	64	81

*Based on the weighted sample of ECM grantees.

FIGURE 3.9
ICP AS AN INCENTIVE FOR ENERGY CONSERVATION

Question: Would ECMs Have Been Installed Within 5 Years Regardless Of ICP?



COMMENT: ICP clearly provided the financial incentives for schools and hospitals to undertake conservation activities that they otherwise would not have done.

Analysts Couldn't Agree on the Cost Effectiveness of Solar ECMs

Because the ICP required the consideration of solar and other renewable energy measures, States usually gave extra credit to those applications during grant ranking and funding. Despite this extra credit, few TA analysts were able to justify applications due to the long payback of such projects. However, the site visit teams found that whereas most TA analysts projected a very long payback for a particular solar project, at a few nearby institutions the same project had been funded. For example, in one case a TA analyst concluded that solar heating of a school's indoor swimming pool would have a 46-year payback. At another school within 30 miles, the analyst calculated a payback of less than 14 years, and solar pool heating was recommended, approved, and installed.

TA analysts in another State were generally in agreement that solar heating of domestic hot water in schools would have an excessively long payback. However, one analyst found the payback to be quite short and recommended this as an ECM. The ECM was approved and installed even though virtually no other solar projects had been approved in that State. No instrumentation or other means of performance evaluation was included or planned, so there was no way for the school to determine whether the solar project was effective. Further, there was no provision to prove the appropriateness of the analyst's unique recommendation.

ICP CASE STUDIES

In addition to the quantifiable data on fuel consumption in institutions and the qualitative and administrative details of ICP participation, each institution visited provided interesting information on the attitudes and behavior of building occupants and users, as well as some insights into the impacts of these attitudes and behavior on energy conservation. Although extensive anecdotal information is beyond the scope of this report, institutions that represent a mix of survey delivery (EA or ECM), institution type (school, hospital, local government), size, and location, have been selected as case studies. These case studies support specific evaluation findings, describe the technical application of O&Ms and ECMs in combination with daily institutional procedures, and highlight the ICP experience in these institutions.

CASE STUDY A: THE EFFECTIVENESS OF A CENTRALIZED CONSERVATION PROGRAM CAN BE OFFSET BY POOR O&M PROCEDURES AT THE BUILDING LEVEL

Institution Type:	2 local government buildings (fire station and health clinic)
Location:	Large urban area
Size:	Fire station: 6,912 sq. ft. Health clinic: 986 sq. ft.
Latest ICP Phase Completed:	EA
EUI:	
Fire station	
Base:	126,591 BTU/ft^2/yr
Latest:	256,636 BTU/ft^2/yr
Health clinic	
Base:	156,825 BTU/ft^2/yr
Latest:	133,884 BTU/ft^2/yr
Savings:	Fire station = - 103% Health clinic = 14.6%
Information:	Fire Station EA completed: 4/80 Health Clinic EA completed: 10/79

The city's energy office, which has been in existence since 1975, coordinated the ICP. A knowledgeable energy manager was appointed to conduct EAs at over 60 local government buildings as part of the ICP, and two buildings were selected for EA site visits.

Purchasing authority and the research efforts of the energy manager afford the city the ability to buy energy-saving equipment at reasonable prices. For example, the manager discovered that it was cheaper to buy a 4-lamp, 2-ballast fluorescent fixture and connect only 2 lamps and 1 ballast than to buy a 2-lamp, 1 ballast fixture.

However, the manager has no direct daily authority over personnel who operate a variety of buildings. The result was that more energy was wasted with poor daily control than the manager was saving through special purchases. At the fire station, all window air conditioners were operating to produce chilling temperatures, and lights were on in the sleeping areas in the morning, even though no personnel were using the area. In addition, incandescent lights of excessive wattage were lit in stairwells during the day, despite the availability of sufficient daylighting. These wasteful habits revealed an alarmingly high increase in energy consumption.

Although the health clinic operates on a schedule that varies from week to week with other clinics in the city, a similar lack of O&M efforts was seen. The HVAC system is operated by a time clock that could be reprogrammed each week to accomodate schedule changes. However, reprogramming is not done by building occupants, and the evaluation team observed it operating all day on the day the clinic was closed. In addition, high wattage incandescent fixtures in the bathrooms could have been reduced, replaced with a fluorescent fixture, and/or connected to a timer switch. Although the clinic did manage to show a savings, it is likely that the results could improve with increased O&M efforts by building occupants.

CASE STUDY 8: TOP LEVEL MANAGEMENT THAT IS CONCERNED WITH OBTAINING ENERGY SAVINGS, BUT USES DECENTRALIZED AUTHORITY FOR IMPLEMENTATION, PRODUCES A WIDE RANGE OF RESULTS

Institution Type:	School (4 schools in a district)
Location:	Rural county
Latest ICP Phase:	ECM
Savings:	0.2% (average of 4 schools)
Program Information:	All EAs completed by 12/79 All ECMs completed by 3/82 Total project costs: $108,994 (total of 4 schools)
ECMs Installed:	Storm windows Boiler controls HVAC controls Lighting modification Window modification Energy management computer systems (2 schools only) Air conditioning retrofit

The school system's administrator was concerned with ways to save energy dollars and was reasonably well informed on general technical methods. However, his management approach is to allow each principal to handle the task in his own way. An added incentive to principals was that the dollars saved through energy conservation were returned to the schools.

The result was considerable daily awareness of energy results in one school, but many procedural oversights and little impact on energy in another. For example, the principal at one high school was very enthusiastic about saving energy. He reported that he continually looked for additional O&Ms to the point that he received complaints from parents that water coolers had been turned off. The ECMs installed through ICP included insulation in ceilings and floors, air conditioning retrofit, and window reductions. The dollars returned to the school from the savings of the ECMs and active O&M efforts allowed the principal to purchase and install window shades throughout the school.

At the middle school in the same district, minimal O&M efforts were observed, and in fact, poor operation of ECMs was seen. The evaluation team observed overlighting in unoccupied areas, where natural lighting would have sufficed even if the area was occupied. Over-cooling of classrooms was evidenced by doors open to the outside and students complaining of the cold. Further, it was discovered that air conditioning units had been installed in a manner that precluded easy access for maintenance, and thus, filter changes and regular maintenance on these units was rarely done. Data analysis indicated that this school had, in fact, increased its energy consumption by about 4%, whereas the high school discussed above achieved a savings of 25%.

In summary, the school system administrator failed to analyze adequately the total energy results by school, in order to monitor the practices of each of the school principals. Potential methods for improving energy management and results were not shared among the schools. Total dollar changes were reported to the principals, but no attempt was made to inform all the principals of the energy saving practices at the most successful schools. Consequently, savings varied dramatically by school.

CASE STUDY C: ENERGY SAVINGS OPPORTUNITIES MAY BE MISSED IF TA ANALYSES ARE NOT BUILDING SPECIFIC OR IF RESPONSIBILITY FOR ENERGY PROGRAMS IS NOT DELEGATED

Institution Type:	11 schools (10 elementary, 1 high school)
Location:	Large urban area
Size:	Smallest school is 10,536 sq. ft. Largest school is 288,724 sq. ft.
Latest ICP Phase Completed:	ECM
Savings:	-2% (average of 11 schools)
Program Information:	EAs for all schools completed: 12/79 ECMs for all schools completed: 3/81 Project cost: Smallest project: $6,460 Largest project: $52,676
ECMs Installed:	Boiler controls HVAC controls Vestibules Water flow restrictors

In this particular school district, 11 schools were selected for site visits. This case study illustrates two findings: to maximize energy savings, building specific ECM recommendations need to be developed, and responsibility for O&M authority is most appropriately delegated to maintenance personnel.

All TA reports and ECM recommendations were made by a single engineering firm. Although TA reports provided appropriate calculations, it became evident that similar ECMs had been recommended for all the schools. In this situation, it may be argued that specialization (emphasis on ECMs with which the analyst is most familiar) can produce better engineering analysis within the given time and dollars allowed for the TA. On the other hand, this approach tended to foster non-creative and less cost-effective solutions. The greatest harm came from an apparent tendency of the analyst to force certain solutions upon all buildings. Although the solution may not have been inappropriate, it may not have been of the highest priority in terms of initially saving the most energy for the least cost. The priority of a given ECM may easily differ among buildings, even though the buildings appear similar. Building utilization, maintenance conditions, and occupancy differences are only a few causes for this. In this school district the results are amplified by recognizing that within a single district, building utilization and maintenance procedures do appear relatively consistent. However, data analysis revealed that energy savings varied widely among the schools. Six of the 11 schools showed increases in energy consumption, while 5 of the schools achieved a savings. Overall, the district showed a 2% increase in consumption when corrected for weather variations. It is likely that savings may have increased if the TA analysts had evaluated which ECMs would benefit each institution the most.

In addition to having the analyst recommend similar ECMs in each school, this district exemplifies the finding that centralized management of energy programs may reduce the savings potential in individual schools. During building walkthroughs, it was learned that maintenance staff had been instructed <u>not</u> to concern themselves with energy systems in general, and the EGMs in particular.

A lack of ongoing O&M efforts was observed--for example, domestic hot water heaters were set at maximum temperatures, filters were dirty, and intake of outside air in ventilation systems was unbalanced--even though the maintenance staff would have been capable of attending to the O&Ms. In some of the schools, the maintenance staff suggested O&Ms that they thought they could undertake, if only they had the authority. Because of the lack of energy savings throughout the school district, there is no question that the schools would benefit from the delegation of O&M authority to the maintenance personnel.

CASE STUDY D: GOOD MANAGEMENT LEADERSHIP FOSTERS SUBSTANTIAL ENERGY SAVINGS

Institution Type:	Hospital
Location:	Large urban area
Size:	510,613 ft^2 1 building with several wings
Latest ICP Phase Completed:	EA in sample, but subsequently completed ECM
Savings:	5%
EUI:	
Base:	606,311 $BTU/ft^2/yr$
Latest:	575,995 $BTU/ft^2/yr$
Program Information:	EA, Completed 8/79

Although this institution was selected as an EA site visit, it actually had received an ECM grant subsequent to the sample selection and prior to the visit. However, the energy results from the ECM did not occur until winter 1982-83.

There had been numerous excellent O&Ms and energy conservation measures implemented at this institution over the past 5 years, by the current director of facilities. During this period energy consumption had been reduced 30% on a BTU/ft^2 basis even though new energy-using equipment had been added. Because of considerable energy use reduction prior to the EA of 8/79, the reduction since then has been only 5%. The key to this achievement is clearly the strong energy-oriented leadership of the facilities director. Many common-sense procedures have been implemented, good preventive maintenance is evident, a computer monitoring system is being used effectively for daily assignment of maintenance tasks, lighting levels have been reduced, temperatures have been optimized, and proper operation of boilers and chillers is being observed to get maximum hardware efficiency.

This facility has documented in excellent detail its energy data from late 1975 to the present and has produced written analysis of the trends. In spite of this unusual level of recordkeeping, continuous building and energy system changes make it impossible to apportion credit for energy use reduction to specific O&Ms or ECMs.

The recently completed ECM (heat recovery chiller) is expected to decrease energy consumption significantly during its first winter season. In the future, this institution should provide interesting energy consumption results, as well as adequate data and system monitoring with which to analyze the improvements in the building's overall energy efficiency, since there is a high level of leadership and management interest in fostering energy conservation.

CASE STUDY E: QUALITY TA ANALYSIS, APPROPRIATE ECM RECOMMENDATIONS, AND ONGOING O&M EFFORTS RESULT IN A HIGH LEVEL OF ENERGY SAVINGS

Institution Type:	High school
Location:	Large suburban area
Size:	640,000 sq. ft.
Latest ICP Phase Completed:	ECM
EUI:	
Base:	201,153 BTU/ft^2/yr
Latest:	134,154 BTU/ft^2/yr
Savings:	36%
Program Information:	EA completed: 11/79 ECMs completed: 12/81 Total project cost: $379,457
ECMs Installed:	Boiler interconnect system Oxygen trim controls Steam trap replacement Pipe insulation Lighting modifications

The evaluation team met with the school's facilities director and TA analyst. Complete energy records were provided, as was a written description of ICP experience, by program phase.

The facilities director reported that the EA was valuable to the school because it caused staff to look at operating systems and procedures from the perspective of energy consumption for the first time. In many instances, it identified cause-and-effect relationships that they had not recognized previously.

The TA analyst was selected after interviewing representatives from several architectural/engineering firms. The TA process was viewed as being extremely useful. Not only did it establish the cost-effectiveness of energy conservation options, but it also served as a source document to determine priorities and budgets for work that could generate enough savings over a reasonable period of time to recover costs and effect real savings in energy and operating costs. The criteria cited by both respondents for selecting those recommended ECMs for which ICP funding was sought included: (1) payback period, (2) practicality in relation to facility usage, and (3) operational practicality.

The primary ECMs included a boiler interconnect system and installation of oxygen trim controls. The ECMs have allowed a complete change in the school's heating system by disconnecting the school's original boilers and operating smaller, more efficient boilers in the annex building. The projected cost savings for the boiler interconnect and a variety of other ECMs was $51,600. The respondent reported that within the first year of operation the savings was over $35,000, since it became possible to eliminate one full-time boiler room maintenance position and another part-time position. Data analysis has shown that the school has achieved a 36% savings since beginning its energy program.

By maintaining an ongoing successful relationship with a highly motivated TA analyst and maintenance staff, the school keeps up-to-date records of energy conservation. At the time of the site visit, the staff was developing a concrete plan for future conservation activities.

CASE STUDY F: INSURING THAT ECMs ARE FUNCTIONING PROPERLY AND AN AGGRESSIVE PROGRAM OF O&Ms SAVE ENERGY

Institution Type:	School (elementary)
Location:	Small rural town
Size:	25,440 square feet - 1 building
Latest ICP Phase Completed:	ECM
EUI	
Base:	139,188 BTU/ft^2/yr
Latest:	103,133 BTU/ft^2/yr
Savings:	18.5%
Program Information:	EA completed: 8/79 ECMs completed: 6/80 Total project cost: $5,523
ECMs Installed:	35-watt fluorescent bulbs schoolwide Energy Management Control System (EMCS)

This elementary school was selected as one of four schools in the district that participated in the ICP. The primary respondent for the site visit was the district's superintendent, who has kept detailed records of ICP expenditures and installation schedules as well as accurate energy consumption data. According to the superintendent, the district has been involved in energy conservation since the early 1970s, due to building renovations and the rising costs of energy. At the district level, an energy committee has been formed to examine future energy conservation potentials in the schools.

During the interview it was discerned that for 2 years following ECM installation, the school actually increased its energy consumption. It was also learned that the current principal had been at the school for less than one year. Final data analysis showed that the school had, in fact, begun saving energy after the new principal's arrival, and had saved 18% since participating in the ICP.

During the building walkthrough, the principal informed the evaluation team that the EMCS controls had been set and he had assumed there was no need to change them. He had discovered, however, that energy systems were cycling on during vacation periods, and that air conditioning was set to cycle on at 5:00 a.m. The principal, therefore, learned the procedures for operating the system and reset timers to reflect actual school schedules.

The principal's interest in energy conservation was further evidenced when the evaluation team pointed out energy saving O&Ms during the building walkthrough. Heating vents located directly inside the building entrance were blasting hot air, which was desirable on cool fall mornings, but unnecessary as outside temperatures rose, and classes were in session. It was recommended by the evaluation team that these vents be closed off completely, even in winter, since school children entering or leaving the building would be dressed warmly. It was also suggested that an overlit empty all-purpose room/cafeteria be monitored to maximize natural lighting and minimize artificial lighting. The school principal showed enthusiasm for the various O&Ms that it would be possible for him to control.

Several months following the site visit, the principal voluntarily reported to the evaluation team on the progress he had made. He had begun monitoring the school's energy consumption, although he had been unable to compare it with previous years at that time. He also reported that not only was he sure that closing off the hallway heat vents had reduced consumption, but it had been successful in curtailing loitering in the hallways. In addition, his monitoring of lighting levels in the cafeteria had led to inquiries into the ability to reduce lighting levels school-wide. From the example of this institution, it may be seen that effective monitoring of O&Ms and ECMs can increase energy savings.

CASE STUDY G: CONSCIENTIOUS O&M EFFORTS PRODUCE SIGNIFICANT SAVINGS

Institution Type:	Local Government (Library)
Location:	Small rural town
Size:	3,366 sq. ft.
Latest ICP Phase Completed:	EA
EUI:	
Base:	110,424 BTU/ft^2/yr
Latest:	84,667 BTU/ft^2/yr
Savings:	23.3%
Program Information:	EA Completed 7/80

This facility uses only electricity and natural gas. It is a very old residential building that was converted to serve as a library.

The EA suggested O&Ms of the conventional kind such as reduced lighting, closer control of temperature settings (for both occupied and unoccupied space), reduced hot water, and improved maintenance for the heating equipment.

Fuel consumption data available in very complete form for several years disclosed a 21% energy reduction from the '77-'78 base period to the '81-'82 period.

The respondent for this EA site visit, the librarian, was impressive in her energy knowledge and persistence in maintaining O&Ms. During the walkthrough portion of the site visit, it was clear that O&Ms were effective. Air conditioning and lights operated only in two occupied rooms. The librarian had reduced lighting levels in all rooms, installed vinyl storm windows, and turned off the hot water for the summer.

Being a local government building, this institution was not eligible for ECM funding. In addition, factors such as building age and hours of occupation would drastically limit the effectiveness of capital expenditures for energy conservation. However, this library serves as a shining example of the significant achievements that are possible with the simplest of O&Ms when they are consistently pursued by enthusiastic management.

CASE STUDY H: SUBSTANTIAL ENERGY SAVINGS MAY BE DUE TO THE CONCURRENT CORRECTION OF POORLY MAINTAINED SYSTEMS WHEN ECMs ARE INSTALLED

Institution Type:	Private High School
Location:	Large Urban Area
Size:	55,941 sq. ft.
Latest ICP Phase Completed:	ECM
EUI:	
Base:	109,991 BTU/ft^2/yr
Latest:	71,345 BTU/ft^2/yr
Savings:	31.2%
Program Information:	EA Completed 3/79 TA Completed 6/80 ECM Completed 2/81: Project cost: $62,245
ECMs Installed:	Ceiling insulation Boiler modifications Lighting modification Window modification Thermostat controls

In this high school the heating system had become so ineffective that students had to be sent home on very cold days. The TA was performed independently and a credit subsequently received under ICP. This was a first experience in federal grant application procedures for the school management, and that was felt to be the cause of failure to receive a hardship grant. Matching funds were obtained in a unique manner. Stock in the school (contributions) was sold, bake sales were held, and a local foundation made a major gift. The management was very pleased with the ECM results both with respect to comfort and to the major reduction of utility cost savings.

The ECMs installed consisted of 128 thermostatic control valves on individual radiators, a night setback time clock, ceiling insulation, a light-colored ceiling and sodium vapor lighting for the gymnasium, fluorescent lighting throughout, and boiler dual fuel burner replacement with conversion from oil to gas.

The energy consumption from the base year of '77-'78 to the post-ECM year of '81-'82 dropped 31%, after correcting for weather variations. There were no apparent changes in floor area, utilization, or energy-using hardware during the interim period.

This case suggests a factor that could have explained part of the significant energy results. The #5 oil-fired boilers had apparently reached such a low level of efficiency, possibly through neglect, that minimum heat conditions for human occupancy could no longer be maintained. In the process of the boiler burner conversion, general boiler cleanup and adjustment may have contributed a major portion of the subsequent energy reduction. Since the burner conversion ECM was done on a seemingly inefficient heating system, there is no way to now assess the division of credit between the ECMs and O&Ms. However, even if good preventive maintenance is not available in the future, the change from oil to gas will prevent boiler efficiency from declining as rapidly as it may have in the past.

Of the 31% overall energy reduction, consumption of fuel for heating fell 23% and electricity use fell 46%. Due to the type of heating system, almost no electricity is consumed in the heating process. Therefore, the 46% electrical reduction appears to have come mostly from the lighting changes. Of these changes, the sodium vapor fixtures in the gymnasium were probably a major contributor, and were observed during the site visit to provide a very attractive form of lighting.

In this institution, ICP helped to reduce energy consumption. Although it was quite evident that boiler replacement was imminent regardless of the availability of federal funds, it is likely that an overall energy conservation program would not have occurred in the institution. Therefore, even though the success of the boiler ECM actually may be due to the correction of a poorly maintained system, this institution's ICP participation also has brought valuable energy conservation knowledge to the institution's occupants, managers, and maintenance personnel.

The following 5 case studies summarize the findings of the detailed follow-up site visits. As may be seen from these case studies, the return site visits permitted an in-depth analysis of the grantees complex energy systems and their overall building energy efficiency.

These follow-up visits indicated that there were no previously overlooked installation or operation discrepancies. Therefore, the amount of time and the general techniques used at each of the original site visits appears to have been adequate to disclose the key findings developed by this evaluation. Precise quantitative explanations for greater-than-expected post ECM consumption did not result from these return visits. However, the individual case studies describe in a qualitative sense the most probable causes in each case, and the circumstances which preclude more precise determinations. The additional site visit time also provided an opportunity to review the energy data being used for the evaluation in more detail with the institutions. This resulted in some minor data changes, but the overall conclusion in each case essentially was unaffected.

CASE STUDY I: FOLLOW-UP SITE VISIT INDICATES THAT APPARENT INCREASES IN CONSUMPTION ARE DUE PRIMARILY TO SYSTEM MODIFICATIONS AND ADDITIONS OF UNASSESSABLE AMOUNTS OF ENERGY CONSUMING EQUIPMENT

Institution Type:	University
Location:	Medium size urban area
Size:	92,670 square feet
EUI	
Base:	482,615 BTU/ft^2/yr.
Latest:	540,675 BTU/ft^2/yr.
Savings:	(-12%)
Program Information:	EA completed 9/79 ECMs completed 6/81 Total project cost: $254,000
ECMs Installed:	Ventilation exhaust air heat recovery system

This facility provides classroom and laboratory space for the University's Chemistry Department. The energy needs of this building are especially impacted by the continuous air ventilation requirements from the laboratory areas through a multitude of vent hoods. Although the occupancy of the building is not continuous, hood ventilation must be continuous to protect the ongoing laboratory experiments.

Because of the year-round ventilation requirement and limited opportunity to cycle-off systems for energy conservation, the selected ECM was an exhaust air heat recovery system. This project, completed in mid 1981, replaced about 24 roof top exhaust fans with two collector duct systems and four large exhaust fans. Nine of the exhaust fans handling highly toxic laboratory areas were excluded from this system.

The energy sources for this building are steam provided by a campus central electric generating plant plus electricity. The electricity consumption is metered at the chemistry building but prior to the ECM installation the steam meter for this building was inoperative. During mid 1981, the faulty steam meter was replaced, so accurate consumption has been available since the ECM was installed. Calculated "best" estimates of steam consumption were used for the pre-audit base year of 1978.

Comparison of the pre-audit and post-ECM energy data shows that steam energy has been reduced but electrical energy has increased by a greater amount so that the net result has been an energy increase of 12%. In this facility, steam is converted to hot water for all heating of space plus domestic hot water. It is also the energy source for air conditioning, using steam absorption chillers. Electricity is used for the fluorescent lighting and all water circulating pumps and air movement fans. A small electrically driven pump was added as part of the ECM exhaust heat recovery system to circulate the glycol/ water heat transfer medium between the exhaust air and outside air heat exchange coils..

Although the on-site operating and maintenance personnel monitor the heat recovery system to be aware that its controls cycle it on approximately when the design conditions should dictate, there has been no measurement of the quantity of heat being recovered. Thermometer test fixtures that would permit measuring the amount of heat being recovered were installed in the glycol circuit but they have not been used. The system is assumed to be recovering exhaust heat because higher supply temperatures are now available during very cold weather than used to be possible. This is a qualitative observation by on-site personnel in the absence of any quantitative measurements.

By reviewing electricity and steam consumption separately, it can be seen that the post-ECM steam consumption has decreased 30.7% but post-ECM electricity use has increased 25.5%. The overall 12% total energy increase is due to the fact that about 5.7 times more electricity is used than steam.

Although no exact pre-ECM air flow data exists, it was alleged that many of the original vent hood air flow rates were less that the original design intention necessary to meet health and safety requirements. During the ECM project, these flow rates were increased by speeding up the two air handler supply fans that introduce makeup air into the building. The new exhaust fans were then adjusted to produce the corresponding balance of internal air pressure and flow. This certainly would tend to increase the building's electrical consumption, but whether this is the major cause of the post-ECM increase can not now be determined. It is also known that additional electrical laboratory equipment was transferred to this building from another, but there is no available documentation to reveal the energy impact of this equipment.

The principal findings were:

a. This facility is now consuming more energy after installation of an ECM project that cost a total of $254,000. Because of inadequate documentation, measurement, testing and subsystem monitoring it is not possible to ascertain the cause accurately. There is a possibility that the increase in air ventilation rates incorporated during the time of the ECM installation plus laboratory equipment additions have increased energy use more than the heat recovery ECM has reduced energy use. Whether this ECM is achieving its projected energy savings, even though outweighed by energy increases elsewhere in the building, has not been determined.

b. A relatively inexpensive instrumentation effort could be used to measure the heat being recovered. The high cost of this ECM would justify such instrumentation to assure that a reasonable payback is achieved. It would also contribute, to conservation technology and the University, valuable knowledge about whether projected savings can be attained from heat recovery designs using certain hardware and concepts in actual building environments.

CASE STUDY J: FOLLOW-UP SITE VISIT INDICATES THAT INADEQUATE ENERGY MANAGEMENT AT AN ALL ELECTRIC FACILITY MINIMIZES ENERGY SAVINGS

Institution Type:	High School
Location:	Small urban
Size:	87,497 square feet
EUI	
Base:	213,944 BTU/ft^2/yr.
Latest:	238,732 BTU/ft^2/yr.
Savings:	(-11.6%)
Program Information:	EA completed 7/79 ECM's completed 9/80 Total project cost: $4,000
ECMs Installed:	Shop door replacement Insulation of raised ends of roof Installation of set point thermostats

At the time of the first site visit in October 1982, it was noted that many O&M actions were needed, such as cleaning filters, delamping, reducing domestic and heating hot water settings, increasing activity by occupants to turn off equipment and lights in unoccupied areas, reducing settings of outside air dampers, improving weatherstripping and adjusting doors for closing.

Upon revisiting the school in March 1983 it was found that no change had occurrred in any of the previously observed conditions. In fact, most of the filters appeared to be dirtier than before. The coarse wire mesh inlet screen over a central outside air duct supplying fresh air to several main air handlers was estimated to be 60%-70% blocked by dirt accumulation. This is readily accessible for cleaning with the use of a vacuum cleaner. Also, several removable air handler filters were found badly restricted with dirt accumulations.

The data from 1978 through the latest period available (mid 1982), indicates that personnel efforts had achieved an 18% reduction in energy consumption from the 77/78 to 79/80 school years. However, since then, there has been a gradual increase resulting in current consumption of 11.6% above the 79/80 base year.

This is the only all electric school in this district of 7 schools. The remaining (five elementary and one junior high) facilities have a mixture of gas and electric energy sources. During the school year period from 77/78 to 79/80, the total energy consumption in the school district was reduced approximately 15% as compared to the 18% reduction in the all electric high school.

Following are a number of factors that affect energy results in this school:

1. The maintenance staff, consisting of only two persons for the seven schools, appears inadequate for good energy conservation results.

2. Custodial personnel are assigned to individual principals and are thus not available to the maintenance staff to obtain direct assistance on such matters as minor preventive maintenance or monitoring actions. Management intends to change this in the near future.

3. The previous achievements in energy reduction appear to have been largely the result of direct personal actions on a daily basis by the Chief of Maintenance. Due to the very small maintenance staff this personal commitment has been difficult to sustain. The diminished focus of national attention on energy in the past year also has contributed to a lessened commitment by even the most dedicated persons.

4. For various management and financial reasons, this school district did not implement very many ECM projects in the high school and thus the bulk of earlier energy savings were almost totally a function of O&M activities. The meager maintenance staff has barely been able to keep abreast of routine repairs and thus preventive maintenance and constructive energy saving actions have been very marginal.

5. There is no effective energy program emanating from the Superintendent downward through the principals, teachers, custodians and other occupants.

6. This school district has experienced disruptions from a high turnover of four superintendents since the beginning of the ICP.

Detailed review of this high school suggests that considerable savings in both energy and cost are possible with very limited hardware investment as follows:

1. Two large air handling units that run continuously to control humidity in a damp basement music room where musical instruments are stored could be shut off by inexpensive time clocks and a portable dehumidifier used instead.

2. Central time clocks could be installed at three electrical panels to shut off individual classroom and central hall air handling units that are now being allowed to run continuously.

3. Several dozen incandescent fixtures in the high ceiling central hall area could be removed and only a few fluorescent fixtures installed to provide minimum required lighting for safety of personnel movement.

4. The gymnasium lighting and two large air handling units could be placed on a time clock with a limited-time-increment override switch available for special uses of the area.

5. The outside air dampers on all air handlers could be reset from their present full open settings to provide measured minimum quantities of fresh air.

6. Electrical demand rate changes and possibly some energy consumption could be reduced by disabling several stages in each of the two ten-stage electric boilers. Demand savings also could be achieved by adding an interlock control relay between the domestic hot water boilers and the ten-stage heating system boilers. This would preclude simultaneous operation of both the heating system and the domestic hot water boilers.

7. Further experimentation by on-site personnel on a seasonal basis should produce additional savings by gradual reductions in hot water temperature settings, restriction in domestic water flow rates, further reductions of light levels in all spaces and continuous occupant cooperation to minimize the total electrical load, particularly during the known peak load periods when demand charges are affected.

The principal findings were:

a. The permanent benefits to this school have been marginal as the result of participation in the ICP. The major reason for this situation is that there has been inadequate top management attention devoted to energy and energy-related cost savings.

b. The school system did not choose to invest in the majority of energy improvements recommended by the ICP program's technical analysis.

c. The observed conditions indicate that management is not achieving a reasonable degree of preventive maintenance, timely energy adjustments, and cooperative occupant actions. The ratio of only two maintenance persons for seven schools appears inadequate. Approximations based on review of this school's consumption over the past several years strongly suggest a combination of actions that might be instigated by top management to reduce the current operating costs by up to 25 - 30,000 dollars per year. Most of these actions can be incorporated and sustained by appropriate personnel with very low cost in materials. Such dollar savings in a single building should warrant management's consideration of adding personnel as a net money saving move. Eventually, an appropriate additional person could probably extend his energy saving capabilities to the other schools in the school district and multiply his dollar effectiveness.

CASE STUDY K: FOLLOW-UP SITE VISIT ANALYSIS INDICATES THAT A LACK OF METERING AND INSTRUMENTATION PREVENT AN ASSESSMENT OF ECM SAVINGS

Institution Type:	Hospital
Location:	Medium size urban area
Size:	57,550 square feet
EUI	
Base:	571,399 BTU/ft^2/yr.
Latest:	613,189 BTU/ft^2/yr.
Savings:	(-7.3%)
Program Information:	EA completed 9/79 ECMs completed 2/81 Total project cost: $90,860
ECMs Installed:	Replacement of glass wall with insulated wall Heat pumps Fluorescent replacement of incandescent lighting

This facility was visited originally in June 1982. Using the data and facts available at that time it was determined that energy consumption had increased by 22% since the ECMs were completed in February 1981.

The ECMs consisted of replacing an essentially all-glass outside wall in one wing with insulated construction, plus in the same wing, conversion from unit heaters to water-to-air heat pumps and replacement of incandescent with fluorescent lighting. The calculated payback was more than 13 years.

Following the first visit to this facility the calculated energy performance was based on a comparison using the base year (1978) that was cited in the TA. During the re-visit, it was learned that certain events occurred in 1978 that caused this to be an unstable reference year. The latest 50% addition to the hospital came into use in 1978 and the kitchen was converted from gas to all electric during the latter part of the year.

By selecting 1979 as a more appropriate base year, the energy results became more favorable, but still showed an increase of 7.3% in total BTUs from 1979 to 1982. This increase consisted of year-to-year percentages of 2.1, 4.0 and 1.0.

The TA had calculated a saving for the recommended ECMs of 5% when compared with the consumption of 1978. By recalculating these expectations referenced to the 1979 year, the projected ECM savings became 4.4%.

Energy used by the hospital consists of electricity, propane and some diesel fuel for several diesel generators which are used extensively for electrical demand limiting. The accuracy of data on diesel fuel is questionable because the exact volume of the storage tanks is unknown and purchases are made according to when prices are best. Quantities of single purchases have varied from 100 gallons to over 6,000 gallons and purchases have varied from only one to as many as six per year. However, the average diesel consumption constitutes less than 2% of the total annual energy so the inexactness of this fuel data is not critical.

Propane is used for heating domestic hot water as well as for booster heat for the laundry hot water. Propane also is used as a backup source for the hot water space heating system. Since the primary space heating boiler is electrically operated and frequently switched off to reduce electrical demand changes, the propane boiler often becomes the primary source during the peak heating season.

Re-evaluation of the installation and operation of the ECMs did not disclose any specific errors or omissions that could explain the increase in energy consumption since the ECMs were completed in early 1981. However, several factors were discovered that appear to explain most of the increase. For example the "Patient Days" have increased 6.8%, from 23,587 in 1979 to 25,189 in 1982. Employees have increased 13.4% and three departments have gone to 24 hour operation (from 8 hours in two cases and from 16 hours in the other). Additional energy consuming equipment has been steadily added throughout the 1981 and 1982 period since the ECMs were finished. Seven additional heat pumps for a total of about 18 tons of cooling were included in this, plus a rooftop unit using both heating water and chilled water from the central system. Although no records were available to identify the consumption of other energy using equipment that has been added, it was found that numerous items such as an 18 Kw drying cabinet, large freezers, nuclear medicine cabinets, X-ray tables, copiers, vending machines, ice machines and medicine refrigeration and warming cabinets had been acquired. Apparently, recent procedures have been implemented to acquire better control and documentation of future energy consuming equipment as it is brought into the hospital.

The present Director of Maintenance for the hospital had held his position for about six months at the time of the return visit. There have been three people in this position plus two hospital administrators throughout the ICP participation. The present Administrator had been there about six weeks at the time of the return visit.

The present Maintenance Director is working hard to reduce electrical costs by limiting electrical demand charges. A demand controller, purchased in 1978, has been connected to additional control points and the diesel generators are operated several hours a day to hold the peak demand within close limits.

Although time did not permit a detailed investigation, it appears possible that some of the high energy use may be due to the following situation:

The basic HVAC system consists of three water loops. Many water to air heat pumps are on a common water heat source loop using cooling tower water. Another loop contains chilled water from a central chiller for air handler cooling coils and a third water loop provides hot water to the same air handlers from the central hot water boiler. There are no air handlers with 100% outside air available through an economizer cycle controller, so virtually all interior cooling in the winter must be provided mechanically. The result is that heat is rejected from the cooling tower all winter except for portions of about a month and a half. On the day of the revisit, the outside air temperature had only risen to 54° by 2:30 PM from the low 40's in the morning and yet the cooling tower vanes were constantly open with water circulating at 84°. During the late morning with the kitchen cooling load, the cooling tower fans periodically cycled to limit water temperature.

This may indicate that even on days cool enough to provide "free cooling" with full outside air, the building is instead being cooled mechanically and the system is producing a net hot water source greater than the water to air heat pump loads can utilize.

It is likely that the total energy load could be significantly reduced in winter (where the peak now exists) if 100% outside air economizer cycles were incorporated, and the rejection of heat from the cooling tower was eliminated.

The principal findings were:

a. A considerable quantity of energy-using equipment apparently has been continuously added to this facility during the several year period from pre-audit to post-ECM completion. The lack of exact information with which to measure this growth in energy use makes it impossible to assess the ECM performance solely on the basis of total energy consumed by the building. However, without special metering and instrumentation it is impossible to measure the effect of the ECMs separately.

b. A relatively high turnover in the hospital's top management in recent years appears to have been a handicap in achieving optimum energy benefits through effective operation and maintenance actions, and timely preventive maintenance. There are very positive indications that this is now improving.

c. The installed ECMs had small projected savings of about 4.4%. However, there appear to be existing system deficiencies that could be corrected with cost effective ECM's that would increase the savings realized.

CASE STUDY L: FOLLOW-UP SITE VISIT OBSERVATIONS SHOW THAT ENERGY PERFORMANCE OF ECMS WITH LOW PROJECTED SAVINGS CAN NOT BE CONFIRMED WITH ONLY BUILDING CONSUMPTION DATA RATHER THAN SPECIAL MONITORING OR METERING

Institution Type:	Hospital
Location:	Medium size urban area
Size:	114,000 square feet
EUI	
Base:	490,480 BTU/ft^2/yr.
Latest:	528,488 BTU/ft^2/yr.
Savings:	(-7.7%)
Program Information:	EA completed 8/79 ECMs completed 9/81 Total project cost: $234,000
ECMs Installed:	Oil to gas conversion Chiller heat recovery

The Technical Analyst for this facility had recommended six ECM projects calculated to have a combined payback of 5.6 years, produce an energy reduction of 21% and cost approximately $457,000.

Only two of these recommended ECM projects were installed at a project cost of about $234,000. The TA had projected an energy reduction of 4% for these two ECMs. Their expected individual paybacks were 2.5 and 10.7 years. A higher than projected project cost resulted from installing a slightly larger heat recovery chiller than originally planned, in order to allow for some future expansion.

Comparison of the post-ECM energy consumption with the pre-ICP period, on a weather corrected basis, shows an increase of 2.5% in total annual BTU use. This includes correction for a floor area addition of 3.2% that occurred during the interim. Also, certain energy consuming equipment was added throughout the period, such as a CAT Scan and X-ray unit and numerous undocumented pieces of laboratory equipment. As is generally the case in hospitals, no useable record of these continuous energy consuming equipment increases is available. During the same interim period, the average annual patient load also increased by 22%.

On-site review of the installed ECMs during the follow-up visit did not disclose any installation or operation problems that could be causing the less than projected savings. One ECM consisted of conversion from oil to gas use by two steam boilers. There is no condensate return of any of this steam in the hospital and the TA did not address this as a possible ECM. The hospital staff, however, has indicated an interest in making this improvement during future energy projects.

The other ECM consisted of replacing a standard chiller with a heat recovery unit for domestic hot water preheating. This project is not instrumented in any manner that would permit savings to be assessed. The chiller cannot be operated throughout the day during much of the year due to total cooling load. For example, when the total cooling load exceeds the heat recovery chiller capacity, a much larger unit is brought on line and the smaller heat recovery unit must be shut down to provide a reasonable percentage load on the bigger chiller. Unless the weather becomes much warmer on such days, the smaller heat recovery unit cannot be added back to the system until the weather cools again. Consequently, the annual percentage operation, and thus, the savings of this heat recovery chiller ECM may be considerably less than the TA assumed. The lack of instrumentation and records of operating-hours makes it impossible to assess this ECM's performance accurately.

The principal findings were:

a. The TA projections of energy savings for these ECMs was approximately 4%. The measured post-ECM energy data shows an overall hospital increase in consumption of 2.5%, rather than a savings. However, both energy consuming equipment and mission requirements have increased but the effect on consumption can not be quantified. The net result is that both the actual and the expected results are in a very small percentage band and a precise evaluation is extremely difficult.

b. It appears that the ECMs were installed properly, but were too minor in contribution to show up in total energy consumption measurements. Separate instrumentation would be necessary to identify the savings generated by these ECMs.

CASE STUDY M: FOLLOW-UP SITE VISIT OBSERVATIONS SHOW THE ABSENCE OF ADEQUATE TA DOCUMENTATION, ADDITIONS OF ENERGY CONSUMING EQUIPMENT, AND A LACK OF MONITORING OR METERING ALL CONTRIBUTE TO APPARENTLY SMALL ECM SAVINGS

Institution Type:	Hospital
Location:	Medium size urban area
Size:	211,192 square feet
EUI	
Base:	444,244 BTU/ft^2/yr.
Latest:	414,980 BTU/ft^2/yr.
Savings:	6.6%
Program Information:	EA completed 10/79 ECMs completed 1/82 Total project cost: $170,775
ECMs Installed:	Heat recovery from boiler Chiller controls Air handler return air ducts and controls on several units Replacement of incandescent lighting with fluorescent

This facility was originally visited in December 1982. The ECMs had been completed in January 1982, and thus there was less than a year of available post-ECM energy consumption data.

The installed ECMs consisted of nine distinct projects that may be categorized into four technical groups: (1) heat recovery for boiler makeup water was added to both the boiler stack and the boiler blowdown; (2) controls were added to an electrically driven 350 ton centrifugal chiller; (3) numerous incandescent fixtures were replaced with fluorescent or sodium vapor lighting; and (4) five projects involved adding return air ducts and additional controls for several air handling units.

In the TA, dollar costs, dollar savings, and payback years were calculated for all of the recommended projects, but projected BTU savings were listed for only 5 projects. For these five, the total expectation was at least a 10% savings in annual BTU consumption.

On-site inspection of the ECM projects indicates that all were correctly installed and there is no obvious malfunctioning. However, several conditions of the design make it difficult to establish the amount of energy savings of most of the ECMs. For example, a complete lack of temperature and flow indicators in any of the ECM heat recovery circuits has made it impossible to establish the amount of boiler waste heat being recovered. The chiller controller ECM functions properly, but during certain weather conditions the resulting higher chiller supply temperature makes it necessary to augment the controlled chiller with a smaller, less efficient chiller in order to provide the necessary lower temperatures in one remote zone. The energy consumption of this combination of a more efficiently controlled large chiller plus a lower efficiency small unit may not be any less during these weather periods than the previously existing large chiller alone (before it received the controls to tailor its output).

The fuels used are electricity and natural gas. Analysis of the consumption history using the pre-EA period of calendar year 1979 versus the post-ECM calendar year 1982 indicates an energy saving of 6.6%. After correcting for weather differences the result is a 5.6% increase in consumption. The base year (1979) had 13% more severe weather.

During the period since 1979, there has been a continual addition of energy consuming equipment in this hospital similar to that generally observed in most hospitals. Although a listing of some of the added equipment is available, there is no acceptably accurate way to estimate the energy impact of this equipment growth. The duration of use, location, impact on heating and cooling loads, etc. of this added equipment has not been documented. With energy consumption analysis based only on knowledge of total facility consumption there is no accurate way to identify the amount of ECM savings.

In general, this hospital has probably achieved more success than most in avoiding energy increases. The condition of the equipment reflects an above average preventive maintenance program. The technical knowledge and management skills of the facilities director are well above average and many actions have been taken both before and since ICP participation to eliminate unneeded energy use. For example, lighting energy consumption has been significantly reduced.

Comparison of the energy use index and patient cost factors of this hospital with several others in the adjacent geographical area clearly indicates that this hospital is a leader in its vicinity.

The principal findings were:

a. The BTU savings to be expected from some of the installed ECMs were not identified in the TA.

b. The energy savings of the completed ECM projects cannot be directly assessed due to the lack of instrumentation.

c. The normal growth of energy consuming equipment since the base-year may now be causing more energy consumption than the ECM projects are saving. As with most complex facilities, very little credible analysis of how energy savings are being offset by these additions is possible without records to track performance.

d. The observed capabilities and regular actions of the facilities staff are above average and cannot be faulted as the cause of low overall energy saving results.

APPENDIX A - THE ICP: BACKGROUND ON THE ICP AND ITS EVALUATION

PROGRAM FUNDING

Allocation of Funds to States

The Department of Energy (DOE), under a formula specified by rule, is responsible for allocating ICP funds to States. The federal government matches State administrative costs associated with implementing the program through SEOs, as well as provides the grant monies for the TA or ECM phases. Fifty-percent matching funds were allocated to States for conducting PEAs and EAs on the basis of a three-part funding formula that included: an equal per-State share, a share based on population, and a climate factor. An additional factor--fuel availability and cost--is used in the formula to allocate TA/ECM funds. Both institutions' and States' matching funds must, in all cases, be from non-Federal sources. Table A.1 describes the resources committed by the 10 sampled States as matching funds.

Allocation of Funds Within States

Individual SEOs chose the means by which they would subsidize the costs of performing energy audits at eligible institutions. Some chose to train institutional personnel assigned for this purpose, others sent State employees or contractors to perform audits at nonprofit facilities, and a few reimbursed institutions for the charges levied by independent energy auditors who had been trained or certified by the State.

TA and ECM grants, on the other hand, are awarded on a competitive basis. A minimum of 30% of funds available for TAs and ECMs were required to go to schools and at least 30% were required to go to hospitals in each grant cycle. Thus, neither schools nor hospitals were permitted to receive more than 70% of the combined TA/ECM allocation in each State. The background and financial data on the 10 sampled States' allocation of funds are presented in Table A.2.

Grant Award Procedures

SEOs were required to produce DOE-approved State Plans describing funding formulae and administrative methods before entering the ICP. These State plans are updated annually.

For PEAs and EAs, the States applied to DOE directly for funding on behalf of themselves and participating institutions, operated the Program, and submitted progress and evaluation reports to DOE periodically. Because DOE wished to allow the States a great deal of flexibility in administering the Program, procedures for conducting PEAs and EAs varied widely from State to State (although these procedures were reviewed by DOE officials in the process of approving each State Plan). SEOs were allowed to apply up to 25% of the funds allocated to them toward administration, monitoring, and evaluation activities.

TABLE A.1. RESOURCES COMMITTED BY THE 10 SAMPLED STATES AS MATCHING FUNDS

	TYPE OF MATCHING SOURCES	$ OR OTHER RESOURCES IN ADDITION TO MATCH
FLORIDA	-- ALL CASH MATCH	-- PEAs AT NO COST BY FACILITIES PUBLIC BROADCASTING SYSTEM -- TRAINING FACILITIES PROVIDED AT NO CHARGE -- SOURCES OF REGIONAL PLANNING CENTERS -- TA ASSISTANCE BY FLORIDA SOLAR CENTER -- MISCELLANEOUS ASSISTANCE FROM SEO
ILLINOIS	-- EA: ALL MATCH WAS IN-KIND	
MINNESOTA		-- $10 MILLION STATE APPROPRIATION TO SUPPLEMENT ICP -- DEPARTMENT OF EDUCATION, REGIONAL DEVELOPMENT COMMISSIONS, LEAGUE OF CITIES ASSISTANCE
MISSOURI	N/A	N/A
NEW MEXICO	-- ALL CASH MATCH	-- $65,900 DONATED AS ADMINISTRATIVE TIME -- STAFF TIME AND TRAVEL TO TRAINING COURSES -- FREE PUBLICITY BY EES OFFICE AND INSTITUTIONAL GROUPS
NEW YORK	-- STATE EDUCATION AND HEALTH DEPARTMENTS PROVIDED -- PROFESSIONAL STAFF FROM OTHER AGENCIES -- ENERGY CONSERVATION HOTLINE	
OKLAHOMA	-- ALL IN-KIND	
RHODE ISLAND	-- N/A	
UTAH	-- N/A	-- STATE HAS CONTRIBUTED MONEY BEYOND THAT REQUIRED BY PROGRAM
VIRGINIA	-- CYCLE I: 75% IN-KIND MATCH -- CYCLE II: ALL CASH MATCH	

N/A - NOT AVAILABLE AT TIME OF SEO INTERVIEW

TABLE A.2 BACKGROUND AND FINANCIAL DATA ON 10 SAMPLED STATES' ALLOCATION OF ICP FUNDS*

	FL	IL*	MN	MO*	NM	NY*	OK*	RI*	UTAH	VA*
WHEN WAS STATE AUDIT PROGRAM ESTABLISHED?	4/79			6/79	5/79				6/79	
TOTAL COST TO DATE IN ADMINISTERING EA PHASE OF ICP ($)	$616,644		$52[illegible]41		$322,395				$125,116	
% FEDERAL FUNDING MATCHED BY STATE FOR EA PHASE OF ICP (%)	100%		100%		100%				100% +	
% FEDERAL FUNDS ALLOCATED TO STATE FOR EAS THAT WAS USED (%)	39.1%		100%		31.5%				16%	
% EA FEDERAL FUNDS EXPENDED TO DATE FOR ADMINISTRATIVE PURPOSES (%)	100%		29%		93.7%				14%	
% FEDERAL FUNDS PASSED THROUGH TO DATE TO PAY COSTS OF EAS THEMSELVES (%)	39.1%		71%		31.5%				2%	
TOTAL COST TO DATE IN ADMINISTERING TA/ECM PHASE OF ICP ($)	$537,783		$707,013		$139,734				$125,552	
% FEDERAL FUNDS MATCHED BY STATE FOR TA/ECM PHASE (%)	100% +		100%		100%				112%	
AMOUNT OF TA/ECM FUNDS EXPENDED TO DATE FOR:										
A. STATE STAFF ($)	$537,783		$441,959		$ 48,907				$ 20,000 +	
B. TRAINING ($)	-0-		$ 75,000		$ 6,987				$ 3,000 +	
C. PROGRAM REVIEW AND EVALUATION					$ 83,340				$ 38,000 +	
AVERAGE # STATE STAFF ASSIGNED TO ICP	3	4.5	21[1]	5	3	25	2	3.5	2.25	5
AVERAGE # OF CONTRACT PERSONNEL (IF KNOWN)	18	SOME								

[1] 13 STATE FUNDED AND 8 FEDERAL FUNDED.

* DATA NOT AVAILABLE AT TIME OF SEO INTERVIEW.

The TA/ECM funding process begins with DOEs allocation of funds on a State-by-State basis. SEOs then solicit, evaluate, and rank applications from institutions. Recommendations for funding are then sent for review to DOE Regional offices. Approved applications could be awarded a grant for 50% of the cost of the proposed project. The other 50% had to be paid by the institution, except in hardship cases (see below). Each State is responsible for grant administration and for monitoring implementation of funded activities. SEOs are allowed to apply for up to 5% of the total TA and ECM funds awarded in each funding cycle for administrative expenses.

Hardship Funds

Ten percent of available funds are reserved for "hardship grants" to financially distressed institutions. Each State is responsible for developing its own formula for disbursement of hardship funds (which is included in the State Plan) and for identifying those institutions eligible to receive incremental funding above the 50% matching requirements. States must develop procedures for determining what increment (1-40%) of additional funding will be given to institutions qualifying for hardship funds. These procedures are included in the State Plans.

PROGRAM IMPLEMENTATION: A CAPSULE HISTORY

Figure A.1 displays the regulatory history of the ICP and some of the milestones achieved.

OPERATIONAL RESPONSIBILITIES OF PROGRAM PARTICIPANTS

The ICP allows a great deal of flexibility in the local management of Program activities. As a result, it also requires significant labor and resource commitments by participating parties to complete necessary paperwork and carry out administrative functions. The areas of responsibility for the four parties - institutions, State energy offices, DOE Regional offices and DOE Headquarters are delineated below.

Institutions

The institutions participating in the ICP are responsible for the following activities:

- Securing matching funds.
- Preparing formal applications for the TA and ECM stages of the program.
- Reporting on expenditures and energy consumption for up to 3 years after grant closing.

FIGURE A.1 THE ICP: A CAPSULE HISTORY BY YEAR

1978:	ALTHOUGH NECPA AUTHORIZED FUNDING FOR 1978, THE LAW DID NOT BECOME EFFECTIVE UNTIL THE FIFTH WEEK OF FY 1979.	
1979:	FINAL RULES FOR PHASE I (PEA/EA) PUBLISHED.	4/2/79
	FINAL RULE INITIATES PHASE I (PEA/EA) OF CYCLE I.	4/2/79 (TO END 9/30/79)
	FINAL RULES PUBLISHED FOR PHASE II (TA/ECM) OF CYCLE I INCLUDING REQUIREMENTS FOR STATE PLAN.	4/17/79
	FINAL RULE INITIATES CYCLE I OF TA/ECM GRANTS.	4/17/79 (TO END 2/1/80)
	OF THE $20 MILLION AVAILABLE FOR SCHOOLS AND HOSPITALS, $18 MILLION (90%) WAS AWARDED.	
	OF THE $7.5 MILLION AVAILABLE FOR LOCAL GOVERNMENT AND PUBLIC CARE INSTITUTIONS, $6.45 MILLION (86%) WAS AWARDED.	
	MOST OF THE STATES PREPARED AND SUBMITTED STATE PLANS BY 12/31/79.	
	NO TA OR ECM GRANTS OF ANY KIND WERE COMPLETED BY THE STATES IN 1979.	
1980:	DOE APPROVED STATE PLANS FOR 52 OF THE 55 ELIGIBLE JURISDICTIONS	
	$112 MILLION AWARDED TO SCHOOLS AND HOSPITALS AND $3.3 MILLION TO LOCAL GOVERNMENT AND PUBLIC CARE INSTITUTIONS FOR TAs AND ECMs.	
	CYCLE II OF PEA/EA BEGINS.	4/1/80 (TO END 5/30/80)
	CYCLE II OF TA/ECM GRANTS BEGINS.	6/2/80 (TO END 9/30/80)
	$11 MILLION WERE AWARDED FOR PEA/EA BY 6/2/80.	
	$109 MILLION WERE AWARDED TO INSTITUTIONS IN 54 JURISDICTIONS FOR TA/ECM BY 9/30/80.	
	PROGRAM TO UPGRADE RULES AND REGULATIONS INITIATED AT DOE.	
1981:	CYCLE III OF TA/ECM GRANTS BEGINS.	4/30/81 (TO END 9/25/81)
	PEA/EA NOT FUNDED BY DOE IN CYCLE III.	
	UPGRADING OF REGULATIONS COMPLETED, PROPOSED, AND MADE FINAL BY 5/81. CHANGES INCLUDED: -- COST SAVINGS NOW CALCULATED AS NET DIFFERENCE IN FUEL COSTS FOR COAL CONVERSION, RATHER THAN AS RESULT ONLY OF ENERGY SAVINGS; -- PAPERWORK FOR GRANTEES SIMPLIFIED; -- GREATER FLEXIBILITY AND EFFICIENCY IN STATE'S ALLOCATION OF GRANT FUNDS.	
	$159 MILLION AWARDED IN ALL FOUR CATEGORIES FOR TA/ECM DURING CYCLE III.	
1982:	FINAL RULE PERMITS DOE TO USE THE MOST CURRENT DATA ELEMENTS IN THE ALLOCATION FORMULAE.	4/13/82
	CYCLE IV FOR TA/ECM GRANTS BEGINS.	4/13/82 (TO END 8/31/82)
	PEA/EA NOT FUNDED BY DOE IN CYCLE IV.	
	$47.4 MILLION AWARDED IN ALL FOUR CATEGORIES FOR TA/ECM DURING CYCLE IV.	
1983:	CYCLE V FOR TA/ECM GRANTS BEGINS.	6/1/83 (TO END 8/30/83)

- Administering competitive bidding for ECM contracts and overseeing construction processes.

- Complying with Davis-Bacon Act and EEO Standards, including recordkeeping, reporting, and contract monitoring.

- Performing ICP "prerequisite" (or comparable activity) before proceeding to next Program phase. In the case of independent audits performed outside the ICP, institutions must assure that they comply with Program requirements.

State Energy Offices

As a result of the ICP, SEOs have taken a major role in identifying and addressing institutional energy conservation needs. Duties assumed by SEOs include:

- Developing and revising State Plans as needed to meet Program requirements.

- Securing State matching funds.

- Performing day-to-day grants management and troubleshooting, providing a link between DOE and the institutions for transfer of information.

- Publicizing ICP activities.

- Reviewing and ranking all TA/ECM applications, focusing technical personnel and administrative resources on the review during application periods.

- Providing fundraising assistance to institutions for matching funds (as needed).

- Monitoring TA/ECM implementation.

DOE Regional Offices

Regional personnel serve as supervisors of Program progress: they facilitate communication between DOE and the SEOs and between different SEOs, oversee Program expenditures, and provide technical and administrative assistance. Specific responsibilities include:

- Reviewing applications after they are processed by the SEOs.

- Issuing Notices of Grant Award for each grant cycle.

- Receiving reports from State Energy Offices.

- Processing payment requests and coordinating financial disbursements with DOE Headquarters.

- Monitoring grant performance.

DOE Headquarters

Headquarters personnel are responsible for the following activities:

- Developing and revising Program regulations.

- Reviewing and approving State Plans and revisions to State Plans.

- Allocating funds to States for PEAs/EAs, and overall financial management.

- Periodically reviewing Program progress.

- Performing and documenting evaluation activities.

- Communicating and coordinating with SEOs, and Regional offices; scheduling grant cycles and regulatory changes.

- Coordinating public communication efforts for the ICP on a national level (through reports, responses to inquiries, etc.), including relations with Congress and with national health and school associations.

The sequence of activities required for grant approval in various phases is shown in Table A.3. As can be seen, DOE delegated to the States a great deal of control over the program.

VARIATIONS WITHIN THE PROGRAM

The decision to run the ICP at the State level allowed the States to custom tailor the Program to their individual needs. However, the flexible nature of the Program, coupled with the great variety of circumstances between States, gave rise to variations and inconsistencies in implementation. The fact that some aspects (e.g., auditor training and TA reporting requirements) were open to interpretation compounded Program variation.

Furthermore, the States, in ranking ECM applications, were given a list of criteria to apply, but were given freedom to assign their own weights to each. Thus, such items as simple payback, types of energy conversions (e.g., oil to coal), types and amounts of energy saved, and local climate were brought to bear in different combinations in each State.

TABLE A.3 SEQUENCE OF GRANT APPROVAL ACTIVITIES

PHASE	PROCEDURE	DOCUMENT GENERATED
PEA/EA	1. SEO APPLIES TO DOE FOR PEA/EA FUNDING.	APPLICATION
	2. DOE APPROVES APPLICATION AND ALLOCATES FUNDS.	
	3. INSTITUTIONS COMPLETE PEA FORMS AND SUBMIT THEM TO SEO.	AUDIT REPORT
	4. INSTITUTIONS REQUEST EA APPLICATIONS, COMPLETE THEM, AND SUBMIT THEM TO SEO.	VARIES BY STATE; MAY BE A TELEPHONE CALL
	5. SEO APPROVES EA APPLICATIONS.	
	6. EA IS CONDUCTED AND AUDIT REPORT IS FILED WITH THE SEO.	EA REPORT
	7. SEO FILES A QUARTERLY PROGRAM PERFORMANCE REPORT AND FINANCIAL STATEMENT WITH DOE.	PERFORMANCE REPORT FINANCIAL STATEMENT
PRE-TA/ECM	1. SEO SUBMITS ITS STATE PLAN TO DOE. APPROVAL IS A PREREQUISITE FOR THE TA/ECM PHASES.	STATE PLAN
TA	1. SEO APPLIES TO DOE FOR TA/ECM ADMINISTRATIVE FUNDS.	PERFORMANCE REPORT APPLICATION
	2. INSTITUTIONS SUBMIT TA APPLICATIONS TO THE SEO, APPENDING EA REPORTS.	TA APPLICATION
	3. SEO RANKS TA APPLICATIONS.	
	4. DOE APPROVES RANKING AND FUNDS TAs.	
	5. WHILE TAs ARE BEING CONDUCTED, INSTITUTIONS ADVISE SEO OF PROGRESS.	SEMIANNUAL STATUS REPORTS
	6. WHEN TA IS COMPLETE, INSTITUTIONS FILE FINAL TA REPORTS WITH SEO.	FINAL TA REPORT
ECM	1. INSTITUTIONS APPLY TO SEO FOR ECMs.	ECM APPLICATION
	2. SEO RANKS THE ECM PROPOSALS.	
	3. DOE APPROVES RANKING AND FUNDS ECMs.	
	4. DURING ECM IMPLEMENTATION, INSTITUTIONS ADVISE SEO OF PROGRESS.	SEMIANNUAL STATUS REPORT
	5. WHEN ECMs ARE COMPLETE, INSTITUTIONS FILE FINAL REPORTS WITH SEOs	FINAL ECM REPORT
	6. INSTITUTIONS FILE ANNUAL REPORTS ON ECM WITH SEO FOR 3 YEARS FOLLOWING COMPLETION.	ANNUAL REPORTS
	7. SEO SUBMITS SEMIANNUAL REPORTS TO DOE FROM DATE OF STATE PLAN APPROVAL TO END OF THE PROGRAM.	STATE STATUS REPORTS

Other circumstances leading to program variability were:

- Size and Financial Capacity of the State Government--Smaller, less populous States had fewer funds for publicizing, training, information programs, responding, etc. They also could spare fewer personnel to attend to the program.

- Climate--Energy needs and equipment vary across the country.

- "Quality Control" Procedures--Some States built more of these into their programs (e.g., in their specifications for EA forms, the type of TA review performed, etc.).

- Interest in Renewable Resources--Some States were more enthusiastic about solar and renewable resources than others.

- Ranking Methods--Ranking procedures and formulae varied.

- Labor and Equipment Committed--Efforts toward data collection were different in different States, as were monitoring and evaluation activities.

- Affiliation of SEOs--The SEOs were associated with different governmental agencies (e.g., governor's office, Department of Resources, Office of Emergency Planning, Department of Energy).

In addition, different types of institutions varied in their needs and approach to participation in the ICP:

- Budget Cycles--Program scheduling was a major barrier to participation for some institutions, which needed lead time to raise matching funds.

- Financial Capacity--Many institutions had to divert funds to the ICP from other uses. Some used funds from other vital areas, others dropped out.

- Administrative Capacity--Institutional administrative resources were scarce for applying, reporting, managing capital improvements, etc.

- Building/Facility Uses--Hospitals, schools, etc. operate differently, occupy different types of spaces, and have different occupancy patterns.

- Regulatory and Political Pressures--Each type of institution included in this program is regulated in a different manner in relation to allowable expenditures, building and life safety codes, etc.

In spite of these Program variations and the usual start-up and execution problems of any Federal effort of this magnitude, the ICP has been very well received and is generally acknowledged to be a successful energy conservation effort.

HISTORY OF THE EVALUATION EFFORT

In the fall of 1979, The Synectics Group, Inc. (TSG) was requested by ICP staff at DOE headquarters to prepare a Preliminary ICP Evaluation Plan. The central focus of this preliminary plan was the process by which overall Program objectives could be clearly defined, and appropriate corresponding performance measures characterized. This definition of objectives, performance measures, and related data sources was to be accomplished through informal interviews with ICP managers, energy conservation specialists, and officials familiar with either the early development of the ICP or the administrative and financial requirements of eligible institution types (i.e. nonprofit schools, hospitals, local governments, and public care facilities). The preliminary plan assumed the ICP evaluation would focus on all four Program phases (PEA, EA, TA, and ECM) simultaneously.

During the fall and winter of 1980-1981, TSG evaluators conducted a number of interviews with relevant specialists and officials concerned with the ICP. This activity included attendance at the All States Conference held in Nashville, Tennessee (November 1980) and a meeting of DOE regional officials held later that year. During these meetings attending officials were briefed on the scope of the Preliminary ICP Evaluation Plan and informal discussions related to Program goals, information sources and major evaluation issues were held.

At the All States Conference, a short survey was conducted of State Energy Office (SEO) officials attending the evaluation workshop. Program objectives that had been defined during previous interviews with officials in Washington, D.C. were "tested," and lists of major problems and benefits associated with implementation of the ICP were generated. These comments were used in refining the material that had been included in the Preliminary ICP Evaluation Plan and in developing draft survey questionnaire outlines.

TSG and DOE staff then conducted preliminary interviews at four State and Regional offices and visited several institutional participants chosen by State officials. These preliminary field visits allowed evaluators to see the ICP in action at a local level and to verify the general evaluation methodology that had been selected.

Restrictions in Program funding and concurrent reductions in available funds for evaluation activities caused DOE to revise its original intention to evaluate the four program phases separately. As a result, in October 1981, Opportunity Systems Inc. (OSI), assisted by TSG, was employed to redesign and implement the evaluation of the first two grant cycles. A general chronology of evaluation activities is provided in Table A.4.

ACTIVITIES AND PARTICIPANTS	DATE
EVALUATION STARTUP	OCTOBER 1981
STATE AND REGIONAL ADMINISTRATIVE PROCESS INTERVIEWS COMPLETED (OSI/TSG/DOE)	MARCH 1982
PRETEST OF SURVEY INSTRUMENTS AND TELEPHONE SURVEY PLAN COMPLETED (OSI)	MARCH 1982
DATA COLLECTION ACTIVITIES AT SEOs COMPLETED (OSI/TSG)	APRIL 1982
FINAL OMB APPROVAL OF SURVEY INSTRUMENTS AND SAMPLING PLAN	APRIL 1982
PRETEST OF SITE VISIT SURVEY PLAN IN MISSOURI (TSG)	MAY 1982
ICP INTERIM REPORT SUBMITTED TO DOE	OCTOBER 1982
TELEPHONE INTERVIEWS COMPLETED (OSI)	NOVEMBER 1982
SITE VISITS COMPLETED (TSG)	DECEMBER 1982
TELEPHONE SURVEY ANALYSIS SUBMITTED TO DOE (OSI)	MARCH 1983
FOLLOW-UP SITE INVESTIGATIONS CONDUCTED (TSG)	MARCH 1983
FINAL SITE VISIT SURVEY REPORT SUBMITTED TO DOE (TSG)	APRIL 1983

APPENDIX B: SITE VISIT EVALUATION METHODOLOGY

OVERVIEW

This chapter presents the details of each activity in the site visit evaluation plan. The following basic topics are discussed:

- Survey Design
- Questionnaires
- Initial Data Gathering
- Computerization and Storage of Site Visit Data
- Data Gathering at Institutions
- Analytical Approach to Site Visit Data
- Practical Problems and Plans for Resolution.

SURVEY DESIGN*

The survey design for the TA/ECM phase of the ICP evaluation is an extension and modification of that designed for the EA phase, and is comprehensible only as an integral part of the entire ICP evaluation. It is presented here in that context.

Target Population

The target population of the evaluation varies with the objectives of its different phases. For the evaluation of the administration of the ICP, the target population is the set of State and Territory energy office administrators. For the EA audit evaluation, the target population is comprised of four types of institutions (schools, hospitals, local government buildings, and public care buildings) participating in the energy audit program. For the ECM evaluation, the target population is comprised of schools and hospitals that participated in this phase of the program during Cycles I and II.

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*The statistical approach was designed by Joseph Steinberg of Survey Design, Inc., consultant to Opportunity Systems, Inc.

Sample Frame

The frame for the evaluation of overall Program administration and implementation, and for the first stage of sampling for the other evaluation activities is comprised of States (49, excluding Nevada), the District of Columbia, and Territories (4, Puerto Rico, Guam, the Virgin Islands, and American Samoa).

The frame for the EA evaluation consisted of the actual EA forms on file at the State Energy Offices. By DOE count, there were 70,512 units in the frame (57,311 schools, 4,023 hospitals, 6,648 local government buildings, 2,488 public care buildings, and 49 energy audits that were not classified) as of September 30, 1981. The frame for the ECM evaluation consisted of completed ECM grants. As of September 30, 1981, there were 8,112 funded; 1,012 were estimated to have been completed.

Sample Design

In this section, the design considerations corresponding to each evaluation objective are discussed separately.

Evaluation of Administration

All States and Territories are included to serve this objective. However, in order to secure the maximum benefit for the available budget, personal interviews were planned in only 10 (instead of 54) sample States included in the sample for the EA and ECM evaluation, and telephone interviews for the balance.

EA Evaluation

The objective of separate estimates for each of the four institution types (i.e., schools, hospitals, local government, and public care institutions) was a major element in the sample design decision process. Because the frame of EA forms for second stage sampling is available only on a State-by-State basis and requires considerable manual processing in some States (or is accessible through computers in others), each State or Territory needed to be a primary sampling unit (PSU), if an optimum probability sample design was to be used. Important factors affecting the sample design decision process include the cost associated with: each stage of sampling, securing the sample frame and the sample of forms, telephone interviewing for certain types of data or site visits for other types of data, processing and tabulating estimates and estimates of sampling variability.

Preliminary analysis of the joint requirements for specified precision for each of the four types of institutions within ~~the~~ available budget resulted in an understanding that a common sample of PSUs would be used for the achievement of the required objectives. Further, the same sample of PSUs was also to comprise the first stage sample for the ECM evaluation.

Sampling Units

The universe of first stage sampling units is comprised of the 54 States and Territories involved in the EA program. The universe of second stage sampling units is comprised of the institutions, by type, that participated in the EA program for the first two funding cycles of the ICP in each of the PSUs. As discussed further below, the sample for first stage units was established as 10 PSUs. Within each of these, the four specified institution types were sampled to provide a probability sample for the establishment of baseline information, as well as for the telephone interview and site visit phases of the evaluation.

Stratification

Preliminary analysis determined that a sample of 10 PSUs would compromise the first stage sample units. Further, the need to satisfy precision goals that were to permit useful analysis required that the character of the distribution of second stage units by first stage units be taken into account. Examination of the records of these distributions, both by institution type and ECM funding status, showed that a relatively small number of States accounted for a substantial proportion of each of the five subpopulations. However, since there were five target groups and only 10 sample PSUs possible, the State in each of the target groups was designated as a certainty PSU. Five States were designated as certainty PSUs: New York, Illinois, Minnesota, Oklahoma, and Virginia. The balance of the PSUs (49) were then grouped into strata, taking into account the DOE Region, the likely average heating and cooling requirement characteristics of Regions and the aggregate measure of size of each PSU (summed over the four institution types). Each stratum had approximately the same aggregate measure of size, within the constraint that PSUs should be formed by grouping the 10 DOE Regions.

The five strata which comprised the PSUs (except for the five certainty PSUs) in the regions are as follows:

Stratum	DOE Regions
6	I, II, III
7	IV
8	V, VII
9	VI
10	VIII, IX, X

As is discussed more fully below, the selection of sample PSUs in each of these non-self-representing strata was with probability proportionate to aggregate measures of size (PPS), with independent selection in each stratum.

Sample Size

The proposed sample sizes for the four types of institutions to be used in the telephone interview phase were determined so that the estimated coefficient of variation would be approximately 0.9 for a proportion type characteristic where the proportion is 0.5. The estimated sample sizes were established as 575 for schools, 500 for hospitals, 500 for local government cases, and 425 for public care cases. For the site visits, proportional sample sizes were designed. The likely variance design effects of the stratification and selection stages were taken into account in estimating sample sizes, as well as the effects of the finite multipliers for the institution types where sample size was a material fraction of the universe.

Allocation of Sample Size

The overall sample for each phase for each type of institution was allocated to strata (and sample PSUs) proportionately to the overall measure of size. The effects of a ratio estimate factor were reflected back into the allocation.

In general, an overall sampling rate was established for each type of institution and for each phase: the sample size divided by the population size. In the PPS sampling, a probability of selection for the set of PSUs in the sample was established: for the certainty PSUs, the probability is one; for the other five PSUs in the sample, the probability is the PSU measure of size divided by the stratum measure of size. The within sampling rate, in general, was estabished so that the product of the within sampling rates and the PSU probability of selection was the overall sampling rate. Where the PSU probability of selection was less than the overall sampling rate, cases in the institution type in the sample PSU are included (with a separate weight); then the difference in the sample take was reallocated to the other PSUs in proportion to the overall measures of the strata. The estimates of units for an institution type were used as the denominator for estimating a ratio estimate factor, with the known universe total being the numerator. The effects of the ratio estimate factors were reflected back into the sampling rates to reduce the variability of the weighting.

Sample Selection Process

The first stage PSUs were selected with probability proportionate to the overall measure of size (the aggregate number of energy audits in the PSU). Within the sample PSUs, the EA cases were classified by institution type and a systematic sample was selected. A random start was used in drawing the sample and the within sampling rates were used as the sampling intervals.

ECM Evaluation: Site Visit Sample

The sample design for this activity parallels that for the EA audit evaluation. The first stage PSUs used for this activity were identical with those selected for the EA evaluation described in the previous section.

The universe counts of completed cases in the ECM program for the 10 sample sites was approximately 400.* Of these, 150 were selected for site visits using exactly the same approaches as for the EA evaluation (use of within PSU sampling rates to achieve the goal of having the product of these rates and the PSU selection probability a constant, where feasible). Institutions that were large in size (250,000 sq. ft. or more) or had a large grant amount ($200,000 or more) were included with certainty.

In each of the 10 sample States, the remaining cases were stratified according to the following institutional characteristics:

Factor	Level
Size	1. Less or equal to 37,500 sq. ft.
	2. Greater than 37,500 sq. ft.
Grant Amount	1. Less than or equal to $50,000
	2. Greater than $50,000
Institution Type	1. Elementary or secondary school
	2. University
	3. Hospital
ECM Type(s)	1. Building envelope (E)
	2. Mechanical (M)
	3. Lighting (L)
	4. Special (S)
	5. E + M
	6. E + L
	7. E + S
	8. M + L
	9. M + S
	10. L + S
	11. E + M + L
	12. E + M + S
	13. E + L + S
	14. M + L + S
	15. E + M + L + S

The method of probability selection used was an approximation to controlled selection on the basis of these factors/levels. This ensured that sample selection was proportionate to the distribution for each characteristic by factors/levels.

*See M. H. Hansen, W. N. Hurwitz, and W. G. Madow (1953) Sample Survey Methods and Theory, Vol. I, pp. 476-80. New York: Wiley.

Estimation Procedures

The estimation procedures followed made use of information on the probability of selection of each sample unit, the number and characteristics of non-response units, and the merger of original sample units. The estimates of sampling variability will be based on standard estimators applicable to the sampling and estimation procedures.

Base Weights

The base weight for each sampling unit is the product of the reciprocal of its PSU's probability of selection and the reciprocal of its within PSU probability of selection.

Non-Response Adjustment Procedures

The characteristics of the responding units and non-responding units were determined from the TA reports and ECM applications. Non-response adjustments were calculated within cells based on unit characteristics. The adjustments used the base-weighted data for the responding and non-responding units, the factor in each group being the ratio for all units to that for responding units.

Merger of Sampling Unit

During the data collection and analysis process, the previously defined sampling unit occasionally was expanded. This typically occurred when the fuel data associated with the original sampling unit was found to be inextricably combined with other members of the sampling frame as, for example, when the fuel consumption data for one building in a complex was only available indirectly as part of the entire complex's energy records. For such cases two weights were calculated: the weight representing the probability of its selection after adjustment for non-response factors, and a second weight reflecting the increased likelihood of this expanded unit being selected within its PSU. The latter weight is used for estimates of magnitude variables (e.g., changes in fuel consumption); the former is applied when estimates of population (e.g., number of ECMs affecting lighting systems) units are desired.

Estimates

Survey estimates are based on results for responding units where each unit has a defined weight: the weight in each case is a product of the base weight and the non-response adjustment factor. The weighted responding units are the entities that are used for deriving estimates of aggregates, cross-classified by analytic variables, aggregates, etc.

Estimation of Precision

For the weighted sample of ECM grantees, estimates of precision were calculated for three estimates of aggregates--base year total energy consumption, latest year energy consumption, and the difference between base and latest year total energy consumption--and for the ratio of the difference in total energy consumption to base year total consumption (i.e., percent energy saved). The 90% confidence limits for these four estimates are:

		90% Confidence Internal*		
	Estimated Variable	Lower Limit	Estimate	Upper Limited
(1)	Base Year Total Energy Consumption	14,914,452	39,143,492	63,372,532
(2)	Latest Year Total Energy Consumption	11,597,000	33,973,839	56,350,678
(3)	Difference Between Base Year and Latest Year	2,850,585	5,169,653	7,488,721
(4)	Percent Energy Saved	9.30%	13.21%	17.11%

As shown above, the 90% confidence intervals for the three aggregate energy figures are fairly wide, reflecting in part the relatively small sample size. However, the 90% confidence interval for percent energy saved is much narrower, indicating that the sample was sufficient to permit a precise estimate of the relative energy savings attributable to the ICP.

*In millions of BTUs.

QUESTIONNAIRES

Two basic survey instruments were designed and presented by DOE for OMB approval:

- Energy Audit Output Survey (EAOS) for use in obtaining follow-up data from EA institutions
- ECM Survey (ECMS) for use in obtaining updated cost and energy use information from ECM institutions.

Both EAOS and ECMS were designed to be used either in a telephone interview or a site visit. The site visit questionnaires, however, contain an additional component: a walk-through verification of reported energy conservation practices, and an assessment by the site-visit team concerning the appropriateness and the quality of ECM installation and maintenance. Pretest results demonstrated that, with minor modifications, the EAOS could be used successfully to gather the requisite data by telephone; it was also used in the field. The ECMS was developed to collect data concerning the impact of ECM installation on the energy usage of grantee institutions and their experience with DOE grant administration, and was used ultimately as a site-visit instrument only.

At the conclusion of the EAOS pretest, the instruments and a supporting statement were resubmitted to DOE. After EIA review, the package was submitted for OMB approval. Notification of this approval was received on April 1, 1982.

INITIAL DATA GATHERING

Initial data gathering involved (1) interviewing DOE Regional offices and State energy offices (SEOs) for administrative information and a sense of Program performance and (2) simultaneous microfilming of the documentation for all ICP phases in which selected institutions had participated. These two operations are discussed in the sections that follow.

State and Regional Interviews

Objectives and Procedures

Before the survey instruments were made final, members of the evaluation teams and officials from DOE Headquarters conducted combined interviews and briefings of Regional offices and SEOs involved in the administration of the Program in the 10 sampled States.

The purpose of the State administrative process interview (API) was not only to gather specific historical information on the implementation of the ICP, but also to get feedback from SEO personnel on the major successes and problems associated with the Program.

The interview sessions served several objectives:

- To brief State and Regional officials on the content and schedule of the ICP evaluation activities.
- To solicit administrative support for the ICP evaluation from various parties.
- To provide DOE Headquarters with an administrative history of the first two grant cycles of the ICP.
- In the case of Regional interviews, to discuss administrative or technical approaches and program experiences in each of the 10 sampled States in comparison to other States within each Region.
- To verify that the basic evaluation design was practicable in each State.
- To understand the viewpoints, needs, and administrative concerns of Program officials at the local level.
- To ascertain local variations in Program administration that could affect the results of telephone and field visit surveys of institutions participating in the EA and ECM phases of the ICP.
- To provide a basis for later correlation between State decisions and actions, and the character and effectiveness of work performed at the institutional level.
- To evaluate the comparative effectiveness of different administrative and technical approaches taken in SEOs to training energy auditors and TA analysts.
- To evaluate the impact of different ranking formulas and regulations used by SEOs.

The following procedures were followed for contacting State and Regional interviewees and initiating data collection activities.

- <u>DOE Letter to State and Regional Offices</u>--This initial letter sent by DOE Headquarters to the ten State and eight Regional offices served as an introduction to the ICP evaluation. Included in the letter was a brief statement on the selection process of States, and procedures and preliminary schedules for data collection activities.
- <u>OSI Letter to State Offices</u>--A letter was sent to each of the ten State Offices introducing the OSI/TSG evaluation team and outlining details for interviews and data collection.

- OSI/TSG Telephone Contact to SEOs--Each SEO was contacted to arrange an interview date. Also during this telephone contact, the evaluation team collected preliminary information on the status of State files in preparation for data collection activities. Information included: total number of EA, TA, and completed ECM files; filing system and accessibility of files; and degree and type of automated data files, if appropriate.

- State and Regional Interviews--The State and Regional interview teams arranged travel geographically, and arranged to meet with Regional support personnel prior to visiting State Offices. The average time spent with administrative personnel was 3 to 4 hours.

- Data Collection--The OSI/TSG data collection team arranged its schedule concurrent with the State and Regional interview teams, when possible. However, data collection efforts required an average of 3 to 5 days on-site to pull the sample from the files, microfilm documents, and restore the office's original filing system.

Type of Information Solicited

Three major categories of information were included in the State API:

1. Resources and Organization

   - SEO Staffing (number of personnel assigned to ICP, special training involved, contractors used)

   - Administrative Costs (total ICP-related costs, deployment of Federal funds, source and type of matching funds, publicizing the Program)

   - Impacts of Other State Energy Conservation Programs

2. Management Policies and Procedures

   - EA Phase (all aspects of auditor training)

   - TA Phase (training and/or qualifications of analysts, guidance for TAs, ranking criteria used on TA applications)

   - Documentation (report design, treatment of grant applications, documentation of participation, quality control)

- Monitoring Activities (types, findings, follow-up activities)

- Implementation of ICP (problems and solutions)

3. General ICP Experience

- Successes and failures concerning institutional participation, and penetration rates of ICP activities

- Any financial, political, or administrative barriers to participation experienced by eligible institutions

Microfilming

Baseline information was collected from the records of SEOs in the initial stage of the data collection process. An OSI/TSG data collection team microfilmed a stratified random sample of EA forms and accompanying information (e.g., correspondence), using a random starting point and a defined sampling interval within each institution type.* The EA and TA reports and the ECM grant application were microfilmed for each completed ECM case. Where they were available, the PEA reports also were copied.

DATA GATHERING AT INSTITUTIONS

The sections that follow briefly describe the procedures used to collect EAOS and ECMS data during site visits, and the activities undertaken in preparation for site visits. The procedures used to collect telephone survey data are found in OSI's report, Institutional Conservation Program: Analysis of the Impact of the Energy Audit on Selected Institutions.

Conducting Site Visits

Objectives

Data from visits to 136** evaluation sites--24 EA only and 112 completed ECMs--are included in the evaluation. The objectives of the site-visit component of the evaluation effort were:

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*This systematic sampling revealed some inaccuracies in the estimates of total ICP population available for inclusion in the evaluation. In one SEO, sampling intervals had to be halved in order to gather a suitable number of records.

**Reduced from an original 188 due to various problems: see Chapter 2.

- To verify (1) fuel savings and (2) continuance of O&M procedures;

- To gather information on (1) costs and savings associated with specific types of ECMs and specific types of institutions, (2) technical successes and difficulties associated with specific ECMs, and (3) administrative processes related to Program implementation;

- To determine (1) the extent to which institutions were involved in energy conservation prior to the ICP, (2) what additional energy conserving activities could be done, and (3) secondary impacts of program participation on individual institutions and local communities.

Site Visit Organization

The order of States visited was arbitrary and has no impact on evaluation findings. Site visits were scheduled geographically within each State, generally allowing one half day per institution, including travel time. Actual time spent at an institution was approximately 2 hours. The following procedures were used for contacting institutions and setting up site visits.

- SEO Contact Call--SEOs were informed by phone of the institutions to be visited and the tentative site visit schedule. The SEO's level of participation in planning and executing site visits (e.g., introductory contact to institutions, scheduling site visits, or accompanying the evaluation team to institutions) was determined.

- Follow-up Letter--A letter was sent to the SEO requesting verification of institutional data such as contact person, grant award amount, total project cost, and installed ECMs. Copies of correspondence also were forwarded to DOE Regional support offices.

- Institutional Contact Call--This first communication with an institution's ICP contact described the overall evaluation plan as well as the types of information sought during the site visit. The visit was scheduled and arrangements were made for other involved parties (e.g., the TA analyst, the building engineer, and/or maintenance personnel) to be present during the site visit.

- Follow-up letter, Institution--This letter confirmed the arrangements made for the site visit, outlined the specific types of questions to be asked during the interview, and enclosed fuel consumption data charts that were to be completed prior to the site visit.

In the early site visits, respondents were asked by telephone and letter contact to provide post-EA energy consumption data for delivery at the time of the visit. This procedure was subsequently revised to request that data be mailed prior to the visit. By pre-visit analysis of such data along with the EA and TA sources of energy data it became possible to identify any need for special probing during the visit. In particular, institutions that disclosed either particularly high or low consumption changes were flagged for more in-depth questioning to confirm this apparent result and to discover its cause. In many cases this allowed errors in data to be resolved and/or provided an opportunity for the respondent to become involved in seeing, sometimes for the first time, what the trend had been during the recent past.

- Pre-Travel SEO Contact--SEOs were called after all site visits in the State had been confirmed to coordinate travel arrangements in those States that wished to have SEO personnel accompany the evaluation team. All SEOs were sent copies of site visit schedules regardless of their participation, as well as copies of the survey instruments that were administered. This enabled the SEO to answer any questions posed by sampled institutions.

On-Site Procedure

Site visits were conducted by a two-person TSG evaluation team composed of an engineer to analyze the technical energy conservation applications in an institution, and a program specialist to review the qualitative and administrative process details of program participation. In some States the team was accompanied by a representative from the SEO. On a few visits a DOE representative was also in attendance.

The institutions that had participated only in the EA phase of ICP were administered EAOS; the institutions that had completed ECMS were administered both EAOS and ECMS. Regardless of the instruments used, every site visit had two components, an interview and a building walkthrough. Each generated a different kind of information:

- Administrative Interview--Administrative processes and grant procedures, energy conservation activities and attitudes of building occupants, verification of fuel consumption data, schedules and cost modifications of grants, secondary impacts of ICP participation (e.g. energy conservation spinoffs within or outside the institution), and general attitudes about each phase of ICP participation

- Building Walkthrough--Verification of O&Ms and ECMs, problems encountered with installation and operation of O&Ms and ECMs, interface of O&Ms and ECMs with other building systems, potential for additional O&M and/or ECM efforts.

The interview process generally required about one hour of question/answer and discussion plus another hour of facility walkthrough with further discussion. The sequence of these activities was kept flexible to best fit the varied circumstances encountered. In most instances the respondent was first met in his/her office and the walkthrough was conducted last. Many respondents had invited additional staff members and/or the auditor or technical analyst to be present. Although a larger number of persons in attendance usually tended to extend the interview, the quality and quantity of available information also seemed to improve.

Use of the formal questionnaire was not allowed to structure the interview in such a way as to limit the range of topics and constructive comments that the respondent wished to address. By using the questionnaire to assure discussion of at least the formal questions, the group was allowed to cover additional matters as it wished and thus voluntarily contribute to the depth and value of the interview. This was vital in certain cases. For example, the random selection process for choosing site visits sometimes selected only one building out of a group or complex of buildings which the respondent had dealt with collectively. In such cases the respondent was not always well equipped to isolate his comments to that particular building, but rather was better able to discuss the overall program and process from his larger viewpoint. Where the interview team's pre-visit study had established the similarities (and differences) of the selected building with the complex of buildings, the respondent was free to convey more useful information than had he been forced to limit discussion to only the specifics of the selected building.

Site Visits: Preparatory Activities

Focus of Preparation

The evaluation team deemed it highly desirable to have obtained maximum insight into the facility and its history before executing the site visit. In preparation for each visit, team members reviewed the institution's ICP documents for the following information:

- The pre-ICP conservation improvements undertaken with other funding
- The baseline energy consumption of the facility and the types of fuels involved
- Some approximate indication of conservation potential derived from an awareness of the age of the structures, types of materials, general configuration, orientation, and type and hourly schedule of facility use. Additional information on existing mechanical equipment and control systems provided the balance of a minimum store of knowledge about the facility to be visited.
- The O&M procedures recommended for incorporation at the time of the EA

- The ECMs recommended for implementation, as well as their projected costs and simple payback estimates

- The general quality of the TA and the EA in order to determine whether a thorough, accurate, and complete analysis was available to the institution.

The TA Review

This pre-visit analysis constituted a "TA Review," since a TA report was always associated with a completed ECM institution and was always examined. However, the pre-visit review often entailed much more: a look at the institution's EA report, correspondence, and ECM grant application, for example. (Of course, EA-only institutions had limited documentation, and pre-visit analysis was less complex for them.)

The TA Review enabled the site-visit team to conduct a more productive interview. The limited time available at the site (and the desire to keep the respondent burden to a minimum) dictated that as many questions as possible be resolved by study prior to travel. Furthermore, it was flattering to the respondent that the evaluators were interested enough to have acquainted themselves with his or her facility. Frequently, this produced more enthusiasm on the respondents' part and led to a freer exchange of useful information.

The task of reviewing the microfilmed ICP documentation varied considerably for several reasons. Generally the size of the task was proportional to the complexity and square footage of the facility, but it also depended significantly on the methods used by the particular technical analyst. There was a wide range of detail provided in the TA reports and the formats used were as numerous as the analysts involved. Particular attention was given to noting the kinds of ECMs selected for study in the TAs and reviewing the engineering calculations that supported such analysis. In some cases, the calculations were nonexistent because a packaged computer program had been used by the analyst. In such cases even the inputs to the computer program were frequently difficult to identify and only computer answers were shown. In cases where manual calculations were shown, it was often difficult to explore them due to the lack of explanation of the underlying assumptions that led to the use of a particular path of reasoning. Obvious mathematical errors were noted. Otherwise, questions were raised in an effort to achieve understanding.

Follow-Up Site Visits

The purpose of follow-up site visits was to determine the causes of apparent increases in energy consumption at selected institutions. Identification of sites in this population were determined by thoroughly reviewing both computerized and field data to correct data errors. Data was then analyzed to determine if energy use increases were due to factors such as changes in weather, building square footage, utilization, and/or energy metering. Additional review by the evalution team's engineer was conducted to determine whether the technical characteristics of the building and its energy conservation activities warranted the original savings projections. A limited number of sites then were selected for in-depth technical on-site review.

Procedures for conducting the follow-up site visits paralleled the procedures described earlier for ECM site visits.

COMPUTERIZATION AND STORAGE OF SITE VISIT DATA

Site Visit Data

Three principal kinds of data were brought back from the field: "checklist" data, energy use data, and OMB survey instrument data. All data were automated.

Checklist Data

Immediately following each site visit, the TSG evaluators completed a "checklist," which is a summary record of their findings and impressions at each institution. The information recorded was not meant to be strictly objective and quantitative. It was intended to record their expert judgment on the factors that appeared to be contributing to the success or failure of the ICP's implementation at that site. By correlating these impressions with the actual energy savings at the institutions, the evaluation staff was able to gain insight into these critical success factors so that DOE and the States can communicate them to all institutions.

Energy Use Data

The site visit team sought energy use data for at least one year preceding ICP implementation (i.e., the EA date) and one year following the latest ICP phase (either EA date, TA date, or ECM operational date) at each institution. The raw data (gallons of fuel oil, cubic feet of natural gas, tons of coal, etc.) were recorded. The data are organized into two periods:

- Base Year, a period preceding the EA date
- Latest Year, a period following ECM implementation.

Where a full year of data after ECM implementation was not available, the periods were adjusted to provide for comparison of like periods.

Other Survey Instrument Data

EAOS and ECMS collected not only energy use information, but also the quantifiable responses to many other questions about Program results. The EAOS and the ECMS responses were incorporated into the site visit data base at TSG.

ANALYTICAL APPROACH TO SITE VISIT DATA

The ultimate goal of the ICP evaluation's analytical effort was to determine the energy savings impact of the program and the factors which contributed to an institution's successful performance. Once all data were collected for the EA and ECM sample, they were adjusted by appropriate weighting factors so that the final analysis reflects a representative sample of all Cycle I and II ECM grantees whose projects were completed as so September 30, 1981.

Data Base Processing

The analysis consisted of the following principal procedures:

- Raw energy data were processed for each site using VISICALC software; this produced BTU totals by energy type for the base year and latest year (see Figure B.1 for a sample VISICALC report).
- Totals for the raw energy data, along with building characteristics, administrative and technical field observations, were coded for entry into the Statistical Analysis System (SAS) software.
- SAS was used as the primary analytical tool. Three kinds of SAS programs were used for various parts of the analysis:
  - frequency distribution, which displays the number and range of values for each variable
  - univariate analysis, which calculates sums, means, and other statistical features for each variable
  - correlation analysis, which is used to calculate and test the significance of relationships between two variables using linear regression.
- Then the SAS programs were used to produce analyses of the following types:
  - Energy and cost savings for the entire data base;
  - Correlation between ECM cost, institution size, energy savings, and cost savings;
  - Energy and cost savings comparisons between varirous subgroups within the data base, including:
    - . ECM recipients and EA participants
    - . schools and hospitals

- types of ECMs
- groups based on questionnaire responses (e.g., respondents answering "yes" or "no" to individual questions).

These analyses were conditioned by the following factors:

- Weighting factors designed to amplify results to represent the original sampling universe of Cycle I and II grantees (see Appendix B for Survey Design).
- Probability factors which determine the significance of correlations between two variables.
- Tests used to assess the significance of comparisons between subgroups such as ECMs/EAs, schools/hospitals, questionnaire responses, etc.

Data generated during the analysis falls into the three following categories:

1. Basic Energy Data

   - Base Year Consumption data in million BTU, for:

     - electricity (source BTU conversion)
     - electricity (site BTU conversion)
     - natural gas.
     - oil
     - coal
     - steam
     - total (source BTU conversion)
     - total (site BTU conversion)

   - Latest year consumption data, as above.
   - Change in energy consumption (base year minus latest year) as above, non-weather-corrected.
   - Weather-corrected change in energy consumption, as above.
   - Percentage change in energy consumption, as above.
   - Weather-corrected percentage change in energy consumption, as above.

2. Related Energy Data

   - Square footage
   - ECM total cost
   - Million BTU saved per square foot.

- ECM cost per million BTU saved.

- ECM cost per square foot.

These five variables, plus total change in BTU consumption and total percentage change in consumption, were tested for correlation with each other.

3. Categorical Data

There are three kinds of categorical variables:

- Institution type (schools and hospitals for the ECM sample).

- ECM type (15 types).

- Field questionnaire responses--includes 56 items from OMB questionnaires and field checklist

For each of these categorical variables, TSG calculated:

- The number of institutions in each category.

- Average percent energy savings (weather-corrected, non-corrected, Source BTU, Site BTU).

- Average square footage.

- Average project cost.

- Average project cost/square foot.

- Average project cost/million BTU saved (weather-corrected, uncorrected, Source BTU, Site BTU).

APPENDIX C

UNDERLYING FACTORS OF THE ANALYSES

Several assumptions, conversion practices, and data adjustments underlie the analyses conducted for the evaluation. These are described in detail below.

Calculation of Energy Savings

Each type of energy used in a facility was first converted to equivalent units using the British Thermal Unit (BTU) standard. The following formulae were used for this purpose:

Electricity:	Kilowatt hours (kWh) x 11,600 BTU/kWh = BTUs
#2 Fuel Oil:	Gallons x 138,690 BTU/gallon = BTUs
#6 Fuel Oil:	Gallons x 149,690 BTU/gallon = BTUs
LPG:	Gallons x 95,475 BTU/gallon = BTUs
Natural Gas:	Cubic feet (CF) x 1,030 BTU/ft^3 = BTUs
Coal:	Tons x 24,500,000 BTU/ton = BTUs
Steam:	Pounds x 1,390 BTU/pound = BTUs

In order to permit proper accounting in equivalent BTUs for energy consumption by facilities using remotely generated steam or electricity as compared to conversion on site of measured quantities of a raw fuel (e.g., fuel oil, natural gas, coal) the following assumptions were used:

- Conversion of electricity is based on an average number of BTUs expended at the generating plant to produce and transmit a kilowatt hour of energy as metered at the user's facility. This metered kilowatt hour of electricity provides the user with 3,413 BTUs, but it required the expenditure of 11,600 BTUs at the generating plant.
- Conversion of metered steam includes an assumed average efficiency for boiler conversion of raw fuel into the steam product. Where a specific boiler efficiency is known, a more accurate conversion of steam to equivalent BTUs may be achieved.

Energy savings were calculated for a given facility by subtracting the total annual BTUs consumed by that facility in the post-ECM period (latest year) from its total consumption during the pre-EA period (base year).

Percentage energy saving results were determined by dividing the above calculated BTU savings by the total BTU consumption of the base year, and multiplying by 100:

$$\% \text{ Saving} = \frac{\text{Latest year BTUs} - \text{Base Year BTUs}}{\text{Base Year BTUs}} \times 100$$

Weather Correction

Because of the limited precision of universally applicable weather correction methods, it was decided to use original, non-corrected data as the basis for overall evaluation. However, weather correction is used in selected cases where weather correction assisted in the case analysis or elaboration of specific points. In such cases, the correction was based simply on adjusting the latest year (post-ECM) consumption by the ratio of the total recorded degree-days of the base year (pre-energy audit) to that of the latest year (post-ECM). The simplicity of this ignores many factors but generally provides a degree of correction to the results that is at least in the proper direction, if not always of the precise magnitude.

Barrel of Oil Equivalent

Sometimes, total BTU savings are translated to Barrels of Oil Equivalent (BOE). This is done for illustrative purposes only. Actual energy savings included a mix of raw fuels.

Since a major goal of ICP was to reduce national oil dependence, comparison of energy savings to BOE is useful to illustrate the hypothetical impact on oil usage. Within the ICP the total heating oil reductions in BTUs exceeded the total of all BTU savings. This occurred because of the large number of fuel conversions from oil to gas which did not necessarily produce BTU savings, but did reduce oil use. The conversion to BOE is based on the standard measure of 42 gallons of oil per barrel, with a total content of 5.23 million BTUs per barrel (bsed on DOE/EA published figures for consumed heating oil in the 1981-82 period).

Energy Cost Savings Calculations

Energy cost savings were calculated on a non-discounted basis (i.e., energy savings in BTUs were valued at 1982 average national energy prices). These prices were then assumed to remain constant. Increases or decreases in energy prices, or discounting of future cost savings could change payback and related financial calculations.

Cost Effectiveness of ICP at ECM Institutions

Cost effectiveness of the ICP at ECM institutions is defined as the total dollars spent for ECMS divided by the total savings in millions of BTUs occuring at those institutions. This also includes savings at the ECM institutions which resulted from O&M actions recommended by the EA, as well as any additional energy saving actions. However, the available energy consumption data does not permit adequate segregation of these contributing factors.

It is assumed that the federal dollar participation in the ECM institutions averaged 50 percent of the total dollars spent. Thus, the cost effectiveness of federal dollars is assumed to be twice that of the total project's cost effectiveness.

APPENDIX D

GLOSSARY

API — Administrative Process Interview. This questionnaire was administered to personnel at State Energy Offices as a preliminary to field and telephone work.

DOE — U.S. Department of Energy

EA — An Energy Audit performed with ICP funds, and the second data-gathering phase of the program. Audits conducted under other programs are referred to as energy audits, not EAs.

EAOS — Energy Audit Output Survey. An OMB-approved questionnaire administered to institutions that participated in the EA phase. EAOS is being administered to institutions over the telephone, and at all site visits.

ECM — Energy Conservation Measure, a major capital expenditure underwritten by ICP funds for the purpose of energy conservation.

ECMS — Energy Conservation Measure Survey. An OMB-approved questionnaire administered to institutions that have completed the ECM phase of ICP. ECMS was administered during site visits.

HVAC — Heating, ventilating and air conditioning (describes an air handling system).

ICP — Institutional Conservation Program

O&M(s) — Operating and Maintenance Procedures undertaken for the purpsoe of energy conservation.

OSI — Opportunity Systems, Inc., the prime contractor for the ICP evaluation.

PEA — Preliminary Energy Audit, the first data-gathering phase of the ICP.

SEO — State Energy Office. Although the names may vary, each of these State offices is responsible for oversight of energy-related activities.

TA — Technical Analysis, an assessment performed by an engineer or other qualified professional with ICP funds for the purpose of recommending the best ECMs for a specific institution.

TSG — The Synectics Group, Inc., the subcontractor for the ICP evaluation.

* U.S. GOVERNMENT PRINTING OFFICE: 1983-0-381-060/0050