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RETROSPECTIVE (IN-PROCESS) PROJECT EVALUATION
SYSTEM

1697
T.O. **MASTER**
FINAL REPORT

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1. INTRODUCTION

The Division of Building and Community Systems allocates RD&D funding to conservation projects in order to accelerate the introduction of these projects into the market. Since the available funds are not sufficient to support all possible conservation projects, decisions must be made as to which will be funded, and at what levels. This project evaluation system is being developed to help BCS managers make these critical decisions.

The first part of the project evaluation system is the Threshold Screening system. This analysis is designed to measure each proposed BCS project against a set of public and private sector threshold values. The public sector criteria are based on a benefit-cost comparison of a project's energy savings and its RD&D expenditures (efficiency of total investment, and marginal efficiency of investment). The private sector criteria looks at the project's rate of return as a measure of its attractiveness to the consumer.

The second phase of the evaluation system was developed to account for the influence of risk on the likelihood of successful adoption and commercialization of the conservation technology. The risk analysis solicits subjective assessments of a project's commercial, institutional and technical probability of success with and without Federal RD&D funding, and calculates a risk-adjusted rate of return.

After the threshold and risk analysis methodologies are performed on each project, the resource allocation methodology uses this information

to select optimal portfolios of projects by assessing the marginal benefits of funding successive projects competing in homogenous market areas.

The logical final step in this project evaluation system is the retrospective (in-process) evaluation methodology. This methodology is being developed to monitor each project's progress and evaluate its success at completion. The criteria for evaluation during development and at completion will vary according to the nature of the project, the anticipated role that the Federal government expects to play in development and commercialization, and the level of development of the technology at the time the Federal funding begins.

Effective application of this retrospective methodology will critically depend on the collection of appropriate information about each project's technical and cost characteristics, energy savings objectives and accomplishments, and market penetration estimates throughout the course of the project. Non-hardware projects will also be evaluated with this goal-oriented approach, but in a more project-specific manner.

The result of the addition of the retrospective (in-process) evaluation methodology to the threshold/risk analysis and resource allocation methodology is one system by which a project can be screened when it is proposed, monitored in its development, and evaluated at its completion. This report describes the methodology, at this early point in its development. Further refinements in this component of the project evaluation system will lead to a cohesive and consistent project management and tracking system for all BCS projects.

2. METHODOLOGY

2.1 INTRODUCTION-GENERAL PRINCIPLES

The retrospective evaluation methodology is designed to measure the accomplishments of BCS projects that are either on-going or completed. The evaluation criteria will vary according to the nature of the project, as well as the stage of development of the technology. The approach of the methodology is goal oriented, and requires that information concerning a product's technical performance, energy savings, cost, and market penetration objectives be collected and evaluated at each critical point, or milestone, during the course of its development.

Since each project has different objectives, and requires different BCS involvement, an individualized approach would seem to be what is required. However, due to the number of projects, and the effort that would be required to implement this sort of project-by-project evaluation, it is necessary to develop a methodology that will describe criteria to be applied to each of a manageable number of project types. Each project can then be classified according to its nature and level of development, and appropriate criteria can be applied to each class.

The typology is based on the possible phase (or phases) of a project's development in which BCS may be involved. Once these phases are defined, and classes of projects are set up which correspond to different combinations of these phases, an individual project may be classified by examining its scope and placing it in the category which best fits its characteristics. The result of this categorization is that specific evaluation criteria may be prepared to correspond to fewer project

types, rather than for a large number of individual projects. In this preliminary system design phase, nine different project types were identified.

2.2 PROJECT TYPOLOGY

The phases of development identified for this methodology are listed below. Before discussing each phase in turn, it should be noted that the distinction between projects whose end-product is hardware, and those which have other objectives is only made as the appropriate development phases are chosen. Also, it is not intended that these phases define the sequence of activities through which all projects will pass. In fact, each project type will include different combinations of phases, and begin at different points.

The classification scheme is summarized in Table 2-1. The first phase labelled "Background Research," includes information gathering that could occur for its own sake, or as a prerequisite to the undertaking of a more involved study or product development. This research would include market studies, surveys, workshops, state-of-the-art reports, and the evaluation of existing systems or products.

The second column represents that phase during which the technical and economic feasibility of a product is determined. These studies would identify technological limitations and costs, as well as institutional barriers that would influence development, such as financing, codes and standards, and zoning and land use regulations. This phase would apply to projects with hardware end-products.

The third phase is the actual development of the technology. In the case of hardware development, this would include the engineering of new

TABLE 2-1
CLASSIFICATION SCHEME

<u>Project Class</u>	<u>Background Research</u>	<u>Feasibility Studies</u>	<u>Technology Development</u>	<u>Demonstration</u>	<u>Technology Transfer</u>	<u>Development of Analytical Tools</u>	<u>Regulations/ Standards</u>
I	X	X	X	X	X		
II	X	X					
III				X	X		
IV					X		
V			X	X	X		
VI	X						
VII	X		X	X	X		
VIII	X					X	
IX							X

mechanical processes and products. However, the classification is set up so that this phase would also correspond to the design of non-hardware systems (such as building design, based on existing technologies).

The fourth column corresponds to the demonstration phase of a technology or system. This includes identifying the demonstration program and site, constructing the prototype, and assessing the technology. Some non-hardware projects address the problem of designing and demonstrating systems that utilize hardware that has already been developed. In these cases, the demonstration phase would include economic concept testing.

The fifth phase, labelled "Technology Transfer," refers to the introduction of the product or technology into marketplace. This phase would also apply to projects which are concerned with consumer motivation. In all cases, it is assumed that any information derived from a project will be disseminated to interested parties; this activity has not been included in the transfer phase.

The last two columns apply to non-hardware programs. "Development of Analytical Tools" concerns strategy implementation, measurement techniques, analytical tools development, etc. "Regulations/Standards" includes activities leading to the development of code manuals and standards to be used to regulate new or existing activities.

Project types may now be defined in terms of these phases. Nine combinations of these categories of work are specified, into which most BCS projects will fit. For each of these nine categories or types of project activity a set of guidelines for reviewing and evaluating each project is prepared. This will enable the project manager to more easily monitor the progress of his projects through a system that is

consistent for all projects having similar characteristics. Those projects that do not fall into any of the categories may still be evaluated by using a combination of the criteria for each of the individual phases that are appropriate. Examples of how this system would perform will be given following the description of each project type below.

Each project class given in Table 2-1 represents those BCS projects that have characteristics that are similar enough to warrant common evaluation criteria. The X's indicate which phases of development are important in achieving the stated objectives of each project class. Table 2-2 briefly summarizes the characteristics which distinguish each type of project, and gives an example of each (taken from the BCS Project Summary Book - March 1978 revision).

In the next section, specific guidelines for project organization and review are presented for each project type. Projects that do not fall into any of the prescribed categories should be evaluated by examining the criteria for each of the phases it entails.

2.3 EVALUATION GUIDELINES

The basic purpose of the retrospective evaluation methodology is to compare the achievements of a project to its objectives, at different times during the course of its development. Consistent application of the methodology will depend heavily on the collection of accurate information about a project at critical points in its development. For this reason, a hierarchy of performers and their responsibilities in this task must be identified. As presented here, the process begins at the initiation of a program. It may be applied, however, to a

TABLE 2-2
DESCRIPTION OF PROJECT CLASSES

Project Class	Characteristics	Examples
I	Hardware RD&D, through commercialization including Technology Transfer	Grid connected ICES
II	Hardware research and feasibility analyses; may identify promising concepts for later projects	Small Systems Resource Recovery Analysis
III	Hardware demonstration of an existing technology, analysis and dissemination of results	Thermal Imaging Applications
IV	Development and testing of motivational techniques and technology transfer strategies	Master Metered Buildings
V	Development and demonstration of a technology (hardware)	Gas Heat Pump
VI	Research programs; information gathered may be put to use in future projects (hardware or non-hardware)	Energy Use in Building Construction
VII	RD&D of systems comprised mainly of available technologies (non-hardware)	Automated Energy Management Systems for Small Buildings
VIII	Research leading to the development and testing of analytical tools	Assessment of Conservation Options
IX	Research leading to the development of code manuals and standards	DOE/NBS Building Energy for Standards Program Performance

project that is in any stage of development by beginning with the guidelines that are appropriate to that stage.

When a proposal for a project is received by BCS, it contains targets for technical performance, cost and energy consumption and market penetration estimates. Once it is determined that the project is consistent with BCS and National energy objectives, and indeed requires BCS involvement, threshold evaluation, risk analysis, and resource allocation are carried out.

When the project is initiated, milestones are specified. Each milestone represents the time by which a specific objective will be reached, and corresponds roughly to the end of each phase of development. Therefore, it is reasonable that these points should be used as checkpoints on a project's progress. The monitoring system developed below is based on evaluations made at these milestones, and naturally at the completion of the project. Figure 1-1 gives an overview of the operation of the system, based on the activities involved in a Type one project.

It is proposed that, at each milestone, the "performing" contractor, that is the developer of the project, report pertinent information to some person (or persons) who has the responsibility of tracking the project's progress. An independent "administrative" contractor may be the best choice for this task. As improved data on technical and operating characteristics is received, performance goals may be revised. Any necessary changes in funding needs will also be noted by this administrative contractor. Other less quantitative accomplishments can be compared against stated objectives at the start of the project using criteria that will be described below.

FIGURE 2-1
EXAMPLE OF PROJECT SCHEDULE AND RESPONSIBILITIES
TYPE 1 PROJECT

After the administrative contractor collects the information and analyzes it to some extent (using threshold and risk analysis on the revised data), he would be responsible for passing his findings on to the project manager at BCS, highlighting those projects that might need further consideration.

The project manager reviews the data, and notifies the next level in the hierarchy (a committee of two or three members) of changes in any project's status that require further review, or a decision to be made. The members of this "committee" will be specialists that are knowledgeable in the appropriate field, and will be drawn from national labs, universities, DOE, and private contractors. In most cases, all that will be required from each member is to read the updated information, and make recommendations as to the future of the project in question. Any decisions regarding changes in funding or cancellation of projects, will have to come from this committee. Physical meetings will only be necessary when a consensus cannot be reached, or when the decision to be made is particularly difficult.

The actual criteria to be used at each milestone by any of the evaluators will vary according to the nature of the project, determined in most cases by the project class into which it falls. The following sections give specific guidelines and criteria for each project type. Checklists, covering some of the major considerations pertaining to the particular stage of project completion, are included following the Type I guidelines.

2.3.1 Type I - Hardware RD&D, Through Commercialization

Milestone No. 1 - Completion of Background Research

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
 - Proposed work plan
- Issues to be considered by project manager and committee
 - Need
 - Why is project needed?
 - Why is DOE involvement necessary to fulfill objectives (why can't private sector do do enough)? (See checklist No. 1.)
 - Are efforts duplicative of any in public or private sector? If so, are any competing technologies better?
 - Design
 - Are all steps provided for by either the private sector or the government? (See checklist No. 2.)
 - Are problems of consumer acceptance and commercialization addressed? (See checklist No. 3.)
 - Results
 - Have any different areas for research been identified?

Milestone No. 2 - Completion of Feasibility Studies

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
 - Proposed work plan
- Issues to be considered by project manager and committee
 - Need
 - Based on revised data, are there other technologies far enough superior to this one to warrant discontinuation of this project?
 - Have studies pointed out a need to revise goals and/or funding levels?
 - Design
 - Have any significant barriers to commercialization been identified?
 - Have institutional problems been identified that need to be taken account of? (See checklist No. 4.)
 - Results
 - Are results of studies accurate and in a form that is useful?

Milestone No. 3 - Completion of Product Development

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
 - Proposed work plan

- Issues to be considered by project manager and committee

- Need
 - Do goals need to be redefined?
 - Are other technologies superior?
- Design
 - Has target population shifted due to development activity?
 - Does design fulfill original (or revised) objectives?
- Results
 - Have there been any unanticipated side effects, which have become evident during development, that might reduce consumer appeal?

Milestone No. 4 - Completion of Demonstration

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
 - Proposed work plan
- Issues to be considered by project manager and committee
 - Need
 - Do goals need to be redefined, in light of demonstration activity?
 - Design
 - Has demonstration reduced uncertainty for the private sector by providing detailed, reliable information about the technology?
 - Have institutional arrangements been made in preparation for next phase?
(See checklist No. 4.)

- How will issues like raw material availability, distribution and logistical consideration, pricing, packaging and service be handled?

- Results

- Was demonstration conducted in a manner that produced reliable results in a useful form?
- Did demonstration closely simulate real conditions?

Milestone No. 5 - End of Technology Transfer (Completion of Project)

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
- Issues to be considered by project manager and committee
 - Need
 - What improvements in the operating characteristics can be directly attributed to Federal assistance?
 - What would have happened if funding was more (or less) than the level it was?
 - What, if any, uncertainties or barriers remain which might prevent the private sector from adopting the technology?
 - Design
 - Did the project follow an unduly rigid plan, or did it change to meet needs as new situations arose?
 - Were marketing efforts effective? How much of the target population has been reached?

- Results

- How closely do the accomplishments of this project match its original (or revised) objectives?
- What further role (if any) should the government play? Further work in this field? Develop spinoff technologies or new applications?

2.3.1.1 Checklists for Project Review

The following checklists suggest some of the major factors that the project manager and the committee may want to consider when reviewing each project. The items included in each checklist are expected to be appropriate for reviewing project Types II through IX, as well as Type I. Therefore, the guidelines that follow for each project type will always refer back to this set of checklists.

CHECKLIST NO. 1

REASONS WHY PRIVATE SECTOR MIGHT NOT DEVELOP
NEW TECHNOLOGIES THAT WOULD BE ECONOMIC

- High technical risk. _____
- High market risk. _____
- Long initial lead times before
projects will earn a return. _____
- Capital requirements too large
for firms or joint ventures. _____
- Benefits will accrue to many
parties other than those who
would provide the investments. _____
- Private sector might do so but
government would have economies
of scale or would only need to
do so once. _____
- Existing firms in industry appear
unwilling to promote competing
technologies. _____
- Existing firms in industry are
simply too lax or unduly skeptical
towards such innovations. _____
- Private sector might do so but
not soon enough. _____
- Private sector faces energy
prices that are temporarily
too low. _____
- The government intends to subsidize
the income of certain parties
as a means to assist poor groups. _____
- Other reasons. Explain. _____

CHECKLIST NO. 2

STEPS IN COMMERCIALIZATION OF NEW TECHNOLOGIES

- Conception of a new technology. _____
- Basic technical development. _____
- Practical or advanced technical development. _____
- Technical performance testing. _____
- Economic testing (payback determination). _____
- Market feasibility evaluation. _____
- Creation of consumer awareness. _____
- Communication of detailed information to consumers. _____
- Setting up institutions to produce, use, or assist the new technology. _____
- Obtaining feedback on market response. _____

CHECKLIST NO. 3

FACTORS THAT MIGHT AFFECT CONSUMER ACCEPTANCE

- Different needs in different regions. _____
- Different resources and objectives
of different consumer age groups. _____
- Durability of product. _____
- Ability of product to maintain
efficiency if not serviced often. _____
- Availability to mass market through
common marketing channels. _____
- Availability of parts and servicing. _____
- Safety. _____
- Size of initial purchase price. _____
- Ability of consumers to purchase
on credit. _____
- Product appearance (color, dimensions,
etc.) and quality. _____
- Whether consumers are aware of the
technology. _____
- Degree to which consumers have
reliable detailed information
on performance and economic
savings potential. _____
- Compatibility with other existing
equipment. _____
- Reviews by prominent consumer and
local experts or other opinion
makers. _____
- Other factors. Indicate. _____

CHECKLIST NO. -4

FACTORS EFFECTING THE COMMERCIALIZATION PROCESS

Proposed (or anticipated) regulatory constraints.	_____
Size of firms making up the industry.	_____
Trade association support (or the lack thereof).	_____
Existence of marketing and/or retail networks.	_____
Attitudes of electric and gas utility companies.	_____
Environmental constraints.	_____
Behavioral prejudices.	_____
Policies of banks and financial institutions.	_____

2.3.2 Type II - Research and Feasibility Studies of a Hardware Product

Milestone No. 1 - Completion of Background Research

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
 - Proposed work plan
- Issues to be considered by project manager and committee
 - Need
 - Why is project needed?
 - Why is DOE involvement necessary to fulfill objectives. (Why can't private sector do enough)? (See checklist No. 1.)
 - Are efforts duplicative of any in public or private sector? If so, are any competing technologies better?
 - Design
 - Has appropriate data been collected, and prepared in a form that satisfies its intended use?
 - Results
 - Have any different areas for research been identified?

Milestone No. 2 - Completion of Feasibility Studies (Completion of Project)

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
- Issues to be considered by project manager and committee
 - Need
 - Have studies identified this technology as important enough to warrant further development?
 - Design
 - What level of BCS involvement would be required to pursue a project that would develop, demonstrate and commercialize this technology? (See checklist No. 2.)
 - Results
 - Are results of studies accurate and in a form that is useful?

2.3.3 Type III - Hardware Demonstration and Commercialization

Milestone No. 1 - Completion of Demonstration

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
 - Proposed work plan
- Issues to be considered by project manager committee
 - Need
 - Do goals need to be redefined, in light of demonstration activity?
 - Why is DOE involvement necessary? (See checklist No. 1.)
 - Design
 - Have problems of consumer acceptance been considered? (See checklist No. 4.)
 - Has demonstration reduced uncertainty for the private sector by providing detailed, reliable information about the technology?
 - Results
 - How closely do the accomplishments of this project match its original or revised objectives?
 - What further role (if any) should the government play? Further work in this field? Develop spinoff technologies or new applications

Milestone No. 2 - End of Technology Transfer (Completion of Project)

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
- Issues to be considered by project manager and committee
 - Need
 - What improvements in the operating and cost characteristics can be directly attributed to Federal assistance?
 - What would have happened if funding was more (or less) than the level it was?
 - Design
 - Did the project follow an unduly rigid plan, or did it change to meet needs as new situations arose?
 - Were marketing efforts effective? How much of the target population has been reached?
 - Results
 - How closely do the accomplishments of this project match its original or revised objectives?
 - What further role (if any) should the government play? Further work in this field? Develop spinoff technologies or new applications?

2.3.4 Type IV - Technology Transfer (Hardware)

Milestone No. 1 - End of Technology Transfer (Completion of Project)

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
- Issues to be considered by project manager and committee
 - Need
 - Why is DOE involvement necessary?
(See checklist No. 1.)
 - What improvements in the operating and cost characteristics can be directly attributed to Federal assistance?
 - What would have happened if funding was more
(or less than the level it was?
 - Design
 - Were issues like consumer acceptance and institutional barriers considered?
(See checklist 3,4.)
 - Did the project follow an unduly rigid plan, or did it change to meet needs as new situations arose?
 - Were marketing efforts effective? How much of the target population has been reached?
 - Results
 - How closely do the accomplishments of this project match its original (or revised) objectives?
 - What further role (if any) should the government play? Further work in this field? Develop spinoff technologies on new applications?

2.3.5 Type V - Hardware Development, Demonstration and Commercialization

Milestone No. 1 - Completion of Product Development

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
 - Proposed work plan
- Issues to be considered by project manager and committee
 - Need
 - Why is project needed?
 - Why is DOE involvement necessary?
(Why can't private sector do enough?)
(See checklist No. 1.)
 - Are efforts duplicative of any in the public or private sector? If so, are any competing technologies better?
 - Design
 - Does design fulfill original (or revised) objectives?
 - Are steps of commercialization provided for? (See checklist No. 2.)
 - Are problems of consumer acceptance and commercialization addressed?
(See checklist No. 3.)
 - Results
 - Have there been any unanticipated side effects, which have become evident during development, that might reduce consumer appeal?

Milestone No. 2 - Completion of Demonstration

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
 - Proposed work plan
- Issues to be considered by project manager and committee
 - Need
 - Do goals need to be redefined, in light of demonstration activity?
 - Design
 - Has demonstration reduced uncertainty for the private sector by providing detailed, reliable information about the technology?
 - Have institutional arrangements been made in preparation for next phase?
(See checklist No. 4.)
 - How will issues like raw material availability, distribution and logistical considerations, packaging and service be handled?
 - Results
 - Was demonstration conducted in a manner that produced reliable results in a useful form?
 - Did demonstration closely simulate real conditions?

Milestone No. 3 - End of Technology Transfer (Completion of Project)

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems

- Issues to be considered by project manager and committee

- Need

- What improvements in the operating and cost characteristics can be directly attributed to Federal assistance?
- What would have happened if funding were more (or less) than the level it was?

- Design

- Did the project follow an unduly rigid plan, or did it change to meet needs as new situations arose?
- Were marketing efforts effective? How much of the target population has been reached?

- Results

- How closely do the accomplishments of this project match its original (or revised) objectives?
- What further role (if any) should the government play? Further work in this field? Develop spinoff technologies or new applications?

2.3.6 Type VI - Background Research

Milestone No. 1 - Completion of Study (End of Project)

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
- Issues to be considered by project manager and committee
 - Need
 - Why is DOE involvement necessary?
(See checklist No. 1.)
 - Design
 - Has information been gathered and presented in a useful manner?
 - Results
 - Is data (or information) reliable enough to be used as a basis for future studies, if desired?

2.3.7 Type VII - Design and Demonstration of Systems Comprised of Existing Technologies

Milestone No. 1 - Completion of Background Research

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
 - Proposed work plan
- Issues to be considered by project manager and committee
 - Need
 - Why is project needed?
 - Why is DOE involvement necessary? (See checklist No. 1.)
 - Are efforts duplicative of any in public or private sector?
 - Design
 - Does the project address the problem of consumer acceptance? (See checklist No. 3.)
 - Results
 - Have any significant barriers to development and commercialization been identified?
 - Have any different areas for research been identified?
 - Have institutional problems been identified that need to be taken account of? (See checklist No. 4.)

Milestone No. 2 - Completion of System Design

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
 - Proposed work plan
- Issues to be considered by project manager and committee
 - Need
 - Do goals need to be redefined?
 - Are other designs superior?
 - Design
 - Has target population shifted due to development activity?
 - Does design fulfill original (or revised) objectives?
 - Results
 - Have there been any unanticipated side effects, resulting from the development, that might reduce its consumer appeal?

Milestone No. 3 - Completion of Demonstration

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
 - Proposed work plan
- Issues to be considered by project manager and committee
 - Need
 - Do goals need to be redefined, in light of demonstration or activity?

- Design

- Has demonstration reduced uncertainty for the private sector by providing detailed, reliable information about the system?
- Have barriers to commercialization been reduced? Identify any that have.
- Have institutional arrangements been made in preparation for the next phase? (See checklist No. 4.)

- Results

- Was demonstration conducted in a manner that produced reliable results in a useful form?
- Did demonstration closely simulate real conditions?

Milestone No. 4 - End of Consumer Motivation (Completion of Project)

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
- Issues to be considered by project manager and committee
 - Need
 - What improvements in the operating and cost characteristics can be directly attributed to Federal assistance?
 - What would have happened if funding was more (or less) than the level it was?
 - Design
 - Did the project follow an unduly rigid plan, or did it change to meet needs as new situations arose?
 - Were marketing efforts effective? How much of the target population has been reached?

- Results

- How closely do the accomplishments of this project match its original (or revised) objectives?
- What further role (if any) should the government play? Further work in this field? Develop new applications?

2.3.8 Type VIII - Research Leading to the Development of Analytical Tools

Milestone No. 1 - Completion of Background Research

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
- Issues to be considered by project manager and committee
 - Need
 - Why is project needed?
 - Why is DOE involvement necessary to fulfill objectives? (Why can't private sector do enough)? (See checklist No. 1.)
 - Are efforts duplicative of any in public or private sector?
 - Design
 - Has information been gathered and presented in a useful manner?
 - Results
 - Is data reliable enough to serve as a basis for the next phase?

Milestone No. 2 - Development of Analytical Tools (End of Project)

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
- Issues to be considered by project manager and committee
 - Need
 - What would have happened if funding was more (or less) than the level it was?

- Design

- Have techniques been developed and presented in a way that is appropriate?

- Results

- Has the need for other tools been suggested by this project?

2.3.9 Type IX - Development of Regulations and/or Standards

Milestone No. 1 - Completion of Project

- Information to be supplied by performing contractor
 - Threshold system data update
 - Comments about progress and problems
- Issues to be considered by project manager and committee
 - Need
 - Why are standards needed?
 - Design
 - Have problems of implementation and institutional barriers been taken into account
 - Results
 - Have other areas of research or concern (need for regulation) been identified?

3. APPLICATION OF GUIDELINES

In order to demonstrate the effectiveness of this methodology for project administration and review, this section will describe the application of the guidelines to several typical BCS projects. These projects have been chosen so that the three basic developmental stages at which the methodology can be applied are represented; projects that have been completed and should be evaluated in retrospect, projects that are on-going and can be brought into the review system at the appropriate stage, and projects that are just being considered for funding and have not yet begun. The Water Heater Refit Kit is an example of a completed project, the Jolly Tiger Restaurant is a project that is on-going and not yet completed, and the Infrared Thermography Program is just beginning.

3.1 RESIDENTIAL WATER HEATER REFIT KIT

The Residential Water Heater Refit Kit project involved a contract with Johns-Manville Sales Corporation to demonstrate and market an inexpensive and easy to install kit for retrofitting insulation to hot water heaters. According to the typology described in this report, this project would be classified as Type III. Since this project has been completed, the evaluation would be carried out by using the criteria given for milestone number five (completion of project). The quantitative information gathered in order to perform the threshold analysis when the project was proposed has been updated in conjunction with the research done in order to write the case study found in Appendix B. Assuming that those numbers are valid, it

may be concluded that although the technology proved to be energy-effective and cost-efficient (with a payback period of from one to 2½ years, depending on fuel and other factors), the kit has had little success on the market. The reasons for this weak market penetration can be studied by applying the more qualitative criteria of the retrospective evaluation methodology to the final stage in this project's development.

The first issue, raised by the guidelines for Milestone 1 (see Section 2.3.1), namely the role of Federal assistance in the project's success (or failure) raises two questions: what improvements in the operating and cost characteristics can be attributed to Federal assistance; and what would have happened if funding were at a different level? The case study in Appendix B indicates that despite the fact that DOE's contract with Johns-Manville included mention of development, testing, and marketing of the kit, development and marketing efforts were paid for by Johns-Manville and were intended to take place anyway. It is also likely that Johns-Manville would have tested the kit without government funding. These questions, then, may be answered by saying that DOE's contribution to this project's progress has been small, but so has the level of funding (\$20,000).

The second issue raised by the methodology concerns the design of the project. The first question, which concerns the flexibility of the workplan may be answered affirmatively. The second question, however, points to the key problem in this project, namely the absence of marketing efforts. Referring to the case study again, it is apparent that Johns-Manville did not adequately study the market for the kit and the availability of new materials before undertaking its development. This weak link in the design of the Water-Heater Refit Kit project is an

example of the type of problem that will be checked for when the retrospective evaluation methodology is performed at each critical point during a project's development, especially the point at which it has been proposed and outlined.

Since Johns-Manville is hesitant about committing itself to the promotion of the kit, it is possible that DOE could play a significant role either by conducting (or funding) a study of how market penetration might be increased, or by handling the actual promotion of the project. These sorts of ideas about the government's further role are solicited in the third group of questions labelled "Results", in the evaluation methodology. In addition, there is a question that asks how closely the accomplishments of the project match its original (or revised) objectives. In this case, the goal of energy conservation has not been achieved to any significant degree, due to minimal consumer interest. The results of the case study lead one to the conclusion that the lack of consumer response (only 121,000 kits sold between Spring 1976 and January 1978) is due to the public's ignorance of the product's savings potential, and inadequate advertisement and availability of the kits.

3.2 ENERGY CONSERVATION IN RESTAURANTS

This on-going project has involved the design and construction of a Jolly Tiger Restaurant near Albany, New York by Sambo's, Inc. The goal is to test the energy conserving capability and economic feasibility of a number of technologies, including a refrigerator rack-dishwasher heat recovery system, an exhaust air heat recovery system, an automated light switch, a makeup air hood, insulation, and double-layered windows. A description of these systems, and some conclusions about their effectiveness are given in Appendix A.

The first step in evaluating this project would be to classify it into one of the nine categories defined earlier in this report. Because many of the technologies it involves are currently available, this project would fall into the Type VII category. Since this project is at the point where the demonstration has been completed, the criteria given for this critical point (Milestone No. 3, Section 2.3.1) will be applied.

The threshold system data has been updated, and the results indicate that for most combinations of systems the payback period is longer than five years. Only the refrigerator rack dishwasher heat recovery system alone would be cost-effective, with a payback period of about four years. Since most of the other systems were not analyzed separately, it is difficult to make valid assessments of their effectiveness. This weakness is one that will be emphasized in the evaluation of the design of the project.

The more qualitative part of the retrospective evaluation methodology begins by asking whether the goals of the project need to be redefined. In this case, the answer to this question would be yes because the study found that work practices are a key factor in energy use, and may in fact outweigh the impact of the technologies. This finding suggests that future work should include a study of work practices, and perhaps an attempt to revise training procedures in order to conserve energy.

The second issue raised in the methodology design effectiveness, is a key factor in this project. The fact that so many technologies were tested simultaneously caused the results to be less useful than they should have been, in light of the elaborate data collection system

employed. In fact, the case study concluded that many of the technologies tested are now obsolete, while others that are better and more applicable have not been considered.

Another weak link in the design of the project was the emphasis on public relations rather than practical market orientation. The only barrier to commercialization that has been reduced is public awareness; the public relations efforts did cause many of the technologies to be publicized.

This leads us to the last issue to be considered, that of the usefulness of the results of the demonstration. Although the demonstration did not give very credible results about any of the technologies, it did make the direction of the next phase, commercialization, more clear-cut. Suggestions for future work include offering financing to restaurant owners, and developing manuals to guide work practices.

3.3 NATIONAL INFRARED THERMOGRAPHY PROGRAM

The goal of this program is to survey approximately half of the nation's building stock using aerial infrared techniques to detect areas of potential heat loss. This data will then be disseminated to building owners and operators to stimulate them to reduce these energy losses through insulation and repair of their structures. DOE has undertaken the planning and implementation of this program at the national level, beginning its funding in 1978. Because the project utilizes a proven technology, it would be classified as a Type VII project, which includes the development and demonstration of a system, and the dissemination of its results.

Since the project is just being initiated on a national scale, the guidelines for evaluation at Milestone No. 1 are appropriate. The threshold screening has been performed, and results indicate that the procedure would be cost-effective, if it achieves its market penetration goals.

The issue of need has been addressed, and it is believed that Federal involvement is necessary to ensure a coordinated effort involving many states. Although smaller scale programs have been carried out in some states, nationwide implementation would occur very slowly without Federal support and guidance. Referring to Checklist No. 1, we conclude that the main reason that Federal involvement is necessary is that the private sector might invest in this program, but not quickly enough to achieve nationwide coverage.

The design of the program has begun. Two components have been identified: the actual survey of the buildings, and the motivation of consumer energy conservation investments. This second component is clearly the most difficult to develop. Presently, DOE is publishing an Aerial IR Users Manual which will introduce community leaders to the program. This question of consumer acceptance can be examined by using Checklist No. 3. Factors that need to be considered, according to this list, are consumer awareness, the degree to which consumers have reliable detailed information on performance and economic savings potential, and the variation of needs by region. These topics are being considered, and it is believed that the proposed marketing arrangement will be effective. Information dissemination centers will be a key contact point with the consumer, and have been found to be successful in similar projects that have been carried out at less extensive levels.

The preliminary studies have not uncovered any significant barriers to development and commercialization. The roles of each participant in the development and motivation activities require further definition. This need has been recognized, as has the need for clearly defining the interactions between participants, institutional problems, incentives, and uncertainties associated with the program. The first phase of the project will attempt to answer these questions, and prepare a detailed work plan for the rest of the program.

INTRODUCTION TO APPENDICES

These Appendices present evaluations of four projects funded by the Department of Energy. The four projects are: (1) a test and demonstration project for energy-saving technologies for restaurants, (2) a test project for household water heater insulation refit kits, (3) a handbook preparation project for energy conservation in several industries with small businesses, and (4) a training project for energy-efficiency building codes at the state level.

In general, the restaurant and water heater projects are "hardware" test or development projects and the small businesses and building codes projects are "educational" or information transfer projects. Each project, however, has a mix of characteristics and has been evaluated with a somewhat different approach.

APPENDIX A

ENERGY-CONSERVING SYSTEMS IN RESTAURANTS

A. 1 INTRODUCTION

The restaurant industry uses about one percent of all the energy consumed in the United States.^{1/} It consists of many different kinds of foodservice establishments -- commercial restaurants, fast-food restaurants, hotel restaurants, office cafeterias, ice cream stands, and others. The restaurant sector has been growing rapidly and will consume larger amounts of energy unless ways are developed for it to use energy more efficiently.

A. 2 PROJECT DESCRIPTION

In the project studied, the Department of Energy (DOE) has spent \$482,000 to fund a test and demonstration of several technologies that can use energy more efficiently in new restaurants.^{2/} The project was funded in response to a request from Elster's, Inc., an engineering firm that has been developing a number of energy-using and energy-saving technologies for the foodservice industry. The project involves partial government sponsorship for a test of the economics of several technologies. Elster's and a restaurant chain, Sambo's Restaurants Inc., invested an additional \$400,000 in the project.

A Jolly Tiger (Sambo's) coffee shop-type restaurant near Albany, New York, was fitted with a package of different technologies and monitored under actual operating conditions. The technologies have been in use for more than a year. Their performance has been

compared to the performance of normal foodservice technologies in a similar nearby Jolly Tiger restaurant and their own performance at the same restaurant when the energy-saving features are shut off for periods of time.

A group from the Atmospheric Sciences Research Center (ASRC) of the State University of New York, Albany, and Fleming Associates has managed and monitored the project. The group has issued an interim report and will issue a final economic assessment of the technologies in late 1978.

In addition to the project sponsored by DOE, two additional programs have been sponsored by New York State at the same site. The New York State programs include a slide exhibit about energy conservation for viewing by school children in an attached room and a planned solar hot water panel to be added on the restaurant's roof. The funds contributed by New York State for these items may total about \$180,000.^{3/}

A number of representatives from major foodservice companies have toured the site. They have reportedly expressed interest in possibly adopting some of the technologies if the payback results of the test prove attractive when the test has been concluded.

This evaluation is based upon interim energy consumption and payback information supplied by the Albany group.^{4/} It is based also upon conversations with members of the ASRC, Elster's Inc., trade association officials in the natural gas and restaurant industries, and others. In addition, a visit was made to the Jolly Tiger site.

The Jolly Tiger project was designed to test a number of different technologies even though it was not expected that all the technologies tested would prove economic or that any single restaurant would wish to adopt all the technologies used at the demonstration site.

Some of the technologies saved energy by avoiding needless energy use or heat loss. Others saved energy by recovering waste heat and re-using it. None of the systems required changes in normal restaurant operating practices or significant losses in convenience.

The main technologies tested in the project are the following:

- Exhaust air recovery system. This system recovers waste heat from cooking area exhaust air.
- Makeup air hood. The hood obtains fresh air from the outside to ventilate the cooking area instead of drawing upon air from the dining area. Air in the dining area has been heated or cooled and is thus too valuable to use in the kitchen, where air continually must be exhausted to the outside.
- Dishwasher heat recovery units. These recover waste heat from hot water as it leaves the dishwasher.
- Refrigeration rack heat recovery unit. This unit recovers waste heat emitted by compressors used in the refrigeration and freezer systems.
- Automatic light switch. This switch turn lights on or off according to incident sunlight conditions.
- Thermopaned windows. Thermopaned windows differ from normal windows in that they have two layers of glass separated by a layer of air that reduces heat transfer.
- Economizer. This unit improves the efficiency of cooling units by reducing the temperature of the air in the area into which cooling compressors discharge waste heat.

In addition, the building was designed with better wall insulation and less window surface area to reduce normal heating and cooling losses. Certain other technologies also were used.

Several of the technologies that used hot water as a medium for transporting recovered heat were interconnected by a network of water pipes and large storage tanks. Recovered waste heat was used to pre-heat water for the dishwasher and to help run a set of heat pumps on the roof for indoor space heating and cooling. Heat pumps are considered standard items for many restaurants constructed in recent years.

The technologies tested in the Jolly Tiger project, in general, are intended for new restaurants only. Retrofit options for existing restaurants were not addressed by the project.

A. 3 TEST RESULTS

The payback analysis in this evaluation is based upon the payback calculations made by the Albany group in the interim report cited earlier. The interim report indicated energy savings and payback calculations only for combinations of technologies, rather than for individual technologies. Assessments given here for individual technologies are thus approximate and are based upon comparative assessments of combinations that relied upon a certain technology and combinations that did not include the technology. The payback estimates are based upon energy consumption experience at an interim point in the test. It was reported by the ASRC group that energy savings for some systems have increased since the interim report was

prepared because equipment failures have been less frequent. The payback as determined reflects the capital costs for the technologies as if they were mass produced rather than those actually experienced for the project.

For a technology to be demonstrated as marketable, it would need a payback period no longer than five years. In general, firms in the private sector would be fairly interested in technologies offering paybacks between two and three years in length. They might be marginally interested in technologies offering paybacks between four and five years in length. Technologies offering payback periods longer than five years probably would not lead to interest by firms since firms probably could find paybacks of five years or less from other investments.

The actual situation for any particular firm might vary. Each firm has an investment strategy that reflects its cash flow situation, portfolio of investment options, and management strategy. The restaurant industry in particular appears to be highly growth-oriented. Investments that increase the number of scale outlets appear to be highly favored over investments that improve efficiency at existing outlets, at least in the case of the large restaurant chains.

In light of these criteria, the test results were mixed. Of eleven combinations of technologies, only two showed payback periods of five years or less. The two combinations were similar -- relying upon the refrigeration rack heat recovery unit and an economizer for one and a combination of these two plus the dishwasher heat recovery unit for the

other. No combination of technologies in the interim report showed a payback period shorter than four years in the interim report, even if expensive electricity was used as the source of energy.

Other systems had less attractive or ambiguous test results. Most of the combinations of technologies showed payback periods longer than five years. Some combinations showed payback periods longer than 20 years. There are, however, a number of additional considerations.

The exhaust air heat recovery system showed a payback period of as low as seven years in one combination. This suggests that it might be marginally economic in special applications where better use can be made of the hot water that it produces. Apparently, the system sometimes produces more hot water than a Jolly Tiger type restaurant can use, and would be better suited for hotel restaurant applications, where the hot water needs of hotel rooms would give the system a payback period shorter than seven years.

A number of other technologies might be economic but were not assessable because the test report showed results for technologies in combinations rather than showing the performance of technologies individually. The makeup air hood is already being installed in many new restaurants to save energy. Insulation is already known and, in fact, is not assessed in any of the interim report's test results even though it was included at the test site. Each of these technologies, it may be noted further, is already in use in some restaurants or other places.

The automatic light swirrh was found to produce an unwanted side effect. By turning off the restaurant's indoor lights during sunny days, the device allegedly made the restaurant appear closed to passers-by and

reduced the number of customers. Elster's, Inc., however, does not agree with this finding of the test and apparently is marketing such technologies anyway.^{5/}

The test produced an unexpected discovery on the importance of work practices in determining energy consumption at restaurants. While it already was known that work practices -- such as operating all grills during slow business periods, leaving lights on inside freezers and so on -- effect energy use, it was not realized how significant this relationship could be until this test was made. During the test, it was found that energy use fluctuated and occasionally was greater in the restaurant with energy-saving technologies than it was in the restaurant with normal equipment. The variations in energy use were traced to differences in work practices and personnel and underline the importance not only of technology but also of people and work methods.

In summary, the test showed that one set of technologies was marginally economic, that another system might be economic in special applications, and that work practices are very important. Some other technologies, could not be assessed because the results were given only for combinations of technologies rather than individual technologies and because some technologies were not new to the test. The results are summarized in Table A-1.

TABLE A-1

SUMMARY OF PAYBACK PERIODS BASED ON INTERIM RESULTS IN TEST PROJECT

<u>Technologies</u>	<u>Apparent Result from Test</u>
Refrigeration rack, economizer, and dishwasher heat recovery system	4 to 5 years, electricity as fuel. Longer if natural gas as fuel.
Exhaust air recovery system	7 years, electricity as fuel. Possibly shorter payback period in special applications.
Automatic light switch	Payback not assessed. Adverse side effects seen.
Makeup air hood	Results not determinable from interim report data.
Insulation, thermo-paned windows	Results not determinable from interim report data.

SOURCE: Based upon data presented in An Energy and Economic Analysis of the Jolly Tiger Restaurant at Colonie, New York, William S. Fleming, et al., 1977.

A. 4 PROJECT EVALUATION

For a number of reasons, it is not clear that the Jolly Tiger project will lead to the actual adoption of many energy-saving technologies in the restaurant industry. As will be shown below, the nature of the test's findings is more suitable for informing DOE than for motivating industry to adopt technologies.

First, by combining the technologies into eleven different combinations, the project provided payback information for certain sets of technologies but not for technologies individually. Combining the technologies would have been fine if that were the only way that restaurants could adopt them. In fact, however, the technologies may be adopted separately and probably would be adopted separately, if at all, because restaurants wish to hold capital costs to a minimum and would prefer to purchase one or two items rather than a whole set.^{6/} The test results are not in a directly useful form for the industry. Second, the test presented performance results in the form of simulations rather than direct results. It would have been more credible to present direct operating data so that potential users of the technology would not have to trust the accuracy of the simulation modeling system. A number of potential users might not be willing to place much trust in computer generated results.

Third, the test findings differ substantially from the information obtained from Elster's on the economics of energy-saving equipment. The technologies showed very poor payback potential in the test. The best combination would yield a payback in four years. Elster's, on the other hand, markets a number of technologies that it claims would give much shorter paybacks -- in some cases in just several months. Some of these are the same as those used in the project. The specifications in Table A-2 may be compared with those shown for

TABLE A-2

ELSTER'S CURRENT INVENTORY OF ENERGY SAVING TECHNOLOGIES

<u>Technology</u>	<u>Approximate Capital Cost</u>	<u>Approximate Payback Period</u>	<u>Applicability In Retrofits</u>	<u>Descriptions or Comments</u>
Makeup air hood	\$500	3-6 Months	No	LTEC hood.
Refrigeration rack with environmental enclosure	\$300	3-6 Months	Yes	30 percent more Btu per Watt.
Economizer of hydro- capacity booster	\$450	2-18 Months	Yes	Senses exterior temperature and uses outside air when cool; pre-cooler for air conditioners.
Automatic photocell light switch	\$20	Not Available	Yes	
Dishwasher hood	\$300-400	Not Available	Yes	Recirculating hood. Collects steam and exhausts only one fourth the air normally ex- hausted from dishwasher.
Electronic energy management system	\$6,000-9,000	1-2 Years	Yes	Automatically turns energy- using equipment off when not needed.
Spring-wound light switches	Not Available	Not Available	Yes	Insures that lights in freezer are turned off after use.
Relamping	Not Available	Not Available	Yes	Redoing lighting arrangement.
Thermopaned windows	Not Available	Not Available	Yes	
Adjustments to seals, equipment locations	Not Available	Not Available	Yes	Maintenance and redesign.
Efficient equipment	Not Available	Not Available	Yes	Replacing inefficient devices with more efficient ones.

SOURCE: Elster's Inc.^{8/} All data are approximate.

the test project earlier in Table A-1. It may be further noted that the combination shown by the test to have the best payback would have an incremental capital cost of \$11,000. This is much higher than the capital costs indicated by Elster's in Table A-2. The other technologies, moreover, are suitable for installation in existing restaurants in many cases.^{8/}

For example, if one accepted the data from Elster's a makeup air hood offers an excellent payback for restaurant. In the Jolly Tiger test, however, it shows up in combinations having payback periods of at least seven years. This points out the dangers of combining technologies in that a potentially excellent technology might be shown uneconomic because it was combined with poor technologies - and at the same time might make the poor technologies seem like better investments than they are. Whether the disparities have arisen from combining the technologies, inaccuracies in the test project, unique circumstances in the test project, or possible inaccuracies in Elster's data, the consequence is to lessen the value of the test in its main purpose - to provide reliable information to guide the private sector in making energy conservation investment decisions.

Hence, while the test may lead to some adoption of energy-saving technologies in a few cases, it was decided to not try to quantify these savings because of the difficulty in drawing a link between the test's results and likely investment decisions by firms in the overall restaurant industry. The test results are not very persuasive in light of the problems identified.

The project has another dimension that raises an interesting point. Besides being a test project, it was also a demonstration project. To date, the project has reportedly elicited some interest by major restaurant firms in adopting some energy-conserving technologies. Some of the firms are reportedly in a wait-and-see mode regarding the final outcome of the testing.^{9/}

The responses deserve further scrutiny, however. First, they appear to be the result simply of the demonstration function of the project, not of the test function. Simply displaying energy-saving technologies at work in a restaurant appears to have sparked some interest quite aside from demonstration of their energy-saving value. This is analogous to displaying equipment in a marketing showroom or trade fair. Hopefully, the interest will not be lessened when the payback results become available to the firms. Second, the response of the industry to date really can be considered only anecdotal - i.e., some firms expressed some interest in some of the technologies. It does not indicate an impact on the mass market, unless this limited adoption by major companies leads to an imitation effect by the rest of the industry. In light of the test's payback results, though, it is doubtful that there will be much adoption by these companies.

Thus, the project largely amounts to a study to help inform DOE about the general economics of certain technologies, rather than a project that would directly influence the restaurant industry. This leads into the question of what DOE should do from here.

Given the fact that Elster's already has an array of energy-saving technologies that are cheaper and offer shorter paybacks than the technologies tested in the Jolly Tiger, it would be helpful to analyze

the experience that Elster's has encountered. According to Gerald Speen of Elster's, even with cheaper and more effective technologies whose paybacks are generally known to major restaurant chains there has been only limited response by the industry.^{10/} Mr. Speen's comments indicated that the main barrier to commercialization of energy-saving technologies in the restaurant industry is the unwillingness of firms in the industry to purchase equipment that would raise the capital requirements for setting up sales outlets. The firms are apparently highly sales-oriented and allocate all available capital into building as many new outlets as possible to boost their sales.

This implies that further test projects would be largely unnecessary and unproductive. Demonstration projects might be helpful but would still encounter the financial barrier against adopting new technologies that increase capital costs. There would be three options for possible further work for DOE in this context, aside from the option of doing nothing.

The first option would be an educational campaign directed at the management of the restaurant industry to try to lessen the unwillingness of firms to invest in energy-conserving technologies. An appropriate medium for doing this might be seminars hosted at annual trade fairs and conventions or direct contacts with key officials in the major firms. Whether this would succeed or not is unpredictable. Activities of this nature do not have a reputation for success in fields like price setting or labor bargaining, and might or might not succeed in this instance. Rather, the case for energy conservation is a rational, profit-oriented one and may stand a better chance of gaining acceptance.

The second option would be to refocus efforts upon work practices. In 1977, the Federal Energy Administration published a handbook entitled Guide to Energy Conservation for Food Service. An official at the National Restaurant Association indicated that the main response by the industry to energy conservation to date has been to change management rules to encourage better work practices that save energy. (The other response, he noted, was to adopt the makeup air hood and redesign cooking areas to draw upon less dining area air.)^{11/}

Apparently, work practices require no increase in capital requirements for sales outlets and therefore are quite willingly adopted by restaurants. A major drawback to trying to address work practices, however, is the high rate of labor turnover among restaurant workers. According to a recent article in the Wall Street Journal, an editor of Restaurant News stated that turnover among restaurant workers was an estimated 35 percent each year.^{12/} With high labor turnover, there would be a continual need for retraining regarding work practices. Perhaps DOE could prepare a simple pamphlet for distribution to (or purchase by) restaurants for employees to indicate simple steps to save energy. Since one finding of the Jolly Tiger project was that work practices can outweigh technologies, some program appears warranted.

It may be noted also that Elster's has an automatic system that shuts off energy-using devices unless manually overridden. This is an alternative approach to improving work practices. Apparently, its cost would be about \$6,000 to \$9,000 for retrofitting into an existing restaurant. The cost might be less in a new restaurant.^{13/}

Finally, there could be a project to test the importance of financial barriers and the efficacy of possible approaches to reducing these

barriers. A possible program is to provide loan guarantees for restaurants to purchase specific energy-saving technologies. Under such a program, DOE would guarantee the loans obtained from banks for purchasing specific equipment. The terms for repayment of the loans would be similar to the estimated payback periods for the equipment and the amounts guaranteed would be equal only to the incremental cost of the energy-efficient equipment compared to normal equipment. Standard interest rates would be used but the loan guarantees would enable greater access to credit than otherwise possible. In effect, DOE would allow firms to obtain more efficient equipment without having to divert any of their normal capital from the desired purposes, except to the extent that firms might be unwilling to incur even guaranteed debt.

Setting up such a program would involve: (1) determining which technologies to specify, (2) determining how much of a guarantee should be allowed for each technology and what length of repayment period should be allowed in each case, (3) determining how large a reserve fund DOE would need to set aside for a pilot program to cover possible loan guarantees in the event of default, (4) building in a feedback mechanism to determine the number of participants that use the program, and (5) publicizing the program among the industry to test the reaction of as many firms as possible.

One would need to select technologies that offer short paybacks and which are not at present eliciting much industry reaction (so as not to guarantee the financing of technologies like the makeup air hood that are being adopted anyway). A good technology to back might be the automatic energy management system that Elster's indicates would cost less than \$10,000 to install in new or retrofit restaurants, and which

would address the work practices problem at the same time.^{14/} Or, if a wide range of technologies were allowed to qualify for the loan guarantees, this might allow the technologies to come into greater use and thereby break down the current industry reluctance to recognize the value of these technologies.

A. 5 SUMMARY AND CONCLUSION

The Jolly Tiger project appears to have contributed some findings on the value of energy-saving equipment but does not appear to have produced information suitable for promoting the adoption of energy-saving technologies in the mass market. This conclusion stems from the fact that results were shown for combinations of technologies that might not be similar to the choices facing firms, the payback results shown in the interim report were not very attractive, the test findings apparently conflict with information supplied by Elster's or lead to confusion, and financial barriers involving restaurant industry investment practices may inhibit the impact of any test project.

For follow on work in the restaurant industry, at least three options are possible for DOE. DOE could try to persuade executives in the major restaurant firms to treat paybacks from energy-saving investments at a parity with paybacks from more conventional sales-maximizing investments. Alternatively, DOE could renew its efforts in the area of encouraging more efficient work practices, requiring no investment by industry. Finally, DOE could experiment with loan guarantees to test the importance of financial arrangements in the commercialization of energy-saving technologies. Or, a combination of these approaches may be taken.

In light of the substantial amount of energy being used by the restaurant industry and the dearth of measures being taken by restaurants to date to conserve energy, this field might warrant additional measures or projects to follow up on the Jolly Tiger project.

FOOTNOTES

1. Energy Research and Development Administration, Energy Conserving Systems In Restaurants, (pamphlet), Washington, D.C.
2. William S. Fleming, et.al., An Energy and Economic Analysis of the Jolly Tiger Restaurant at Colonie, New York, 1977.
3. This figure is based upon a conversation with members of the ASRC and is only a preliminary estimate. The actual amount is not yet determined.
4. Fleming.
5. Private communication by telephone between Gerald Speen of Elster's Inc. and John Viola of Energy and Environmental Analysis, Inc.
6. Ibid.
7. Ibid.
8. Ibid
9. Based upon private communications between ASRC staff and John Viola in a visit to the site.
10. Speen-Viola communication.
11. Private communication by telephone between Andrew Poledor of the National Restaurant Association, Chicago, and John Viola of Energy and Environmental Analysis, Inc.
12. "Huge Central Kitchens Help Restaurant Firms Keep Food Cost Down," Wall Street Journal, July 13, 1978, page 1.
13. Speen-Viola communication.
14. Ibid.

APPENDIX B

HOUSEHOLD WATER HEATER INSULATION REFIT KITS

B. 1 INTRODUCTION

Water heating is the second greatest source of residential energy consumption in the United States.^{1/} Water heaters use about three to four percent^{2/} of the energy annually expended in this country, or about 2.8×10^{15} Btu/year.^{3/}

Between 15 and 21 percent of this energy goes to heat loss during storage.^{4/} Thus, the application of additional insulation to the outside of the hot water storage tank should prevent most of this energy waste, often referred to as standby or jacket loss.

B. 2 PROJECT DESCRIPTION

In the project studied, Johns-Manville Sales Corporation, in conjunction with the Department of Energy (DOE), was to develop, test, and market an inexpensive kit for retrofitting insulation to hot water heaters that could be easily installed by the consumer.^{5/} DOE's contribution to this project was \$30,000 for testing.

This report will present some preliminary conclusions about the effectiveness of the kit in saving energy and money, the success of the project overall, and the impact of DOE's involvement.

B. 3 ENERGY AND COST SAVINGS OF THE KIT

Retrofitting insulation proved to be both energy effective and cost efficient. Tests were performed by three different labs on the energy

savings due to the added insulation. Table B-1 presents the daily and annual energy savings of added insulation. The tests were performed with different thicknesses of insulation and at different temperatures, but the results have been standardized in the table for the sake of comparison.

The savings in the table, though they may serve as rough guidelines, are not universally applicable. In practice, savings vary widely according to the following factors:

- Size of tank
- Efficiency and type (gas or electric) of water heater
- Ambient temperature
- Temperature to which the water is heated (120-160°F)
- Location of water heater (is it in a heated area of the house?)

Thus, for example, a small water heater located in the kitchen in a house in Maine would save at most about a third of the amount shown in Table B-1 since the heat lost during the heating season would not really be lost, but would serve to heat the room so that, for two thirds of the year, any savings resulting from insulation would be illusory. On the other hand, a house in Florida with a large inefficient water heater might save up to 1¼ times the amount estimated since heat given off by the water heater in an air conditioned house is not only lost from the water, but also adds to the air conditioning load.^{6/} From these examples, it is clear that, although the estimated savings may be valid for a typical house, the kit is not equally beneficial for each consumer.

Cost savings will vary even more widely than energy savings, depending both on regional fuel prices and on the energy savings of each consumer.

TABLE B-1
TYPICAL ENERGY SAVINGS^{a/}

<u>Fuel/lab</u>	<u>Tank Size (gals)</u>	<u>Daily Standby without Insulation (Btu's)</u>	<u>Daily Standby with Insulation (Btu's)</u>	<u>Percent Saved of Stand^{b/} by Energy</u>	<u>Annual Savings (10⁶ Btu's)</u>
Electric					
Johns- Manville ^{c/}	40	11500	8300	28	1.2
Johns- Manville	50	13500	4400	30	1.5
ORNL ^{d/}	66	17400	12700	27	1.7
ADL ^{e/}	42	14100	10200	28	1.5
Gas					
Johns- Manville	40850	35500	24700	30	4.0
ORNL	50	33100	24700	25	3.1

- a/ In each case conditions have been linearly corrected to the equivalent of 1½" of insulation, and a temperature differential of 70°F (ambient temp: 70°F). A similar comparison was done by Oak Ridge National Laboratory, but this did not take into account temperature differential. Still, the results are in general agreement.
- b/ Standby energy is the energy used to keep the water at a certain temp, not the energy to heat incoming cold water.
- c/ Johns-Manville, pp. 32-37; 40-43; 51.
- d/ E.E. Spann and G.G. Slaughter, Oak Ridge National Laboratory, An Efficiency Evaluation and Consumer Economic Analysis of Domestic Water Heaters prepared by ERDA and FEA, March 1977, pp. 21, 40, and 43, corrected from 3½" insulation and 130° or 150°F water temperature.
- e/ Arthur D. Little, p. 240, corrected from 2½" insulation and to 70°F temperature differential.

The kits cost from \$15 to \$23 retail and the price is expected to remain stable in the near future. Installation should take between 30 and 90 minutes, adding perhaps \$5 to the real cost of the kit depending on how the consumer values that time.

The average payback period for insulating an electric water heater ranges from one to 1½ years, and for a gas heater from two to six years. This range is due principally to the variation in fuel prices. Consumer Reports also did an estimate of cost savings resulting from the use of the kit and found that on an electric water heater the payback would be around one year, using electric rates of 5¢/kWh (\$14.65/10⁶ Btu), while on a gas heater the payback would be about 2½ years, given a gas rate of 25¢/100 ft³ (\$2.43/10⁶ Btu). Consumer Reports cautioned, however, that their tests were performed on inefficient water heaters and did not take into account the possibility of having the water heater located in a heated area.

The large variation in payback periods for gas and electric water heaters is due to the price differential, since in fact energy savings are greater for gas than for electric heaters (eight to ten percent overall for gas; five to six percent for electric). If gas prices are de-regulated, the payback will become substantially shorter.

B. 4 OVERALL SUCCESS OF THE PROJECT

Despite its attractive cost and energy savings, the kit has had little success on the market. There are around 58 million residential water heaters in the United States. Around 72 percent of these are gas fueled, but the proportion of electric water heaters is rising. Annual sales average about 5.3 million units, or nine percent of the total water heater population. About 45 percent of these are electric, 55 percent are gas. The life cycle of a water heater is estimated at about seven to 12 years.

If the kits were to achieve 100 percent market penetration, annual energy savings would total around 2.15×10^8 million Btu, on an overall savings of about 7.7 percent.

Until now, however, market penetration of the Johns-Manville kits has been weak. They have sold only around 121,000 kits between Spring 1976 and January 1978. Although they predict a slight rise in sales later this year, water heater kits are a very minor portion of their sales, and they have not expended much effort on increasing the distribution of the kits. The market penetration that has been achieved has been due principally to the advertising efforts of two distributors: Hechinger's in Washington, D.C., and Southern California Gas in Los Angeles.

There are a number of other companies involved in the manufacture and distribution of water heater insulation kits besides Johns-Manville. Heleron Corporation, which has limited its marketing efforts to the Northwest and part of California, has sold between 8,000 and 10,000 kits since December 1976, and plans to step up its distribution campaign. This company manufactures two different kits. The first type is $1\frac{1}{2}$ inches thick and the second is three inches thick. Owens-Corning also manufactures two different kit sizes, one for single family unit water heaters and a larger one for multi-unit water heaters.

Distribution of the kits should be fairly rapid, since, under the Energy Policy and Conservation Act of 1975, water heaters produced after 1980 will be required to have adequate insulation built in. Additional insulation will have at best about one-third the impact it has now.

The kit will probably still be cost effective, at least for electric water heaters, but it will not be nearly as beneficial to the consumer as now.

One promising method of selling the kits is through the utility companies. Johns-Manville proposed this in their report to ERDA, but apparently only followed through with one utility. Their lack of success with other utility companies may have been due in part to a lack of effort and in part to their unwillingness to sell the kit in small quantities and at low wholesale prices. Pacific Gas and Electric sold around 3250 kits as a result of only one advertising mailing. Their mailing program is temporarily stopped pending resolution of an order by the California Utilities Commission to gratuitously install insulation blankets on all water heaters in homes meeting R-19 insulation standards. If the order is not revoked, it will require the insulation of approximately 1,000,000 water heaters in Pacific Gas and Electric's district alone, and thus will on a statewide basis, constitute a major escalation in the conservation impact of water heater retrofitted insulation. There is, however, considerable room for improvement in the distribution of the kits without regulatory action.

B. 5 THE ROLE OF DOE

Government participation in this project has been of minor importance until now, but there is potential for significant Federal impact in the future. The specific contribution of the government to this project was a contract with Johns-Manville for the testing of the kit. Although the contract included mention of the development and marketing of the kit, those two functions were actually paid for by Johns-Manville and were intended to take place anyway. In fact, Johns-Manville later

backed out of the obligation to market the kit should it prove unsuccessful or compete with their other products.

Since it is more than likely that Johns-Manville would have tested the kit without the government's funding and since a number of other organizations also tested the value of insulating water heaters (some independently, some not), DOE's contribution to date is minor, both in terms of funding and results.

The success of the project now depends on the extent to which the public can be persuaded to adopt the kit. The consumer must be made aware of the savings value of the kit and the kit must be made easily available before it can effect significant conservation on a national scale.

One of the most successful avenues of distribution has been through the utilities and, to a certain extent, through certain large homeowner oriented retail outlets such as Hechingers and K-Mart. The utilities in particular offer a number of interesting strategies for getting the kits to the consumers. Two examples are the idea of offering customized energy and cost conservation suggestions through the billing system, and the idea of financing conservation investments through the billing system. Under the first program, the consumer would fill out a questionnaire sent to him with his bill, which the utility could then analyze and from which it could suggest the most lucrative and effective conservation measures for the homeowner to take. Under the second program, the consumer could pay for certain conservation measures (such as the insulation kits) either fully or partially through his bills in monthly installments, by continuing to pay the amount he would have paid without applying conservation techniques until the investment is paid off.

These and other possibilities might be rewarding for the government to investigate and possibly promote. This is where government involvement might make a substantial difference, particularly since time is of the essence in the adoption of the kits. Eventually, if gas prices rise, the private sector probably will expend greater effort in promoting the kits. But at the moment, private industry seems reluctant to aggressively promote water heater insulation. DOE's experience in this field gained in this project so far could be useful in such an endeavor.

B. 6 SUMMARY AND CONCLUSIONS

The retrofitted insulation of water heaters has obvious energy conservation potential. The payback on an insulation kit is short (one to 1½ years) for electric water heaters, and acceptable (two to six years) for gas heaters. If gas is deregulated in the near future, the payback on the insulation of gas water heaters is likely to become more attractive as fuel prices rise.

Unfortunately, however, consumer interest in the kit has been minimal to date and, therefore, little actual conservation has been achieved. The lack of consumer response probably does not lie in opposition to the idea, but rather in ignorance of the savings potential and, generally, in the inadequate advertisement and availability of the kits.

The government's contribution to the project has had little impact, but has also cost very little. The success of the project in achieving substantial energy savings now hinges on the degree to which the kit is adopted by the general population in the next few years. After that, legislative requirements affecting water heaters sold after 1980 will

increase built-in insulation and decrease the need for the kit. The private sector seems hesitant about committing many resources to the promotion of the kit, and it is in this area that there is a real possibility for a significant government contribution in the form of the study of how market penetration might be increased, or the actual promotion of retrofitted water heater insulation, or both.

The unsatisfactory market penetration is due to a variety of factors. First and probably foremost is ironically the extent to which the insulation market is booming. Insulation sales in the last year were so high that there was a shortage of fiberglass. Naturally, the insulation companies, including Johns-Manville, wanted to concentrate their efforts on the most lucrative market, which was definitely not the water heater refit kit.

Second, the use of plain R-19 batting to insulate electric water heaters is just as effective, almost as simple, and about half as expensive as the refit kit. At least one utility has been advising its customers to use this method rather than a kit.

Third, in California, which is probably the state that has been most responsive to the retrofitting of water heater insulation, the State Utilities Commission has ordered the utilities to install water heater insulation for free on houses meeting R-19 insulation standards. The utilities are contending the order, meanwhile the sale of kits has suffered, since no consumer wants to pay \$20 for a kit if he may get it for free, while at the same time the utilities cannot justifiably try to sell the kits.

FOOTNOTES

1. Stanford Research Institute, Patterns of Energy Consumption in the United States, Washington, D.C.
2. Ibid., p. 16; Johns-Manville Sales Corporation, Insulation Refit Kit for Domestic Water Heaters, prepared for ERDA, March 1977, p. 5; Arthur D. Little, Study of Energy Savings Options for Refrigerator and Water Heaters, prepared for FEA, May 1976, p. 4.
3. ADL, p. 4, this figure is based on primary energy usage, and is estimated at 10 percent accuracy.
4. Johns-Manville, p. 5; ADL, pp. 176-177, 203.
5. Johns-Manville, pp. 7-12.
6. Johns-Manville, pp. 77-78 has a similar example, but the savings in the Maine house are still considerable, since they postulate an electric water heater in a gas heated house, and since gas is a cheaper fuel, the consumer will save money, if not energy, by installing the kit. These examples must not be taken to mean that energy savings due to the kit are basically regional: a water heater in a house in Maine that is located in the basement will probably save more energy than a comparable water heater in Florida, since the basement in Maine is likely to be cooler than the basement in Florida. Since the five variables are independent, it is difficult to identify any simple correlations.

APPENDIX C

ENERGY CONSERVATION IN SMALL BUSINESSES

C. 1 INTRODUCTION

The project studied is intended to promote energy conservation in eight small business sectors. In each case, the educational medium used consists of a handbook and a series of workshops to supplement the information contained in the handbook.

Mariscal and Company, with some subcontracting to Xenergy, Inc., was responsible for developing both the handbooks and training programs on how to conduct the workshops.

The project has been in operation only about a year (the first handbook came out in February 1977 and the last is not yet published) and information on actual adoption of conservation measures and resultant savings is not yet available. Therefore, any attempt at a retrospective, or even a quantitative, midpoint evaluation would be somewhat premature.

This report will instead:

- Describe the course of the project to date
- Make some general observations on
 - the success of the project
 - the potential for broadened application
 - the value of government involvement in the project
- Conclude with some recommendations for further study

C. 2 PROJECT DESCRIPTION

The eight participating businesses and their respective trade associations, in order of handbook distribution, are:

- Laundry and Drycleaning . . . International Fabricare Institute
- Apartment Management Institute of Real Estate Management
- Commercial Printing Printing Industries of America
- Auto Repair Shops Automotive Service Councils, Inc.
- Gasoline Service Stations . . National Congress of Petroleum Retailers
- Retailing American Retail Federation
- Automobile Dealerships National Automobile Dealers Association
- Florists and Greenhouses . . . Society of American Florists and Ornamental Horticulturists

Each of these sectors is made up of small individual firms. With the possible exception of retailing, a majority of the firms in each sector have fewer than twenty employees.^{1/} Most of these firms cannot risk large capital outlays or long payback periods. In fact, several sectors are having economic difficulties. For example, in the non-industrial laundering and dry-cleaning sector, the number of firms is decreasing; in apartment management, the growth rate is down, and in petroleum retailing the sector is just recovering from a major setback.^{2/} The reluctance of these businesses to make large or risky investments was a major factor in selecting strategies with relatively low capital expense.

The Residential Energy Efficiency Program is the largest single measure in Nebraska, with a projected 1980 energy savings of 14 TBtu or 40 percent of the State goal. The conservation plan outlined many sub-elements for the measure including infra-red aerial thermography, low income weatherization assistance, experimental utility activities, and residential audits. The Nebraska Energy Office (NEO) projected that these activities would stimulate 75 percent of all homeowners to adjust their thermostats, 60 percent to caulk or weatherstrip, and 47 percent to install storm windows and attic insulation.

Although the conservation plan does not identify the energy savings for each subelement, the evaluation team believes that most of the SECP effort and TBtu savings is based upon the residential audits. The Nebraska gas utilities have just begun a thermography program which may ultimately extend to 30 municipalities, but direct NEO involvement in this and other utility programs appears quite minimal. The plans in other sample States indicate that low income weatherization is never a major energy saver due to the limited number of homes reached by the program. Because of severe problems in recruiting and keeping CETA workers, The DOE weatherization in Nebraska reached only 650 homes by June 1978. Although the NEO staff hoped to oversee the weatherization of 500 homes per month, it appears the rate during the start-up phase will be markedly lower. The only residential subelement supported by SECP funds that could stimulate the high conservation participation rates outlined in the plan are the audits.

All subelements of the entire residential program are assigned to a single member of NEO. The low income weatherization program consumes 50 percent of the person's time. Other miscellaneous duties reduce the total time devoted to residential audits to 12 hours per week. Although the conservation plan called for a second full-time specialist to be hired in July 1978, as of September 1978 only one person was assigned to the program.

Nebraska was one of 12 States funded by the FEA's pilot Home Energy Savers Program in the winter of 1976-1977. Part of the \$100,000 grant was used for a State-specific energy film, local informational meetings, and answering homeowner inquiries. Distribution of audit materials during the HESP was substantial, in excess of 230,000 pieces. However, an official in the NEO expressed grave doubts about the effectiveness of the Class C materials; declaring that "No more than 100 people could have filled out the HESP workbook."

In light of the presumed bad response to Class C audits, the NEO intends to devote more time and money to the Class B computer assisted audits. Two such programs are presently underway - one using AGNET, a five State network of agricultural extension services reaching homeowners through extension agents, and a private contractor's audit program. At the time of the evaluation visit, the latter system had been tested in a door to door campaign in three cities with disappointing results. Given the relative importance of the residential program to the Nebraska energy savings goal, and the dramatic assumptions of homeowner behavior change, a strong evaluation was in order to determine if the program was progressing successfully. However, the residential specialist estimated less than one percent of the program effort was spent on evaluation activities, noting that no additional evaluation was planned by NEO management. The SECP Office did expect to receive some data on insulation sales from Owens-Corning but this data would not include sales of competing insulation, or indicate homeowner compliance in other weatherization activities.

The lack of staff dedicated to the residential programs and the tepid public response to both Class C and B audits raises questions about the energy savings that will result from this program. The NEO assumptions for all weatherization activities are far above the other sample States. For example, the plan expected 47 percent of all homeowners, add attic

insulation and install storm windows, participation rates that are almost two and three times the projected response in the next highest residential audit program. Since many homes already have storm windows and attic insulation, these assumptions probably would require 100 percent of the remaining homes to do all weatherization activities. The observed staffing levels and reported homeowner responses to the current program indicate that the projected 1980 energy savings of 14 TBtu are extremely optimistic and totally unlikely to occur.

Xenergy, Inc., conducted energy audits on two to ten businesses in each sector. These audits provided the basic information for the suggestions contained in the handbooks.

The test businesses implemented Xenergy's recommendation themselves, at their own expense.^{3/} Only those measures that were generally applicable to businesses in that sector, had fast and significantly large paybacks (estimated paybacks ranged from immediate to a few years), did not demand excessively high initial investments (investment costs ranged from \$0 to \$8,000, but most suggestions cost less than \$1,000 to implement),^{4/} and did not present problems in implementation, were included in handbooks. Because the suggestions were based on actual experience and were aimed at a narrow group, they could be specific. Each suggestion in the handbooks was accompanied by an example drawn from experience with the test businesses.

The handbooks were printed and distributed by the respective trade associations. In most cases all the members of the trade group received a handbook free of charge. In some cases, a nominal fee was charged. In addition, some trade associations sold or otherwise distributed a certain number of copies outside of their membership. See Figure C-1 for details on the distribution of the booklets.

Mariscal Corporation then held seminars in each of the Federal Energy Administration's region on how to conduct workshops to supplement the guidebooks. These seminars were attended by State energy officials, Federal Energy Administration (FEA) regional officials, trade association representatives, Small Business Administration officials, and representatives from the Service Corps of Retired Executives (SCORE).

In addition, some of the trade groups requested a separate training session. Workshops now are being conducted by the various participants in the regional training programs.

C. 3 EARLY OBSERVATIONS

It is not advisable to draw conclusions about the conservation value of the project at this date, both because the project has not been running long enough for sufficient data to have accumulated and because as yet there has not been any effort to obtain feedback on the success of the project. However, some preliminary observations can be made at this stage and can serve to suggest what direction further study should take.

Informal feedback in the form of letters and comments to the trade associations and the contracting firms has been generally positive. This feedback, however, is not quantitative, nor is it necessarily representative.

It appears that the workshops have a major impact on the degree to which the energy recommendations are implemented. Mariscal Corporation performed a check on the impact of the cost reduction guide for drycleaning and laundry establishments in Boston. In a questionnaire distributed before the workshop began, about 50 percent of the participants expressed the intent to implement at least some of the suggestions contained in the handbooks. When the same questionnaire was distributed after the workshop, 80 to 90 percent of the respondents said they would apply some of the recommendations. These findings may not be representative, but they do suggest both that the project may, in fact, achieve substantial results and that the workshops have important incremental value.

FIGURE C-1
DISTRIBUTION OF HANDBOOKS IN THE VARIOUS SECTORS

Laundry and Drycleaning	10,000 handbooks distributed to members
Apartment Management.	4,000 handbooks distributed to members; 16,000 sold outside of trade group
Commercial Printing	8,000 handbooks distributed to members
Gasoline Service Stations	12,000 to 13,000 handbooks distributed in the last six months through the small Business Administration and the Federal Energy Administration
Automobile Repair Shops	5,000 books distributed to members; some additional books sold
Retailing	18,000 books sold since September, books are sent on consignment to State branches
Automobile Dealers	21,000 books distributed to members
Florists and Greenhouses	Handbooks not yet printed, the trade association includes over 7,000 members

The project is in essence a pilot. If the format of promoting energy conservation in specific businesses through handbooks and workshops proves successful, it easily can be expanded to include other similar commercial sectors. In theory, conservation measures involving small investments and fast paybacks should be very attractive to small businesses, so the idea of involving additional industries certainly warrants consideration.

A more in-depth investigation and evaluation of the program should be conducted in about six to 12 months. This would allow sufficient time for the most recent program, the retail florists and wholesale growers cost reduction program, to get underway without letting so much time go by that the effects of the program are difficult to discern in the sectors that have been involved longest.

Government involvement in the program was probably crucial. As noted above, most of the businesses in the sectors involved have small staffs and are in marginal industries. Individual firms are too small for an in-depth or expert analysis of energy use to be cost efficient and, in the past, have not been particularly conscious of energy issues in general. Thus, even if a businessman was worried about energy costs, he would probably have neither the expertise nor the wherewithal to determine what conservation measures to implement.

Although the trade associations would have the means to investigate fruitful avenues of energy cost reduction, most have not done so. In at least one instance, the trade association did publish some information on energy conservation but their publication did not give information about cost savings, nor did it provide adequately precise suggestions and, consequently, did not receive much attention.^{5/}

Thus, it seems unlikely that the private sector would have developed a comparable program without government involvement. There also do not appear to be any other government programs that duplicate the impact of this one.

C. 4 QUESTIONS TO ADDRESS IN THE IN-DEPTH EVALUATION

When the project has been allowed to mature, it should be analyzed in greater depth, both to determine the value of the project and to provide information on how best to expand it, should that be found desirable. First, such an evaluation should attempt to find out the actual savings resulting from the project, overall, by sector, and by individual firm, both in terms of Btu's and in percentage points. This cannot be accomplished without a mechanism to gather information on the degree to which the suggestions were actually heeded. Some additional feedback is definitely needed.

The evaluation should also attempt to determine:

- What effect the handbook alone had in each sector
- What incremental effect the workbook had in each sector, and which organization (i.e., trade association, State energy office, SBA, etc.) was most effective in producing results
- Whether there is any correlation between response to the program and geographic location, and what might cause such a variation.

Naturally, these are only guidelines, and the evaluation should also address any other findings that appear significant.

C. 5 SUMMARY AND CONCLUSIONS

This project addresses a need that has not been met in the private sector or in other governmental programs. The small businessman has been the victim of rising energy costs and the target of much public discussion

of the need for energy conservation. However, he typically has not had the expertise to determine what specific measures will be cost effective for him. This program provides the kind of specific information such a businessman needs to achieve both cost and energy savings.

Because of this and because the program confined itself to recommending only those measures that are indeed cost effective, available, and within the means of a small firm, preliminary informal feedback indicates that the project is in fact saving energy. This indicates that the idea may be worth applying to other small business sectors, and perhaps to other areas entirely.

First, however, the project must be evaluated in quantitative terms and in greater depth. This cannot be done properly until the project has been allowed to mature and until quantitative data has been gathered on the degree to which the suggestions were implemented and on the actual cost and energy savings. Until this occurs, no final judgment can be made on the success of the project.

FOOTNOTES

1. See macroanalyses prepared by Mariscal and Company for the Federal Energy Administration Small Business Energy Cost Reduction Program.
2. Ibid.
3. Personal communication, Walt Henry, Xenergy, Inc.
4. One recommendation, namely that to correct overheating in apartments, cost \$39,000. This was the only exception. Energy Cost Reduction for Apartment Owners and Managers, p.5.
5. Personal communication, Ken Faig, International Fabricare Institute.

APPENDIX D

ENERGY EFFICIENCY BUILDING CODES FOR STATES

D. 1 INTRODUCTION

Part C of the Energy Policy and Conservation Act of 1975 calls on the States to formulate energy conservation program and for technical and financial assistance from the Federal government to those States whose plans meet certain specifications. One of these conditions is that the States should set minimum thermal efficiency standards for all new construction.

The purpose of the project studied was to assist the States in implementing such standards by providing a model code and by developing courses and training instructors to teach State officials to administer such standards. This report will, first, describe the project; second, discuss the impact on energy conservation; and, third, look at the need for government involvement and possible areas of expanded participation.

D. 2 PROJECT DESCRIPTION

The project essentially consists of two parts: one, the formulation of the model code, and two, the development of training programs for State officials effected by energy standards for new construction. See Figure D-1 for an explanation of how the project fits into the overall picture of energy standards for new construction.

The model code is based on the standard put out by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (henceforth

FIGURE D-1

* Explanation of steps follows on following five pages.

EXPLANATION OF THE CATEGORIES IN FIGURE D-1

1. The Energy Policy and Conservation Act, (PL-163), passed by Congress in December 1975, was the original impetus for the project under discussion. Title III, Part C of the Act calls for State Conservation Plans and for Federal technical and financial assistance to the States if their Plans meet certain criteria. One of the requirements is for the State Plans to include minimum thermal efficiency standards for new construction.
2. For 1974, the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) was commissioned by the National Conference of States on Building Codes and Standards (NCSBCS) to create a set of guidelines, completed in 1975 (and called the ASHRAE 90-75 standard), and adopted by DOE as the standard for the State's thermal efficiency requirements.
3. The ASHRAE 90-75 standard is written in engineering language, and cannot be used directly by the States to enforce energy efficiency requirements in new construction. Therefore, the first part of DOE's project was to commission NCSBCS to translate ASHRAE 90-75 into enforceable code language.
4. The second part of the project was to develop an educational program on energy questions for building officials and to train qualified instructors from each State.
5. Many of the States did not have any statewide regulation of building and for this or other reasons most of the States have or had

to pass legislation to permit them to regulate energy efficiency in new construction. See Figure D-2 for the schedule on which the States are adopting the necessary legislation.

6. Four states already had energy efficiency standards for new construction or for other reasons chose to create their own energy codes. 39 States have adopted or intend to adopt the NCSBCS/DOE model energy code or the related energy provisions from one of the model code groups. Seven States are still undecided as to what code they will use, but it is likely that they will also adopt one of the model codes.^{1/}

7. Obviously, before all this regulation can result in energy savings, it must be enforced. The major obstacles to the actual implementation of the standards are the need to educate a large number of local officials with small State staffs, and the shortage of enforcement personnel, since the burden of enforcement in most cases falls on the localities who do not want to hire new personnel. Almost all the States intend implementation of the standards by July 1979, but it is not clear that this goal will be reached, and no data has been gathered on actual enforcement to date.

8. The Energy Conservation Standards for New Building Act of 1976 (Title III of the Energy Conservation and Production Act (PL 94-385)) requires Federal energy efficiency standards in new constructions. These provisions differ from that in E.P.L.A. first because it is on a Federal rather than a State level, and second because it requires that the standards be performance standards. Under ASHRAE 90-75 and thus under the State Plans, each component of a building must meet thermal efficiency standards, but the standard does not address itself to the

building as a whole. Performance standards, on the other hand, set minimum standards for the buildings as a unit, and do not regulate the separate components.

9. DOE and the Department of Housing and Urban Development are both working on setting the minimum standards under the Energy Conservation Standards for New Buildings Act of 1976. The standards are scheduled to be determined in 1979, and implementation is scheduled for 1980.

FIGURE D-2

EXISTING AND PLANNED STATE AUTHORITY
TO ISSUE ENERGY CONSERVATION STANDARDS FOR BUILDINGS^{2/}

<u>Authority</u>				<u>No Current Authority</u>	
<u>All Buildings</u>	<u>Residential</u>	<u>Nonresidential</u>	<u>Public (State Buildings) Only</u>		
CA (L)	WA (L)	WI (L)*	AL (A)*	AK (NPA)	
CO (L)	NY (A)*	WY (L)	AZ (L)*	AR (NPA)	
CT (L)			ID (A)	DE (P)	
FL (L)			ME (A)	GA (P)	
IN (L)			TX (L)	HI (P)	
IA (L)				IL (P)	
KS (A)(P)				LA (NPA)	
KY (A)(P)				MD (P)	
MA (L)				MS (P)	
MI (L)				MO (P)	
MN (L)				NE (P)	
MT (L)				OK (P)	
NV (L)				PA (P)	
NH (L)				SC (P)	
NJ (L)				SD (NPA)	
NM (L)				TN (P)	
NC (L)				VT (NPA)	
ND (L)				WV (P)	

FIGURE D-2 (Continued)

EXISTING AND PLANNED STATE AUTHORITY
TO ISSUE ENERGY CONSERVATION STANDARDS FOR BUILDINGS

Authority				No Current Authority
All Buildings	Residential	Nonresidential	Public (State Buildings) Only	
OH (L)				
OR (L)				
RI (L)				
UT (L)				
VA (L)				
(L) 20	(L) 1	(L) 1	(L) 1	(P) 13
(L)* 1	(A)* 1	(L)* 1	(L)* 1	(NPA) 5
(A)(P) 2			(A)* 1	
TOTAL STATES: 23	2	2	5	18

Those dates with pending enabling legislation should have the legislation passed by 12/78 at the latest.

The five states that have no pending authority are not necessarily uninterested in energy efficiency standards for new construction. In at least two cases, (VERmont and Sough Dakota), the lack of action is caused by the fact that the legislature only meets 30 to 45 days a year, and action is expected early in 1979.

Legend: (L) Legislative Authority
(A) Administrative Authority
(P) Legislative Authority Pending
(NPA) No Pending Authority
* Additional Authority Pending

referred to ASHRAE 90-75), which was declared the minimum acceptable standard by the Department of Energy (DOE). Energy provisions incorporated into the other model codes also are based on ASHRAE 90-75 and are considered interchangeable with the code developed by the National Conference of States on Building Codes and Standards (NCSBCS) for DOE.^{3/}

The training program was developed and tested in the spring of 1977. It consists of four different aspects and level of code administration. NCSBCS held an institute to train qualified instructors at Salt Lake City in August 1977, which was attended by representatives from all the states and territories. The course was judged excellent by the participants.^{4/}

The development of the model code cost \$200,000; the training program cost \$345,000 to develop and test, and an additional \$125,000 was spent on public meetings and seminars, etc., in 1977, making the total expenditure for FY 77 \$670,000. An additional expenditure of \$200,000 is planned for FY 78.^{5/}

D. 3 PROJECT EVALUATION

The project accelerated energy conservation, and facilitated the task of the states to varying degrees. The extent of the acceleration, however, is difficult to determine because there is no "unaccelerated" development of energy standards with which to compare the present rate of implementation. Thus, any quantitative estimate of this effect is tentative.

The impact of the project on energy conservation must not be confused with the effects of energy conserving building codes themselves. The project under discussion only affects energy savings to the degree to which it accelerates the implementation of such codes.^{6/}

There is little question that all the States wish to participate in the State Energy Conservation Program under EPCA, and therefore would be required to adopt thermal efficiency standards for new construction.^{7/} The major obstacles to implementation of such standards in the various States are generally:

- Need for enabling legislation
- Need for a working code
- Need for a structure to administer the new rules and to assist builders in conforming to them.

Before the enactment of EPCA, most of the States left the regulation of construction to the localities and assumed no jurisdiction over that area. For this and other reasons many need or needed new legislation to enable them to set building standards.

ASHRAE 90-75, which was declared the minimum standard for thermal efficiency, was written as an engineering document. The States could conceivably have translated it into code language without assistance, but it was certainly more efficient for the standard to be put into code language once than for the same effort to be duplicated fifty times. In addition, the States, in many cases, do not have officials with the same level of expertise in energy problems in construction as were available to the Federal government in this case. The fact that almost all the States are basing their regulations on the model code developed in this project^{8/} indicates that this option was the best one available to the States. Even those States that developed their own codes based their work to some extent on the model code. Finally, many if not most of the States have fixed budgets for energy matters. Had the States in fact been able to develop codes as quickly as this project, which is unlikely for the reasons above, the time and money used to develop the code would have been lost from some other energy program.^{9/}

With very few exceptions, State and local building code officials have had no experience with energy questions before the work on the State Energy Conservation Programs of EPCA. It is necessary for them to develop some familiarity with energy conservation methods, both so that they can better enforce the thermal efficiency provisions in the new codes and so they can provide some assistance to builders who rely on them for information and help in meeting regulations.

The National Conference of States on Building Codes and Standards has developed four courses for involved officials and has held an institute to train qualified instructors, which was attended by over 100 representatives. So far, however, only eight States have definitely used or plan to use the courses developed by NCSBCS for DOE.^{10/} Other States have either not yet gotten to the point of training officials or have developed their own courses.

The NCSBCS courses do have some problems. First, they are set up as classroom courses of instruction. Thus, officials have to either cut into their already heavy schedules to attend the courses (which ranges from one to 30 hours) or they simply miss the material completely. Second, even if the official can find the time to attend the classes, 30 hours, which is the length of the most exhaustive course, is hardly enough time to develop a complete familiarity with the subject. Finally, it may be desirable to tailor the courses more exactly to different kinds of officials. The first two problems can best be corrected by the development of materials to accompany and elaborate on the classroom instruction, that also can be used independently. Thus, the courses will be more flexible and the official will be able to go beyond the classroom material should that be necessary. The last problem mentioned may be something best addressed by the States themselves, since categories of officials may differ from State to State, and even from locality to locality.

Despite these problems, it is likely that the institute held at Salt Lake City has been of some benefit. Although the courses have not been adopted directly for State use in most cases (at least not yet), the meeting was doubtlessly educational for the representatives who attended, and almost certainly had some influence on the courses that are being developed by the States. Finally, it is possible that many States have simply not yet reached the stage of instructing local officials, and may still use the NCSBCS source.

The total acceleration value of the model code and of the training program lies between one and three years. In 1980, energy efficiency standards to be developed under the Energy Conservation Standards for New Buildings Act of 1976 (Title III of the Energy Conservation and Production Act of 1976) are scheduled to take effect. Although it is not certain what form those standards will take, they will probably be at least as inclusive and stringent as the ASHRAE standards (see Figure D-1, and accompanying explanations). However, for implementation to be as rapid as planned, some preparation on the State level is probably necessary. This ground work is being done by the thermal efficiency standards under EPCA and, more specifically, by the project under discussion. Thus, the maximum possible acceleration value of the model code and of the training program is something more than two years.

It took NCSBCS over a year to develop the model code from start to final publication. During this time, States were using their resources to develop and pass legislation to permit the adoption of energy standards. (See Figure D-2 for the State's schedule of passing the necessary legislation.) It would have been difficult, if not impossible, for the States to develop their own codes during this time period. The development of the codes by the Federal government has made it possible for the States to implement the regulations immediately.

Each year of acceleration of nationwide implementation of energy standards saves 27 percent of the energy consumed annually in new construction. This amounts to about 150 trillion Btus for one year of acceleration, 460 trillion Btus for two years, and a total of around 930 trillion Btus for three years.^{11/}

D. 4 THE ROLE OF GOVERNMENT

The configuration of this project lends itself to Federal involvement. Since the Act calls for Federal assistance to the States in implementing the conservation plans, and since, in any case, the Department of Energy (DOE) had to approve the codes, DOE was the natural candidate to translate the standard into code language. No private organization was as suited for the task as the Federal government.

The fact that each of the model code groups also is issuing energy standards for new construction does not mean that Federal involvement was redundant. In fact, the code groups worked together with NCSBCS on the production of the model energy code. The energy standards to be incorporated in their general building codes, if approved by their members, will be those of the NCSBCS model code. This is not a case of duplication of effort, but of combination of effort.

The development of training courses is not as obviously a Federal responsibility as the production of the model code, but those who developed the code are probably those most qualified to explain it. Thus, although many of the States may choose to develop their own courses for a variety of reasons, NCSBCS and DOE have a responsibility to provide instruction on the code and its implementation. If the States then produce their own educational programs, this does not necessarily constitute duplication, but may simply mean that the States have special needs that the more general training program developed by NCSBCS does not meet.

However, the present DOE course does have the major drawback of being limited to a classroom situation. Since many of the States have staff shortages, such a "labor intensive" educational program may be inconvenient. The development of course materials that could be used independently of the classroom or to extend classroom instruction is probably the major area for improvement or expansion of the government role.

D. 5 SUMMARY AND CONCLUSIONS

The Energy Policy and Conservation Act of 1975 calls for technical assistance to the States in implementing State Conservation Plans. The project studied helped the States to implement the thermal efficiency standards called for in EPCA.

The project itself, which includes the translation of the technical ASHRAE 90-75 energy standards into working code language and the creation of a training program in energy code matters for building officials, accelerated the implementation of thermal efficiency standards by about one to three years. The model code was adopted or is being adopted by almost all of the States that did not already have energy efficiency standards before they were required under the State Conservation Plans.

The training program does not have as good a record. In part, this may be due to the fact that most States are not yet at that stage of implementation, or because they have specific needs that cannot be met by a general program aimed at a nationwide level. In part, however, it may be due to the fact that the present program is designed exclusively along the lines of classroom instruction, which demands a high commitment of resources on the part of the State (staff time both to teach and to attend classes) and at the same time offers less educational materials to extend or work independently of classroom instruction is the major area for expansion of the government role in this program.

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FOOTNOTES

1. National Institute of Building Sciences, Energy Conservation Standards for Buildings: Status of States' Regulatory Activities, March 1978, Exhibit I.
2. Ibid.
3. Personal communication, Mr. Trant, Council of American Building Officials. The model energy code was developed by NCSBCS with the cooperation and advice of the model code groups (Building Officials and Code Administrators International, Inc., (BOCA)); International Conference of Building Officials (ICBO); and Southern Building Code Congress International, Inc. (SBCCL). BOCA has some energy provisions based on ASHRAE 90-p incorporated in its code, and the other two groups have appendices suggesting voluntary compliance with ASHRAE 90-75. All three groups plan to incorporate the model energy code into their general codes if their membership approves, which is likely.
4. Comprehensive Progress Report, NCSBCS, December 1977, pp. 11-15.
5. Personal communication, James Shivar, Project Manager, DOE.
6. See Arthur D. Little, Energy Conservation in New Building Design, An Impact Assessment of ASHRAE Standard 90-75 for the savings values of the codes themselves.
7. ECPA, Title III, Section C.
8. NIBS, Standards: Status of States' Activities, pp. 10-18; and P. Cooke and R. Eisenhard, NBS, Building Energy Conservation Programs, p. 8.
9. P. Cooke and R. Eisenhard, pp. 13-14.
10. Personal communication, Caroline Fitch, NCSBCS.
11. Arthur D. Little, p. 98.