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Customer Attitudes toward Thermal-Energy-Storage Heating

H. N. Hersh



ARGONNE NATIONAL LABORATORY
Energy and Environmental Systems Division

prepared for
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CUSTOMER ATTITUDES TOWARD
THERMAL-ENERGY-STORAGE HEATING

by

Herbert N. Hersh

Energy and Environmental Systems Division
Special Projects Group

June 1981

prepared for

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Energy Technology Division

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Assistant Secretary for Conservation and Renewable Energy
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PREFACE

Argonne National Laboratory conducted a field study of thermal energy storage (TES) in Vermont and Maine in the winter heating seasons of 1978/79 and 1979/80. The objectives were to determine reliability, operating performance, costs, user acceptance, and other determinants of the viability of TES heating systems that use only off-peak electricity. These systems supplement direct electric baseboard heating, thereby reducing oil consumption for the generation of electric power.

The studies of operating performance and other features of TES systems, which were subcontracted to the University of Vermont and the University of Maine at Orono, indicated generally satisfactory technical and economic performance, leading one of the participating utilities, Central Maine Power Company of Augusta, to promote TES in its service area. Other studies covered performance of TES systems in monitored test homes, cost-benefit analyses, cost-effectiveness to consumers, impacts on utility load curves, and appropriate rate forms.

This report on user attitudes toward TES systems has been prepared for the Energy Technology Division of Oak Ridge National Laboratory under U.S. Department of Energy sponsorship as one part of a field study of thermal energy storage by Argonne National Laboratory. The manuscript was completed in September 1980. A companion report, Optimal Sizing of Thermal Energy Storage Heating Systems, ANL/SPG-18, is in press.

ACKNOWLEDGMENTS

The experience and information accumulated at Argonne National Laboratory from its assessment of energy storage technologies and systems, including thermal energy storage (TES), from its two-year field study of TES in Vermont and Maine, and from its thermal test facility at Purdue University have been available for the preparation of this report. The seminal contributions of J. G. Asbury, Director of Special Projects of the Energy and Environmental Systems Division; of R. Giese, to the field of assessment of storage technologies and systems in general; and of J. V. Caruso, who arranged the contracted survey of customer acceptance, were particularly helpful. The contributions of G. Mirchandani at the University of Vermont and R. Rowe at the University of Maine at Orono, the subcontractors, and their colleagues and collaborators at their respective universities and at the Central Vermont Public Service Corp., Green Mountain Power Corp., Vermont Electric Cooperative, Inc., and Central Maine Power Co., are especially acknowledged.

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CUSTOMER ATTITUDES TOWARD
THERMAL ENERGY STORAGE HEATING

by

H.N. Hersh

ABSTRACT

This study of attitudes among users of thermal energy storage (TES) heating systems indicates that more than 90% of the users regard TES as an acceptable residential heating technology. This conclusion draws upon three sources of information: a formal customer acceptance survey exploring attitudes and levels of satisfaction, face-to-face contacts between utility representatives and users, and a survey of pertinent published information.

1 INTRODUCTION

The federal government is interested in thermal energy storage (TES) heating systems that use off-peak electricity because they conserve oil, relative to direct electric heaters.¹ Cost-benefit analyses show that net benefits accrue to society and to utilities from TES, and that some of these benefits can be passed on to electric heat users who install TES instead of direct electric baseboard heating.²⁻⁴ Studies of the technical performance of TES systems in New England^{2,5-8} show them equal to conventional systems in thermal comfort. To accelerate the commercialization of TES heating, potential electric heat customers, manufacturers, vendors, and architects must be encouraged to accept TES systems, which are initially more expensive than direct electric heaters but are intended to have lower operating costs.

One way to encourage the use of TES is to demonstrate that present users are satisfied with TES systems. This study determined the degree of satisfaction or dissatisfaction of electric heat residential customers with their TES heating systems through the use of conventional user acceptance survey research techniques, previous studies of customers, records of personal utility-customer contacts, and other sources of information. The results of a formal survey of user acceptance of TES heating systems in New England, carried out by an independent survey research firm, and the conclusions drawn from a review of customer complaint records and contacts are included. To evaluate the validity and practicality of the formal survey, the results are compared with other studies of the typical utility customer's level of knowledge and perception of heating and electricity, and of general utility customer attitudes toward energy conservation and the electric utility industry that might condition customer response to questioning.

The two main conclusions of this study are that: (1) TES heating systems are installed for economic reasons by customers who can afford higher initial costs and understand the concept of lower total cost (capital plus operating), and (2) attitudes toward TES are positive, the key indicator

being that 90% of TES users would recommend their heating system to a friend or neighbor. TES systems are not regarded more favorably than conventional systems, however, and it is likely that lower electric heating bills are responsible for the favorable perceptions of most TES users. These conclusions remove an element of uncertainty about thermal energy storage systems for heating, and should be useful to private and public policymakers.

2 BACKGROUND

Thermal energy storage heating systems in the United States are still few in absolute numbers and are located mostly in New England. The price of fuel oil is high in New England, relative to the cost of electricity, and electric heating is seen as the main alternative. To conserve oil and to forestall a massive shift to direct on-peak electric baseboard heating, which would put heavy burdens on local electric utilities, the federal government and the utilities favor the use of off-peak electric space heating, such as can be accommodated by TES systems.

The strategy for increasing the use of customer-owned TES includes documenting the technical feasibility of TES and eliminating obstacles to rapid commercialization. Studies by the federal government and electric utilities confirm the good aggregate thermal and economic performance of residential TES heating systems.²⁻⁷ Figure 1, for example, shows the maintenance of inside temperatures during six weeks of cold weather in January and February of 1979. To remove any remaining uncertainties about the commercial readiness of TES heaters, it was necessary to determine the attitudes of individual users toward their TES systems. This report, which follows a two-year field study of TES in Vermont and Maine,^{2,6} provides answers to the question as to what TES users think of TES heating.

Thermal energy storage heating systems have been described in detail elsewhere.⁷ In brief, they are electric appliances that supply personal comfort heat from previously stored, electrically generated thermal energy. Figure 2 is a cutaway of a typical TES heater. These heaters use fixed amounts of electricity obtained at lower cost during periods of low electrical demand, such as late at night or early morning. The electricity generates heat in electrical resistance heaters in thermal contact with the heat storage medium, which may be bricks or water. The unit is thermally insulated; however, radiation from the stored heat supplies a continuous level of background heat. Additional stored energy is released as needed by a fan that circulates warm air. The total amount of energy stored is fixed by the total charging time and a weather-sensitive energy control. In contrast, conventional direct electric resistance heaters, such as electric baseboard heaters, have no storage capacity, require a semi-infinite energy source, use on-peak as well as off-peak electricity, and provide instant heat.

The aggregate functional performance of TES systems, which also are used extensively in Europe, has been good. They are reliable and, if sized and installed properly, provide thermal comfort at costs lower than for direct electric heat. The relative rate benefits of off-peak electricity may be guaranteed, and necessary agreements between the utility and the customer to protect the security of the utility have not turned potential customers away.

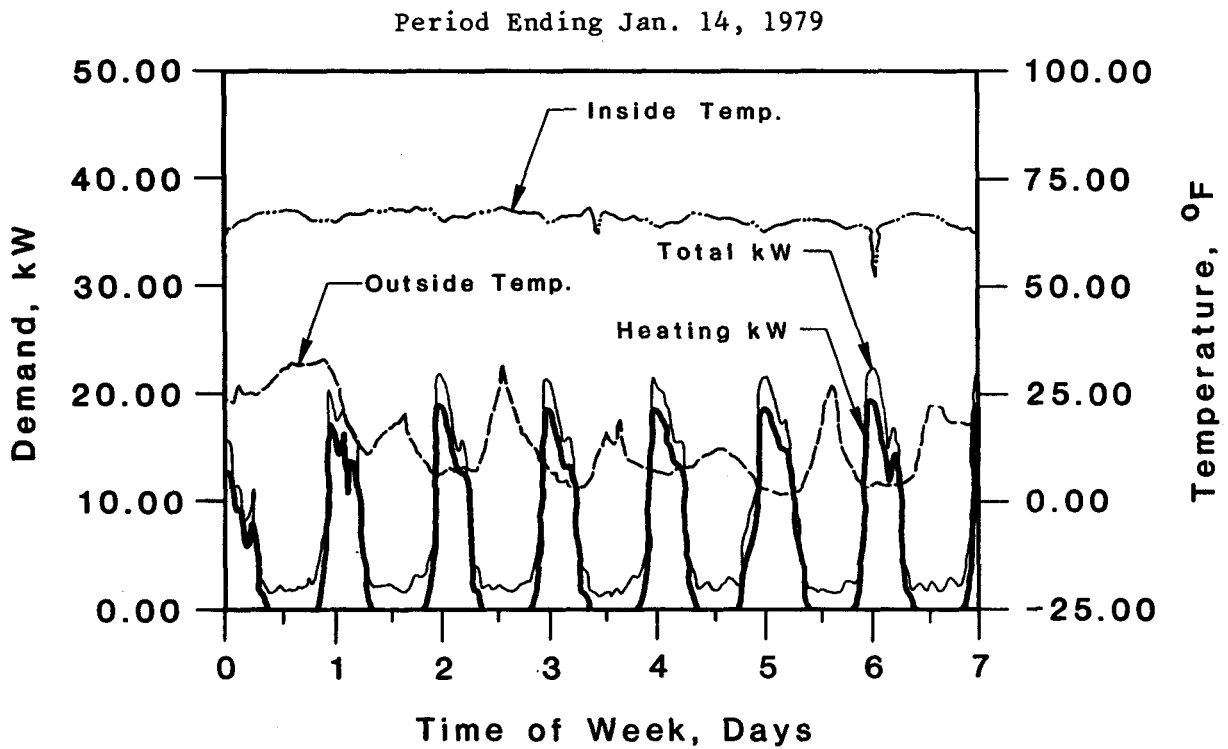
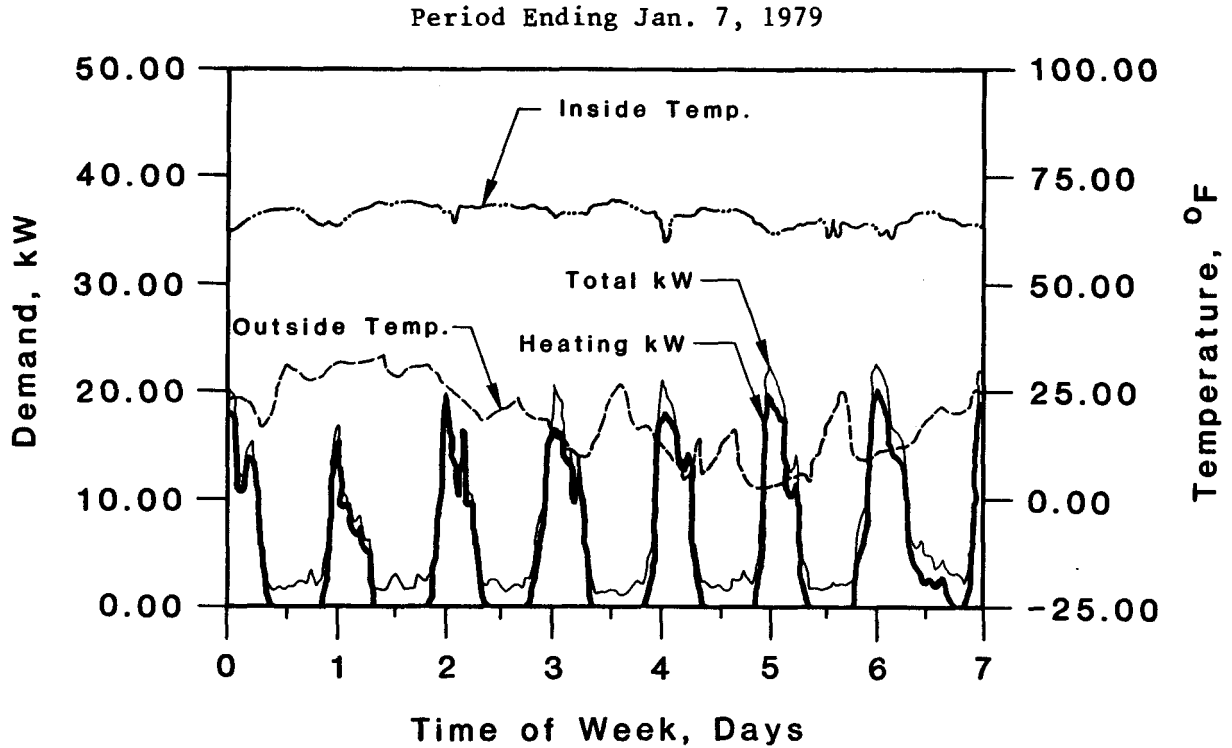


Fig. 1 Six-Week Summary of Indoor Temperatures Maintained by Thermal Energy Storage (upper curves are temperature; lower curves are electric demand)

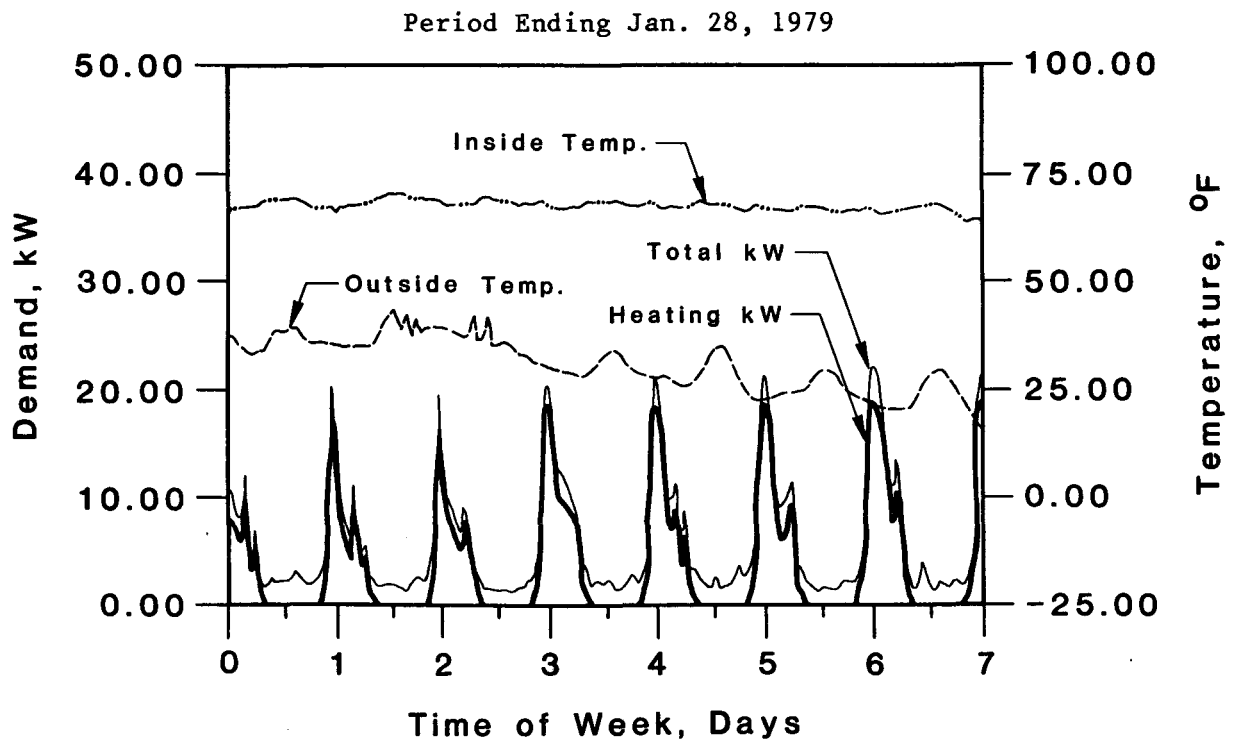
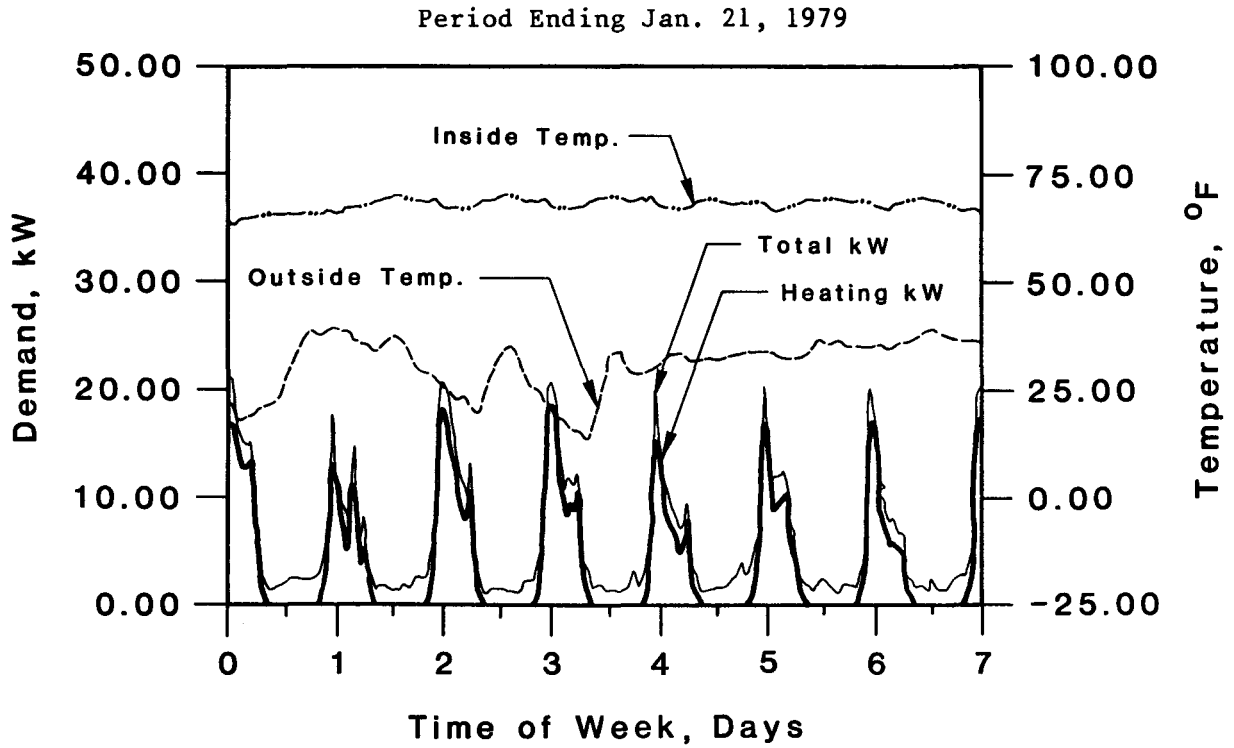
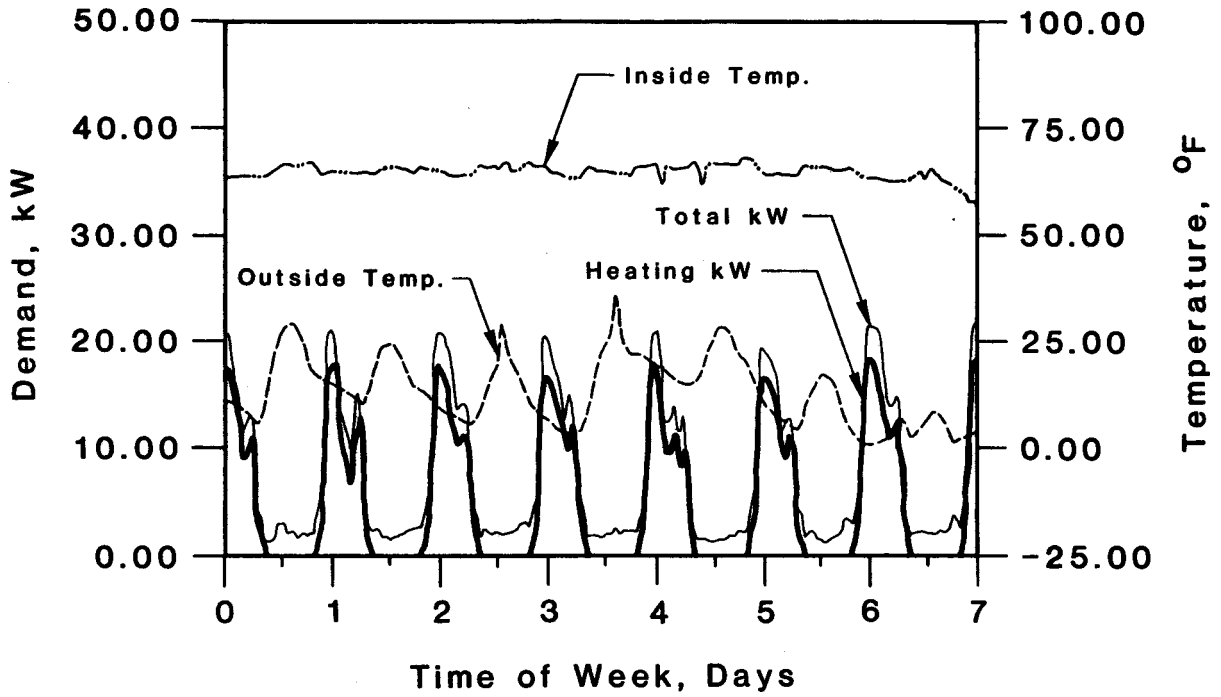


Fig. 1 (Cont'd)

Period Ending February 4, 1979



Period Ending February 11, 1979

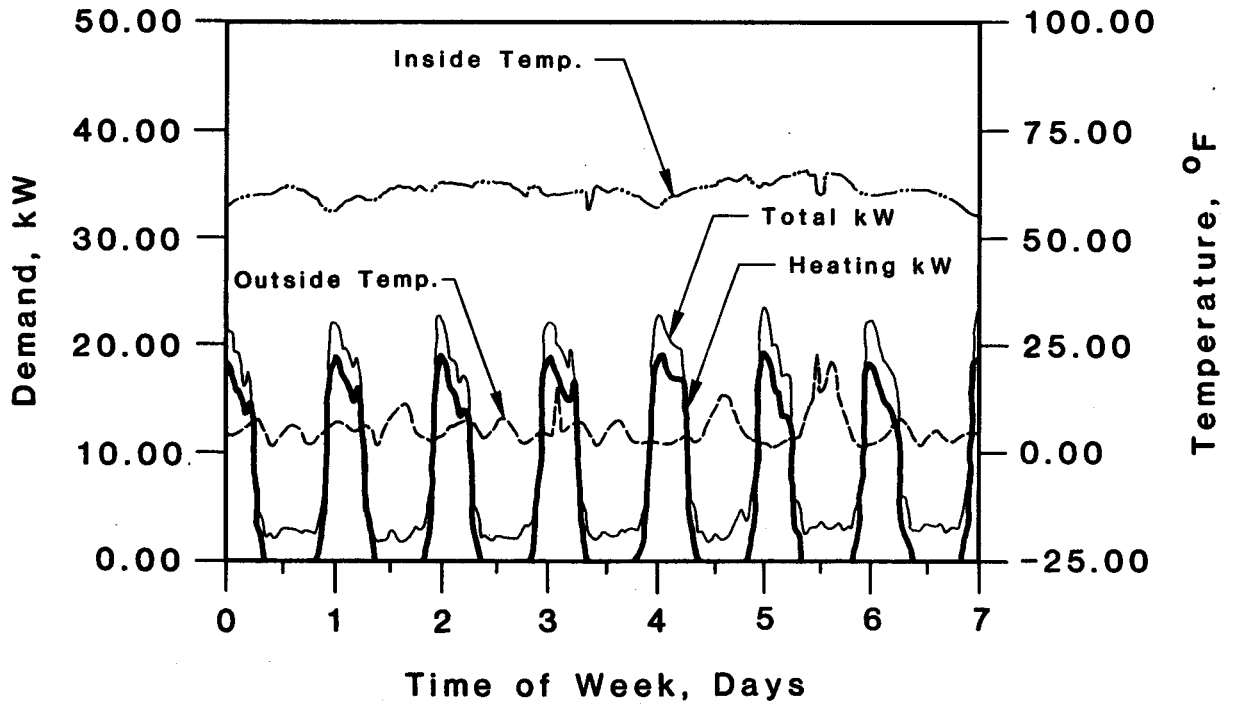


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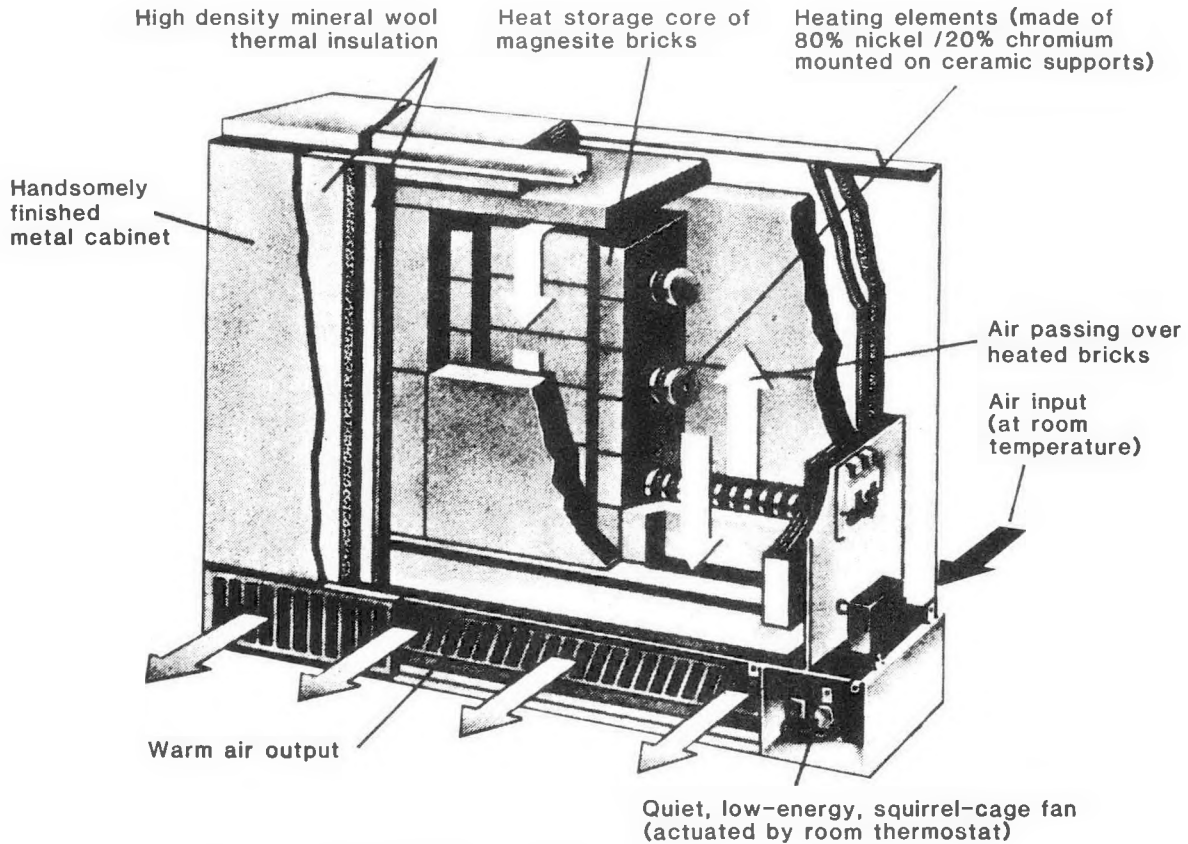


Fig. 2 Cutaway of a Thermal Energy Storage Heater
(Source: Control Electric Corp., Burlington, Vt.)

3 METHODOLOGY

Three methods were used to determine customer attitudes about TES:

1. A formal survey of user acceptance of TES by an independent research firm.
2. An examination of utility records of customer complaints and contacts.
3. A survey of other pertinent studies, to aid in interpreting the results.

Opinion surveys may have indefinite accuracy limits. For this reason, the above three methods were employed simultaneously to obtain conclusions that decision-makers can use to predict ranges of customer attitudes and responses, and for extrapolation to potential new customers.

4 NEW ENGLAND CUSTOMER ACCEPTANCE SURVEY

4.1 INTRODUCTION

The objective of the New England survey was to ascertain customer acceptance of thermal energy storage heating. Acceptance was determined by probing attitudes toward, and degree of satisfaction with, TES heating systems. Initial lists of questions were solicited from cognizant individuals at Argonne National Laboratory (ANL), the University of Vermont, and the University of Maine. There were direct questions about unit performance, and the survey sought additional information, which was to be derived from answers to the following questions:

1. Why did homeowners, who volunteered for a thermal energy storage program, initially do so? What did they expect to gain? What was the primary motivation?
2. How, if at all, have living patterns or habits changed in thermal energy storage homes? What is done differently now? How favorable or unfavorable are perceptions of any changes that have taken place?
3. What did the volunteers expect installation and operation costs to be? How do perceptions of actual costs compare with original expectations? What unanticipated expenses were incurred?
4. Would homeowners with thermal energy storage systems recommend this investment to their neighbors? Would homeowners with thermal energy storage do it again, knowing what they now know?
5. What are the attitudes and opinions on:
 - a. Energy conservation?
 - b. Convenience or inconvenience of TES?
 - c. Thermal comfort?
 - d. Short- and long-term cost savings?
 - e. Ease of installation and maintenance?
 - f. Comprehension of TES, how it works, and how it affects an electricity bill?
 - g. Physical appearance, i.e., attractiveness?
6. What differences, if any, does length of experience with thermal energy storage make in expressed attitudes and opinions?

Initially, only participants in the ANL field study were to be queried. However, because TES systems have been installed in New England since the early 1970s, the survey population was enlarged to include those users, with the ANL participants as a subpopulation.

Elrick and Lavidge, Inc., a customer research firm, was employed to make the survey. A telephone survey was selected, so the questions were refined to be more neutral and understandable, then rephrased for computer-aided data processing, and finally put in an order appropriate for telephone interviewing. Figure 3 shows the format of the first page of the telephone interview. The full Elrick and Lavidge report appears in the Appendix.

Letters of introduction were mailed to TES and control households (see Appendix), and interviewers were trained. Between May 17 and June 5, 1979, 133 interviews were conducted in Vermont, Connecticut, and Maine. The interview was with the person in each household who indicated responsibility for the heating system.

4.2 FINDINGS

The main findings of the New England customer acceptance survey are as follows:

1. Thermal energy storage systems are installed for economic reasons.
2. Attitudes toward TES are positive (see Fig. 4); for example, 90% of TES owners would install TES again and would recommend TES to friends or neighbors (see Fig. 5).

Other findings include the following:

1. Almost 60% of TES owners consider their TES system to be better than their previous conventional heating system, primarily because TES is more economical and cleaner-operating.
2. These same owners have varying opinions about other aspects of storage heating, such as:
 - a. Convenience of operation.
 - b. Level of comfort.
 - c. Ease of installation.
 - d. Ease of understanding how the system works.
 - e. Saving money in the short run (see Table 1).
3. The most frequently mentioned problems were temperature control, defective parts, and inadequate heat. These problems were not regarded as being very serious. Manufacturers and installers were most frequently blamed for these problems.
4. Compared with owners of conventional heating systems, TES owners appear convinced that their heating systems will save money in the long run.
5. Thermal energy systems cost about \$3,000 installed, more than twice the cost of conventional heating systems. Even so, most TES households indicated that they paid about what they expected for installation. Few reported unexpected installation costs.

Elrick and Lavidge, Inc.
 10 South Riverside Plaza
 Chicago, Illinois 60606
 Phone: (312) 726-0666

Project #2279-1
 May, 1979

Office # _____
 DOE Home - 1
 Other _____
 Storage Heater Homes - 2

STORAGE HEATING STUDY

- Homes with Storage Heating Units -

Respondent _____ Phone () _____
 (Print)
 Address _____
 (Print)
 City, State _____ Zip Code _____
 Interviewer _____ Date _____
 Time AM Time AM Length of
 Started PM Completed PM Interview Mins.

Hello, my name is _____. I am with Elrick and Lavidge, Inc., an independent marketing research firm based in Chicago. We are doing a study for the United States Department of Energy on storage heaters. About a week ago we sent a letter to your household saying that we would call. Do you remember seeing the letter?

Yes - 1 --> CONTINUE No - 2 --> EXPLAIN LETTER AND CONTINUE

The purpose of the study is to gather information about consumers' attitudes toward this type of heating system. Since only a limited number of homes are equipped with this type of heating system, your local power company has provided us with your name and the names of other households where storage heaters have been installed. All of the information you provide will be kept strictly confidential.

1. First of all, are you the person in the household most responsible for having storage heating installed in your home?

Yes - 1 --> CONTINUE NO - 2 --> ASK TO SPEAK TO THAT PERSON.
 IF UNAVAILABLE, MAKE AN APPOINTMENT.

2a. Is your home equipped with a central storage heater or is it equipped with individual room units?

Central unit - 1 Individual room unit - 2
 IF "CENTRAL UNIT," ASK: IF "INDIVIDUAL ROOM UNITS," ASK:

2b. Do you have any additional units?
 GO TO
 Yes - 1 --> Q. 2d
 No - 2 --> Q. 3

2c. Besides the individual storage units, do you have any additional heating units?
 Yes - 1 --> GO TO Q. 2d
 NO - 2 --> GO TO Q. 3

Fig. 3 Format of First Page of Telephone Interview Questionnaire

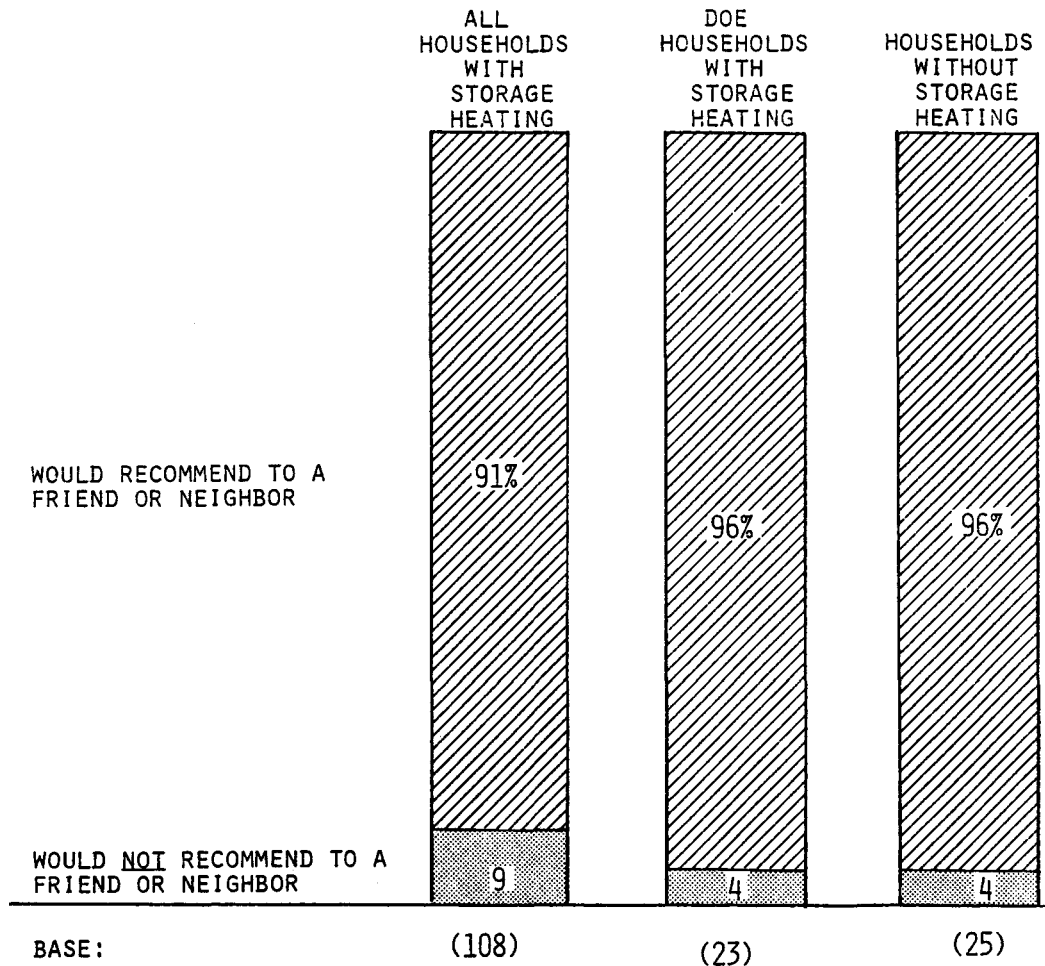


Fig. 4 Attitudes Toward Thermal Energy Storage Systems
(Source: Elrick and Lavidge, Inc.)

6. During an average winter, TES households spent about \$75 per month for electric heat. This operating cost appeared to be about the same as for homes with conventional heating systems, which were mostly electric. About 30% of TES households said \$75 per month was lower than they expected. Few households reported unexpected operating costs.
7. Thermal energy storage households in this survey have the following characteristics:
 - a. Almost all have individual room units rather than central systems.
 - b. Approximately 75% are single-family homes.
 - c. Nearly 66% have had their systems since 1977.
 - d. Most households installed TES as an original heating system.

Table 1 Level of Satisfaction with Current Heating System

Comment or Question Response	All Households with Storage Heating	DOE Households with Storage Heating	Households without Storage Heating
Better than previously owned heating system (%)	59	78	80
Worse than previously owned heating system (%)	5	-	-
About the same as previously owned heating system (%)	34	22	20
First system owned (%)	2	-	-
Base ^a	(106)	(23)	(25)
Why is TES better than other heating systems? (%)			
More economical	59	44	
Cleaner, less mess	38	39	
More even heat	16	6	
Less maintenance	11	17	
Quieter	11	-	
Better heat	10	11	
Individual room control	8	11	
House more comfortable	8	11	
Base ^a	(63)	(18)	
Why is TES worse than other heating systems? (%)			
Lack of heat	80	-	
Poor appearance	20	-	
No cooperation from utility	20	-	
Base ^a	(5)	(0)	

^aNumber of households queried.

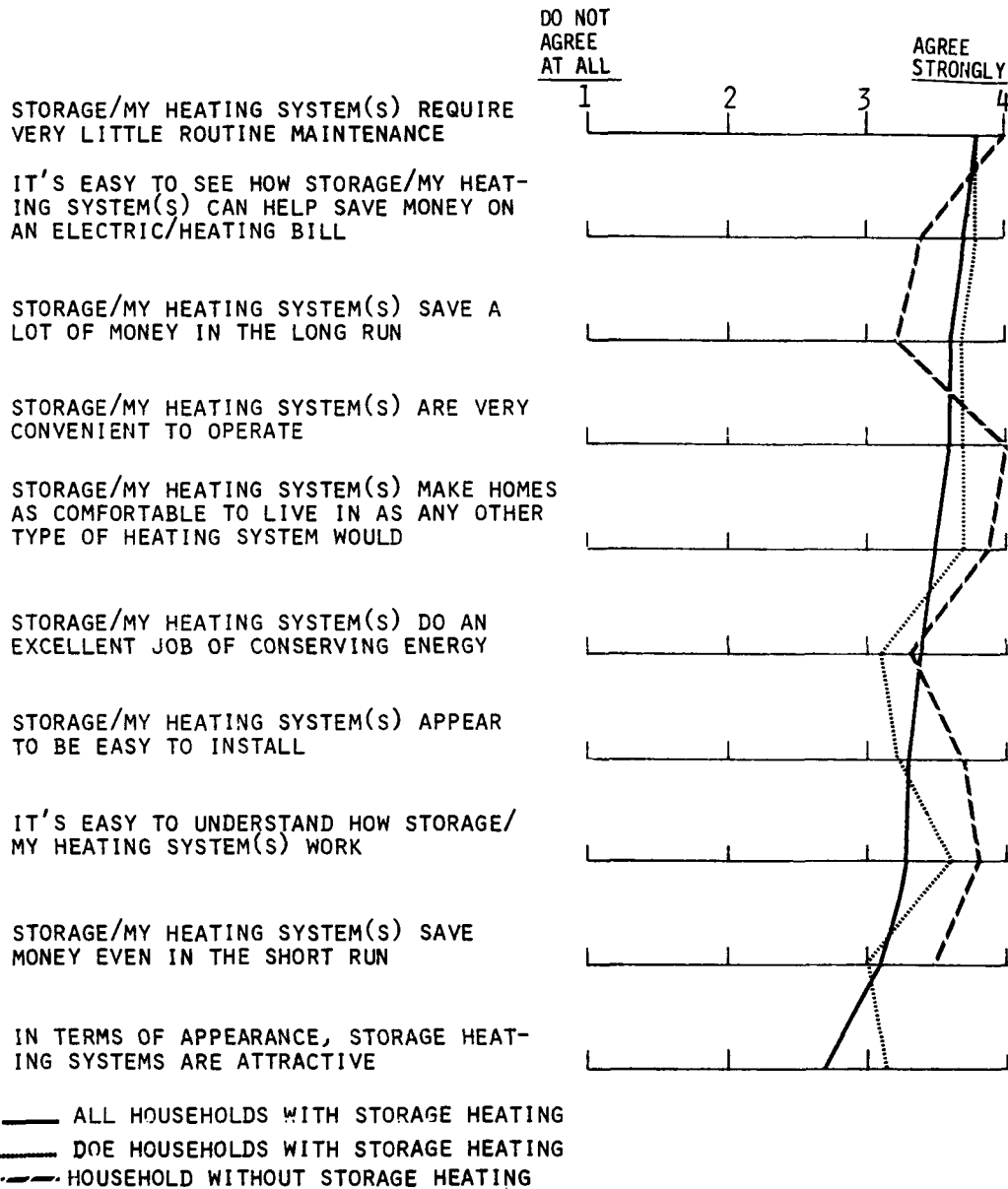


Fig. 5 Range of Opinions on Aspects of Thermal Storage Systems (Source: Elrick and Lavidge, Inc.)

- e. Approximately 66% of TES households have an average of four additional heating units, most of which are electric and are operated for an average of 35 hr/wk.
- f. About 20% of TES households made some kind of energy conservation improvement, mostly in insulation.

Items 5 and 6 imply that some TES owners are satisfied with units that they knew had higher initial costs and that they now know have operating costs equal to conventional units.

5 FACE-TO-FACE INTERVIEWS

5.1 INTRODUCTION

In addition to the formal telephone survey, information on customer acceptance and attitudes was obtained in face-to-face interviews. This data source provides qualitatively different information. If obtained by policy-makers themselves, the data may have more impact (see Sec. 8.2). This report therefore includes a representative sampling of information obtained directly from customers by utility representatives.

5.2 UTILITY CUSTOMER CONTACTS

In the New England field study, the electric utilities were required to follow up on all customer complaints and subsequently to keep in touch with the customer. The following are excerpts from utility records of some of these contacts (customer names have been changed to maintain privacy).

5.2.1 Excerpt from April 1979 Utility Records

April 1979 - To supplement data being collected via magnetic tape devices, we surveyed those participants whose indoor temperature data were nonexistent or perceived to be unsatisfactory. Tabulation includes only the aforementioned participants and is not a complete list of all TES/Control accounts:

	<u>TES</u>
# 4 68°F	No temperature set-backs
# 5 60°F	Set temperature back to 50°F for 10 hr
# 6 68°F	No set-backs
# 7 70°F Living Area 60°F Bedrooms	No set-backs
#12 65°F 55°F Basement	No set-backs

Customers #4 and #12 commented that room temperatures were characteristically 5°F to 8°F different from (above) thermostat settings, but consistent. It would appear that analyses using temperatures would be more nearly correct using 70°F or 71°F, rather than thermostat settings, in nearly all cases surveyed.

Four of the five TES participants contacted rated the system "excellent." The fifth participant, #6, said "satisfactory." Customer #4, who has had problems, primarily because of improper installation, was one of those whose appraisal of TES was "excellent."

Appointments are being set up with each TES participant to explain the physical and rate changes that will follow completion of the research project and to secure a decision on continuing or discontinuing thermal energy storage, or to record their comments or answer their questions.

5.2.2 Excerpt from June 6, 1979 Utility Records

June 6, 1979 - As indicated in previous reports, most TES participants were contacted in May. Some of the situations encountered and comments received follow:

May 1 - Called on the Leonard Abbotts in Caledonia. The Abbotts are pleased with the system. They plan to continue. Otis Moneium, an electrician, will remove the data collection equipment and prepare them for permanent metering, in keeping with their rate selection. They are very bright people and have an excellent grasp of operational adjustments, which they make spring and fall to promote better and more economical functioning of the TES system.

May 5 - Called on Abel Harvey in Windham. Mr. Harvey has not occupied the house. However, his tenant, John Adam, has appreciated the performance of the distributed thermal storage equipment. Mr. Harvey will expand the TES to additional areas and will insulate the cellar walls rather than enlarge the capacity of the units in that area. We were able to assist in this decision as well as to call his contractor's attention to a serious source of heat loss in the cellar ceiling insulation, namely leaving the sill area uncovered. Mr. Harvey will change to our proposed load management rate.

Same Day, PM - Called on the Cyrus Franks in Manchester. The Franks have experienced some discomfort in their kitchen and living room areas, which, upon investigation, seemed to relate directly to an error in the heat loss computation. A window area of 40 square feet was used in the calculation, whereas the actual window area is approximately 120 square feet. The Franks elected the load management rate (A-LM).

May 6, PM - Called on Mr. and Mrs. Marion Chapman. The Chapmans had a problem with inadequate capacity and they have been on an extended charge period throughout most of the winter. The problem stems from dropping from a recommendation of TES capacity. The change took place through Mr. Chapman's reduction of areas to be conditioned. The adjustment should have been enlargement of remaining units to maintain the initial level within the shell. They have a capacity problem with regard to electrical service and distribution, and due to this shortcoming and their general feeling, or attitude, we agreed to take the equipment back as per the initial agreement. Mr. Chapman wants to be the electrician on this job as apparently he was on the installation. We did not comment on this point.

May 7, PM - Conferred with Charles Chen. He expressed satisfaction with the system and will discuss our rate options and stipulations with his parents and inform us of their decision. He leans toward time-of-day rates and would presumably do the electrical work as he did previously.

May 9 - Called on Peter Webber. Mr. Webber and his tenant are pleased with the TES concept and plan to build more condominiums with storage heat on

the A-LM rate. His permanent tenant would like to go on the A-LM rate and would like to do his own wiring. No commitment has been made at this time.

May 13 - Called on Haydn Polacek of Ashland. He is very favorably disposed toward the system and will continue with it. His decision on rate options is still pending. He has written asking that we come back to see him to clarify some matters.

May 14 - P. Watson and I called on P. Goldberg, who is carried as both #1 and #2 on the project. Our visit was productive in that his disenchantment with TES is a function of his particular life-style rather than of a general indictment of storage heat. He requires a flexible system with fast response and expects to forego any rate advantages to get it.

Same Day, PM - Called on Don Webber in Casco. This home was featured in a magazine article. He likes the functioning of the system and wants the A-LM rate. He feels the 10-hr charge will make his system even more satisfactory.

May 15 - Called on R. Taylor in Danforth. This house has considerable passive solar gain. Back along, they had planned to try to sell back two units that they felt were superfluous. We were able to eliminate this unorthodox transaction. They plan to continue on the A-LM rate.

May 15, PM - Called on the R. Swansons. They are enthusiastic about the equipment and plan to use the A-LM rate. Their water heater does not have sufficient capacity to operate on the A-LM rate option at this time. It has been requested that the meters be near or around the southeast corner of the house due to the addition of a greenhouse.

May 19 - Called on Mr. and Mrs. Julian Kenneth in Stowe. The Kenneths have problems that, in our opinion, are due to poorly installed insulation. Nevertheless, they want to take the equipment out and we concur under the circumstances.

6 OTHER STUDIES

Pertinent literature was surveyed to develop a background for the findings of the customer acceptance survey and to determine a basis for extrapolating results on present TES users to future TES users. The Vermont Load Control Study is reviewed in Secs. 6.1 and 6.2. The American Electric Power study is reviewed in Sec. 6.3. Information on general attitudes of typical electric utility customers, who are not users of TES systems, is presented in Sec. 6.4.

6.1 VERMONT LOAD CONTROL SURVEY

A study by Green Mountain Power Corp. (GMP) of 10 houses equipped with hydronic storage systems indicated that after two heating seasons, 1975-1976 and 1976-1977, all users were satisfied with their systems.⁵ Six of these homes were part of the ANL 1978-1979 and 1979-1980 New England field

study. Dollar-savings from hydronic systems in 1976 and 1977 have been analyzed by GMP (Table 2). The GMP analysis points out that the average user of stored heat in the GMP service area saved more than \$200 annually in space heating operating expenses by using off-peak electricity. Average use was 27,345 kWh of electricity, 88.1% of this demand being off-peak. In subsequent heating seasons, there were additional savings, but the statistics are ambiguous because large numbers of wood stoves were being used then to supplement thermal energy storage heaters.

6.2 ATTITUDES TOWARD TIME-OF-DAY RATES

An attempt by GMP to offer a time-of-day (TOD) rate on an optional basis to all of its customers provides relevant information on customer values and attitudes that may relate to customer attitudes toward TES.

The TOD rate offer was introduced to 47,500 residential customers by means of a bill-stuffer. Within six months, 3,500 customers indicated serious interest in the cost-savings of TOD, but, according to GMP, most of these customers eventually dropped TOD because they were more willing to accept higher electric bills than they were to change life-styles.⁵ The relevance of this response to TES is that potential TES customers can achieve dollar savings without having to change life-styles, which should provide a positive bias for TES.

6.3 AMERICAN ELECTRIC POWER SURVEY

Of the participants in the American Electric Power Corp. (AEP) field test of central thermal energy storage heaters, more than 90% said they would recommend TES to friends on the basis of their own experience and virtually all agreed that TES was practical.⁹ These results correspond to the ANL-Elrick and Lavidge survey. Most customers in the AEP survey said thermal performance was satisfactory.

6.4 STUDIES OF CHARACTERISTICS OF RESIDENTIAL ELECTRIC UTILITY CUSTOMERS

Many studies have probed general customer knowledge of electricity concepts, costs, and attitudes toward energy conservation and utilities. The findings of these studies, taken separately, are inadequate because there may be no typical utility customer, because some responses are time-dependent, and because many responses are to hypothetical questions. There appear to be wide variations in levels of knowledge, awareness, and attitudes. However, a synthesis of some studies^{10,11} indicates some noteworthy commonalities among residential customers. For example, residential customers appear to have the following characteristics:

1. A widely varying but mostly poor understanding of the relative energy-intensiveness of electric appliances.
2. An unawareness of time-dependent electricity costs.
3. An ability to understand time-of-day (TOD) rates if explained.

Table 2 Savings from Off-Peak Thermal Energy Storage Heating (Green Mountain Power Corp. analysis of energy consumption for "megatherm" hydronic heat storage customers for year ending June 30, 1977)

Customer	On-Peak ^a (kWh)	Off-Peak (kWh)	Total (kWh)	Rate 11 Bill (\$)	Rate 01 Bill (\$)	Savings (\$)	Savings (%)	kWh Off- Peak (%)	kWh On- Peak (%)
1	4,260	19,820	24,080	784.04	922.30	138.26	15.0	80.9	19.1
2	2,390	22,840	25,230	724.26	935.80	211.54	22.6	90.5	9.5
3	2,590	15,990	18,580	592.66	715.71	123.05	17.2	86.1	13.9
4	3,240	27,070	30,310	867.14	1,108.02	240.88	21.7	89.3	10.7
5	2,190	26,250	28,440	784.28	1,040.85	256.57	24.7	92.3	7.7
6	2,260	26,270	28,530	789.05	1,061.01	271.96	25.6	92.1	7.9
7	5,200	25,650	30,850	959.04	1,129.16	170.12	15.1	83.1	16.9
8	3,310	23,640	26,950	794.97	992.28	197.31	19.9	87.7	12.3
9	2,310	25,490	27,800	775.59	1,025.07	249.48	24.3	91.7	8.3
10	4,910	27,770	32,680	986.04	1,192.18	206.14	17.3	85.0	15.0
Total	32,660	240,790	273,450	8,057.07	10,122.38	2,065.31	20.4	88.1	11.9

^akWh figures are actual consumption for total household. Hot water consumption for July, 1976, was estimated and estimates ranged from 210 kWh to 900 kWh, based on actual August, 1976, consumption.

Source: Ref. 5.

4. A positive attitude, in principle, to TOD and load management concepts.
5. A widely varying ability, or willingness, to change living habits, such as times for bathing and laundering, to avail themselves of TOD rates, unless they are strongly motivated by a conservation ethic.
6. A greater awareness and understanding of electricity and energy costs, and a more favorable attitude toward the utilities, when they participate in an experiment.

7 REVIEW OF THE SURVEYS

7.1 NEW ENGLAND CUSTOMER ACCEPTANCE SURVEY

The questions and execution of the New England customer acceptance survey have been reexamined in order to judge the validity of the findings. The main objective of the survey was to determine how TES users feel about thermal energy storage on the basis of their experiences. Reexamination indicated that the wording of the questions was precise and simple enough to be understood by all the respondents and that the order of the questions seemed to introduce no bias. However, there was some doubt about possible preconditioning of respondents.

Responses to questions can be conditioned by focused information or publicity to which the respondent has been previously exposed. It is known that all respondents in the field study sample had received information in the form of letters, newspaper promotions, advertisements, and bill-stuffers. This information described the advantages of TES heating when combined with off-peak electricity rates (Figs. 6 and 7)^{12,13} and it may be inferred from the demographic profile and other information that respondents in the total sample were aware of potential TES economic and energy conservation benefits. For example, one user, a member of a department at the University of Vermont, commented enthusiastically in TES sales material:¹⁴

Finally, you may quote us as to utilities: The system is fantastic. During the -30° weather, our highest bill was less than \$40.00. Most of the year it has been in the \$20-\$28 range!!

Such information should play only a small role in the attitudes of TES respondents. Respondents would be influenced much more strongly by direct experiences with their storage heaters and the size of their electric bills than previous exposure to publicity. These positive or negative direct experiences provide a realistic basis for assessing user attitudes toward TES. Preconditioning of respondents by exposure to promotional campaigns for TES and TOD is therefore not likely to invalidate the customer acceptance survey.

The survey is believed to have been designed, implemented, and analyzed in a reasonable way that introduces little bias. The telephone questionnaire



GREEN MOUNTAIN POWER CORPORATION

GREEN MOUNTAIN POWER INTRODUCES
NEW OPTIONAL RATES THAT MIGHT
SAVE YOU MONEY ...

The Company has been investigating many possibilities to help keep the cost of your electric bill down and we are now prepared to offer all residential and general service customers new optional rates designed to give customers the opportunity to control the size of their monthly electric bills.

Residential customers will be offered optional rate 11, and general service and industrial customers will be offered optional rate 21. Both optional tariffs will introduce variable prices for electricity, depending on the time of day it is used. Some customers may be able to benefit from adopting the rates and many may not, as explained inside this brochure. The optional residential rate 11 is discussed in detail. Rate 21 will not be extensively discussed, since it is based on the same general principle as rate 11.

Fig. 6 Announcement of Time-of-Day Rates
(Source: Ref. 12)



It may work for you . . . to save big energy dollars on your electric heat!

Everybody knows you *can't store electricity*. It travels at the speed of light and you have to use it at the moment it's produced.

BUT, you can store heat! And electric storage heaters may be the best bet for today's residential customers planning to install electric space heating or water heating in their homes.

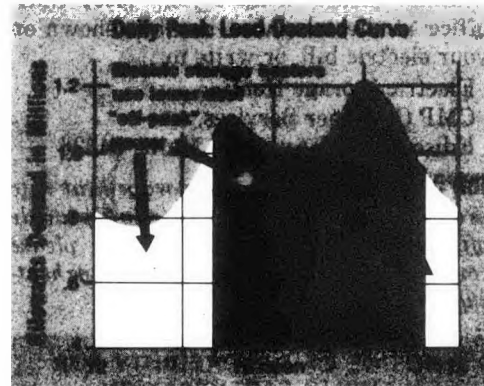
Electric storage heaters can:

1. take advantage of lower cost "off-peak" electricity,
2. adequately meet home heating requirements, and
3. help hold down growth of costly new power facilities.

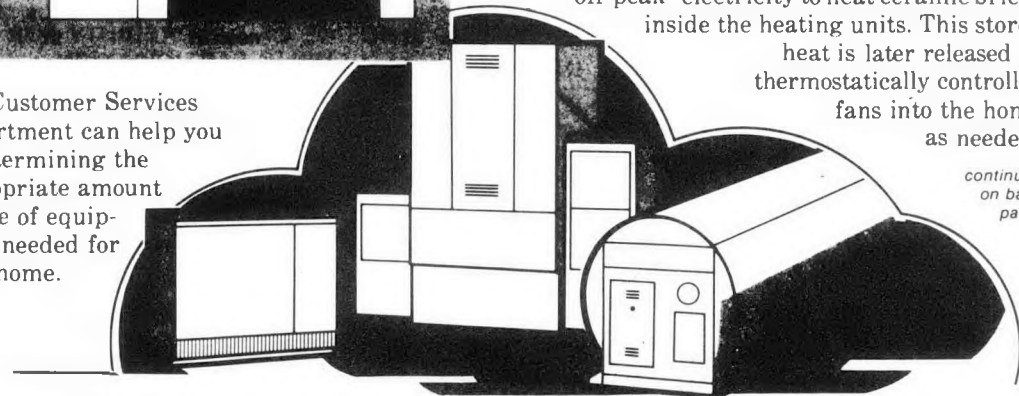
WHY LOWER ENERGY COSTS?

Electric storage heaters use only "off-peak" electricity. "Off-peak" means periods when there is less demand on power generating stations (usually during late night and early morning—see chart) and the cost of producing additional kilowatt-hours of electricity is lowest. In short, electric storage heaters make the most efficient use of CMP's power generating facilities and avoid the need to add costly new plants. They also help lessen the demand for high-cost oil needed to make electricity during "on-peak" hours.

Customers receiving Storage Heat Service from CMP can save up to 30 percent or more on their energy costs because the energy cost per kilowatt-hour (including fuel cost



Our Customer Services Department can help you in determining the appropriate amount or size of equipment needed for your home.



Storage heaters can be purchased as individual units or central warm air systems. Central hot water home heating systems use either bricks or water to store the heat then circulate water for house heating as needed. Special water heaters (for household hot water needs) are also available and use the same concept.

adjustment) is currently about 3.6¢ compared to about 5.2¢ for regular residential service. A separate meter is used to provide and record only "off-peak" electricity to storage heat systems.

Just like CMP's Kilowatt Saving Time and Time-of-Day Rates, electric storage heating can help hold down the need for costly new power facilities and can make *more efficient use of existing plants*. This means a more economical power supply for all our customers.

HOW DO STORAGE HEATERS WORK?

Electric storage heaters basically use "off-peak" electricity to heat ceramic bricks inside the heating units. This stored heat is later released by thermostatically controlled fans into the home as needed.

*continued
on back
panel*

Fig. 7 Promotional Flyer on Storage Heat (Source: Ref. 13)

covered the essential questions and presented them in as neutral a way as possible. Because the survey included more than 100 TES households and because questions were answered on the basis of experience, it is felt that the survey results are valid.

7.2 FACE-TO-FACE INTERVIEWS

Face-to-face interviews can be a strong adjunct to formal surveys in forming policy. In one directly observed case, the attitude of a utility toward TES went from guarded neutrality to enthusiasm. Central Maine Power Corp. acknowledges that personal contacts provided direct information on the attitudes of most of its TES customers toward their heating systems. As a result of its net evaluation of customer attitudes, the utility offered TES as a regular feature of its own load management program, rather than on an experimental basis, in spite of several start-up problems and some negative reactions.

7.3 ECONOMICS AND DEMOGRAPHY

The two principal perceptions of representative TES users were:

1. Thermal energy storage heating provides thermal comfort.
2. Economics was an important motivation in installing TES systems.

The first perception is believed to be essentially correct. The survey showed that a small percentage of TES users experienced inadequate heating at times, a generic possibility because TES operates from a fixed and finite energy supply. Furthermore, there is a tendency to install less TES capacity than may be needed during extremely cold weather, because of high capital cost. Not enough information is available from the survey to determine whether or not these few homes were adequately equipped or insulated. However, the answers in the questionnaire established the inherent reliability of adequately sized TES systems and the acceptability of TES technology.

The conclusion that owners were motivated mainly by the economics of TES is less secure. First, most of the TES households paid for their systems without a subsidy of any kind. Although there was an installation subsidy in the relatively small Maine experiment, there were five times as many unsubsidized TES homes as partially subsidized homes.

TES owners also perceived TES to have a high investment cost and an operating expense comparable to electric baseboard heating. This perception is inconsistent with the perception that economics was an important motivation in installing TES. (The average TES capital cost, according to the survey, was more than twice the cost of a conventional electric heat system, and TES operating costs were about the same or slightly lower than conventional system costs.)

Such inconsistencies in survey answers are not unusual. Leading questions in questionnaires are well known, and the concept of a rational economic person may be a theoretical convenience rather than a reality.

However, in this case, the different demographic characteristics of TES owners may have affected the results. The survey indicates that 50% of the DOE-TES households had total annual incomes greater than \$25,000, whereas only 18% of the control homes were in that income group. In the group with incomes below \$12,000, 18% of the households had TES and 32% of the households did not. Thus, the survey sample, while representative, distinctly correlates TES with affluence. This is not unexpected, considering the incremental capital cost of TES, but it may explain in part why many TES owners are satisfied with TES systems that they believe cost more to run and operate than conventional heating systems. The practical meaning is that the first market for TES will be the relatively affluent home owners and home buyers.

8 CONCLUSIONS

The main conclusions of this study pertain to attitudes, customer acceptance, and the market for TES. Most users have a positive attitude toward thermal energy storage and would recommend it to a friend or neighbor. The stated principal motivation for using TES heating is economics. Users of TES accept thermal energy storage technology as being as practical as conventional heating. This acceptance is based on adequate TES performance, in the experience of most users. In the residential heating system market, TES systems initially will be of greater interest to relatively affluent home owners and home buyers because of the high incremental cost of TES, compared to conventional electric heating.

The conclusions of this study should be of interest to private and public policymakers, and others, because the results appear to confirm the general acceptance of thermal energy storage heating and specifically the potential for TES in the affluent portion of the market for residential heating systems.

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APPENDIX: A SURVEY OF CUSTOMER ACCEPTANCE OF THERMAL
ENERGY STORAGE IN NEW ENGLAND*

A.1 BACKGROUND AND PURPOSE OF THE STUDY

Under a grant from the U.S. Department of Energy (DOE), ANL began a residential thermal energy storage (TES) heating experiment in the fall of 1978. The experiment involved about 50 single-family dwelling units, half of which were retrofitted with storage heating systems. The other units constituted a control group and were without storage heating. All the residences were located in New England, primarily in Vermont, and all participated in this experiment on a voluntary basis. While the participants paid for the storage units themselves, DOE paid the installation cost, which was the larger of the two costs.

In addition to dwellings in the ANL-DOE experiment, other residences in New England have been retrofitted with TES heating through programs offered by local electric utilities, primarily Central Vermont Public Service Corp. These storage heating units have been in place for varying lengths of time, some units having been installed in the early 1970s.

At the time of this study, homes participating in the ANL-DOE experiment had completed their first heating season. The purpose of this study was to determine customer acceptance of storage heating. To do this, the study examined customer attitudes toward TES and the level of customer satisfaction with this new heating system.

A.2 RESEARCH PROCEDURE

Telephone interviews were completed with 133 respondents from a list of 219 households, the latter containing 190 residences with storage heating, including the ANL-DOE TES homes. The remaining households on the list were homes with conventional heating systems and were in the ANL-DOE control group. In total, 108 interviews were completed from the list of 190 homes equipped with storage heating, 23 of these being ANL-DOE homes. Twenty-five interviews were completed from the list of 29 homes with conventional heating.

In order to secure cooperation, a letter of introduction was sent to each household on the list about a week before the telephone interview. A copy of the letter sent to the residences with and without storage heating is included in this appendix. About two weeks after the telephone interviewing was completed, a letter was sent, thanking each respondent participating in the study.

*This appendix was adapted from text prepared for Argonne National Laboratory in July 1979 by Elrick & Lavidge, Inc., 10 S. Riverside Plaza, Chicago.

The telephone interview was with the person who indicated being most responsible for having the TES system installed. The respondents were in Vermont, Connecticut, and Maine. The interviewing occurred between May 17 and June 5, 1979.

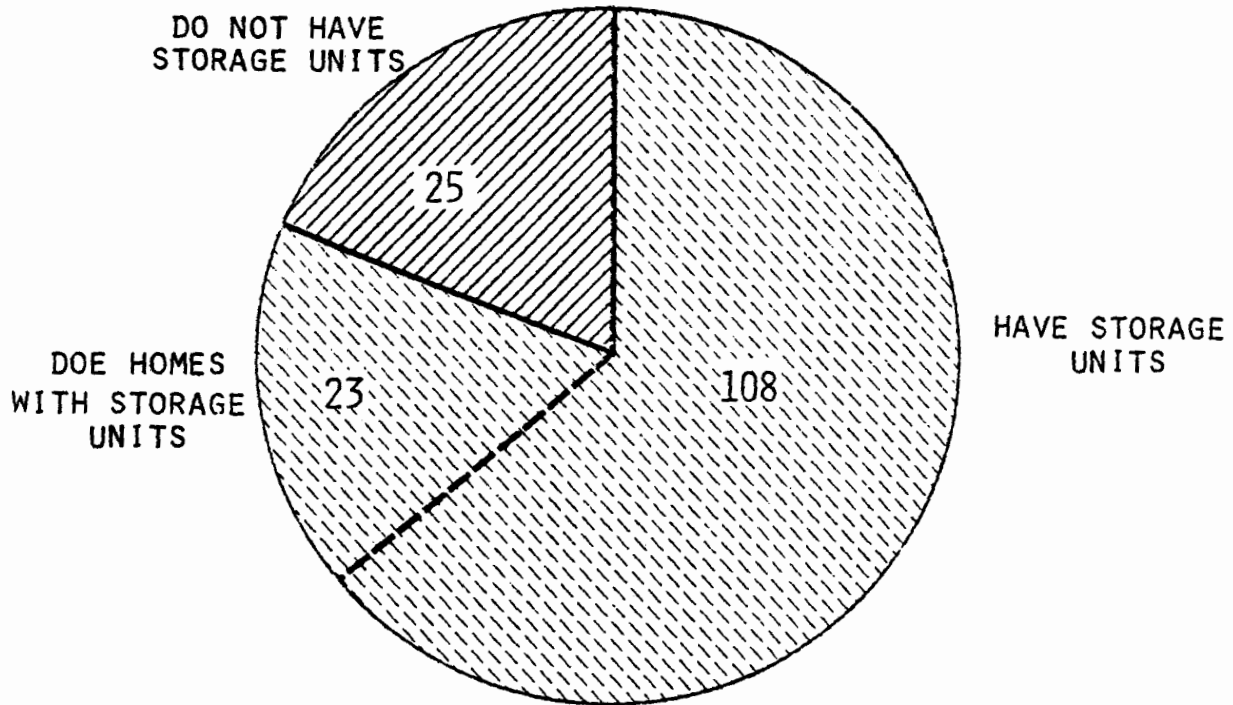
A.3 SUMMARY AND CONCLUSIONS

1. Households with TES had the following characteristics:
 - a. Almost all had individual room units rather than a central system.
 - b. About 75% were single-family homes.
 - c. About 66% were residences that were occupied all year.
 - d. Nearly 66% had TES installed in 1977 or since then.
 - e. Most had TES installed as the original heating system, not as a replacement for an existing system.
 - f. About 66% had additional heating units. (The average was 4 additional units, most of which were electric that operated for an average of 35 hr/wk).
 - g. About 20% had some sort of energy conservation improvement, mostly insulation.
2. Thermal energy storage heating was installed mainly for economic reasons.
3. The most frequently mentioned TES problems were:
 - a. Temperature control.
 - b. Defective parts.
 - c. Inadequate heat.

On the average, none of these problems was regarded as "very serious." Manufacturers and installers were blamed most frequently for the problems.

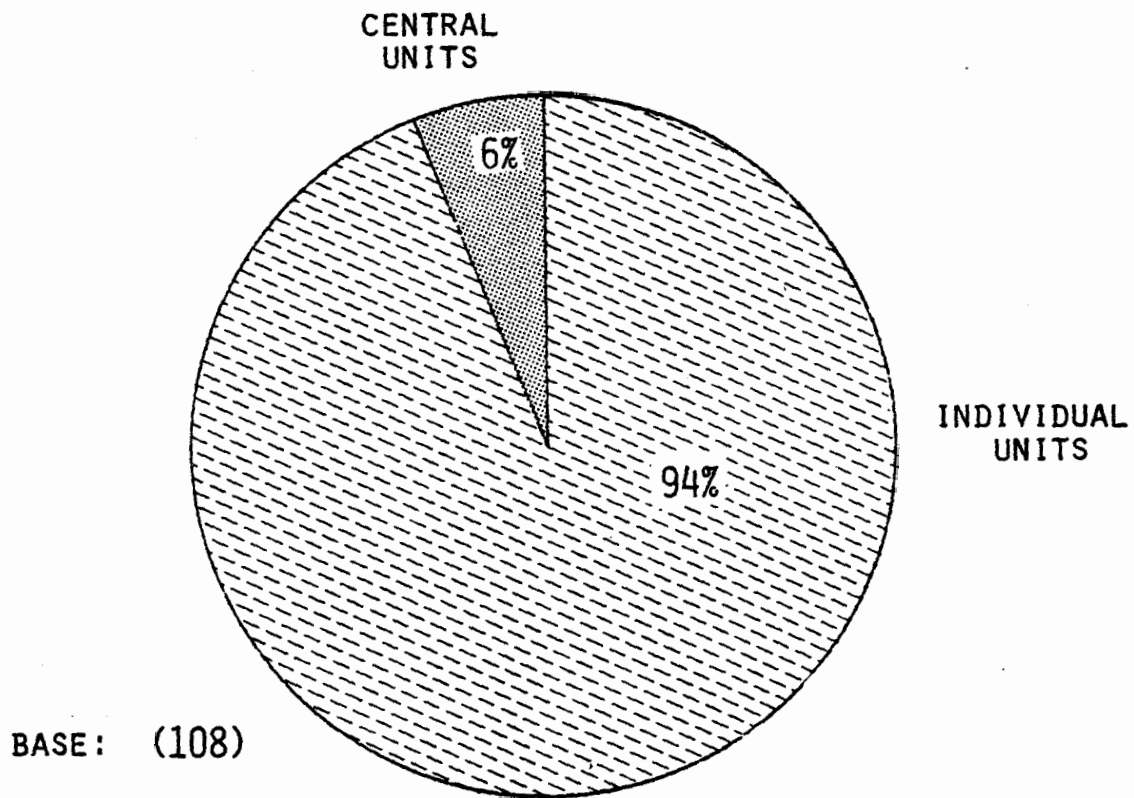
4. Households with TES paid about \$3,000 for installation, or more than twice the cost of conventional heating systems. However, most TES households expected to pay about that amount, and few households reported unexpected installation costs.
5. Respondents spent an average of about \$75 per winter month for electricity for heating.
 - a. This amount appeared to be about the same as that paid by homes with conventional heating systems, which were mostly electric.
 - b. About 30% said \$75/mo was lower than they expected; 60% said \$75/mo was about what they expected.

- c. Few households reported unexpected operating costs.
6. Residences with TES appeared to have thermostats set slightly lower than residences with conventional heating systems.
7. Compared with owners of conventional heating systems, TES owners appeared convinced that TES would save money in the long run. However, TES owners appeared less confident of other aspects of TES, such as:
 - a. Convenience of operation.
 - b. Comfort level.
 - c. Ease of installation.
 - d. Ease of understanding how the system operates.
 - e. Capability for saving money in the short run.
8. Almost 60% of the TES owners considered their system to be better than their previous heating system, largely because it is more economical and cleaner-operating.
9. Overall satisfaction with TES seems to be quite high, as
 - a. Ninety percent of the owners would have TES installed again.
 - b. Ninety percent would recommend TES to a friend or neighbor.
10. The changes most frequently suggested for TES were to:
 - a. Make the TES units smaller, possibly recessing them into walls.
 - b. Improve the appearance of the units by making them look more like furniture and making them available in more colors.



TOTAL NUMBER OF HOUSEHOLDS: (133)

Fig. A.1 Composition of Sample



BASE: (108)

Fig. A.2 Type of Thermal Energy Storage Unit

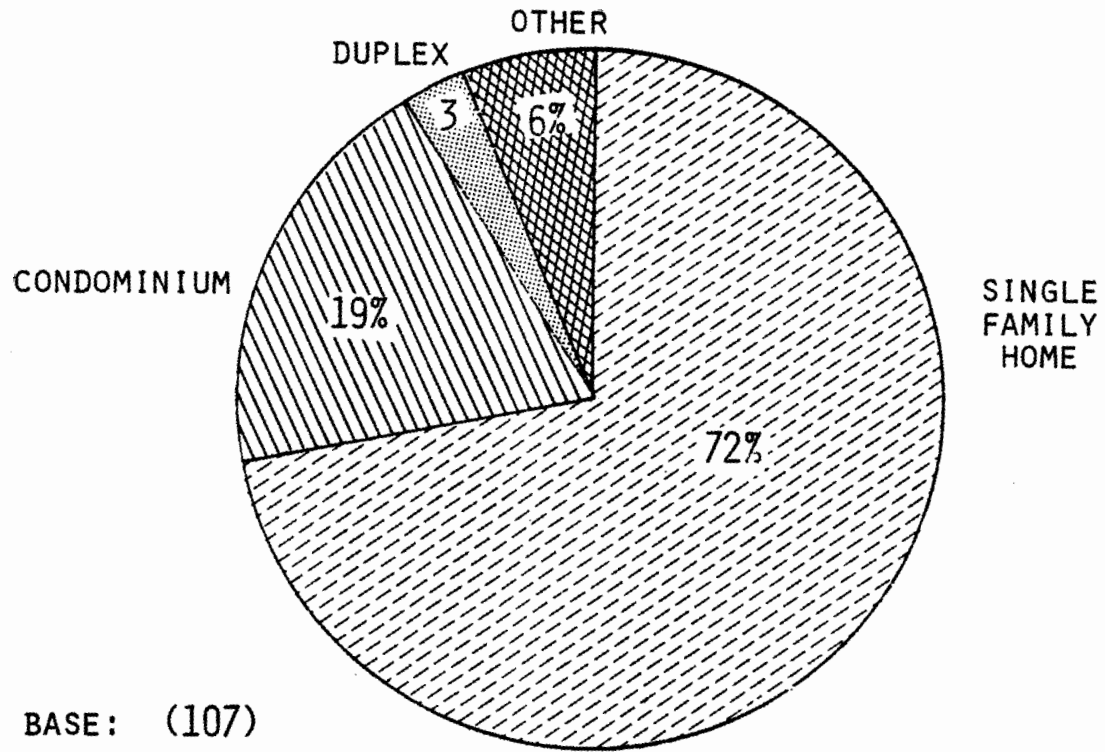


Fig. A.3 Types of Dwellings with Thermal Energy Storage Heating

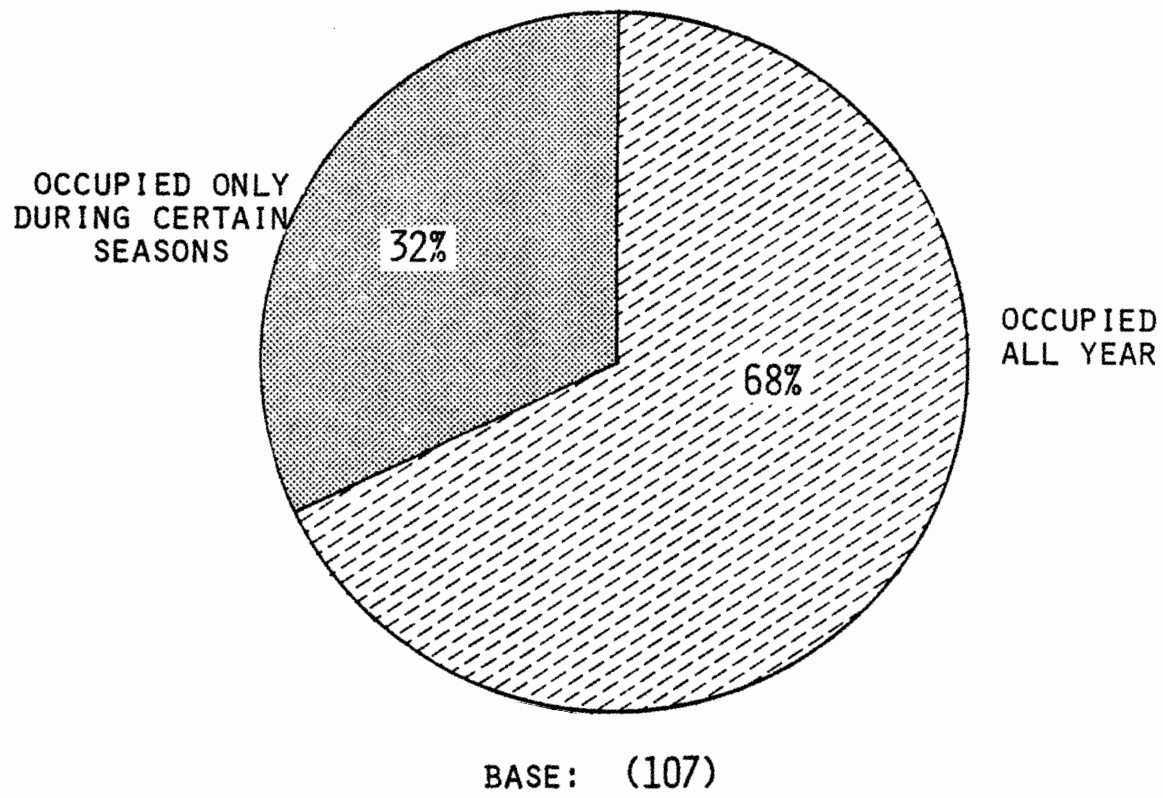


Fig. A.4 Occupancy of Dwellings with Thermal Energy Storage Heating

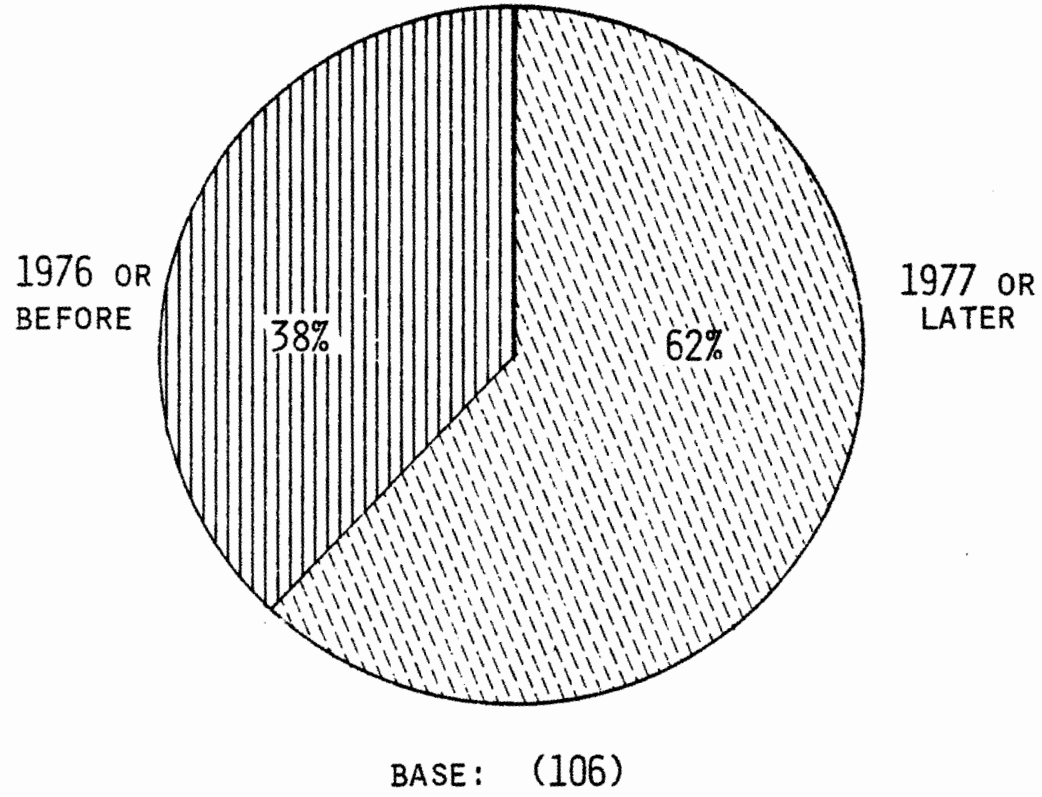
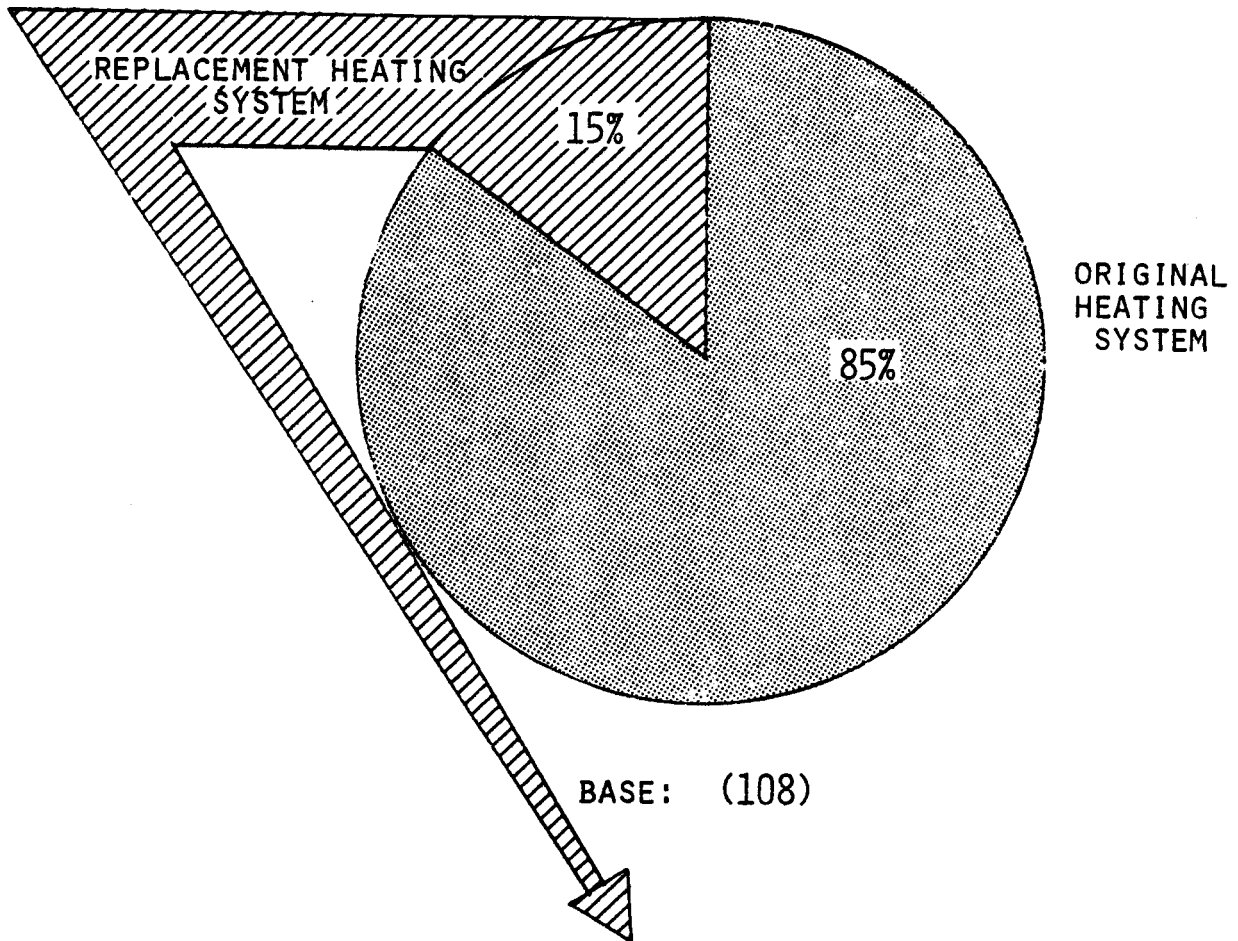


Fig. A.5 Period when Thermal Energy Storage Heating was Installed

Table A.1 Reasons for Installing Thermal Energy Storage Heating

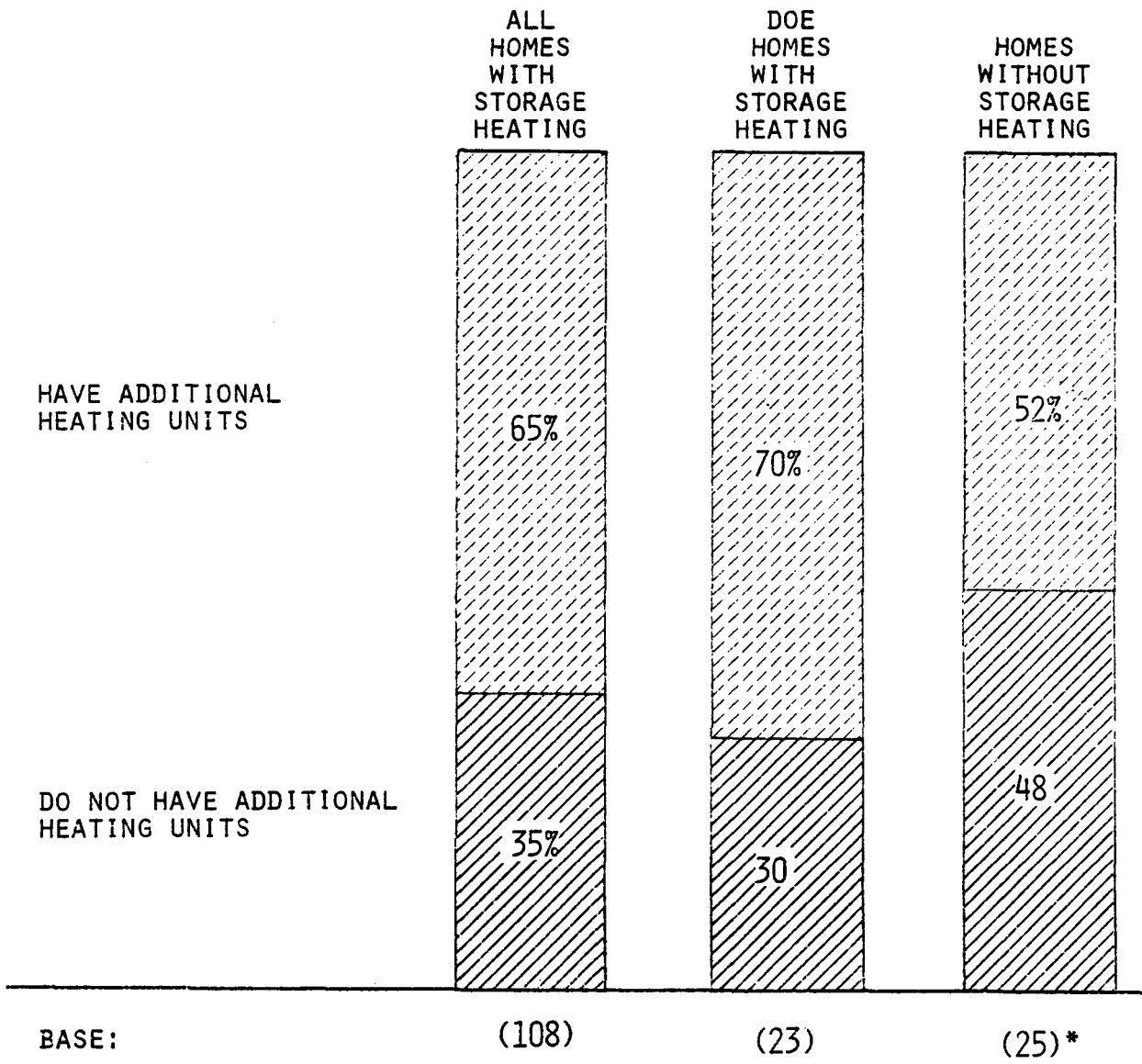
ECONOMICS (NET)		66%
CHEAPER TO OPERATE	26%	
ECONOMICAL REASONS	19	
OFF-PEAK COST OF RUNNING IT	15	
REASONABLE/COMPETITIVE PRICE	7	
REASONABLE INSTALLATION COST	5	
GOT A GOOD DEAL	3	
EXPECTED RATE INCREASE FOR OTHER TYPES OF ENERGY	2	
ALTERNATIVE TO OTHER FUELS (NET)		13
ALTERNATIVE TO OIL	9	
ALTERNATIVE TO CONVENTIONAL HEAT	4	
ALTERNATIVE TO GAS	1	
ALREADY INSTALLED		13
CLEANER (NET)		12
CLEANER/LESS MESSY	10	
NO CHIMNEYS TO CLEAN	2	
CONSERVATION (NET)		11
ENERGY CONSERVATION	8	
ENERGY CRISIS/MAY RUN OUT OF OIL	3	
BEST FROM STANDPOINT OF OUR HOUSE CONSTRUCTION		7%
AVAILABILITY OF ELECTRICITY (NET)		7
AVAILABILITY OF ELECTRICITY	5%	
HAVE TO USE ELECTRIC ENERGY	2	
LESS MAINTENANCE		5
BASE:		(108)



WHAT DID IT REPLACE?

ELECTRIC	56%
OIL	38
GAS	6
BASE:	(16)

Fig. A.6 Dwellings with Original or Replacement Thermal Energy Storage Heating



*24/25 HAVE ELECTRIC HEAT

Fig. A.7 Dwellings with Additional Heating

Table A.2 Type, Number, and Use of Additional Heating Units

<u>ALL HOMES WITH STORAGE HEATING</u>	<u>PROPORTION OF HOUSEHOLDS WITH UNIT</u>	<u>AVERAGE NUMBER OF UNITS</u>	<u>AVERAGE USE (HOURS/WEEK)</u>
<u>TYPE OF UNIT</u>			
ELECTRIC	69%	4.0	35
OIL/WOOD	39	1.4	76
OTHER	3	1.0	*
BASE:	(70)		

DOE HOMES WITH
STORAGE HEATINGTYPE OF UNIT

ELECTRIC	56%	3.4	56
OIL/WOOD	50	1.4	32
OTHER	6	1.0	*
BASE:	(16)		

HOMES WITHOUT
STORAGE HEATINGTYPE OF UNIT

ELECTRIC	-	-	-
OIL/WOOD	77%	1.2	66
OTHER	23	1.3	29
BASE:	(13)		

*DON'T KNOW

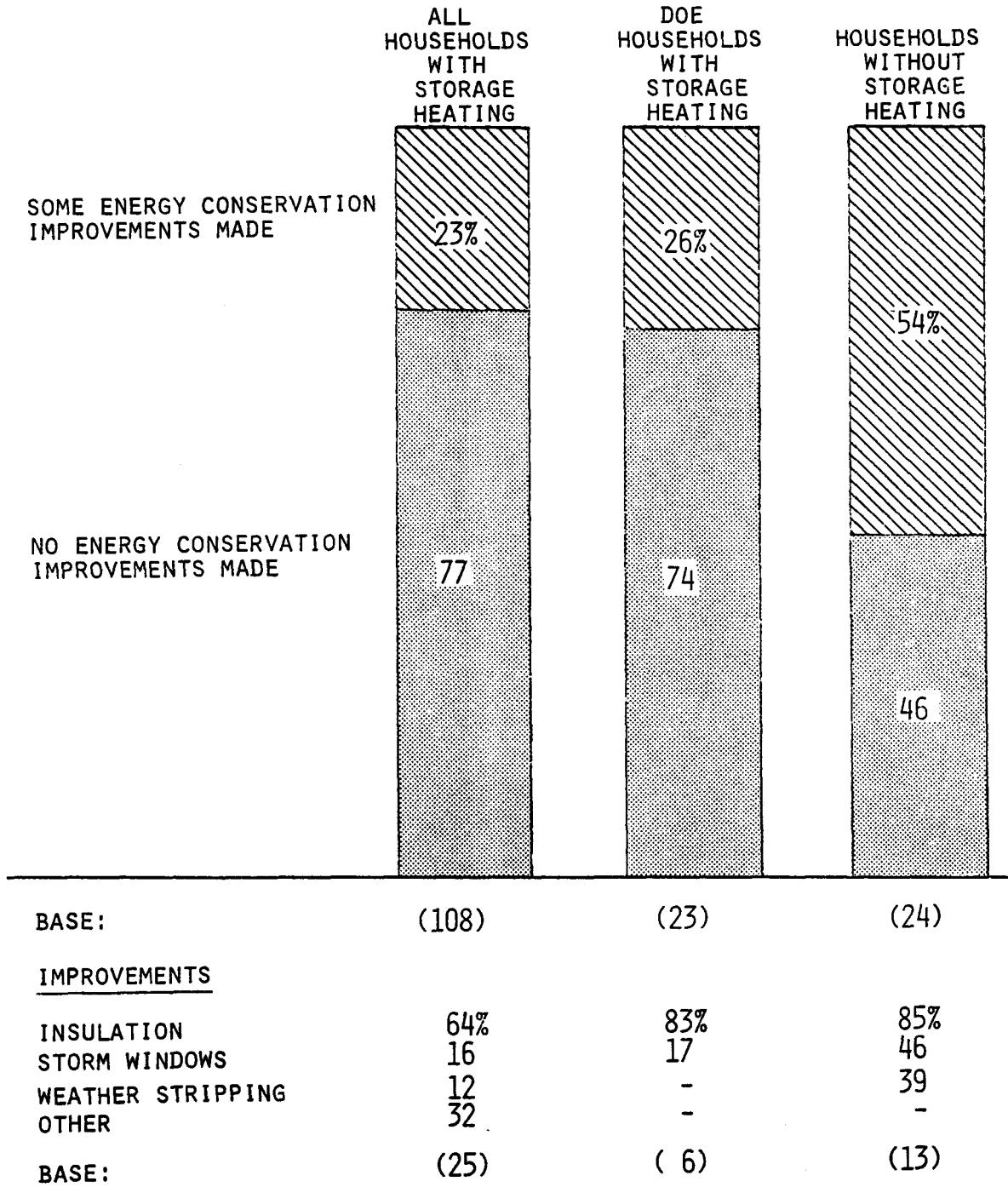


Fig. A.8 Dwellings with Energy Conservation Improvements

Table A.3 Problems Reported with Thermal Energy Storage Heating

TEMPERATURE CONTROL (NET)		22%
CONTROL DEVICE PROBLEMS	14%	
THERMOSTAT CONTROL PROBLEMS	6	
TEMPERATURE FLUCTUATION	3	
DEFECTIVE PARTS (NET)		17
DEFECTIVE WIRING	5	
DEFECTIVE PARTS	5	
BLOWER MALFUNCTION	4	
BURNED OUT PARTS	3	
BAD/DEFECTIVE ELEMENT	2	
INADEQUATE HEAT (NET)		14
INADEQUATE HEAT IN SOME PARTS OF THE HOUSE	5	
RAN OUT OF HEAT BY LATE AFTERNOON	5	
SOMETIMES RAN OUT OF HEAT	4	
DOES NOT HEAT ADEQUATELY	1	
INSTRUCTIONS (NET)		8
INSTRUCTIONS HARD TO UNDERSTAND	6	
INSTRUCTIONS IN GERMAN	3	
TOO MUCH HEAT		7
REQUIRED ADJUSTMENTS (NET)		7%
INITIAL ADJUSTMENTS TO GET PROPER HEAT	4%	
ADJUSTMENTS FOR WEATHER CHANGES	3	
DEFECTIVE UNIT		6
FAULTY INSTALLATION		6
NO PROBLEMS		37
BASE:		(108)

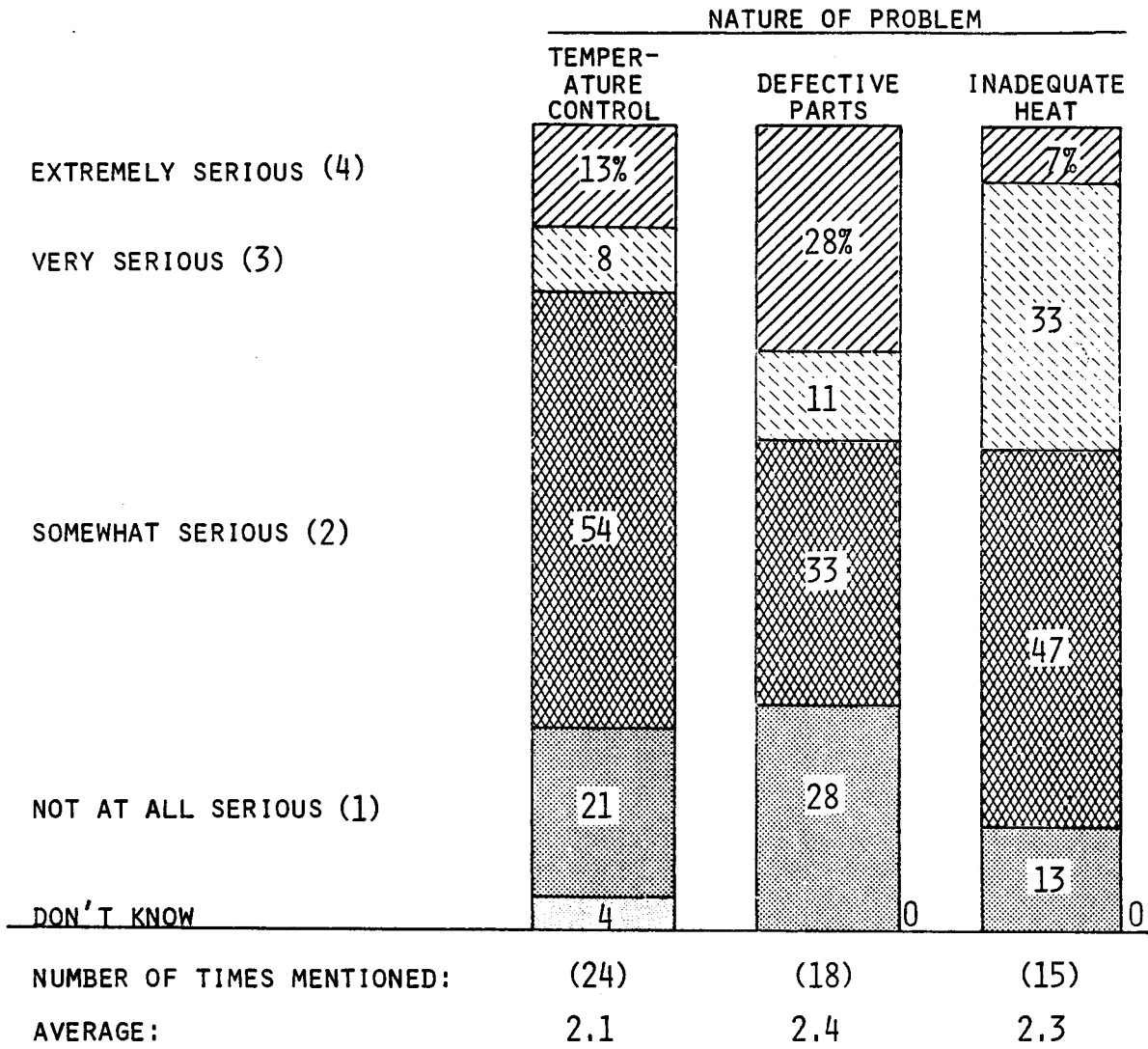


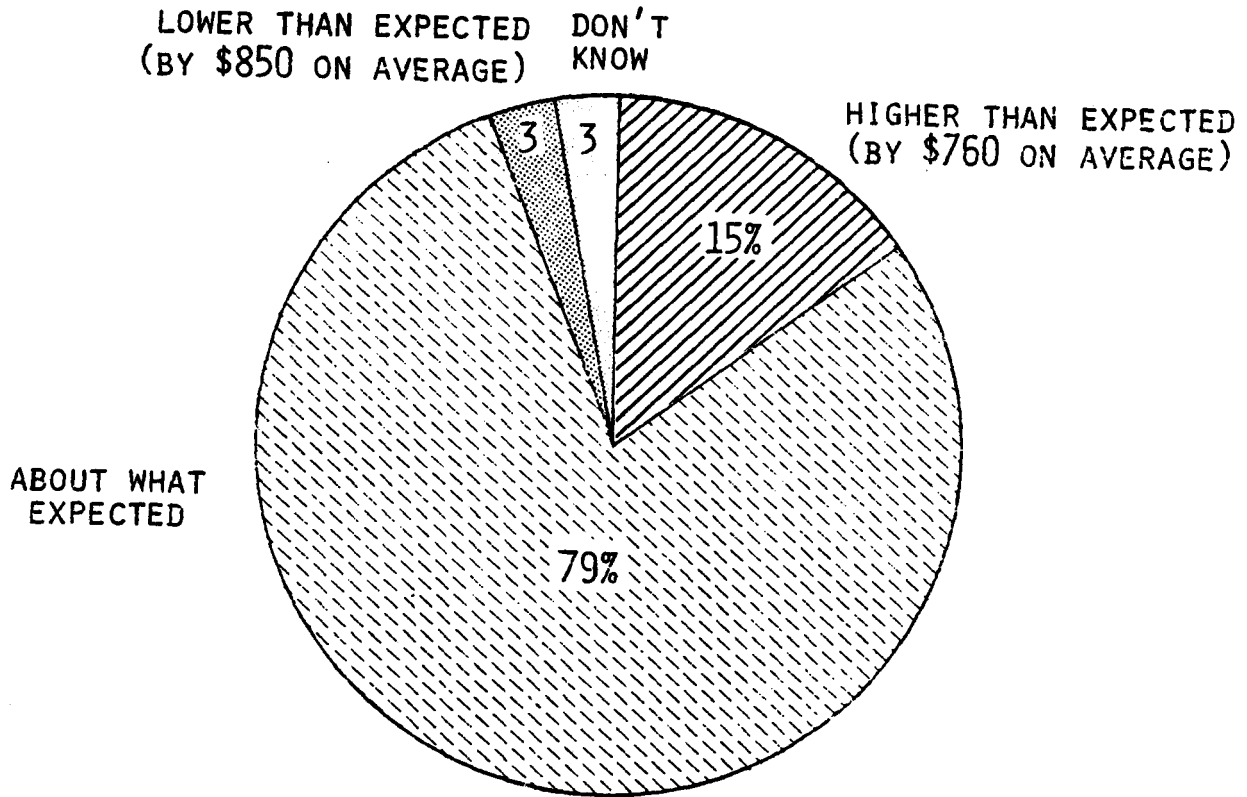
Fig. A.9 Degree of Seriousness of Problems Reported with Thermal Energy Storage Heating

Table A.4 Sources of Most Frequently Reported Problems with Thermal Energy Storage Heating

	TOTAL SAMPLE	NATURE OF PROBLEM		
		TEMPERA- TURE CONTROL	DEFECTIVE PARTS	INADEQUATE HEAT
MANUFACTURER	44%	50%	61%	20%
INSTALLER	14	4	22	13
USERS	7	8	6	-
DESIGN ENGINEER	6	4	-	20
UTILITY	3	4	-	-
DEALER	3	4	-	7
DON'T KNOW	23	25	11	33
NUMBER OF TIMES MENTIONED	(103)	(24)	(18)	(15)

Table A.5 Installation Costs for Thermal Energy Storage and Conventional Heating Systems

	HOUSEHOLDS WITH STORAGE HEATING	HOUSEHOLDS WITHOUT STORAGE HEATING
UNDER \$1,500	11%	57%
\$1,500 - \$2,499	24	43
\$2,500 - \$3,499	37	-
\$3,500 - \$4,499	19	-
\$4,500 AND OVER	9	-
NUMBER OF PEOPLE WHO KNEW WHAT THEY PAID	(63)	(7)
AVERAGE	2,940	1,270
DON'T KNOW	41	18



NUMBER OF PEOPLE WHO
KNEW WHAT THEY PAID: (62)

Fig. A.10 Expectations of Thermal Energy Storage Heating Installation Costs

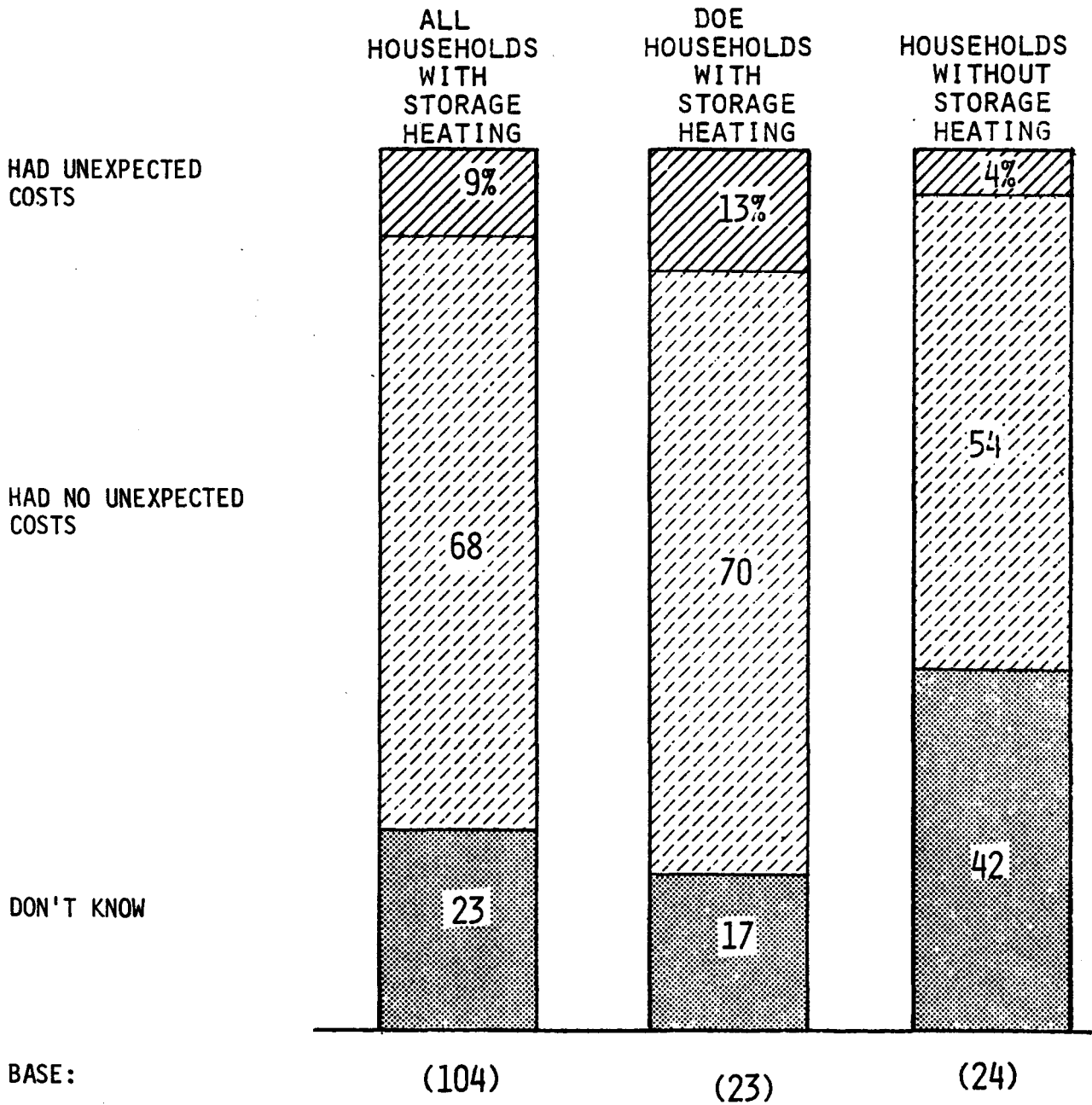


Fig. A.11 Unexpected Installation Costs for Thermal Energy Storage and Conventional Heating

Table A.6 Costs, Cost Expectations, and Unexpected Costs of Operating Thermal Energy Storage and Conventional Heating Systems

	<u>ALL HOUSE- HOLDS WITH STORAGE HEATING</u>	<u>DOE HOUSE- HOLDS WITH STORAGE HEATING</u>	<u>HOUSE- HOLDS WITHOUT STORAGE HEATING</u>
<u>MEAN ELECTRIC BILL FOR HEAT IN AN AVERAGE WINTER MONTH</u>	\$75.50	\$69.70	\$74.00
BASE	(80)	(20)	(7)
DON'T KNOW/NO ANSWER	28	3	18
 <u>COST EXPECTATIONS</u>			
HIGHER THAN EXPECTED	10%	9%	18%
ABOUT WHAT EXPECTED	58	67	73
LOWER THAN EXPECTED	32	24	9
BASE:	(93)	(21)	(22)
 <u>UNEXPECTED EXPENSES</u>			
YES	9%	13%	12%
NO	91	87	88
BASE:	(107)	(23)	(25)

Table A.7 Daily Variations in Temperature Settings for Thermal Energy Storage and Conventional Heating Systems (°F)

<u>TIME OF DAY</u>	<u>ALL HOUSE-HOLDS WITH STORAGE HEATING</u>	<u>DOE HOUSE-HOLDS WITH STORAGE HEATING</u>	<u>HOUSE-HOLDS WITHOUT STORAGE HEATING</u>
EARLY MORNING HOURS (7:00 AM - 12:00 NOON)	64*	65	66
AFTERNOON HOURS (12:00 NOON - 5:00 PM)	64	65	66
EARLY EVENING HOURS (5:00 PM - 8:00 PM)	65	67	68
LATE EVENING HOURS (8:00 PM - 11:00 PM)	65	66	67
NIGHTTIME HOURS (11:00 PM - 7:00 AM)	64	64	64
BASE:	(105)	(23)	(25)

*INCLUDES MORE HOMES WHICH ARE SEASONALLY OCCUPIED

Table A.8 Agreement or Disagreement with Statements About Thermal Energy Storage Heating

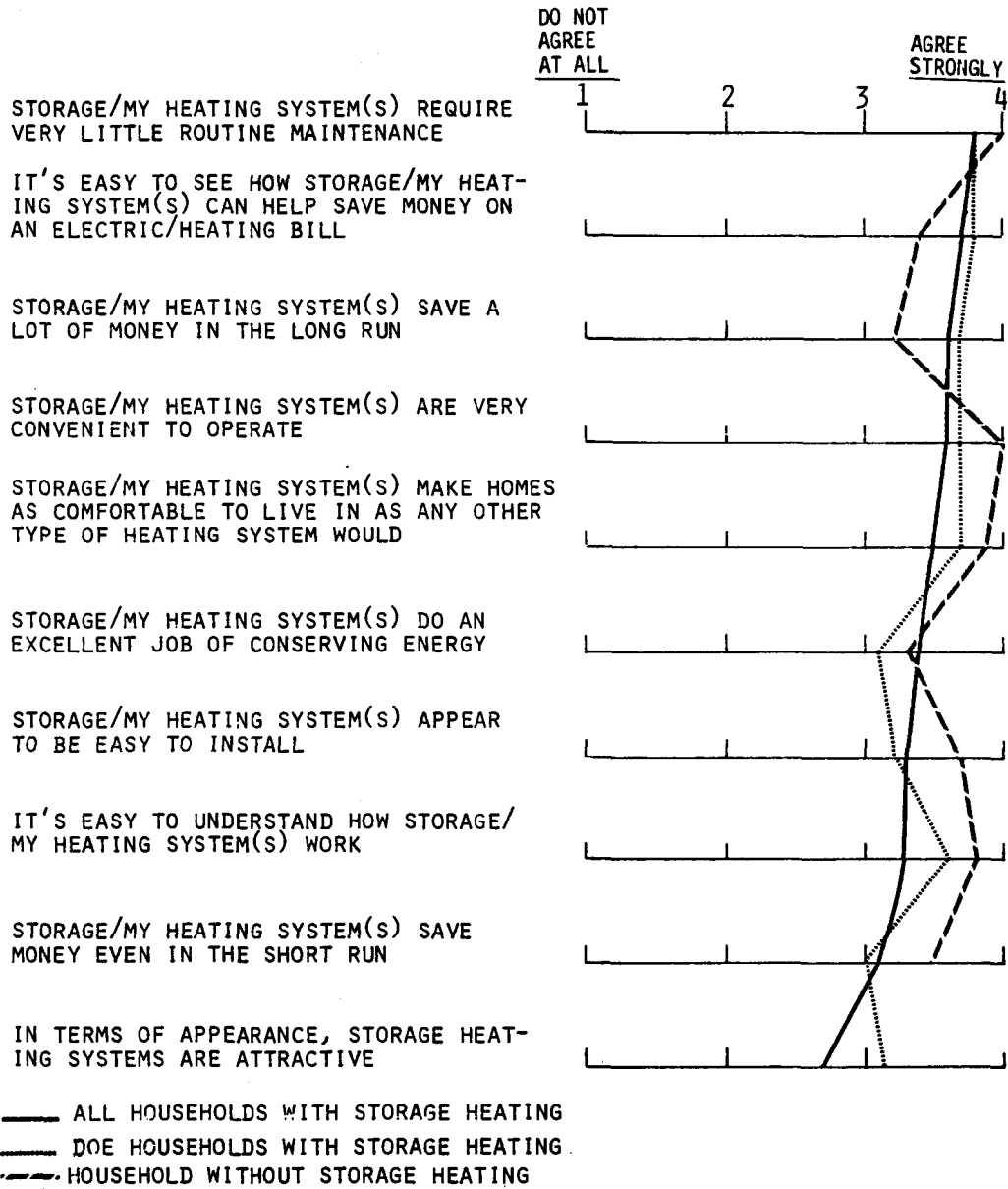


Table A.9 Degree of Satisfaction with Thermal Energy Storage
or Conventional Heating System

	<u>ALL HOUSE- HOLDS WITH STORAGE HEATING</u>	<u>DOE HOUSE- HOLDS WITH STORAGE HEATING</u>	<u>HOUSE- HOLDS WITHOUT STORAGE HEATING</u>
<u>BETTER THAN HEATING SYSTEM PREVIOUSLY OWNED</u>	59%	78%	80%
<u>WORSE THAN HEATING SYSTEM PREVIOUSLY OWNED</u>	5	-	-
<u>ABOUT THE SAME AS HEATING SYSTEM PREVIOUSLY OWNED</u>	34	22	20
FIRST SYSTEM OWNED	2	-	-
BASE:	(106)	(23)	(25)

WHY IS STORAGE HEATING BETTER THAN OTHER HEATING SYSTEMS?

MORE ECONOMICAL	59%	44%
CLEANER/LESS MESSY	38	39
MORE EVEN HEAT	16	6
LESS MAINTENANCE	11	17
QUIETER	11	-
BETTER HEAT	10	11
INDIVIDUAL ROOM CONTROL	8	11
HOUSE MORE COMFORTABLE	8	11
BASE:	(63)	(18)

WHY IS STORAGE HEATING WORSE THAN OTHER HEATING SYSTEMS?

LACK OF HEAT	80%	-
POOR APPEARANCE	20	-
NO COOPERATION FROM UTILITY	20	-
BASE:	(5)	(0)

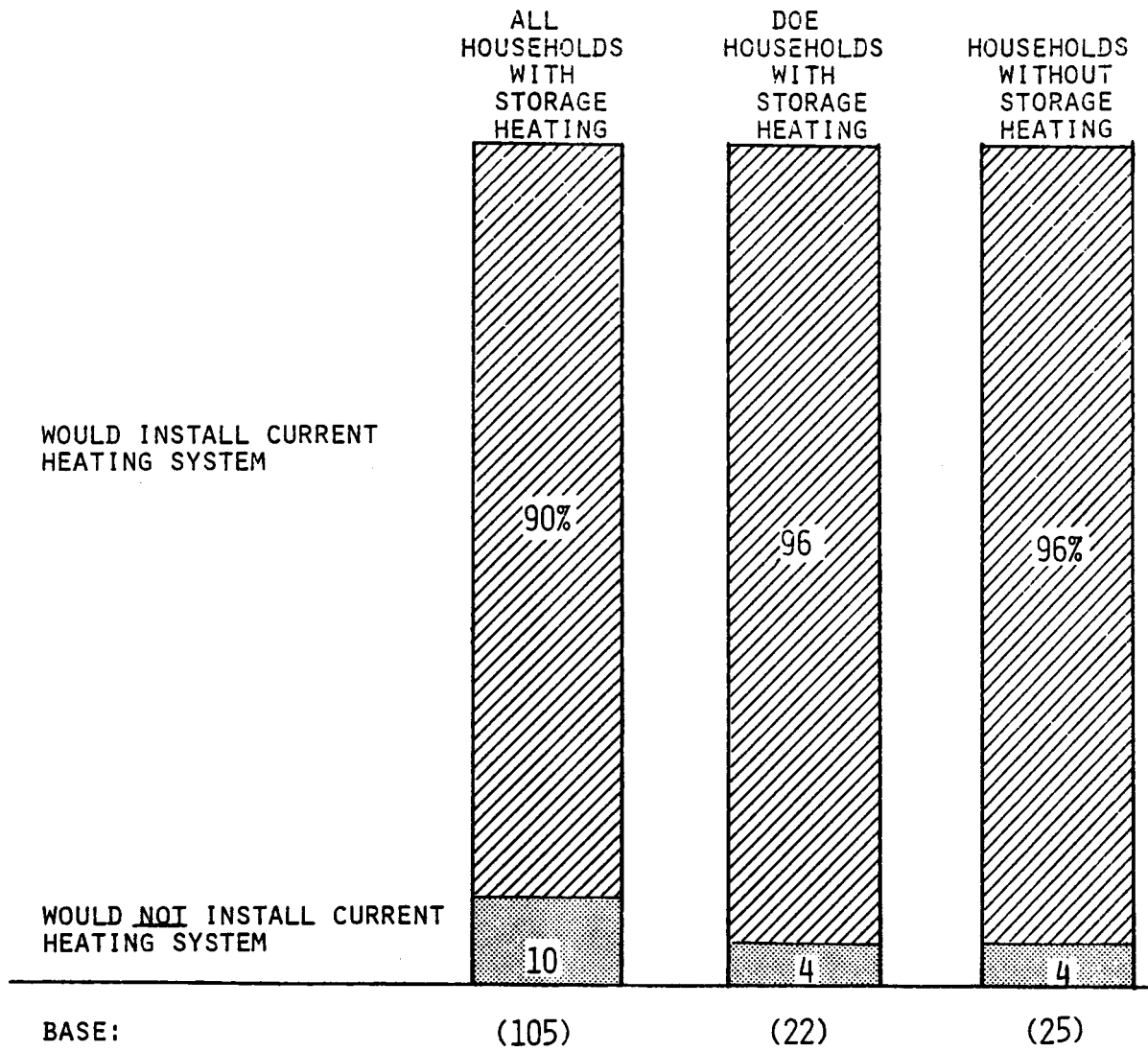


Fig. A.12 Owners Who Would Again Install Their Present Thermal Energy Storage or Conventional Heating Systems

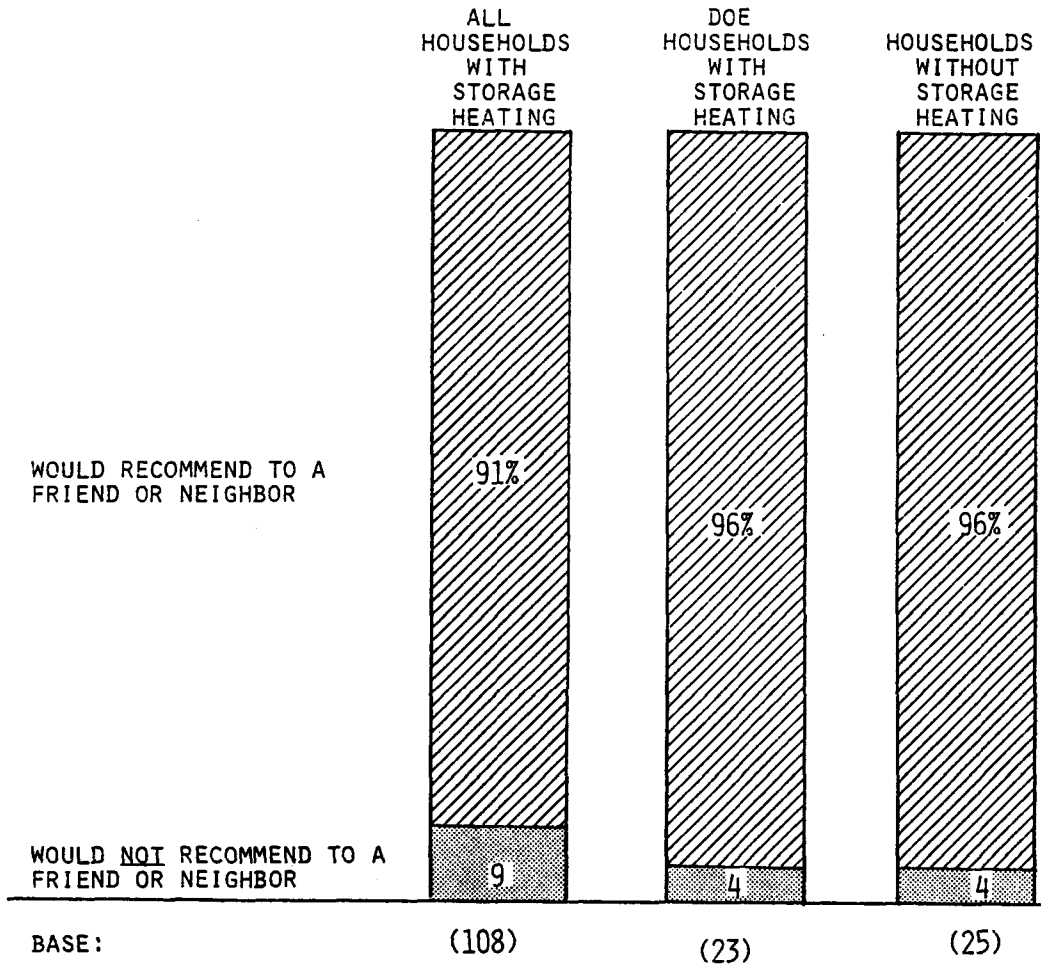
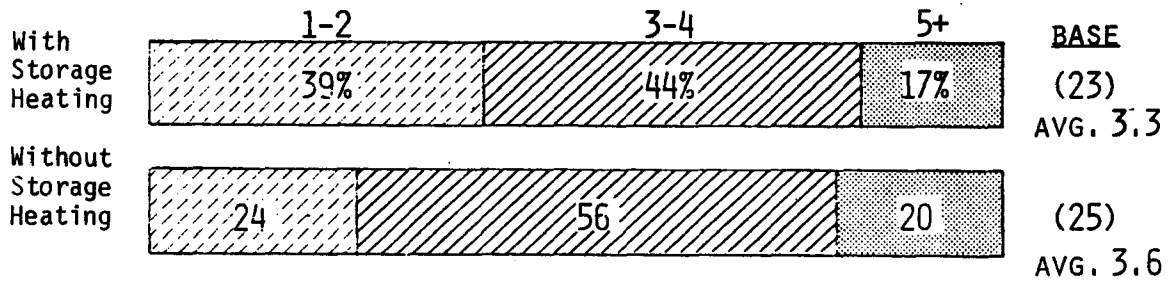


Fig. A.13 Owners Who Would Recommend Their Present Thermal Energy Storage or Conventional Heating System to a Friend or Neighbor

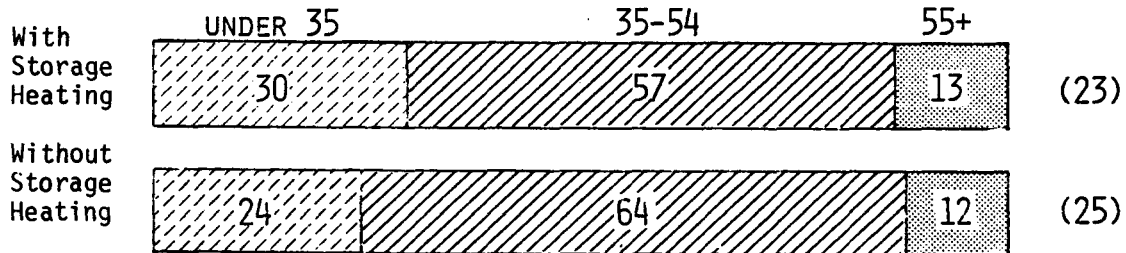
Table A.10 Suggested Changes for Thermal Energy Storage Heating Systems

MAKE UNITS SMALLER (NET)		14%
MAKE UNITS SMALLER	9%	
RECESS UNITS INTO WALLS	6	
MAKE UNITS MORE ATTRACTIVE (NET)		14
MAKE UNITS MORE LIKE A PIECE OF FURNITURE	9	
MAKE UNITS IN DIFFERENT COLORS	5	
MORE EMPHASIS ON CENTRAL UNITS		9
BETTER INSTRUCTIONS/INFORMATION ON HOW TO OPERATE THEM		9
MORE ADAPTABLE REGULATING CAPABILITY		6
BETTER INSULATION		5
NO CHANGES ARE NECESSARY		22
BASE:		(103)

Number of Persons in Household



Age of Head of Household



Total Household Income, Before Taxes

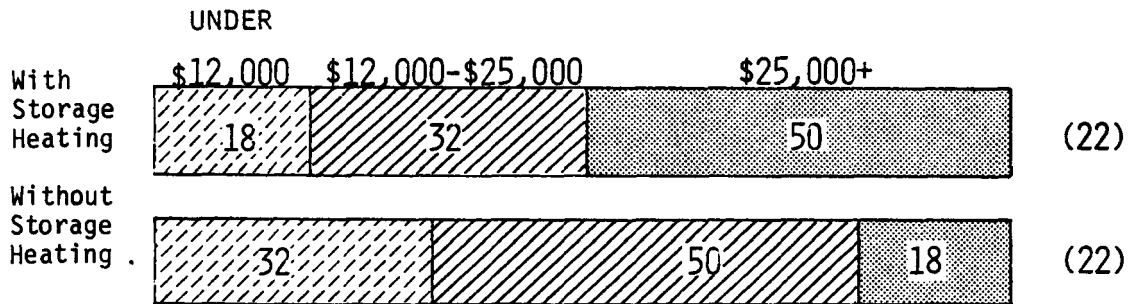


Fig. A.14 Demographic Characteristics of Homes with and without Thermal Energy Storage Heating in the ANL-DOE Study

ELRICK and LAVIDGE, inc.

Marketing Research

For Management Decisions

10 South Riverside Plaza • Chicago, Illinois 60606 • Telephone area 312) 726-0666

Within the next week or so a representative of Elrick and Lavidge, Inc., an independent Chicago-based marketing research firm will be calling you in order to ask some questions about your thermal energy storage system. The purpose of the survey is to determine residential attitudes and opinions toward this new type of heating system. The study is being sponsored by the Department of Energy.

As you probably know, there are only a limited number of households which are equipped with thermal storage heating systems. This being the case, it is extremely important that every household equipped with this type of heating system be included in the survey so that an accurate picture of consumers' opinions toward this type of heating system can be determined. All of the information you provide will be kept strictly confidential. That is why Elrick and Lavidge is conducting the survey instead of the Department of Energy.

We appreciate your cooperation.

Sincerely,

HH/nb

Herb Huffer,
Senior Project Director

#2279-1

ELRICK and LAVIDGE, inc. 660 California St. San Francisco, Cal. — Affiliated with THE ECONOMIST INTELLIGENCE UNIT, 27 St. James Place, LONDON, ENGLAND

Fig. A.15 Letter Sent to Households in Thermal Energy Storage Heating Survey Prior to Telephone Interviews

Elrick and Lavidge, Inc.
 10 South Riverside Plaza
 Chicago, Illinois 60606
 Phone: (312) 726-0666

Project #2279-1
 May, 1979

Office #
 DOE Home - 1 [4]
 Other
 Storage Heater Homes - 2

STORAGE HEATING STUDY

- Homes with Storage Heating Units -

Respondent _____ Phone () _____
 (Print)
 Address _____
 (Print)
 City, State _____ Zip Code _____
 Interviewer _____ Date _____
 Time AM Time AM Length of
 Started PM Completed PM Interview Mins.

[5-6]

Hello, my name is _____. I am with Elrick and Lavidge, Inc., an independent marketing research firm based in Chicago. We are doing a study for the United States Department of Energy on storage heaters. About a week ago we sent a letter to your household saying that we would call. Do you remember seeing the letter?

Yes - 1 --> CONTINUE No - 2 --> EXPLAIN LETTER AND CONTINUE

The purpose of the study is to gather information about consumers' attitudes toward this type of heating system. Since only a limited number of homes are equipped with this type of heating system, your local power company has provided us with your name and the names of other households where storage heaters have been installed. All of the information you provide will be kept strictly confidential.

1. First of all, are you the person in the household most responsible for having storage heating installed in your home?

Yes - 1 --> CONTINUE No - 2 --> ASK TO SPEAK TO THAT PERSON.
 IF UNAVAILABLE, MAKE AN APPOINTMENT.

2a. Is your home equipped with a central storage heater or is it equipped with individual room units?

Central unit - 1 Individual room unit - 2 [7]

IF "CENTRAL UNIT," ASK: IF "INDIVIDUAL ROOM UNITS," ASK:

2b. Do you have any additional units?

GO TO
 Yes - 1 --> Q. 2d
 No - 2 --> Q. 3 [8]

2c. Besides the individual storage units, do you have any additional heating units?

Yes - 1 --> GO TO Q. 2d
 NO - 2 --> GO TO Q. 3 [9]

Fig. A.16 Telephone Interview Questionnaire for Households with Thermal Energy Storage Heating Systems

2d. What type of heating units are they -- gas, electric, oil/wood or some other type?

	2d.	2e.	2f.	
	Type	How many?	Hrs/Week	
Gas	1	11		16-18
Electric	2	12		19-21
Oil/wood	3	13		22-24
Other (specify)		14		25-27
		15		28-30

FOR "EACH TYPE," ASK: _ _

31-

2e. How many (TYPE) heating units do you have? (RECORD IN GRID ABOVE)

32-

f. Thinking about last winter, about how many hours in an average week did you run the (TYPE) heaters? (RECORD IN GRID ABOVE)

3a. In what year was your storage heating system installed?

19

33-34

b. In which month of (YEAR MENTIONED) ?

Jan/Feb - 1
 Mar/Apr - 2
 May/June - 3

July/Aug - 4
 Sept/Oct - 5
 Nov/Dec - 6
 DK - X

35

4a. Is your storage heating system the first heating unit for your home or did it replace an existing heating system?

First system - 1 → GO TO Q. 5

Replacement system - 2

36

IF "REPLACEMENT," ASK: _ _

4b. Was your previous heating system run by electricity, oil, or gas?

Electricity - 1
 Oil - 2
 Gas - 3

GO TO Q. 5

37

IF "GAS," ASK: _ _

4c. Is that gas hot water or gas-forced air?

Water - 1

Forced air - 2

38

Fig. A.16 (Cont'd)

5a. Thinking back to when your storage heating system was first installed, what were your primary reasons for putting this type of heating system in your home? (PROBE) . . . What other reasons were there?

39-
40-
41-

b. What do you consider to be the single most important reason?

42-
43-
44-

Fig. A.16 (Cont'd)

6a. What problems, if any, have you had with your storage heating system? (PROBE) What others? (RECORD IN GRID BELOW)

Q. 6a			Q. 6b		Q. 6c		
Problem			Problem lies within		Severity		
			Manufacturer - 1	Extremely - 4	49		
			Installer - 2	Very - 3			
			Other (Specify) -	Somewhat - 2			
45-	46-	47-	_____ 48	Not at all - 1			
			Manufacturer - 1	Extremely - 4	54		
			Installer - 2	Very - 3			
			Other (Specify) -	Somewhat - 2			
50-	51-	52-	_____ 53	Not at all - 1			
			Manufacturer - 1	Extremely - 4	59		
			Installer - 2	Very - 3			
			Other (Specify) -	Somewhat - 2			
55-	56-	57-	_____ 58	Not at all - 1			
			Manufacturer - 1	Extremely - 4	64		
			Installer - 2	Very - 3			
			Other (Specify) -	Somewhat - 2			
60-	61-	62-	_____ 63	Not at all - 1			
			Manufacturer - 1	Extremely - 4	69		
			Installer - 2	Very - 3			
			Other (Specify) -	Somewhat - 2			
65-	66-	67-	_____ 68	Not at all - 1			

FOR EACH PROBLEM, ASK: (RECORD ABOVE)

- b. Thinking about the (PROBLEM) problem, do you think the problem lies with the manufacturer of the system, the installer of the system, or someone else? IF SOMEONE ELSE, ASK WHO. (RECORD ABOVE)
- c. Do you consider the (PROBLEM) problem to be extremely serious, very serious, somewhat serious, or not at all serious?

Fig. A.16 (Cont'd)

7a. Thinking back to this past winter, what was your normal thermostat setting for . . .

	Q.7a Temperature	Q. 7b		
		Yes	No	
. . . Early morning hours (7:00 a.m. - 12:00 Noon)?	<input type="text"/> °F <input type="text"/> 5-6	<input type="text"/> 1	<input type="text"/> 2	<input type="text"/> 15
. . . Afternoon hours (12:00 Noon - 5:00 p.m.)?	<input type="text"/> °F <input type="text"/> 7-8	<input type="text"/> 1	<input type="text"/> 2	<input type="text"/> 16
. . . Early evening hours (5:00 p.m. - 8:00 p.m.)?	<input type="text"/> °F <input type="text"/> 9-10	<input type="text"/> 1	<input type="text"/> 2	<input type="text"/> 17
. . . Late evening hours (8:00 p.m. - 11:00 p.m.)?	<input type="text"/> °F <input type="text"/> 11-12	<input type="text"/> 1	<input type="text"/> 2	<input type="text"/> 18
. . . Nighttime hours (11:00 p.m. - 7:00 a.m.)?	<input type="text"/> °F <input type="text"/> 13-14	<input type="text"/> 1	<input type="text"/> 2	<input type="text"/> 19

b. In general, is someone usually home during the (READ CATEGORIES ABOVE)? (RECORD ABOVE)

Let's talk for a moment about the costs of installing a storage heating system. Then, in a few minutes, we'll talk about the costs associated with operating it.

FOR HOUSEHOLDS NOT IN DOE EXPERIMENT

8a. Approximately how much did you originally pay for your storage heating system, including installation?

\$ _____ GO TO Q. 9a. 20-23

FOR HOUSEHOLDS IN DOE EXPERIMENT

8b. Approximately how much did you originally pay for your storage heating system?

\$ _____ 20-23

9a. Thinking back to when you first considered storage heating was the amount you actually paid for your system higher than what you expected to pay, about what you expected to pay, or lower than you expected to pay?

Higher than expected -1- About what expected -2- Lower than expected -3- 24

IF "HIGHER," ASK: _____

9b. How much less did you expect to pay?
 \$ _____ total expected
 or
 \$ _____ more 25-28

IF "LOWER," ASK: _____

9b. How much more did you expect to pay?
 \$ _____ total expected
 or
 \$ _____ less 25-28

Fig. A.16 (Cont'd)

10a. Were there any unexpected expenses associated with installing this type of heating system?

Yes - 1 → No - 2 → SKIP TO Q.11 [29]

IF "YES", ASK

b. What expenses were there? _____

30-
31-
32-

Now, lets talk briefly about the cost of operating a heating system of this type.

11a. First of all, since you've had this new type of heating system, during an average Winter month, what do you normally pay for the electricity to heat your home?

\$ _____ /month [33-35]

b. Thinking back to when you had your system installed, is this higher than expected, about what expected, or lower than expected?

Higher than expected	- 1	36
About what expected	- 2	
Lower than expected	- 3	

c. Are there any expenses which you did not expect in operating a heating system of this type?

Yes - 1 → No - 2 → SKIP TO Q.12 [37]

IF "YES", ASK:

d. What expenses are these? _____

38-
39-
40-

12a. Did you make any improvements in insulation, storm windows, weather stripping or other such things since the installation of your storage system?

Yes - 1 → No - 2 → SKIP TO Q. 13 [41]

IF "YES", ASK:

b. What improvements did you make? _____

42-
43-
44-

Fig. A.16 (Cont'd)

13. Now I would like to read some statements to you about storage heating. As I read each statement, I want you to tell me whether you agree strongly with the statement, agree moderately with the statement, agree slightly with the statement, or do not agree at all. That's agree strongly, agree moderately, agree slightly, or do not agree at all.

Okay. The first statement is . . . (START WITH RED X'D ITEM AND CONTINUE UNTIL ALL STATEMENTS HAVE BEEN READ.)

Start With Red X	Statements	Agree Strongly	Agree Moderately	Agree Slightly	Do Not Agree At All	DK	
	Storage heating systems do an excellent job of conserving energy.	4	3	2	1	X	45
	Storage heating systems save a lot of money in the long run.	4	3	2	1	X	46
	Storage heating systems make homes as comfortable to live in as any other type of heating system would.	4	3	2	1	X	47
	It's easy to understand how storage heating systems work.	4	3	2	1	X	48
	Storage heating systems save money even in the short run.	4	3	2	1	X	49
	Storage heating systems are very convenient to operate.	4	3	2	1	X	50
	Storage heating systems require very little routine maintenance.	4	3	2	1	X	51
	Storage heating systems appear to be easy to install.	4	3	2	1	X	52
	It's easy to see how storage heating systems can help save money on an electric bill.	4	3	2	1	X	53
Omit if central system - See Q2a	In terms of appearance, storage heating systems are attractive.	4	3	2	1	X	54

Fig. A.16 (Cont'd)

14a. Overall, would you say your storage heating system is better, worse, or about the same as the heating system you previously owned?

Better	- 1	55
Worse	- 2	
About the same	- 3	
First system owned	- X	

GO TO Q. 15

IF "BETTER" or "WORSE," ASK: -----

14b. Why do you say that? _____

56-
57-
58-

15. What changes could be made in the system to make it more acceptable? (PROBE)
... What others?

59-
60-
61-

16a. Finally, knowing what you know about storage heating systems, would you recommend this type of heating system to a friend or neighbor?

Yes - 1 _____ No - 2 _____ 62

b. Would you install it in your home again?

Yes - 1 → GO TO Q. 17 _____ No - 2 _____ 63

IF "NO," ASK: -----

16c. Why is that? _____

64-
65-
66-

Fig. A.16 (Cont'd)

Elrick and Lavidge, Inc.
 10 South Riverside Plaza
 Chicago, Illinois 60606
 Phone: (312) 726-0666

Project #2279-1
 May, 1979

Office #

Prior - 3
 Non-Prior - 4

4

STORAGE HEATING STUDY

- Non Storage Heating Unit Homes -

Respondent _____		Phone () _____	
(Print)			
Address _____			
(Print)			
City, State _____		Zip Code _____	
Interviewer _____		Date _____	
Time Started _____	AM PM	Time Completed _____	AM PM
		Length of Interview _____	Mins.

5-6

Hello, my name is _____. I'm with Elrick and Lavidge, Inc., an independent marketing research firm based in Chicago. We are doing a study for the United States Department of Energy on home heating systems. About a week ago we sent a letter to your household saying that we would call. Do you remember seeing the letter?

Yes - / → CONTINUE No - 2 → EXPLAIN LETTER AND CONTINUE

The purpose of the study is to gather information about consumers' attitudes toward different types of heating systems. All the information you provide will be kept strictly confidential.

1. First of all, are you the person in the household most responsible for having your present heating system installed in your home?

Yes - 1 → CONTINUE No - 2 → ASK TO SPEAK TO THAT PERSON. IF UNAVAILABLE, MAKE AN APPOINTMENT.

2. What type of heating system does your home have--electric, gas forced air, gas hot water, oil or some other type?

Electric	-	1	7
Gas forced air	-	2	
Gas hot water	-	3	
Oil	-	4	
Other (specify)			

8-

Fig. A.17 Telephone Interview Questionnaire for Households without Thermal Energy Storage Heating

3a. In addition to the heating system you just mentioned, do you have any other heating units?

Yes - 1 → No - 2 → GO TO Q. 4a 9

IF "YES," ASK: _ _ _

3b. What type of heating units are they -- gas, electric, oil/wood or some other type?

	3b. Type	3c. How many?	3d. Hrs/Week	
Gas	10 7		11	16-18
Electric	2		12	19-21
Oil/wood	3		13	22-24
Other (specify)			14	25-27 31-
			15	28-30 32-

FOR "EACH TYPE," ASK: _ _ _

3c. How many (TYPE) heating units do you have? (RECORD IN GRID ABOVE)

3d. Thinking about last winter, about how many hours in an average week did you run the (TYPE) heaters? (RECORD IN GRID ABOVE)

4a. In what year was your heating system installed? 19 _____ 33-34

b. In which month of (YEAR MENTIONED) ?

Jan/Feb - 1	July/Aug - 4 35
Mar/Apr - 2	Sep/Oct - 5
May/Jun - 3	Nov/Dec - 6
	DK - X

5a. Is your heating system the first heating unit for your home or did it replace an existing heating system?

First system - 1 → GO TO Q. 6 Replacement system - 2 36

IF "REPLACEMENT," ASK: ← _ _ _

5b. Was your previous heating system run by electricity, oil, or gas?

Electricity - 1	} GO TO Q. 6 37
Oil - 2	
Gas - 3	

IF "GAS," ASK: ← _ _ _

5c. Is that gas hot water or gas-forced air?

Water - 1 Forced air - 2 38

Fig. A.17 (Cont'd)

6a. Thinking back to when your heating system was first installed, what were your primary reasons for putting this type of heating system in your home? (PROBE) . . . What other reasons were there?

39-
40-
41-

6b. What do you consider to be the single most important reason?

42-
43-
44-

Fig. A.17 (Cont'd)

7a. What problems, if any, have you had with your heating system? (PROBE) What others? (RECORD IN GRID BELOW)

Q. 7a			Q. 7b		Q. 7c	
Problem			Problem lies within		Severity	
			Manufacturer - 1	Extremely - 4	49	
			Installer - 2	Very - 3		
			Other (Specify) -	Somewhat - 2		
45-	46-	47-		48		
			Manufacturer - 1	Extremely - 4	54	
			Installer - 2	Very - 3		
			Other (Specify) -	Somewhat - 2		
50-	51-	52-		53		
			Manufacturer - 1	Extremely - 4	59	
			Installer - 2	Very - 3		
			Other (Specify) -	Somewhat - 2		
55-	56-	57-		58		
			Manufacturer - 1	Extremely - 4	64	
			Installer - 2	Very - 3		
			Other (Specify) -	Somewhat - 2		
60-	61-	62-		63		
			Manufacturer - 1	Extremely - 4	69	
			Installer - 2	Very - 3		
			Other (Specify) -	Somewhat - 2		
65-	66-	67-		68		

FOR EACH PROBLEM, ASK: (RECORD ABOVE)

- b. Thinking about the (PROBLEM) problem, do you think the problem lies with the manufacturer of the system, the installer of the system, or someone else? IF SOMEONE ELSE, ASK WHO. (RECORD ABOVE)
- c. Do you consider the (PROBLEM) problem to be extremely serious, very serious, somewhat serious, or not at all serious?

Fig. A.17 (Cont'd)

8a. Thinking back to this past winter, what was your normal thermostat setting for . . .

	Q.7a Temperature	Q. 7b		
		Yes	No	
. . . Early morning hours (7:00 a.m. - 12:00 Noon)?	°F 5-6	1	2	15
. . . Afternoon hours (12:00 Noon - 5:00 p.m.)?	°F 7-8	1	2	16
. . . Early evening hours (5:00 p.m. - 8:00 p.m.)?	°F 9-10	1	2	17
. . . Late evening hours (8:00 p.m. - 11:00 p.m.)?	°F 11-12	1	2	18
. . . Nighttime hours (11:00 p.m. - 7:00 a.m.)?	°F 13-14	1	2	19

b. In general, is someone usually home during the (READ CATEGORIES ABOVE)? (RECORD ABOVE)

Let's talk for a moment about the costs of installing your heating system. Then, in a few minutes, we'll talk about the costs associated with operating it.

9. Approximately how much did you originally pay for your storage heating system, including installation?

\$ _____ 20-23

10a. Thinking back to when you first considered this heating system, was the amount you actually paid for your system higher than what you expected to pay, about what you expected to pay, or lower than you expected to pay?

Higher than expected -1- About what expected -2- Lower than expected -3- 24

IF "HIGHER," ASK: - - - -

10b. How much less did you expect to pay?

\$ _____ total expected

or

\$ _____ more 25-28

IF "LOWER," ASK: - - - -

10b. How much more did you expect to pay?

\$ _____ total expected

or

\$ _____ less 25-28

Fig. A.17 (Cont'd)

11a. Were there any unexpected expenses associated with installing your heating system?

Yes - 1 → No - 2 → SKIP TO Q.12 29

IF "YES", ASK _____

b. What expenses were there? _____

30-
31-
32-

12. Now, lets talk briefly about the cost of operating your heating system.

a. First of all, since you've had this heating system, during an average Winter month, what do you normally pay to heat your home?

\$ _____ /month 33-35

b. Thinking back to when you had your system installed, is this higher than you expected, about what you expected, or lower than you expected?

Higher than expected	- 1	36
About what expected	- 2	
Lower than expected	- 3	

c. Are there any expenses which you did not expect in operating your heating system?

Yes - 1 → No - 2 → SKIP TO Q.13 37

IF "YES", ASK: _____

d. What expenses are these? _____

38-
39-
40-

13a. Did you make any improvements in insulation, storm windows, weather stripping or other such things since the installation of your storage system?

Yes - 1 → No - 2 → SKIP TO Q. 14 41

IF "YES", ASK: _____

b. What improvements did you make? _____

42-
43-
44-

Fig. A.17 (Cont'd)

14. Now I would like to read some statements to you about your heating system. As I read each statement, I want you to tell me whether you agree strongly with the statement, agree moderately with the statement, agree slightly with the statement or do not agree at all. That's agree strongly, agree moderately, agree slightly, or do not agree at all.

Okay. The first statement is . . . (START WITH RED X'D ITEM AND CONTINUE UNTIL ALL STATEMENTS HAVE BEEN READ.)

Start With Red X	Statements						
		Agree Strongly	Agree Moderately	Agree Slightly	Do Not Agree At All	DK	
	My heating system does an excellent job of conserving energy.	4	3	2	1	X	45
	My heating system will save a lot of money in the long run.	4	3	2	1	X	46
	My heating system makes my home as comfortable to live in as any other type of heating system would.	4	3	2	1	X	47
	It's easy to understand how my heating system works.	4	3	2	1	X	48
	My heating system saves money even in the short run.	4	3	2	1	X	49
	My heating system is very convenient to operate.	4	3	2	1	X	50
	My heating system requires very little routine maintenance.	4	3	2	1	X	51
	My heating system appears to be easy to install.	4	3	2	1	X	52
	It's easy to see how my heating system can help save money on a heating bill.	4	3	2	1	X	53

54-

Fig. A.17 (Cont'd)

15a. Overall, would you say your current heating system is better, worse, or about the same as the heating system you previously owned?

Better	- 1	55
Worse	- 2	
About the same	- 3	
First system owned	- X	

GO TO Q. 16

IF "BETTER" or "WORSE," ASK: _____

15b. Why do you say that? _____

56-
57-
58-

16. What changes could be made in the system to make it more acceptable? (PROBE)
 . . . What others?

59-
60-
61-

17a. Finally, knowing what you know about your heating system, would you recommend this type of heating system to a friend or neighbor?

Yes - 1 _____ No - 2 _____ 62

b. Would you install it in your home again?

Yes - 1 → GO TO Q. 18 _____ No - 2 _____ 63

IF "NO," ASK: _____

17c. Why is that? _____

64-
65-
66-

Fig. A.17 (Cont'd)

Thank you. Now I have a few more questions which will be used to classify your responses with the responses of others participating in this study.

18. Is your residence a single-family home, a duplex, an apartment building, a mobile home, a farm residence or some other type of residence?

Single-family homes	- 1	67
Duplex	- 2	
Apartment building	- 3	
Mobile home	- 4	
Farm residence	- 5	
Other (specify)	-	

19a. Do you live in your home all year or only during certain seasons of the year?

All year - 1	Certain seasons - 2	68												
IF "ALL YEAR," ASK: _ _ 19b. Is this your primary place of residence or is it a year-around vacation home? <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 80%;">Primary residence</td> <td style="width: 10%; text-align: center;">- 1</td> <td style="width: 10%; border: 1px solid black;">69</td> </tr> <tr> <td>Vacation home</td> <td style="text-align: center;">- 2</td> <td></td> </tr> </table>	Primary residence	- 1	69	Vacation home	- 2		IF "SEASONAL," ASK: _ _ 19c. Do you use the home more in the Winter or more in the Summer? <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 80%;">Winter</td> <td style="width: 10%; text-align: center;">- 1</td> <td style="width: 10%; border: 1px solid black;">70</td> </tr> <tr> <td>Summer</td> <td style="text-align: center;">- 2</td> <td></td> </tr> </table>	Winter	- 1	70	Summer	- 2		
Primary residence	- 1	69												
Vacation home	- 2													
Winter	- 1	70												
Summer	- 2													

20. Including yourself and any infants and children, how many persons live in your household?

1	2	3	4	5	6	7	8	9	10-0	71
---	---	---	---	---	---	---	---	---	------	----

21. Is the head of the household

. . . Under 25 years of age?	- 1	72
. . . 25 to 34	- 2	
. . . 35 to 44	- 3	
. . . 45 to 54	- 4	
. . . 55 to 64	- 5	
. . . 65 and over	- 6	

22. Is the total household family income, before taxes,

. . . Under \$12,000	- 1	73
. . . Between \$12,000 - \$25,000	- 2	
. . . More than \$25,000	- 3	

23. OBSERVATION: Sex: Male - 1 Female - 2 74

75-
76-
77-

END INTERVIEW -- THANK RESPONDENT

80 - ②

Fig. A.17 (Cont'd)