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A MARKET ASSESSMENT FOR ACTIVE SOLAR HEATING AND COOLING PRODUCTS

Category B: A Survey of Decision-Makers in the HVAC Marketplace

Final Report

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OR/MS Dialogue, Inc.
Cambridge, Massachusetts

U.S. Department of Energy

Solar Energy

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A MARKET ASSESSMENT FOR ACTIVE SOLAR
HEATING AND COOLING PRODUCTS

CATEGORY B: A SURVEY OF DECISION MAKERS
IN THE HVAC MARKET PLACE

FINAL REPORT

September, 1980

Prepared for:

Active Building Systems Branch
Office of Solar Applications for Buildings
U.S. Department of Energy

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SECTION ONE
EXECUTIVE SUMMARY

A. OBJECTIVES

The scope of the work reported on here is a comprehensive evaluation of the market for solar heating and cooling products for new and retrofit markets. The focus of the work is the analysis of solar knowledge among HVAC decision makers and a comprehensive evaluation of their solar attitudes and behavior. This section serves as a summary of the project; it highlights the project's approach, findings and methodology.

The U.S. Department of Energy has the responsibility for developing policies that meet congressional market penetration objectives for solar-energy technologies. In order to achieve acceleration of demand, knowledge of market response is necessary; DOE must understand what the demand is for solar technologies and the hurdles that solar energy must cross.

This study addresses the following questions:

- What is the profile of a potential solar adopter?
- What is the awareness, interest and likelihood of solar purchase for key market segments?
- How do these levels of awareness and interest vary by sector, type of individual and type of product?
- What criteria other than economics affect the purchase decision?

B. BACKGROUND AND APPROACH

Experience with new-product marketing in general and with solar-energy marketing in particular leads to two important conclusions:

- A major cause of commercial failure among technically successful new products is a lack of appreciation of the way customers actually perceive and evaluate those products. Buyers, both industrial and consumer, do not always act "economically," that is, rationally. A perusal of the body of literature describing the impact of noneconomic factors affecting purchase decisions forces one to arrive at this conclusion. An understanding of the noneconomic factors affecting purchase decisions is, therefore, an important prerequisite for a successful commercialization program.

Ultimate product success in the market place is most likely when information from that market place is integrated into product development and marketing plans.

The methodology selected for this project reflects an understanding of these two points. Methodologies used in recent solar studies have also been integrated into our approach. The product/market combinations which have been chosen for detailed study are those with the highest market potential.

The analytical approach used employs state-of-the-art modeling procedures for consumer and organizational purchasing decisions. A measurement tool called a "decision matrix" has been used to study the organizational decision-making process; a procedure called "disjoint measurement" has been employed to develop insight into the market potential for different solar product designs. Factor analytic techniques and preference regressions have been used to identify the underlying structure of solar attitudes and to identify the relative importance of those attitudes in the solar choice process. These analytical techniques have been used to provide insight into the adoption process for large organizations as well as into the choice process for individual consumers.

In order to delimit the scope of this work, a set of product and market combinations have been selected that appear to have high potential for early solar commercialization. These are as follows:

Decision-influencing Segments Studied

- Residential market -- single-family home
 - * new
 - * retrofit
- Manufacturing-building market
- HVAC contractor/consultants
- Architects
- Builder-developer market
- Commercial/institutional market

Products Studied

- Active solar space heating - flat-plate and concentrating technologies
- Active solar water heating - flat-plate and concentrating technologies
- Solar cooling -- absorption-type equipment
- Solar-assisted heat-pump technologies - flat-plate and concentrating technologies

As detailed below, specific methodology has been developed to collect and analyze data in each of these segments, including pilot studies completed in each segment to refine the data collector and analysis procedures.

C. THE RESIDENTIAL SOLAR MARKET

1. Measurements

Two residential samples were selected -- (a) those who now own a home and (b) those who were in the market for a newly constructed home. Each sample was built up on a state-by-state basis using a "sales-potential" index developed for this study. A total of 1608 existing-home and 1454 new-home respondents were studied.

Data was collected in each case in two parts:

- (a) a short screening interview done by phone to collect background information and be sure the respondent qualified, followed by
- (b) a mailed follow-up, with a description of one or two solar systems, state- and fuel-specific information about the economics of owning the solar system and questions about likelihood of solar power.

A total of 880 existing-home and 744 new-home questionnaires were returned.

2. Sample Description

For existing homes, Exhibit 1-1 shows the degree of awareness about solar energy among home owners. Note that 20.9% reported never previously having heard of solar energy for home or water heating (Question A). In Question B, respondents from the South were significantly below the national average for having seen a solar-equipped home. In Question C, southerners were significantly below the national average while westerners were above the national average. In Question D we see that only a small fraction of the sample had actually sought information about solar and, again, the South lagged behind the other regions.

In Exhibit 1-2, we see that government incentives were known to 46.6% of the respondents, with the highest awareness in the North East and West and the lowest in the North Central states. Of those who claimed to know about government incentives, 21% correctly identified the federal tax rebate, and of those, 20.3% gave an estimate that was within the range of what was then available (15 to 30% of the gross price). For the entire sample, 4.3% was within the correct range.

Several questions were asked of the respondents both over the telephone and in the mail study, giving the respondent an opportunity to

EXHIBIT 1-1

Solar Awareness -- Existing-home Owners

	<u>Yes</u>	<u>No</u>	<u>Unsure</u>
A. Heard of solar for home or water heating?			
North East	81.0%	19.0%	- %
South	79.7	20.3	-
North Central	75.4	24.6	-
West	81.4	18.6	-
TOTAL SAMPLE	79.1%	20.9%	- %
B. Seen a home equipped with solar panels?			
North East	45.0%	54.4%	0.6%
South	39.3	59.9	0.8
North Central	46.4	53.6	-
West	56.0	44.0	-
TOTAL SAMPLE	45.5%	54.1%	0.4%
C. Know anyone now using solar?			
North East	23.4%	76.3%	0.3%
South	13.3	86.5	0.2
North Central	17.7	81.9	0.4
West	27.8	71.5	0.7
TOTAL SAMPLE	18.8%	80.9%	0.3%
D. Actually gone looking for solar?			
North East	9.8%	90.2%	- %
South	6.1	93.9	-
North Central	11.3	88.7	-
West	10.3	89.7	-
TOTAL SAMPLE	9.1%	90.9%	- %

EXHIBIT 1-2

Awareness of Federal Incentives -- Existing-home Owners

	<u>Yes</u>	<u>No</u>	<u>Uncertain</u>
Heard of government incentives? (base = sample)	59.1%	38.4%	2.5%

21% correctly identified federal tax rebate.

Of those identifying the tax rebate:

4.8%	said rebate would pay 10% or less of system cost.
9.7%	15%
6.1%	20%
1.9%	25%
2.6%	30%
4.7%	35% or more
70.2%	didn't know

4.3% of the sample has some idea (15 to 30%) about what is really available.

revise his views based on the information received. An interesting pattern emerged (see Section 3.C.1 for details): in most regions and for most questions, the respondents' attitudes toward solar became less favorable after exposure to basic information. This finding suggests a lack of real information accompanied by a generally favorable view in the general population, which is changed negatively when hard information becomes available.

Exhibit 1-3 shows, by region, the results of the solar-awareness question for new-home buyers. These figures show that respondents from the West were much more aware of solar than were respondents from other regions. The numbers were higher for western respondents across all four questions, but the differences were especially large on the "seen a solar-equipped home," "know anyone using solar" and "gone looking for solar" questions. In fact, just under half of western respondents reported having looked into solar. Southern and north-central respondents reported the fewest direct attempts to investigate solar.

Exhibit 1-4 compares buyers of new homes with owners of existing homes. The new-home respondents showed much more awareness of solar, had seen more installations and had considered solar for more homes than existing-home respondents. Those who had looked for solar-energy systems were asked what kinds: 55.8% said water heaters, 36.8% said space and water heaters and 13.8% said heat pumps.

Government incentives were known to over 60% of the sample, with almost three-quarters of western respondents aware of incentives. Of those who claimed to know about government incentives, 32.1% correctly identified the federal tax rebates, and of those, 22.6% gave an estimate that was within range of what was available. For the entire sample of new-home buyers, 73% were within the correct range.

In terms of changes of attitudes before and after exposure to solar information, the same pattern emerged here as with the existing home population, i.e., an unfavorable change in attitude to solar occurred after exposure.

3. Results of Analysis

This section reviews the conclusions and issues that emerged from our tabulations and analyses. The decision-making and behavior issues that arose suggest possible courses of action for solar marketers, as well as for commercialization programs under the sponsorship of federal or local government agencies.

The key obstacle we see to the rapid commercialization of active solar-energy systems is the surprising confusion and lack of knowledge about solar in the general population. The resolution of these two problems is crucial if the full potential of solar as a source of energy for the nation is to be realized.

EXHIBIT 1-3

Solar Awareness -- New-home Buyers

	<u>Yes</u>	<u>No</u>	<u>Unsure</u>
A. Heard of solar for home or water heating?			
North East	91.2%	8.8%	- %
South	83.0	17.0	-
North Central	86.1	13.9	-
West	88.3	11.7	-
TOTAL SAMPLE	86.5%	13.5%	- %
B. Seen a home equipped with solar panels?			
North East	73.4%	26.0%	0.6%
South	60.1	39.6	0.3
North Central	58.0	41.4	0.6
West	82.9	17.0	0.1
TOTAL SAMPLE	66.6%	32.9%	0.5%
C. Know anyone now using solar?			
North East	27.5%	70.9%	1.6%
South	22.9	76.9	0.2
North Central	32.1	67.5	0.4
West	45.7	54.3	0.0
TOTAL SAMPLE	30.6%	68.8%	0.6%
D. Actually gone looking for solar?			
North East	34.9%	65.1%	- %
South	26.8	73.2	-
North Central	24.7	75.3	-
West	45.8	54.2	-
TOTAL SAMPLE	31.5%	68.5%	- %

EXHIBIT 1-4

Solar Awareness -- Existing-home Owners Compared to New-home Buyers

		<u>Percent responding "yes"</u>	
		<u>New-home buyers</u>	<u>Existing-home owners</u>
A.	Heard of solar for home or water heating?		
	North East	91.2%	81.0%
	South	83.0	79.7
	North Central	86.1	75.4
	West	88.3	81.4
	TOTAL SAMPLE	86.5%	79.1%
B.	Seen a home equipped with solar panels?		
	North East	73.4%	45.0%
	South	60.1	39.3
	North Central	58.0	46.4
	West	82.9	56.0
	TOTAL SAMPLE	66.6%	45.5%
C.	Know anyone now using solar?		
	North East	27.5%	20.7%
	South	22.9	13.3
	North Central	32.1	17.7
	West	45.7	27.8
	TOTAL SAMPLE	30.6%	18.8%
D.	Actually gone looking for solar?		
	North East	34.9%	9.8%
	South	26.8	6.1
	North Central	24.7	11.3
	West	45.8	10.3
	TOTAL SAMPLE	31.5%	9.1%

The problem is simple: 20 percent of the nation's home owners and 14 percent of new-home buyers have never heard of solar energy for home or hot-water heating. In our study sample, over half (54 percent) of the home owners and 45 percent of the home buyers did not understand the financial aspects of solar energy. Over half (55 percent) of the home owners and 36 percent of the home buyers had never heard of government incentives, either federal or state.

Even among consumers who stated that they had seen or heard about solar energy, there was considerable confusion about what was currently available. About half of the home owners and just over sixty percent of new-home buyers who said they knew about solar were not aware or were unsure whether solar space or water-heating systems were for sale in their areas. And over 72 percent of home owners and 65 percent of new-home buyers who said they knew about solar said that they could, or are unsure whether they could, buy solar-powered air conditioning and solar-powered electricity-generating equipment. One can infer from this result that many people do not distinguish various solar technologies -- the high-technology, experimental systems are confused with the more mundane systems that have been available and working for a number of years.

Only 21 percent of home owners and 32 percent of home buyers were aware of the federal tax rebate program. This number is surprisingly low when one considers that the survey was underway in February and March, 1980, shortly after the IRS had mailed Form 5695, "Energy Credits," to tax payers and during the time when most people were filing their tax forms.

Finally, in almost every case we encountered, consumers became significantly less prosolar in their attitudes after they had been exposed to some basic information about the system's operation and economics. And at the same time they reported that their understanding of these issues had risen.

These statistics point up the general lack of awareness and knowledge as well as the amount of confusion that exist over the various solar technologies. These problems must be resolved before a more finely tuned approach addressing specific marketing variables will have any major impact.

The solution to this primary problem lies in communications. People must be made aware of the solar-energy systems that are available today. Consumers must be made to understand that these systems are based on a tried and workable technology.

This particular solution -- a generic communication program -- is probably beyond the scope of any one firm's communications effort. We would recommend that it be undertaken with the sponsorship of a government agency or an industrial association.

Besides the awareness or knowledge problem that the data indicates, a number of other conclusions can be reached from this study:

- (1) Among potential buyers there is a lack of sophistication in the decision-making process.
- (2) Home owners appear to use a single financial criterion -- expected savings -- in their evaluation of solar-energy systems. Home buyers are more likely to consider other financial variables.
- (3) The other critical variable in the solar purchase decision-making process is the consumer's attitudes towards system economics.
- (4) Attitudes about solar's social acceptability, both short term and long term, are important. Consumers want to be sure that the concept is not a fad.
- (5) There are regional differences in the solar purchase decision-making process. Those residing in the West, and especially new-home buyers in the West, are the best potential market. The North East is the region with the second-highest overall potential, followed by the South, and finally the North Central region.
- (6) New-home buyers make up a segment with about twice as much potential as existing-home owners in terms of likelihood of purchase. The differential remains about the same in the short term (one year) and in the long term (five years).
- (7) Demographic variables do not generally appear to be good indicators of who is likely or unlikely to purchase solar equipment.

4. Recommendations

In terms of hastening the adoption of active solar-energy systems by residential consumers, we would consider actions for government agencies or industry in terms of (a) product design, (b) communications, (c) distribution and (d) targeting. In other words, the right product has to exist, aimed at the right segment, and available to that segment. In addition, the segment must be made aware that the product exists, and that it can fulfill an existing need.

Product Design

Since savings is the critical determinant of likelihood of purchase, product efficiency is a major goal. This study suggests that design effort aimed at increasing solar fractions would pay off in increased acceptance by the market, assuming only minor accompanying differences in price and size. Varying warranty periods beyond five years does not appear to increase market acceptance; dependability tends to be of relatively small importance in the consumer's decision-making process.

Communications

The key communication effort needed in the residential market for solar has been discussed above (see Section 3.E.1): what is required is a major, generic communications program aimed at generating awareness and knowledge of commercially available solar technologies and government incentives.

The variables in attitudes that are important in the decision-making process suggest the content for product-oriented communications as well as generic messages: themes such as increase in a home's resale value or protection from future energy shortages come out of the economic attitudes that are important in the decision-making process. A general theme stating that solar economics makes sense would appear to be more consonant with what many consumers want to hear than with facts born out by hard numbers. Another area for communications is the social acceptability of solar. Consumers need to hear that there is a "band wagon" for them to get on; they need to be convinced that though solar is not widespread now, it will be used on more and more homes as the years go by.

Other communications themes can be suggested by variables specific to each region.

Distribution

There is no solar distribution problem for new homes -- a buyer of a new home looks to the builder to provide the mechanical systems in the house. As a result, builders are the distribution channel in the new-home segment.

In the existing-home or retrofit segment we encounter more difficulty. When asked from whom they would like to buy a solar-energy system, assuming that they were going to purchase one, 71.3% of consumers said they wanted a specialized solar dealer (see Exhibit 3-84A). Only five percent reported that they would call a plumber. When a water-heating system needed replacement, however, almost two-thirds of the respondents said they would call a plumber (see Exhibit 3-84B). It seems to us that the most likely time to retrofit a system is at the time the old system has ceased to function. If this is the case, plumbers must be viewed as a potentially important channel of distribution. We do not necessarily see plumbers as distributors themselves, any more than they are distributors of particular brands of bathroom fixtures or faucets. Rather, we see them as important influencers in the decision-making process -- they are called in at the right time and they could arrive with the right information and knowledge about installation.

The retrofit market is large, roughly 50 million single-family residences; plumbers appear to be one key to tapping that market. To determine the viability of this particular channel, we suggest a study of plumbers' perceptions of solar and ways in which they might interface with solar manufacturers and distributors.

Targeting

Our analysis suggests that new-home buyers are the segment with the greatest potential for active solar. These consumers should be encouraged to seek solar as a part of their new homes. Clearly their builders are important influencers in the decision-making process. What is necessary is to build demand or "pull" while also influencing the builder to use solar in his speculative construction (see Section 6).

For further targeting, our regional analyses indicate that the primary solar markets are in the West and North East, followed by the South and North Central regions.

Demographic variables are generally not good indicators of who is or is not a likely solar purchaser. Rather, potential solar purchasers seem to come from all demographic strata, with some minor exceptions that are specific to regions.

D. THE MANUFACTURING BUILDING MARKET

1. Measurements

Data for manufacturing buildings, that is, industrial respondents, were collected in two parts: a telephone interview followed by a mailed measurement instrument. The objective was to provide each respondent with semitechnical descriptive information about solar-energy systems and to measure the effect of that information on intention to purchase. The measurement instrument gathered information about respondents':

- awareness and knowledge of active solar-energy systems,
- experience with solar systems,
- attitudes and beliefs about solar systems,
- likelihood of purchasing active-solar systems,
- HVAC investment criteria,
- HVAC decision-making process, and
- company and individual characteristics.

Following a pilot study of 190 telephone interviews, seven SIC codes -- 20, 22, 26, 27, 35, 36, and 38 -- were identified as high potential solar adopters. The final sample was drawn from a series of mailing lists of engineers, plant supervisors and manufacturing firms; a random sample was drawn in the appropriate SIC codes. The respondents all qualified as "actively involved" in HVAC decision-making processes for their organizations.

In the mailed portion of the measurement instrument, each respondent saw two out of a possible four descriptions of solar-energy systems: solar water heating, space heating, space air conditioning, and solar-assisted heat pump.

A total of 655 telephone interviews were completed and a total of 208 questionnaires were returned by mail.

2. Sample Description

The responses were distributed among seven major industrial groups as described in Exhibit 1-5. Prior to this study, 50.4% of the respondents had seen or heard of the use of active solar-energy equipment for domestic water heating or space heating or cooling for industry. Exhibit 1-6 shows that, of those who had previous knowledge of solar HVAC equipment, 77.1% had knowledge of domestic water-heating applications and a total of 2.1% reported their companies were using solar for some application.

Exhibit 1-7 gives the attitudes of the sample toward solar-energy equipment. As a whole, industry disagreed with the statement that they could obtain reliable and dependable solar-energy equipment. Exposure to information encouraged the sample to be more positive about solar energy. Beliefs about solar cooling were the most negative. In general, the group felt it knew how solar-energy systems work and understood the financial merits of the system.

Solar equipment has to pass a number of purchasing criteria to be acceptable to industry as a whole. Exhibit 1-8 displays those criteria. In terms of financial investment criteria, in our sample the payback method was the most commonly used one. As seen in Exhibit 1-9, half the firms required a 3-year payback or better on HVAC equipment.

Exhibit 1-10 gives a picture of the structure of the HVAC decision-making process. For the sample as a whole, inside the firm, general management and production or maintenance engineers had the most influence in the decision-making process. External personnel were important as well, suggesting the need to study HVAC engineering firms and architects.

3. Results of Analysis

The results of the analysis performed on those data can be summarized as follows:

- (1) Potential industrial users of solar HVAC equipment are aware of how the systems work and understand the financial merits of the systems.
- (2) In general, respondents are not receptive to solar HVAC equipment, with very few giving any significant likelihood of system adoption.
- (3) Impressions of solar cooling systems in general are fairly negative; solar cooling is the most unfavorably rated, followed by heat pumps and solar space heating. Solar water heating gets the most favorable ratings.

EXHIBIT 1-5

Industry Distribution

	<u>Code</u>	<u>% of Sample</u>
Food and kindred products	20	15.6
Textile-mill products	22	12.2
Paper and allied products	26	15.0
Printing and publishing	27	14.7
Machinery except electrical	35	13.6
Electrical and electronics machinery and equipment	36	15.3
Measuring, analyzing and controlling equipment	38	13.6

n = 655

EXHIBIT 1-6

Industrial Solar Power System Knowledge and Use

<u>Solar System</u>	<u>Previous Knowledge of Industrial Application</u>	<u>Company Uses System</u>
Domestic water heating	77.1%	0.8%
Process water heating	59.9%	0.8%
Space heating	67.4%	0.5%
Space cooling	48.1%	0.0%

EXHIBIT 1-7

Solar Attitude Means -- Industrial Segment

	<u>Pre</u>	<u>Post</u>			
		Water Heating	Space Heating	Space Cooling	Heat Pump
We can currently obtain reliable and dependable solar-energy equipment (post = a particular system)*.	3.32**	2.86	3.28	2.88	2.90
			<u>2.98</u> (mean)		
We can currently obtain solar-energy equipment (post = a particular system)* that makes economic sense.	3.57	3.45	3.69	3.44	3.38
			<u>3.49</u> (mean)		
Solar-energy equipment will be widely used in our industry in the next five years.	3.49		3.36		
I understand the financial merits of solar-energy systems.	2.32		2.22		
I understand how solar-energy systems work.	2.00		1.71		

* In the "post" questionnaire, the respondent was asked the question with regard to a particular system.

** Responses are on a 5-point scale in which 1 = strongly agree and
5 = strongly disagree

EXHIBIT 1-8

HVAC System Purchasing Requirements

	<u>Median Requirement</u>	<u>% Using</u>
Minimum Expected Life	10 years	80%
Minimum Warranty Period	12 months	74%
Minimum Number of Previous Successes	3	67%
Maximum Annual Maintenance Cost	5% of investment	46%
Require Manufacturer Have Local Presence	-	47%
Purchase Only if Had Experience with Manufacturer or Vendor	-	34%
For retrofit:		
Require Same Type System	-	6%
Require Same Energy Source	-	11%

EXHIBIT 1-9

HVAC Financial Criteria

<u>Method</u>	<u>% Use***</u>	<u>First Quartile*</u>	<u>Median</u>	<u>Third Quartile**</u>
Payback	81%	2 years	3 years	5 years
Net Present Value Method	19%	17%	13%	10%
Internal Rate of Return	24%	40%	20%	15%
Initial Investment	62%			

* Read: "75% of the respondents find this level acceptable."

** Read: "25% of the respondents find this level acceptable."

*** Note: Some companies use several methods and column sums to more than 100%.

EXHIBIT 1-10

**Mean Structure of Organizational Buying Process
for HVAC Equipment in Sample**

	Decision Phases Decision Participants	1 Identification of HVAC alternatives		2 Financial and technical evaluation*	3 Final equipment and source selection**
		New Installation	Retrofit Installation		
INTERNAL COMPANY PERSONNEL	Production engineer	1.8 %	1.3 %	1.7 %	2.2 %
	Plant or maintenance engineer	20.4 %	25.4 %	19.2 %	22.8 %
	Design engineer	6.3 %	7.4 %	5.8 %	6.2 %
	Plant or factory manager	9.4 %	11.4 %	11.2 %	12.1 %
	Financial controller or accountant	3.7 %	4.8 %	15.8 %	5.3 %
	Procurement or purchasing officer	1.4 %	1.3 %	3.7 %	4.7 %
	General management	24.0 %	22.8 %	27.3 %	34.3 %
	Other (specify)	2.3 %	2.8 %	3.1 %	1.1 %
EXTERNAL PERSONNEL	HVAC/Engineering firm	14.3 %	11.1 %	7.8 %	6.2 %
	Architects	10.1 %	3.8 %	1.7 %	3.4 %
	HVAC equipment manufacturers/vendors	6.3 %	7.9 %	2.7 %	1.7 %
	COLUMN TOTAL	100%	100%	100%	100%

*Decision phase 2 generally involves evaluation of all alternative HVAC systems that meet your company's needs, while

**Decision phase 3 involves only the alternatives (generally 2-3) retained for final selection

- (4) To be generally acceptable to the sample, solar HVAC systems would need to demonstrate a 3- to 5-year payback, last at least 10 years, carry at least a 12-month warranty, and show maintenance costs of no more than 5% of the initial investment.
- (5) Key decision participants for HVAC equipment within organizations are plant or maintenance engineers and general managers. Engineers are more favorably disposed toward solar than are managers; SIC codes 22, 26, and 36 show decision processes that involve engineers more heavily and are more prosolar than the other SIC codes.
- (6) In terms of likelihood of recommendation, some key correlates are
 - (a) belief that solar makes economic sense,
 - (b) belief in solar benefits and ease of use,
 - (c) belief in solar flexibility, and
 - (d) an understanding of the financial merits of solar (life-cycle costing concepts).

4. Recommendations

With respect to having solar HVAC systems adopted in the industrial sector, we consider actions for marketers or for the government in terms of (a) product design, (b) communications, and (c) targeting. In other words, to penetrate the market, the right product has to exist, aimed at the right market segment which has been convinced of certain key issues with respect to solar.

Product Design

Payback period and warranty or reliability are key decision dimensions. Solar will not be considered for an application unless it has short payback and long life. If we consider a target of 10% of the market, in order to have the potential to meet that target, a solar system must last 20 years, offer a 12-month warranty and have an 8-year payback. Under these conditions, 10% of the HVAC market would consider such an HVAC system. Design targets must be in the 3- to 5-year payback range, however, to see significant penetration.

Communications

A variety of noneconomic dimensions affect solar receptivity. Of most importance are the belief that solar systems are (a) protection against full rationing and power failures and (b) that solar is "easy to install and use," that is, does not cause construction delays, involves minimal retraining, has modular systems, has no major maintenance problems, and so on. These issues are critical in affecting solar receptivity.

Targeting

Our analysis suggests that a firm is more likely to be receptive to solar if:

- (a) it has plant or maintenance engineers involved in the HVAC decision-making process;
- (b) it does not have top managers involved in the HVAC decision-making process;
- (c) HVAC decisions are made centrally;
- (d) the decision makers are younger; and
- (e) the firm is in the paper and allied products industry.

E. HVAC ENGINEERS AND ARCHITECTS

1. Measurements

Prior interviewing experience with HVAC engineers and architects indicated that these groups were well aware of solar applications and were up to date on equipment design and availability. Thus, there was no need to provide this group with descriptive material and the measurement procedure was performed over the telephone. The telephone interview was designed to obtain:

- respondents' attitudes toward solar,
- likelihood of specifying solar for various applications in the future,
- decision criteria that the respondent used in evaluation HVAC systems, and
- demographic measures about the firm and the respondent.

The sample used stratified by regions, was selected from the membership list of ASHRAE, the subscription file of Heating, Piping, and Air Conditioning, and from the membership roster of the American Institute of Architects. A total of 398 respondents were obtained, of whom 212 qualified as architects; the rest were made up of HVAC engineers.

2. Sample Description

Virtually all (99.2%) of the respondents reported that they were aware of how solar-energy systems work and 80.2% reported having sought information about solar energy from a solar equipment manufacturer or dealer.

Exhibit 1-11 shows the breakdown of the types of solar-energy systems about which respondents reported asking for information; hot-water and space-heating systems were most commonly mentioned.

Exhibit 1-12 shows that a large fraction of this population (over 75% for domestic hot water) had considered recommending solar for some application. Exhibit 1-12 also shows that 38% of the respondents had, in fact, specified solar for some domestic hot-water application.

EXHIBIT 1-11

Kinds of Solar-energy Systems about which
Respondents Reported Searching for Information

Domestic Water Heating	83.1%
Process Water Heating	42.3%
Space Heating	74.9%
Space Cooling	49.3%

n = 319

EXHIBIT 1-12

Consideration/Specification of
Solar-energy Systems

	<u>Considered</u>	<u>Specified</u>
Domestic Water Heating	75.6	38.2
Process Water Heating	30.4	14.9
Space Heating	66.1	32.9
Space Cooling	36.7	13.8

Exhibit 1-13 shows the amount of the firm's business that was solar related. Here we see that 4% of the responding firms had 25% or more of their business solar related.

Exhibit 1-14 gives likelihood of recommending solar. 90% of architects and 79% of HVAC engineers reported being somewhat or very likely to recommend solar for some application in the next five years.

In terms of financial criteria used for evaluating HVAC equipment for clients, the payback period was most commonly used, with 61% of architects and 68% of HVAC engineers reporting using it. Exhibit 1-15 lists other key criteria used in evaluating HVAC equipment. Overall, the sample reported that when recommending an HVAC system, the most important criteria were maintenance cost and lack of maintenance, as well as availability and the future cost of fuel.

3. Results of Analysis

The analysis of the responses of architects and HVAC engineers is quite interesting since they exert strong influence in the selection of HVAC equipment though they do not actually purchase equipment. The data and analysis presented in this chapter lead to the following conclusions.

- (1) HVAC's and architects are well aware of solar energy and understand solar merits. In fact, over a third of the sample specified a solar-energy system for some application.
- (2) Architects are more prosolar than HVAC's; the key difference in solar receptivity is linked to belief in the need for solar to lead the nation to energy independence.
- (3) The most common economic criterion used is payback period. To be acceptable to half of the individuals, a 10-year life and a 12-month warranty are required.
- (4) The key criteria for HVAC decisions are, interestingly, maintenance cost and fuel costs, with initial cost being rated as of lesser importance.
- (5) In terms of likelihood of recommending solar, the key indicators are
 - (a) past action - past specifier,
 - (b) solar citizenship ("Is solar an answer to our energy problem?"),
 - (c) profession (architect or not), and
 - (d) perception or belief about solar.

4. Recommendations

The HVAC/architect group is of critical importance in influencing HVAC decisions. The product must be designed to meet their needs and

EXHIBIT 1-13

Amount of Business Solar Related

None	54.0%
Less than 5%	28.4%
5% to 25%	13.6%
More than 25%	4.0%

n = 398

EXHIBIT 1-14

Likelihood of Recommending Solar for Some Application

	(a) In The Next Year		(b) In The Next Five Years	
	<u>Architects</u>	<u>HVAC</u>	<u>Architects</u>	<u>HVAC</u>
Very Likely — 100% Sure	25.6	17.3	44.5	31.6
\ Pretty Sure	14.8	6.8	22.5	15.0
Somewhat Likely	23.5	30.8	22.5	32.3
Unsure	6.0	4.5	5.5	5.3
Somewhat Unlikely	13.7	10.5	3.8	7.5
Very Unlikely	16.4	30.1	1.2	8.3

n = 398

EXHIBIT 1-15

Criteria Used in Selecting HVAC Equipment
Threshold Acceptability

<u>Criterion</u>	Median Level of Threshold Acceptability		% Using Criteria	
	<u>Architects</u>	<u>HVAC</u>	<u>Architects</u>	<u>HVAC</u>
Minimum Life (Years)	10	10*	84%	77%
Minimum Warranty (Months)	12	12	84%	89%
Number of Prior Installations	3	5	41%	48%
Agree to Consider if No Prior Experience with Vendor	-	-	64%	53%
For Heating Minimum % Conversion Efficiency	60%	75%	46%	50%
For Cooling, Minimum Coefficient of Performance	4.0	3.0	45%	44%
Minimum Profit Margin	8%	11%	48%	68%

* Read this as "Half of HVAC professionals require at least a 10 year life for a system they will recommend."

they must be convinced of solar viability. They are aware of solar as a group and know it works. But how well does solar meet their needs and how important is solar to them?

Product Design

The payback period on solar is critical for recommendation. It must be short, 3 to 5 years, although some applications will permit long economic lives. Systems should have at least a 12-month warranty and last at least 12 to 15 years to be viable. The system must be designed to provide few or no problems in terms of maintenance. Maintenance problems eliminate a solar system from further recommendation considerations.

Communications

There are several key perceptual variables that relate closely to solar recommendation. For this group to be influenced, it must be convinced that solar is (a) an important technology and (b) a valuable way of achieving energy independence. Individuals must also be convinced that solar is "here," that it is a currently viable technology leading to few problems.

The communication of these messages is a big job. Nonetheless, these perceptual variables explain about half the variance in the likelihood of purchase equations -- they represent critical roadblocks on the path to solar recommendation.

F. BUILDERS

1. Measurements

The measurement questionnaire for home builders was designed for face-to-face administration at the 1980 National Association of Home Builders Exposition, an efficient, cost-effective means of reaching a large cross-section of the target audience. Questions were included in the survey to obtain data in:

- awareness or use of solar and government incentives,
- history of solar installation,
- plans or likelihood of future solar installation,
- attitudes and opinions about solar, and
- demographic information, both personal and about the firm.

Interviews were conducted with 256 builder-attendees of the NAHB Exposition in Las Vegas, Nevada, January 18 to 21, 1980. Those who attended the convention were screened to be sure they or their firm built single-family residential homes on speculation. The exposition

consisted of 9,622 single-family residential builders; at least one percent of this number came from each of 37 states and the District of Columbia.

2. Sample Description

Exhibit 1-16 gives the number of single-family homes, both spec built and custom, that the builder's company built in 1979. The distribution corresponds well to Census Bureau statistics on the housing industry: 75% of the sample built 47 or fewer homes, while the top 1% of the sample built between 1700 and 6100 homes.

Exhibit 1-17 shows regional breakdown by the four census regions, reflecting the heavy new-home construction volume in the Southwest. Exhibit 1-18 gives the breakdown of home buyers, with the sample reflecting a tendency toward building middle-priced homes. Exhibit 1-19 shows the usual selling price for a spec-built home.

In terms of installing active solar-energy systems, 22% of the sample reported having installed a solar-energy system, 55% reported having considered installing, but not actually installing, and 23% reported never having considered installing a solar-energy system. Exhibit 1-20 gives details, including the solar product that was actually installed. By far the most common solar product, with 85% of installers reporting it, was an active-solar water heater.

When asked about criteria that builders find important when considering solar, they responded that reliability of equipment and ease of installation were most critical.

When asked what they thought solar manufacturers should do to make their product more marketable, builders responded that they should (a) improve system performance, (b) have the product certified and (c) advertise its financial benefits.

3. Results of Analysis

Builder/developers represent HVAC decision-making opportunities in one of the largest segments of potential solar use -- the new-home market. The data and analysis presented in this chapter lead to the following conclusions:

- (1) Builders are aware of solar-energy systems. In fact, 22% of the sample reported having installed an active solar-energy system while another 55% reported considering having a solar HVAC system installed.
- (2) Past installations are more likely to be found in the Southwest and to be built by large builders and builders of higher-priced houses.

EXHIBIT 1-16

Number of Homes Built in 1979

Percent of group		Number of homes
25		0 - 8
25		9 - 20
25		21 - 47
25	20	48 - 300
	4	300 - 1700
	1	1700 - 6100

mean = 111

median = 20

n = 256

EXHIBIT 1-17

Regional Building Breakdown, by Main Region

23%	North East
18%	South East
26%	North West
33%	South West

EXHIBIT 1-18

Home Building-type Breakdown

Entry-Level Houses	23%
Middle-Price Houses	44%
Luxury Houses	33%

EXHIBIT 1-19

Purchase Price of a Typical Spec-built House

\$ 30 - 50K	14%
50 - 70K	31%
70 - 90K	23%
90 - 110K	9%
110 - 130K	8%
130 - 150K	5%
150K+	10%

EXHIBIT 1-20

Solar-energy Installation

(3) In distinguishing between installers and noninstallers, critical discriminating factors are:

- building large numbers of custom homes,
- southwest location,
- having architects involved in the HVAC selection process, and
- feeling that solar makes economic sense.

(4) Builders are less likely to install if:

- they feel that solar manufacturers are small operators,
- they feel consumers are highly concerned about reliability,
- they are concerned about regulatory problems, and
- they are located in the North West.

(5) In predicting the future installation of solar equipment, the most important correlates, besides past installation history, are:

- belief that solar makes economic sense, and
- belief that home owners are not concerned about aesthetics.

4. Recommendations

The builder/developer group can exert strong leverage in the solar adoption process. In particular, we should consider (a) the kind of product they require, (b) the way to communicate the product benefits to them, and (c) how to determine a target market.

Product Design

Over three-quarters of the builders said that they did payback analysis on their investments for spec-built homes. In other words, solar has to be perceived by the consumer as worth the extra investment. If it is not perceived as advantageous, the house will not sell. The two top priority items for solar adoption deal with performance and supplier reliability. If the builder is convinced the house will sell with solar, he will adopt it only if it (a) works and (b) does not cause him maintenance problems.

Communications

To generate receptivity among builders, it is necessary to convince them that (a) solar makes economic sense, (b) home buyers are concerned about good citizenship, and (c) aesthetics are not critical in the house-buying decision-making process. They will also be more likely to install if they are convinced that solar is inevitable, that is, that solar is "now" and not just a chance for the future.

Finally, installers do not see regulatory problems as being difficult -- noninstallers do. The "ease of regulations" issue therefore needs to be addressed as well.

The above issues represent a series of targets and challenges for the emerging solar-energy industry and for the Department of Energy.

Targeting

Our analysis indicates that when trying to sell solar products more success will be had with the following market segment:

- southern or southwestern location,
- large builders of custom homes, preferably expensive homes, and
- builders who have architects involved in the energy-system selection process.

Of course, if the builder has previously installed a solar system, he will be a superior target in the future.

G. COMMERCIAL

1. Measurements

Personal and telephone interviews were conducted with owners and operators of three kinds of small businesses with large apparent hot-water needs: low-rise motels, laundries, and car washes. Most of the interviews in the car-wash segment were conducted at the International Car Wash Association Convention. All interviews were based on an open-ended protocol, and were designed to gather data about:

- current and expected fuel usage,
- the purchase decision-making process,
- awareness of and attitudes toward solar for use in business, and
- ways to speed up the adoption of solar by businesses.

Discussions were held with 183 individuals in the commercial sector. In addition, discussions were held with a small number of hospital administrators and engineers in an initial probe into the hospital segment.

2. Conclusions and recommendations

The small commercial operations studied relied heavily on hot water used in large amounts. They also operated on small capital budgets and margins. Due to these constraints, the businesses were suffering greatly from increasing fuel costs, and ways to cut these costs were of grave concern. Without exception, the owners or operators were using, or soon switching to, the fuels they felt were least expensive for their operations. They remained, however, very receptive to new ideas and ways to reduce the cost of heating water.

By and large, the respondents were aware of solar water-heating systems. They viewed solar energy as a good alternative energy source in the face of rising traditional fuel costs. There were, they felt, two primary criticisms of solar systems: 1) the initial cost was too high for their small business capital; and 2) the systems were not tested and proven enough and the industry not established enough to provide reliable equipment and service.

To deal with the first criticism, respondents suggested that the government provide larger tax credits and, through industry-specific communication programs, attempt to increase awareness of those incentives already available. They also mentioned long-term low-interest loans as another means of reducing overall cost. This solution, however, may not be attractive to the more transient owners of small businesses such as motels.

Another suggestion for dealing with the impact of the high initial cost was to stress the importance of the long-term investment in terms of projected fuel costs and savings over time. While many small businesses tended to think in terms of the short-run because of their transient association with the business, owners of businesses such as car washes and motel or hotel chains regarded long-term savings as more important than initial cost. To these owners, the long-term advantages of solar equipment were an attractive selling point.

Many suggestions were made for overcoming the perceptions of unreliability and solar systems being untested or for resolving perceived service and maintenance problems. The major suggestion was a call for demonstration programs. Owners showed a willingness to travel substantial distances at their own expense to view new products in their industry, especially when these products could help add to the bottom line. But they tended to be skeptical of government involvement, and instead wanted to see demonstrations monitored by the industry and its associations. Almost without exception they said they would be willing to become personally involved in a demonstration.

A further comment called for the endorsement of solar manufacturers by industry associations. Each of these industries has several such associations. There is an association-sponsored car-wash research institute which is interested in solar and has industry-wide credibility. Many independent motels belong to associations or chains which provide them with product test results and business recommendations. A favorable test or recommendation from such an organization could have considerable effect among its members.

A final recommendation was that solar system manufacturers and distributors display at conventions, showing a system design applicable to the specific industry. Ideally this would be a design that had operated in its particular use for a long enough period to generate a documented record of savings.

H. EXTENSIONS AND FURTHER WORK

The results and analyses presented here stand by themselves in value -- they provide clear direction for action both by government policy makers and by private industry for making solar HVAC systems most attractive. There are, however, two key extensions of this work that will make it more valuable:

- (a) Integration of market acceptance criteria with solar product performance goals: Our analysis here shows what solar-energy systems need to deliver in order to be acceptable to a given percentage of different markets. Current and projected needs for HVAC equipment have been collected as part of Part A of this study; current and future technical performance characteristics -- price, lifetime, payback -- are needed for each solar-energy system in order to develop market penetration projections. This information can be used to help define the level of government support (subsidies, conservation programs, and so on) that is needed to meet DOE penetration goals.
- (b) Behavioral tracking: Some of the most important information needed for energy planning cannot be collected in a static, cross-sectional study like this. Time trends of awareness, attitudes and intentions to purchase can give:
 - early indication of future successes or failures of government programs,
 - guidance about what private sector or government actions are most effective in supporting solar, and
 - the possibility of development of leading indicators of solar projections (intent to purchase a product usually leads to purchase by 1 to 3 years in product claims like these).

We feel strongly that a great deal of extremely valuable information has been collected in this study. To get the most from this information, an integration of existing technical and behavioral information is needed and a replication of this study over time is required. In this way, the most information can be derived from this and related studies to aid in DOE energy policy planning and projections.

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SECTION TWO

BACKGROUND AND DEVELOPMENT OF TECHNICAL APPROACH

The scope of the work presented here is a comprehensive evaluation of the market for solar heating and cooling products for new and retrofit markets. The focus of the work is the analysis of solar knowledge among HVAC decision makers and a comprehensive evaluation of their solar attitudes and behavior. This document reports on that data collection analysis procedure, aiming at identifying ways to aid the development of solar energy as a viable and significant alternative energy source.

The U.S. Department of Energy has the responsibility for developing policies that meet congressional market-penetration objectives for solar-energy technologies. In order to achieve acceleration of demand, knowledge of market response is necessary; DOE must understand what the demand is for solar technologies.

Many studies have shown that demand for solar technologies is not based solely on economic criteria:

There are some people who buy solar systems which are more expensive than conventional energy sources, perhaps because of some perceived increase in status, or because of having a value system which may be described as voluntary simplicity. In other markets there is little demand for solar domestic hot water systems which compare well economically against traditional water heating systems (Booz, Allen and Hamilton [1980]).

The main questions that this study seeks to answer include:

- What is the profile of a potential solar adoptor?
- What is the awareness, interest and likelihood of solar purchase for key market segments?
- How do these levels of awareness and interest vary by sector, type of individual and type of product?
- What criteria other than economics affect the purchase decision?

A. SOLAR ENERGY FROM A MARKETING PERSPECTIVE

Many alternatives to fossil fuels, including most solar energy systems, require that buyers adopt new ways of thinking about energy use when making investments in their homes and businesses. To sell alternative energy products successfully, manufacturers must consider new marketing and communication strategies that are sensitive to the attitudes of different categories of users and the operation of different real estate markets.

1. Uniqueness of Solar Devices as Building Products

A transition from one primary fuel to another has occurred twice in United States history; once from wood to coal, and then from coal to natural gas and oil. Unlike these past transitions, the present change-over from petroleum and natural gas to new energy sources is not the result of a new primary fuel that is cheaper, more abundant, and more environmentally acceptable than the current sources of energy. This contrast points to the unique problem confronting those engaged in trying to market solar devices. Solar systems represent the first major new building technology that adds substantially to the first cost of a structure and whose justification is found in a stream of savings delivered over time. In addition to high first costs, solar devices require many consumers to rethink their traditional notions of building design, and to accept considerable uncertainties with respect to performance and durability. These factors all compound the problems confronting any new product struggling to gain acceptance in the market place.

2. Lessons from the Market Research Literature

Clearly the nascent solar industry (the manufacturers, distributors, and installers) confront sizable risks in their efforts to assemble a viable market for their products and services. Balanced against these risks is a market demand of enormous potential. The categories of space heating, water heating, and air conditioning account for about 25% of the U.S. energy budget. A considerable portion of this total is potentially convertible to solar energy, suggesting that solar devices at some future time may become major items in our energy portfolio.

Past experience in new-product development points to the importance of timely market research if fledgling solar enterprises are to survive and their long-term potential for helping supply the nation's energy needs is to be realized. For industry as a whole, about two-thirds of the technically successful products that emerge from R & D departments fail to become commercial successes. From a cost standpoint, more than 70% of all money spent on new-product activities is spent on products that are never commercial successes (Booz, Allen and Hamilton [1965]).

Mansfield and Wagner (1975) have investigated the probabilities of success for new industrial products in different stages of their development cycle. They report on average:

- a 57% rate of technical completion, that is, the development of a working product prototype;
- a 65% rate of commercialization, that is, bringing the product to market following successful technical completion; and
- a 74% probability of economic success after commercialization.

This leads to a 27% commercial success rate for product development projects. Although this number should be interpreted carefully due to considerations of sample size and lack of agreement about what a commercial success is, it provides a gross estimate of the risks associated with new-product development activities.

There are over a score of studies that have appeared during recent years about the determinants of new-product failures. These studies are mainly of three types:

- Case analyses of some new industrial products that emerged successfully from R & D programs only to become market failures (Briscoe [1973]).
- Cross-sectional studies of new industrial product failures (Cooper [1975]), Calantone and Cooper [1977], von Hippel [1978]).
- Experimental or quasi-experimental studies that focus either on differences between successful and unsuccessful innovations competing in the same market (Rothwell et al. [1974]) or about factors influencing new product success probabilities (Mansfield and Wagner [1975]).

By and large, the results reported by these studies are consistent.

They stress as a major cause of failure:

- the lack of appreciation for the way customers perceive and evaluate the new product;
- the misassessment of the firm's existing stock of resources, especially its marketing skills; and
- the lack of specific objectives for the new product in terms of its target market and place in the company's product mix.

The result of these studies is that a better understanding of the product and the market place is a key to reducing the risk of new-product failure. Mansfield and Wagner (1975) show that the probability

of commercialization and economic success is strongly related to the speed with which market analysis is performed. Calentone and Cooper studied 117 new-product failures and found that the largest, most conspicuous group of failures was associated with products whose markets failed to materialize.

In sum, evidence about ways to reduce new-product failure points strongly to the need of a better understanding of customers' requirements and the market structure, as well as a closer integration of market research findings with engineering developments. High new-product failure rates are closely related to attempts to sell R & D output as opposed to satisfying users' needs.

What, then, is the message for solar? The systematic collection and careful analysis of market data can clearly help reduce risks found both by manufacturers and potential buyers. A careful catalogue of who the decision makers are, what their level of knowledge is, what their attitudes toward solar are and what their behavior is likely to be can help answer the "what-if" questions that a manufacturer needs answered in order to successfully penetrate the market. This is the focus of our analysis.

B. THE SOLAR CHOICE PROCESS: MODELS AND MEASUREMENTS

The purchase process for solar devices is quite complex. As previous work has shown (Epstein et al. [1977]), only solar water heaters for home use have a significant retrofit market -- a purchase process that is fairly simple. Space heating, a much larger piece of the energy picture, is most feasible in a new-home purchase situation.

But in such a situation, who decides? Is it the buyer? Certainly not in the case of a spec-built house. And in a custom home, an architect, an HVAC consultant and a builder may also influence the purchase decision.

We note the following:

- (1) A large proportion of solar purchase potential is accounted for by situations involving multiple decision makers. We will refer to these individuals as "decision participants."
- (2) Organizational buying (involving more than one individual) is more complex than consumer choice. When dealing with consumer choices (retrofit solar water heaters, for example) much of the analysis described here does not directly apply. We will analyze a consumer as an organization with a single decision participant.

Thus, industrial or organizational adoption is the more intricate problem analytically and we focus on it here. Section 2.C, which addresses individual choice analysis, is directly applicable to the housing consumer as the single decision participant.

1. Adoption of New Products by Organizations

The organizational purchasing process has been the focus of study for a number of years. Previous work on industrial buying behavior has

been essentially concerned with (a) the development of integrated conceptual models and (b) the empirical verification of hypotheses pertaining to specific aspects of this behavior. For example:

- Robinson and Faris (1967) have developed a descriptive model of industrial buying behavior which categorizes this process according to purchase situations.
- Webster and Wind (1972) have proposed a descriptive model of organizational buying, incorporating the concept of a "buying center" and includes those individuals involved in a purchase decision. Response of the buying center is analyzed as a function of four classes of variables: individual, interpersonal, organizational and environmental.
- Sheth (1973) has developed a model that tries to encompass all industrial buying decisions. The Sheth model distinguishes three main elements of industrial buying: (a) the psychological characteristics of the individual involved; (b) the conditions that precipitate joint decision making; and (c) the conflict resolution procedure affecting joint decision making.

In addition, a number of empirical studies have dealt with certain aspects of industrial buying behavior. On the whole, these studies are:

- observations of actual purchase decisions (Cyert [1965], Brand [1972]);
- analyses of the involvement of various organizational functions in industrial purchasing (Harding [1963], Scientific American [1969], Buckner [1967]); and
- studies of the behavior and decision styles of individual decision participants (Lehman and O'Shaughnessy [1974], Cardozo and Cagley [1971], Hakansson and Wootz [1975], Wilson [1971], Sweeney et al. [1973], Scott and Bennett [1971], Widt and Bruno [1974], Scott and Wright [1976]).

These studies, by and large, neglect key issues of managerial use and measurement needed to give them more than conceptual value. To address these limitations, Choffray and Lilien (1980) have developed a

framework to model organizational buying.. It focuses on the links between the characteristics of an organization's buying center and the three major stages in the industrial purchasing decision process through:

- (1) elimination of evoked product alternatives that do not meet organizational requirements;
- (2) formation of decision participants' preferences; and
- (3) formation of organization preferences.

Making the analysis most valuable involves explicitly handling customer heterogeneity. This approach addresses the following issues:

- Need specification heterogeneity: Potential customer organizations may differ in their need specification dimensions, that is, in the criteria they use to specify their requirements. Company A may use payback period as a criterion while Company B uses initial cost only. They also differ in their specific requirements. Company A may require a 3-year payback, while Company C may find 4 years satisfactory.
- Buying center heterogeneity: Potential customers may differ in the composition of their buying centers. Who is involved? What are their responsibilities? Company A has a purchasing agent and an engineer involved in the buying process for industrial cooling equipment. The engineer screens alternatives. The purchasing agent "buys." In Company B, top management is also involved.
- Evaluation criteria heterogeneity: Decision participants may differ in their sources of information as well as in the number and nature of the criteria they use to assess alternatives. Engineers may be concerned about reliability, while purchasing agents are most concerned about price.

Exhibit 2-1 describes the model. The first two stages define the market technically and perform a first-level segmentation called macrosegmentation. This characterizes organizations likely to react to

EXHIBIT 2.1

General Structure of the Market Analysis Procedure

the product offering differently because of their industry or other observable characteristics.

The next step is called "microsegmentation." Here we divide macrosegments into smaller groups with similar decision-process structures. We use a survey tool, called a "decision matrix" to measure the involvement of different categories of individuals in a particular organization in each stage of the purchasing procedure. Organizations with similar structures across individuals and across decision process phases are grouped together for analysis.

How can we determine the likely purchase behavior of our target customers?

- (1) Our first tool is an "awareness" model, aimed at assessing the relative levels of information each category of decision participant has.
- (2) The next model is the "acceptance" model. It is designed to account for the process by which organizations eliminate products that are outside their range of acceptability. They do this by setting bounds on price, criteria for reliability, specifications on the number of prior successful installations, minimum values of payback period, and so on. Our procedure is designed to measure organizational differences on those acceptance criteria and to provide managerial feedback leading to (a) insight into product design trade-offs and (b) accurate assessment of the market or microsegment acceptance rate for a product with a given design.
- (3) Next we come to "individual evaluation" models. Decision participants (purchasing agents, engineers, controllers, and so on) do not always share the same criteria about product selection and usually view product alternatives quite differently. These models are decision-participant-group specific. They allow a sensitivity analysis of likely industrial market response to changes in product positioning and elicit communications trade-offs.

We now reach a difficult problem: "purchasing interaction," or "group choice." When there is a disagreement between decision

participants as to the product to be purchased, what is the firm likely to do? Group choice models are based on a set of hypotheses about the most likely mode of interaction in potential buying organizations. The selection of the one or combination to be used is based on our assessment, through focus group interviews, on how the individuals are most likely to interact.

In each of the segments studied, therefore, it is critical that we model and measure awareness levels, buying criteria, the determinants of individual choice and the structure of the buying process. As subsequent chapters show, the explicit consideration of these issues are a focal point of our analytical approach.

2. Types of Guidance Provided by the Analysis

The seemingly complex mode of analysis described above provides answers to the key questions that must be addressed in making any product development and marketing decision. These questions have been defined by Little and Cooper (1977) as:

- (1) Does the project warrant further investment? This is the GO/NO GO evaluation that is made at the beginning and at intervals throughout the development process.
- (2) What product performance requirements are required by buyers? This is the product design question that positions the product in specific market segments.
- (3) What are the buying processes in each market segment? This is the problem of judging new product adoption patterns among buyers for purposes of planning the market introduction.

The procedure we use answers all these questions; it provides specific quantitative guidance to support the following decision problems:

- Improving Product Design. An important problem in the development of a new product is determining the features that the product should incorporate. The product acceptance analysis provides key support for such decisions. Thus:
 - the analysis identifies and evaluates dimensions of organization need;
 - the acceptance model assesses design trade-offs in terms of market potential; and
 - the acceptance model allows marketing managers to analyze product design and pricing decisions explicitly.
- Developing and Testing Communication Programs. Communication programs, including advertising and sales presentations, affect response through the awareness model and the individual evaluation models.

The analysis of individual preferences for each category of decision participant allows analysis of product positioning. Results of the evaluation and preference analysis can be used in three different ways:

- Those attributes of solar products that are not perceived by certain categories of decision participants in desirable ways can be identified. Corrective action can be taken in a communication strategy for a potential marketer.
 - A communication program that addresses the needs specific to each group of decision participants can be developed.
 - The impact of changes in communication content on the preferences of each category of individuals can be simulated.
- Segmenting Markets and Targeting Communication Programs. The microsegmentation procedure identifies those categories of decision participants most likely to become involved in the purchase decision. By isolating homogeneous microsegments of organizations, the procedure provides descriptions of the structure of the purchasing decision differences in:
 - the number of decision phases in which each category of participants is involved;
 - the number of participants' categories involved in each stage of the process; and
 - the frequency of involvement of each category of participant in each decision phase.

C. THE STRUCTURE OF INDIVIDUAL CHOICE

As Webster (1965) has noted, "In a final analysis, all organizational buying behavior is individual buying behavior." At the heart of all of our analyses are individual choice models.

Individual behavior is often noneconomic. Jerome Scott's (1977) study on solar water heating indicates that most consumers are willing to pay \$1.40 to \$1.70 per month in incremental mortgage payments associated with a solar system to offset \$1.00 of incremental fuel savings. Man is not wholly an economic animal. As pointed out by Peter Drucker, "What a business thinks it produces is not of first importance . . . What the customer thinks he is buying, what he considers value is decisive -- it determines what a business is, what it produces, and whether it will prosper."

How do consumers process information in evaluating products and making choices? A considerable amount of recent work has helped provide guidance in this area. Several methodologies have been proposed that investigate consumers' product perceptions and the way perceptions relate to individual preferences (Allaire [1973], Hauser and Urban [1977]). Exhibit 2-2 outlines the key steps and associated measurements used to investigate how individual preference and choice evolve.

Step 1: Perception

This step refers to how individuals perceive a product. Individuals position products in a multidimensional product attribute space. Individual i's perception of an alternative may then be thought of as the coordinates of that alternative on the perceptual dimensions. Operationally, an individual's perception of a product is provided by his ratings of the product on a set of agree-disagree scales that we call "perceptual items."

EXHIBIT 2-2

Major Steps in Formulation of Individual Choice

Consider Exhibit 2-3. Here we have two individuals (1,2), two products (A,B), and two dimensions (value for the money and reliability). The symbol $1A$ represents individual 1's ratings of product A. Both individuals agree that product A is a good value for the money and quite reliable. However, individual 1 thinks product B is a good value for the money and not very reliable; individual 2 thinks that the product is quite reliable, but not a good value for the money.

Step 2: Evaluation

This step deals with the reduction of a perceptual space to a subspace of low dimensionality, whose axes represent basic performance dimensions used by individuals to assess products in this class. An individual's evaluation of a new product may then be viewed as a point in this reduced space.

Exhibit 2-4 illustrates this concept. Here we start with six perceptual dimensions. We find that engineers really use only three dimensions to characterize solar products, so that a highly reliable product (+) means poor environmental soundness (-). For top managers, these latter two dimensions are essentially combined. What this means is that top managers do not use as many criteria to discriminate between products as do engineers.

A good way to understand this concept is to relate an ordinary layman's evaluation of wine with that of a wine connoisseur. The wine expert tasting a number of wines may rate them from good to bad along the dimensions of color, clarity, dryness, acidity, tannin, nose, and so on. He may also suggest that a wine has good tannin but a poor finish. Another individual, the nonexpert, knows only whether he likes the wine or not. Thus, if he gives a wine a good rating for bouquet, he probably

EXHIBIT 2-3

Perceptual Analysis Example

EXHIBIT 2-4

Evaluation Analysis

will give it a good rating for acidity as well. That is the way he thinks: his tastes are not highly discriminatory. In our jargon, the wine expert uses many evaluation dimensions, while the layman uses few. They may both know what they like, but, in the case of the wine connoisseur, there are more independent controls.

The identification of differences in evaluation criteria across decision-participant groups is important when we try to understand purchasing behavior. We would not expect production and maintenance engineers to use the same criteria as those used by members of purchasing departments when they assess product alternatives. Engineers are more concerned with product reliability and efficiency, while purchasing officers are more concerned with cost. Factor analytic techniques are the main tools we use in analyses. These are discussed in detail in Appendix 1.

Step 3: Preference

Preference formation deals with the relationship between individual i's evaluation of the product and his preference for it.

Consider two individuals, an engineer and a purchasing agent, evaluating three different products, a, b, and c. Assume that we have already determined their evaluation criteria and have developed composite rating scores. Exhibit 2-5 gives the results of the evaluation scores as well as their stated product preferences.

Here we see that the engineer prefers the high-reliability product while the purchasing agent likes the high cost-value product. Through statistical analysis across several engineers and purchasing agents, we determine that the relative importance of reliability to cost for the

EXHIBIT 2-5

Preference Formation Example

Relative Importance	ARCHITECT			MANAGER		
	Reliability Score	Cost-Value Score	Preference Score*	Reliability Score	Cost-Value Score	Preference Score
	0.83	0.17		0.17	0.83	
Product A	6	2	5.33	3	3	3.00
Product B	3	3	3.00	4	2	2.33
Product C	1	5	1.67	1	4	3.50

* The higher the score, the better the evaluation of the product.

engineer is 5:1 (0.83/0.17 in Exhibit 2-5), while the situation is reversed for the purchasing agent. This result is of key importance in determining which issues should be stressed in communications programs targeted at different groups. In the case of engineers, there is five times the preference payout for a convincing reliability story than with a cost-value story.

Of key interest is the ability of the models to identify and quantify differences in the relative importance of evaluation criteria across groups. As in the example above, knowledge of such differences allows differentiated positioning of a new product for each category of decision actors and permits more accurate prediction of the impact on preferences of a product repositioning. Regression and discriminant analysis-based procedures are used here to relate evaluation criteria to preference. See Appendix 2 for a discussion of discriminant analysis.

Step 4: Choice

Choice formation deals with the mapping of each decision participant's preferences of product alternatives into an estimate of his likelihood of endorsing each. Indeed, individuals do not always choose their most preferred product. It is usually agreed, however, that the higher an individual's preference for a product, the higher the probability that he will choose it when placed in a purchase situation.

As an example, Exhibit 2-6 takes the preference scores from the engineer in Exhibit 2-5 and relates them to his probability of choice for the products in question. Once estimated, individual probabilities of choice for the new product are aggregated within each participant category. Follow-up studies will be required to determine how, for solar, HVAC equipment preference and intent-to-purchase questions relate to actual choice. Our cross-sectional analysis does not provide the measurements over time needed to perform this final step.

EXHIBIT 2-6

Relating Preference to Probability of Choice

D. MARKETING MEASUREMENTS

In this section we introduce the basic concepts associated with collecting the information we use to perform the analyses described here. Exhibit 2-7 outlines the sources and uses of the information.

1. Market Measurements

The first measurement step aims at specifying the target market for the product investigated. Its purpose is to narrow the scope of the analysis to only those organizations most likely to purchase the product. This step of the analysis was performed in Part A of this study, A Survey of the HVAC Markets, and included two phases: target market descriptor definition and market potential assessment.

2. Customer/Organization Measurements

Two major types of measurements have to be obtained at the customer/organization level:

- product-specification requirements, and
- buying-center composition.

3. Measurement Method

The development of reliable questions to measure the two variables of interest follows several steps.

First, a series of open-ended interviews or group interviews (see Wells [1974]) are conducted. Our experience indicates that such interviews generate much of the information necessary to develop prototype survey questions.

SOURCE	MEASUREMENTS	USE
Market	Target Market Description	Macrosegmentation
Organizations	Need Specification Dimensions and Organizational Requirements	Calibration of Feasibility Model
	Buying Center Composition	Microsegmentation
Decision Participants	Product Awareness and Communication Consumption Patterns	Calibration of Awareness Model
	Product Concepts Evaluation and Preferences	Calibration of Individual Choice Models

EXHIBIT 2-7

Measurements for Calibrating the Market Response Model

Careful content analysis of these interviews allows development of prototype survey questions for assessing organization specification requirements. For this purpose, we use questions requesting the maximum or minimum value along each specification dimension beyond which the firm would reject a product out of hand. In order to reduce individual response bias, respondents are allowed to use any information sources in their organization, including colleagues, to provide their answers.

These interviews also provide decision-process information needed for developing a prototype decision matrix. This measurement tool assesses the percentage of task responsibilities at each relevant stage in the purchasing process associated with each category of potential participants.

Second, the purchase-specification questions as well as the decision matrix are administered to a small pilot sample. The information is analyzed to assess the validity of the measurements obtained and questions are modified for final administration.

4. Sample Selection

Sampling theory addresses the issue of determining sample size when a relatively small number of items are to be measured. Our measurement instruments are complex, so a combination of judgment and pretest analysis are used in each case to determine a reasonable sample size.

In this study, our selection procedure in the consumer area included calls to builder/developers to obtain the names of new-home buyers and names in the industrial area; the latter was a two-stage sampling procedure. Here, we first identified a target candidate in each company in the sample using published sources of information.

Second, we asked him to specify those members of his organization who, in his judgment, would be most likely to participate in the purchase of HVAC equipment. Individuals identified at this second stage were interviewed. This procedure increased our likelihood of reaching key decision participants. The details of the separate sample selection strategies are given by chapter.

5. Decision Participant Measurements

At the individual level, product awareness, perceptions, and preferences for the major product alternatives available in the market are measured. Product awareness is obtained by asking individuals what products or brands of product they are aware of in the product class.

The measurement of individual perceptions, evaluations and preferences for product alternatives requires more complex methods. We are unable to expose potential buyers to actual products. We therefore rely on concept statements to expose and measure individual perceptions and preferences. This approach is suitable for application to both industrial and consumer markets (Hauser and Urban [1977]).

Individual product perceptions are then recorded along a set of perceptual scales that include the relevant attributes used by individuals to assess products in the class investigated. Development of these scales follows a three-step procedure:

- first, focus groups are conducted with potential decision participants to identify all relevant product attributes;
- second, perceptual scales are developed, one for each attribute; and

third, the items are administered to a small number of decision participants during a pilot study. Statistical analysis is used to identify those items that exhibit significant discriminating power across product alternatives. These items are retained in the final measurements.

6. Administration

In this project, because of the time constraints telephone interviewing was used to collect much of the data. The process was as follows:

- (a) contacting the interview prospect by telephone and eliciting cooperation;
- (b) mailing a copy of an information form to guide his data gathering; and
- (c) calling back to help answer any difficult questions.

In this way, some fairly complex questions could be asked without personal interviewing.

Where appropriate, the following solar products were studied in the appropriate segment:

- solar water heating
- solar space heating
- solar absorption cooling
- solar-assisted heat pump

In addition, flat-plate and concentrating-collector techniques were studied for each application.

The remainder of this document is devoted to the description and analysis of the data collected from each of the sectors studied:

Section 3: residential - new
 - retrofit

Section 4: organizational adoption -
 manufacturing buildings

Section 5: builder/developers

Section 6: HVAC professionals and architects

Section 7: commercial/institutional

SECTION THREE

RESIDENTIAL CONSUMERS

A. INTRODUCTION

Residential energy usage for space and water heating makes up about 14 percent of the national energy budget (Berg, 1974). The potential market for solar energy use in this sector is large; in 1980 there were approximately 60 million one- and two-family dwellings in the United States, with an estimated two million new-home starts each year (GE SHAC Report, 1974). In addition, the temperature required for space and water heating are relatively low. These two factors combine to make residential consumers an important target market for solar technologies.

The two technologies studied in this project, active solar water heating and active solar space heating, do not lend themselves equally to retrofitting for the existing housing stock. Indeed, retrofitting with a solar space-heating system is often impossible, and is in any case more costly than installing the same system while a house is under construction. Accordingly, in this study, for existing homes we examined only water-heating applications. In the context of new construction, space heating and water heating were both examined.

This work has been a consumer market study. Two principal segments -- owners of now-existing houses and potential buyers of newly constructed houses -- were surveyed. The data from the survey has been presented regionally, using the four U.S. census regions. The objectives of the work were:

- (a) to develop a baseline understanding of awareness, interest and intent-to-purchase solar in the residential market, and

- (b) to develop an understanding of the consumer decision-making process -- the variables that go into the decision to purchase solar and their relative importances.

This chapter finishes with a series of conclusions and recommendations for ways to increase solar penetration in the residential market.

B. MEASUREMENTS

1. Instrument Design

The questionnaire for both the new-home and existing-home segments of the residential sample was designed for administration in two parts. The first part was done by telephone while the second follow-up section was a mail questionnaire. This means of administration was chosen for several reasons:

- (1) The amount of data to be collected was large and it appeared to be necessary to break the interview into two sections so as not to lose the participant's interest.
- (2) The level of knowledge about solar in the general population appeared to be low, so a part of the questionnaire was designed to provide a basic description of a active solar system with pertinent financial information.
- (3) A test using amount and kind of financial information provided to the respondent was incorporated in the study. Several versions of this financial information were lengthy and would have been impossible to provide over the telephone.
- (4) Several questions were asked before, over the telephone, and after, in the mail questionnaire, as part of the test of the information provided.
- (5) Because of the differing system economics, as well as local incentives, financial information had to be customized for each state.
- (6) Joint telephone-mail administration established who the direct-mail nonrespondents were, since demographic data was collected in the telephone portion of the interview.

The study was designed to examine home owner's and home buyer's:

- awareness of active solar energy systems,
- awareness of federal and state incentives for installing solar equipment,
- attitudes and beliefs about active solar systems,

- likelihood of purchasing a solar system in the short term and in the long term,
- likelihood of purchasing a solar system if price, savings or warranty could be substantially changed, and
- demographics.

2. Instrument Pretest

The residential questionnaires were pretested both in focus groups and in a pilot study of 300 full interviews. The focus groups were conducted primarily to aid in the development of the descriptions of solar systems and the presentations of financial information. The groups identified specific problems in both areas, and those were subsequently modified. In addition, the groups provided valuable in-put about a number of the perceptual items used in the mail questionnaire. A brief report on the first focus group is included as Appendix 3.

The pilot study included a full test of the administration methods to be used in the final study. The test involved 341 respondents from the North East and South West who reacted to information about solar water heaters. Respondents were screened by telephone and, if they qualified, the first portion of the survey was administered to them. Those interviewed were told that a short questionnaire would be mailed to them within ten days to two weeks, and a call-back appointment was made to "answer any questions about the survey." Respondents were then contacted at the agreed-upon time and urged to complete the questionnaire, and to return it. A postage-paid business-reply envelope was enclosed for convenience in returning completed surveys.

In all, 141 mail surveys, or a total of 41.3 percent, were returned before the cutoff date for the pilot study. The return rate was deemed

adequate, especially since the study had been conducted during the Christmas holiday, so the method of administration was finalized. A number of preliminary analyses were run on the data collected during the pilot phase, and those analyses suggested further modifications in the questionnaire. The key areas in which modifications were made was in the formatting of likelihood-of-purchase questions to make them easier for the respondent to understand. Other changes were made in the perceptual scales and in some of the psychographic measures.

3. Sample Selection

For the final administration of the questionnaire, two distinct samples were obtained. The first sample was of people who now own a home, while the second was of people who were in the market for a newly constructed home. Each sample was built up on a state-by-state basis. The number of interviews done in each state was determined by an index which weighted that state's "solar potential" (see Appendix 4) by its population.

For the existing-home segment, a sample of 1608 home owners was selected by random-digit dialing within each of the 48 contiguous states. For the new-home segment, the same number of potential buyers was obtained from several sources. The following three sources provided most of the sample:

- Home builders interviewed at the NAHB Exposition were asked if they would be willing to provide names. If they agreed, they were contacted by mail after the show.
- A list of purchasers of Hudson's Home Plans was obtained from the Litton Publishing Group.
- The random screening process for home owners produced about 15% qualified new-home respondents.

The quotas for both samples, by state, are shown in Exhibit 3-1. All respondents were screened to insure that they fell into an appropriate category (home owner or home buyer) and that they did have a water heater in the home. If a potential respondent had any kind of solar system in his or her home, he or she was excluded from the main sample. In that case, a short interview was done to determine the specifics of the solar system, as well as the owner's feelings about its functioning.

4. Questionnaire Administration

If a potential respondent passed the screening questions, he or she was told about the survey - its purpose, the data collection method and the time required - and asked to participate. Those who agreed were then taken through the telephone questionnaire.

The telephone portion of the survey was completed by interviewers from the Valley Forge Information Service, Valley Forge Corporate Center, King of Prussia, Pennsylvania, 19406. The interviewers were thoroughly instructed in the administration of the questionnaire by Dialogue and VFIS supervisory personnel during sessions held before the telephone interviewing was started. Dialogue and VFIS people listened in on a number of interviews in progress for each interviewer, and made comments and suggestions for sharpening techniques on certain questions. The interviewers were thus made to understand the issues that Dialogue was trying to address in the questionnaire, and were better able to deal with those issues when a respondent had a problem understanding what was being asked. VFIS supervisory personnel worked full-time on the project

EXHIBIT 3-1

Residential Quotas by State

<u>State</u>	<u>Existing & New Homeowners Each:</u>
Alabama	20
Arizona	30
Arkansas	10
California	250
Colorado	30
Connecticut	46
Delaware	4
Florida	134
Georgia	38
Idaho	8
Illinois	42
Indiana	16
Iowa	26
Kansas	20
Kentucky	16
Louisiana	20
Maine	9
Maryland	28
Massachusetts	80
Michigan	42
Minnesota	16
Mississippi	10
Missouri	30
Montana	20
Nebraska	20
Nevada	12
New Hampshire	9
New Jersey	36
New Mexico	20
New York	84
North Carolina	36
North Dakota	8
Ohio	46
Oklahoma	28
Oregon	16
Pennsylvania	40
Rhode Island	9
South Carolina	20
South Dakota	8
Tennessee	24
Texas	120
Utah	20
Vermont	7
Virginia	38
Washington	16
West Virginia	10
Wisconsin	20
Wyoming	8
TOTAL	1400

while the interviews were underway to maintain consistency in asking questions across interviewers, and generally to insure that the interviewing was performed at a high level of quality.

At the conclusion of the interviews VFIS edited the questionnaire forms and sent them to Dialogue, which did the mail-out portion of the study.

The mail questionnaire was produced as a booklet containing:

- a letter of introduction and thanks for participation,
- a brief (one-page) description of one or two solar systems,
- information about the financial aspects of purchasing and owning a solar system, and
- questions about likelihood of purchase, attitudes, current fuel usage, expectations of fuel inflation, and so on.

Existing-home owners received only materials relevant to solar water heaters (see Exhibit 3-2), while new-home buyers required the same information about both water heaters and space-heating systems (see Exhibits 3-2 and 3-3). In the existing-home sample, three different presentations of financial material were used (see Exhibits 3-4 to 3-6). Since it was important to provide respondents with accurate data about the size, cost and savings of an optimal system in their area, the questionnaires were drawn up to reflect changes in these figures, including incentives, on a state-by-state basis. In addition, two other questionnaires were drawn up -- one using a description of concentrating collectors and another with a financial presentation using very high fuel-price inflation expectations.

The questionnaire types thus included:

(1) financial presentations:

- o short deterministic (see Exhibit 3-4)
- o long deterministic (see Exhibit 3-6)
- o short uncertain
 - normal inflation expectations (see Exhibit 3-5)
 - high inflation expectations

(2) system types:

- o flat-plate collector (see Exhibit 3-2)
- o concentrator collector

(3) customization by state (see Appendix 5):

- o collector size
- o solar fraction
- o price, including incentives
- o savings

The total number of questionnaire types thus produced was 164 in the existing-home sample and 53 in the new-home sample, since only the short deterministic form was used for new-home respondents.

Questionnaires were mailed as soon as possible to participants identified by VFIS. A postage-paid business-reply envelope was enclosed for convenience in returning the completed questionnaire.

Completed interviews, both telephone and returned mail, were examined for completeness and consistency and were coded as necessary. Data was keypunched from the interview forms, 100-percent verified and placed on tape for computer access.

EXHIBIT 3-2

Sample Solar Domestic Water-heating System Description

A typical solar domestic water heating system is composed of a collector, a hot water storage tank, and the piping that connects them. The radiation of the sun heats the water as it passes through the collector. From the collector the warm water flows directly into a storage tank. The tank would be in the basement, or underground; it would be a standard size (about 80-90 gallons), of a type readily available. Controls keep the water circulating through the collector as long as the sun raises the temperature of the water. In general, this means that as long as the sun is out, the water will continue to circulate. At night, or when the weather is cold or cloudy, the water remains in the tank.

A solar system cannot, by itself, provide enough energy to meet all the hot water needs of an average family of four. In Alabama, system manufacturers and dealers say that the system will supply between 60 and 80 percent of those needs. Any additional water heating that is required is provided automatically by a conventional backup system using oil, gas, or electricity.

Most families would need four solar collectors to trap the sun's heat. These collectors are a little bigger than an average door. They are made of a piece of metal painted black, covered with glass and mounted in a wooden or metal frame. Collectors may be mounted on your roof if you have a roof that faces south, or installed in your yard.

A solar domestic water heating system comes with a 5-year manufacturer's warranty. The system has an expected life of 15 years, which is comparable to the expected life of the roof of your home.

A diagram of a typical system is on the next page.

A TYPICAL SOLAR DOMESTIC WATER HEATING SYSTEM

EXHIBIT 3-3

Sample Solar Home and Water-heating System Description

A typical residential solar home heating system is composed of a collector, a storage tank and the piping that connects them. The radiation of the sun heats water (or, in some systems, air) as it passes through the collector. The heat is then distributed through the house through its normal set of air ducts, radiators or baseboard units. If the heat is not needed immediately, it is placed in a storage system. Controls keep the circulation going as long as the sun is providing additional heat to either the house or to the storage system. At night, or when the weather is cold or cloudy, the collector circulation shuts down and the distribution system works to draw heat from storage, and to distribute that heat to the living space in the house.

Part of the system would also provide hot water for domestic use.

A solar energy system cannot, by itself, provide enough energy to meet all the heating and hot water needs of most families. In Alabama, a typical system will supply between 50 and 70 percent of those needs. Any additional heat that is required is provided automatically by a conventional back-up system, using gas, electricity or oil.

Most families in this area would need 10 collectors to trap the sun's heat. These collectors are a little bigger than an average door. They are made of a piece of metal painted black, covered with glass and mounted in a wooden or metal frame. Collectors are usually mounted on the roof of your home, although they can also be installed in your yard. The storage system consists of a large water tank (about 1000-2000 gallons of water) or a bin of small rocks or pebbles. Storage systems are usually installed in the basement or buried immediately outside if no basement or crawl space is available.

A solar home and water heating system comes with a 5-year manufacturer's warranty. The collectors have an expected life of 15 years, which is comparable to the expected life of your roof.

A diagram of a typical system is shown on the next page.

A TYPICAL SOLAR HOME AND WATER HEATING SYSTEM

EXHIBIT 3-4

Sample Short Deterministic Financial Information

PRICE: The gross price of a solar water heating system would be about \$2600 for a family of four with average hot water needs. These numbers include materials and installation. However, the federal government offers a refund, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be lower than the gross price.

	Gross Price	\$2600
(minus)	<u>Tax Rebate</u>	<u>720</u>
	Actual Price	\$1880

SAVINGS: The solar water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see below). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. The most likely projections would have the rates of increase over the next years be about the same as over the last 10 years, as shown in the accompanying table. Under this assumption, the number of years it will take for total savings to add up to more than the original cost of the system (payback) has been calculated and is also shown in the table.

Solar Water Heating Savings by Fuel Currently Used

	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
<u>Rate of Fuel Price Increase</u>			
Past 10 years	15%	10%	12%
Projected	15%	10%	12%
<u>Estimated Savings</u>			
First year	\$124	\$163	\$ 43
Fifth year	\$228	\$242	\$ 74
<u>Years to Payback</u>	8 1/4	8	15

The figures shown take into account:

- 1) energy used to run the solar water heater's pumps, and
- 2) annual maintenance and upkeep expenses, estimated at

EXHIBIT 3-5

Sample Short Uncertain Financial Information

PRICE: The gross price of a solar domestic water heating system would be between \$1900 and \$3300, or about \$2600 for a family of four with average hot water needs. These numbers include materials and installation. However, the federal government offers a refund, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be much lower than the gross price. For an average system the figures would be:

	<u>Low Estimate</u>	<u>Average Estimate</u>	<u>High Estimate</u>
Gross Price	\$1900	\$2600	\$3300
(minus) <u>Tax Rebate</u>	<u>570</u>	<u>720</u>	<u>860</u>
Actual Price	\$1330	\$1880	\$2440

SAVINGS: The solar domestic water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see table). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. The "most likely" projections would have the rate of increase over the next years be about the same over the last 10 years, as shown in the accompanying tables. However, forecasting future energy costs is no easy business. Energy costs could increase at a lower or higher rate than in the past. As a result, the tables show savings calculated using low and high rate increase assumptions as well as the most likely assumption. Under each assumption, the number of years it will take for your total savings to add up to more than the original cost of the system (pay-back) has been calculated, and is also shown in the tables.

EXHIBIT 3-5 (continued)

Solar Water-heating Savings by Fuel Currently Used*

<u>Oil</u>			
	<u>Low</u>	<u>Most likely</u>	<u>High</u>
<u>Rate of fuel price increase</u>			
Past 10 years - 15%			
Projected	10%	15%	20%
<u>Estimated savings (\$)</u>			
First year	124	124	124
Fifth year	185	228	276
<u>Years to payback</u>	10	8 1/4	7 1/4

<u>Electricity</u>			
	<u>Low</u>	<u>Most likely</u>	<u>High</u>
<u>Rate of fuel price increase</u>			
Past 10 years - 10%			
Projected	7%	10%	15%
<u>Estimated savings (\$)</u>			
First year	163	163	163
Fifth year	214	242	296
<u>Years to payback</u>	9	8	7

<u>Gas</u>			
	<u>Low</u>	<u>Most likely</u>	<u>High</u>
<u>Rate of fuel price increase</u>			
Past 10 years - 12%			
Projected	8%	12%	17%
<u>Estimated savings (\$)</u>			
First year	42	42	42
Fifth year	59	74	94
<u>Years to payback</u>	19	15	12 1/4

*The figures shown take into account

- 1) energy used to run the solar water heater's pumps, and
- 2) annual maintenance and upkeep expenses.

EXHIBIT 3-6

Sample Long Deterministic Financial Information

PRICE: The gross price of a solar domestic water heating system would be about \$2600 for a family of four with average hot water needs. These numbers include materials and installation. However, the federal government offers a refund, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be much lower than the gross price.

	Gross Price	\$2600
(minus)	<u>Tax Rebate</u>	<u>720*</u>
	Actual Price	\$1880

SAVINGS: The solar domestic water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see Appendix 1). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. (See graph shown in Appendix 2.) The most likely scenario would have the rate of increase over the next years be about the same as over the last 10 years, that is, 12%. Under this assumption, the number of years it will take for your total savings to add up to more than the original cost of the system, (payback) has been calculated and is shown in Appendix 1.

* see Appendix 3 for calculation of Tax Credit

EXHIBIT 3-6. (continued)

PAYING FOR A SYSTEM: You could pay for a solar system in cash -- in that case you would forego the interest that you could earn on the \$1880 that you use to purchase the solar system. Instead of buying a solar system, you could put the money in a 10% savings account, but of course you would have to pay income tax on the interest earnings -- how much tax would depend on your tax bracket.

You could also borrow money to pay for the system -- several banks are now giving "energy improvement" loans for 12 - 13 1/2 percent interest. If you were to borrow \$1880 for 10 years at, say, 13%, the payments would add up to \$337 per year. In this situation, of course, the interest portion of your loan payment would be deductible for federal tax purposes, so your real annual expense would be less -- how much less would depend on your tax bracket.

Appendix 1 presents a comparison of interest earnings, loan payments, and most likely savings from a solar domestic water heater.

INCENTIVES AND REBATES: The federal government has a tax rebate that you can take advantage of if you buy a solar domestic water heating system. See Appendix 3 for further information on the federal tax rebate.

EXHIBIT 3-6 (continued)

<u>Year</u>	<u>Savings</u>			<u>Annual Interest Earnings(1)</u>	<u>Annual Loan Payment(2)</u>
	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>		
1	\$ 124	\$ 163	\$ 43	\$ 188	\$ 337
2	145	180	49	207	337
3	168	199	56	227	337
4	196	220	65	250	337
5	228	242	74	275	337
6	265	268	84	303	337
7	307	296	96	333	337
8	356	326	110	366	337
9	413	360	125	403	337
10	478	397	142	443	337
11	554	438	161		
12	641	484	183		
13	741	534	208		
14	857	589	235		
15	<u>990</u>	<u>649</u>	<u>267</u>		
Totals:	\$ 6461	\$ 5345	\$ 1897	\$ 2996	\$ 3370
Years to Payback	8 1/4	8	15		

The figures shown take into account: a) energy used to run the solar water heater's pumps, and
b) annual maintenance and upkeep expenses estimated at \$25/year.

(1) assumes \$ 1880, plus all accumulated interest, left in a 10% account for 10 years. (You would have to pay income tax on these earnings, so your actual interest income would be lower than these numbers indicate; how much lower would depend on your income tax bracket.)

(2) assumes \$ 1880 loan for 10 years at 13%. (You would get to deduct the interest portion of these payments from your income before figuring your taxes, so your out-of-pocket expense would actually be lower than these numbers suggest; how much lower would depend on your income tax bracket.)

EXHIBIT 3-6 (continued)

	<u>Overall</u>	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
Past 10 years	12%	15%	10%	12%
Projected	12%	15%	10%	12%

Energy Price Index for 12 years*

* Data from Consumer Price Index, U.S. Department of Labor

EXHIBIT 3-6 (continued)

Federal Income Tax Rebate

30% of the first \$2,000 of gross price (including installation)

20% of the amount over \$2,000

Total rebate not to exceed \$2,200

Thus, on a \$2,600 system, rebates are calculated as:

Federal

30% of \$2000 = \$600

20% of \$ 600 = 120

Total Rebate = \$720

C. DATA DESCRIPTION

The descriptive material presented here parallels the order in which the questions were asked of the respondent: the telephone screening interview, with its awareness, attitude and demographic questions, and then the mail returns, with likelihood of purchase and in-depth attitude questions. Where appropriate, comparisons have been made between screener and mail survey. Note that most of the data presented here has been weighted to produce a representative regional sample (see Appendix 6). Exceptions are noted in the exhibits.

1. Existing Homes

Screener Statistics

The data collected in the existing-home segment included telephone interviews with 1608 respondents. Of these, 880, or 54.7 percent, returned the mail survey. Exhibit 3-7 shows the number of interviews in each of the four census regions.

In the initial series of telephone questions the survey assessed the awareness of home owners about solar energy. Exhibit 3-8 shows, by regions, the results of this assessment. Note that 20.9 percent of the respondents reported never previously having heard of solar energy for home or water heating (Question A). In Question B, respondents from the South were significantly below the national average in having seen a solar-equipped home, while in Question C, southerners were still below average but respondents from the West were significantly above the national average in knowing someone who owned solar equipment. Finally, in Question D only a small fraction of the sample had actually sought information about solar, and once again, the South lagged behind the other regions.

When respondents were asked what types of solar equipment they could purchase in their area (see Exhibit 3-9), only half of the respondents thought they could buy the equipment existing on the market for space heating or water heating, while about a quarter believed that electrical-generating and air-conditioning equipment was available. The numbers suggest substantial confusion about what really is for sale, and, by extension, confusion about some attributes of existing solar equipment (untried, new, unproven technology, and so on).

Government incentives were known to 46.6 percent of the respondents (see Exhibit 3-10) with the highest awareness coming in the North East and West, and the lowest in the North Central states. The overall level of awareness seems low considering the fact that the study was conducted during February and March, 1980, when people presumably were filing their income tax returns, and that in 1980 the federal government mounted a communication effort on behalf of energy tax credits.

Of those who claimed to know about government incentives, 21.0 percent correctly identified the federal tax rebate, and of those, 20.3 percent gave an estimate that was within the range of what was then available (15 to 30 percent of gross price). In terms of the entire sample, only 4.3 percent was within the correct range (see Exhibit 3-11).

When asked about the likelihood of their purchasing a solar home- or water-heating system in the next year, responses were as shown in Exhibit 3-12A. Respondents seemed, however, to hold expectations that they would be using solar in the future (see Exhibit 3-12B), as shown in their much higher stated likelihood of purchasing in the next 5 years.

Note that regional differences were quite small in both cases, but that in Exhibit 3-12B respondents from the West and the South showed somewhat higher likelihoods than the other two regions.

Turning next to the series of 5 attitude statements that were used in the telephone interview (see Exhibits 3-13 to 3-17), we see that there was fairly close agreement across all regions. Interesting differences that can be noted from these exhibits include:

- Northeastern respondents felt they knew more about solar than those from other regions; southerners said they knew least. This pattern is seen both in the question about financial knowledge (see Exhibit 3-13) and the question about mechanical knowledge (see Exhibit 3-14).
- North Central respondents showed the lowest level of belief in obtaining reliable and dependable equipment (see Exhibit 3-15), while all regions showed the same level of belief in the economic viability of solar (see Exhibit 3-16).
- Westerners and southerners believed that solar would be widely used in their areas in 5 years (see Exhibit 3-17). This tied in with their higher expectation of purchasing a system for themselves in the next 5 years (see Exhibit 3-12B). Respondents from the North East showed the lowest level of expectation for solar's widespread use in the near future.

The demographics of the sample are shown in Exhibits 3-18 to 3-22. Note that the demographic data for the full sample of telephone screeners and the smaller sample of respondents who returned the mail survey match up very closely, suggesting that nonresponse bias is not a critical issue.

Mail Questionnaire Statistics

Respondents were asked several questions about their current hot-water energy source and costs. Exhibits 3-23 to 3-25 show this data. Exhibit 3-23 displays the fuel currently used. The first thing noticeable in this chart is the high proportion of North Central and

Western homes using natural gas to heat water (83.7 and 76.7 respectively). Even in the North East and South, 45 to 46% of the population was using gas. Financial arguments for switching from gas to solar could not be expected to carry much weight with these home owners, since it is currently not economical to switch from gas to solar. But in the North East and South, over half the population was using electricity or oil, while in the West 22.5% was using electricity. The financial prospects of solar ought to look better to these people.

Exhibit 3-24 shows respondents' estimates for the cost of replacing their current system with one using the same fuel. The figures range from less than \$200 to over \$800, but 75.2% of the respondents expected a price of \$300 or less. While this figure is a little on the low side of full replacement cost, it is not extremely inaccurate, indicating that respondents did have a reasonable idea of conventional equipment costs.

Exhibit 3-25 shows average respondents' estimates of fuel costs for water heating, both current and future. These estimates reflect the fuel distribution (Exhibit 3-23). The anticipated fuel inflation rate for the next year was consistent, 23 to 26%, across regions; the North East and West had expectations of moderately higher fuel inflation over the next five years.

Exhibit 3-26 shows responses to the question, "Have you seriously considered an alternative way to heat water?" Over a third of respondents in the North East, and about a quarter in the South and West had. Only the North Central lagged far behind (about 15%).

Exhibit 3-27 shows average probability of purchase of a solar water-heating system, both under current conditions and with more favorable assumptions about price and savings. In the questionnaire, respondents were asked to state their estimate of the price of a solar water-heating system for their use, and the savings they would expect to generate from such a system. They were then asked the likelihood of their purchasing that system. This likelihood is shown on the "base price" line. Reductions from this base were then made at a 25% and 50% level, keeping the "base savings" constant. Respondents were also asked for a likelihood estimate with the base price held the same, but a 50% increase in expected savings. Finally, with base price and savings fixed, a question was asked for likelihood of purchase with an increased warranty.

Some interesting observations can be made from Exhibit 3-27. First, there was a low likelihood of purchase under current conditions across all regions. The North East had the highest current likelihood followed by the West, South, and North Central, in that order. Likelihood of purchase increased with price reduction, savings increase or warranty increase. An enhanced warranty, from 5 years to 20 years, gave the least increase in likelihood, a 5.4 point change on the 100-point scale. The largest change was generated by increased savings - about a 19-point difference across all regions. Note that this change was greater than the change produced by a 50-percent price cut, about 16 points, suggesting that the value of savings was more important than the first cost of the equipment.

Exhibit 3-28 shows mean score, by region, on the questions on attitude in the mail survey. There was remarkable regional similarity in all of the data on attitude. Some differences worthy of comment include:

- Question 2 - North Central respondents, mostly gas users, were less likely to believe that solar made economic sense than those from all regions as a whole,
- Question 3 - more than those from other regions, respondents from the West expected wide spread solar use in 5 years. Those from the North East were the most skeptical.
- Question 4c - more than other respondents, North Central respondents believed that solar could protect them from future energy shortages, possibly because of memories of natural gas shortages a year before the survey. Southerners did not think as much protection could be had as did the other respondents, perhaps because many of them are from gas- and oil-producing states.
- Question 4f - Those from the West were less likely to think solar collectors would be unattractive.
- Question 4j - A surprising number of people, 21%, agreed or strongly agreed that they would support zoning to ban solar collectors from the fronts of homes. Those from the South and North Central were most likely to take that position, 23.4% and 21.3%, respectively.
- Question 4k - Respondents from the North East were most concerned that solar firms would be small "here-today-gone-tomorrow" outfits.

Exhibit 3-29 - shows the distribution of after-exposure likelihood of purchase responses.

Before-and-after Comparisons

Several questions were asked both in the telephone screener and in the mail survey, giving the respondent the opportunity to revise his or her views based on the information that he or she received. These questions included five attitude issues and two likelihood-of-purchase

probabilities; the comparisons of the "before-and-after" results are shown in Exhibits 3-30 to 3-35.

Exhibits 3-30 to 3-35 show an interesting pattern: in all regions and for all questionnaire types, respondents' attitudes toward solar became less favorable after exposure to basic information. This finding suggests a lack of real information accompanied by a generally favorable view in the general population, which is changed negatively when hard information becomes available. The level of change was similar across regional and questionnaire types on all except the "economic sense" issue. Here the change in the North East and South was observably less than in the other two regions, while the short, undeterministic version of the questionnaire produced a much greater shift. Note also that the undeterministic version of the questionnaire produced a more negative shift on all three issues.

Exhibit 3-33, showing changes in perceived understanding of the financial merits of solar, indicates increased understanding after exposure by respondents in the South and the West. In the North East and North Central regions a decrease occurred. The change in the latter two regions probably indicates an increase in confusion, pointing to a low level of real information in the unexposed populations, rather than a real decrease in knowledge. In other words, when an individual with little information but generally favorable attitudes received financial information that was unfavorable, for instance about higher costs, lower savings or a longer payback than he or she expected, he or she experienced a cognitive conflict and responded with a lower rating for understanding, meaning "I thought I knew, but now I'm not sure."

Note that the "long deterministic" version of the questionnaire did significantly less well in explaining the financial aspects of solar to respondents.

Exhibit 3-34, showing changes in understanding of the mechanical working of a solar system, indicates a significantly greater understanding after reading the descriptive material in the questionnaire. Note that the deterministic versions of the questionnaire produced slightly more change than the undeterministic version.

Exhibit 3-35 shows change in likelihood-of-purchase estimates given by respondents for the next year and for the next 5 years. Only in the North Central region, and then only in first-year likelihoods where pre-exposure likelihood was lowest, was there a change to a somewhat greater likelihood. Note that the changes in the one-year column were small in general because of the low preexposure likelihood (4.4/5.0), so there was not much room for movement. Larger changes were observed in the 5-year column, where they were on the order of 8 to 14 percent in an unfavorable direction. The higher preexposure likelihood (3.0/5.0) could accomodate larger shifts, as people's higher expectations of installing solar "in the future" were reduced.

In terms of questionnaire type, respondents who received the "short undeterministic" questionnaire showed a significantly larger decrease in likelihood of purchase than did respondents receiving other questionnaire types. This finding ties in with the larger decrease in prosolar attitudes associated with this version of the questionnaire.

EXHIBIT 3-7

Return Rate - Existing-Home Owners

<u>Census Regions</u>	<u>Telephone Interviews</u>	<u>Mail Questionnaires Returned</u>	<u>Return Rate</u>
North East	316	170	53.8%
South	565	309	54.7
North Central	299	176	58.9
West	428	225	52.6
TOTAL	<u>1608</u>	<u>880</u>	<u>54.7%</u>

EXHIBIT 3-8

Solar Awareness -- Existing-home Owners

	<u>Yes</u>	<u>No</u>	<u>Unsure</u>
A. Heard of solar for home or water heating?			
North East	81.0%	19.0%	- %
South	79.7	20.3	-
North Central	75.4	24.6	-
West	81.4	18.6	-
TOTAL SAMPLE	79.1%	20.9%	- %
B. Seen a home equipped with solar panels?			
North East	45.0%	54.4%	0.6%
South	39.3	59.9	0.8
North Central	46.4	53.6	-
West	56.0	44.0	-
TOTAL SAMPLE	45.5%	54.1%	0.4%
C. Know anyone now using solar?			
North East	23.4%	76.3%	0.3%
South	13.3	86.5	0.2
North Central	17.7	81.9	0.4
West	27.8	71.5	0.7
TOTAL SAMPLE	18.8%	80.9%	0.3%
D. Actually gone looking for solar?			
North East	9.8%	90.2%	- %
South	6.1	93.9	-
North Central	11.3	88.7	-
West	10.3	89.7	-
TOTAL SAMPLE	9.1%	90.9%	- %

EXHIBIT 3-9

Awareness of Types of Solar Equipment - Existing-home Owners

Can you, in your area, buy
solar equipment for:

	<u>Yes</u>	<u>No</u>	<u>Unsure</u>
space heating	49.4%	23.5%	27.1%
providing electricity	26.5	27.5	46.0
heating water	49.9	23.6	26.7
air conditioning	25.7	27.3	47.0

EXHIBIT 3-10

Awareness of Government Incentives - Existing-home Owners

Have you heard of any federal
government incentives?

	<u>Yes</u>	<u>No</u>	<u>Unsure</u>
North East	51.2%	48.2%	0.6%
South	45.9	50.7	3.4
North Central	38.6	60.1	1.3
West	55.0	43.3	1.7
TOTAL SAMPLE	46.6%	51.4%	2.0%

Base = Respondents awareness of solar.

EXHIBIT 3-11

Awareness of Amount of Federal Incentives - Existing-home Owners

	<u>Yes</u>	<u>No</u>	<u>Uncertain</u>
Heard of government incentives? (base = sample)	59.1%	38.4%	2.5%

21% correctly identified federal tax rebate.

Of those identifying the tax rebate:

4.8%	said rebate would pay 10% or less of system cost.
9.7%	15%
6.1%	20%
1.9%	25%
2.6%	30%
4.7%	35% or more
70.2%	didn't know

4.3% of the sample has some idea about what is really available
(15 to 30% of gross price).

EXHIBIT 3-12

Likelihood of Purchasing a Solar System - Existing-home OwnersTelephone Survey

A. Likelihood of purchase next year

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Very likely (1)	4.1%	5.2%	1.8%	2.8%	3.6%
Somewhat likely (2)	10.6	6.6	4.7	6.8	7.0
Unsure (3)	4.8	6.1	5.8	6.7	5.8
Somewhat unlikely (4)	18.1	11.4	20.7	17.6	16.5
Very unlikely (5)	62.5	70.8	67.0	66.1	67.1
	100.0%	100.0%	100.0%	100.0%	100.0%
N:	273	419	342	237	1272
mean:	4.2	4.4	4.6	4.4	4.4

B. Likelihood of purchase within 5 years

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Very likely (1)	16.3%	18.8%	8.7%	17.0%	15.2%
Somewhat likely (2)	19.0	25.6	31.6	31.0	26.8
Unsure (3)	22.1	17.2	19.8	18.1	19.1
Somewhat unlikely (4)	14.7	11.6	13.4	8.0	12.1
Very unlikely (5)	27.9	26.8	26.5	25.9	26.8
	100.0%	100.0%	100.0%	100.0%	100.0%
N:	274	419	339	237	1268
mean:	3.2	3.0	3.2	2.9	3.1

EXHIBIT 3-13

Existing-home Owners' Attitude Statements - Telephone Interview -
the Financial Merits of Solar-energy Systems

I understand the financial merits of solar energy systems.

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Strongly agree (1)	22.9%	21.9%	17.9%	23.9%	21.4%
Moderately agree (2)	43.9	28.4	45.0	30.9	36.6
Unsure (3)	11.9	8.3	7.8	6.4	8.6
Moderately disagree (4)	11.6	23.4	15.4	20.7	18.2
Strongly disagree (5)	9.7	18.0	13.9	18.1	15.2
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	272	419	342	237	1270
mean:	2.3	2.9	2.5	2.8	2.7

EXHIBIT 3-14

Existing-home Owners' Attitude Statements -- Telephone Interview --
How Solar-energy Systems Work

I understand how solar energy systems work.

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Strongly agree (1)	14.4%	15.2%	18.0%	18.4%	16.4%
Moderately agree (2)	44.3	36.5	40.8	40.9	40.1
Unsure (3)	7.6	3.2	5.0	2.8	4.5
Moderately disagree (4)	19.7	22.9	20.1	18.9	20.7
Strongly disagree (5)	14.0	22.2	16.3	19.1	18.3
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	274	419	342	237	1272
mean:	2.6	2.8	2.7	2.8	2.8

EXHIBIT 3-15

Existing-home Owners' Attitude Statements -- Telephone Interview --
Reliable and Dependable Solar-energy Equipment for Home Use

Do you believe that you can obtain reliable and dependable solar energy equipment for home use?

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Definitely can (1)	20.6%	24.2%	20.5%	29.5%	23.3%
Probably can (2)	46.1	40.2	37.6	38.1	40.4
Unsure (3)	13.8	17.1	14.3	12.9	14.9
Probably can not (4)	15.2	13.4	20.3	14.6	15.9
Definitely can not (5)	4.3	5.1	7.3	4.9	5.5
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	100.0%	100.0%	100.0%	100.0%	100.0%
N:	274	419	342	237	1272
mean:	2.3	2.3	2.6	2.2	2.4

EXHIBIT 3-16

Existing-home Owners' Attitude Statements -- Telephone Interview --
Solar Equipment that Makes Economic Sense for Home Use

Do you believe that you can obtain solar equipment that makes economic sense for home use?

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Definitely can (1)	21.6%	19.4%	23.3%	26.1%	22.1%
Probably can (2)	39.2	37.8	36.5	36.5	37.5
Unsure (3)	11.9	15.9	10.1	17.0	13.7
Probably can not (4)	18.1	17.3	19.5	13.1	17.3
Definitely can not (5)	9.2	9.6	10.6	7.4	9.4
	<hr/>	<hr/>	<hr/>	<hr/>	<hr/>
	100.0%	100.0%	100.0%	100.0%	100.0%
N:	274	419	342	237	1272
mean:	2.7	2.7	2.6	2.4	2.6

EXHIBIT 3-17

Existing-home Owners' Attitude Statements -- Telephone Interview --
Solar-energy Equipment Widely Used in Five Years

Do you believe that solar energy equipment will be widely used
 by homeowners in your area within the next 5 years?

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Definitely will (1)	13.0%	16.2%	9.4%	24.6%	15.2%
Probably will (2)	15.8	34.9	32.4	30.4	29.3
Unsure (3)	7.2	4.9	5.2	7.0	5.9
Probably will not (4)	42.3	30.7	31.4	24.1	32.1
Definitely will not (5)	21.7	13.3	21.6	13.9	17.5
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	274	419	342	237	1272
mean:	3.5	3.0	3.1	2.8	3.1

EXHIBIT 3-18

Age Distribution - Existing-home Owners

	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>telephone survey</u>	<u>mail return</u>	<u>telephone survey</u>	<u>mail return</u>	<u>telephone survey</u>	<u>mail return</u>	<u>telephone survey</u>	<u>mail return</u>
under 25 years	4.1%	2.4%	4.4%	2.3%	5.0%	4.6%	2.3%	1.8%
25 - 34	27.8	31.2	26.4	26.5	26.2	25.7	22.4	22.2
35 - 44	29.7	34.1	23.9	23.0	26.8	28.0	28.3	31.1
45 - 54	19.6	17.1	21.2	21.0	16.8	18.9	22.4	20.4
55 and over	18.8	15.2	24.1	27.2	25.2	22.8	24.6	24.5
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
TOTAL	316	170	565	309	298	175	428	225

EXHIBIT 3-19

Head-of-household Education-level Distribution - Existing-home Owners

	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>
grammar school	2.8%	1.8%	7.1%	3.9%	6.7%	5.1%	4.0%	3.1%
high school	44.9	41.2	38.7	33.7	40.5	39.8	36.0	31.1
college	32.3	31.2	35.8	37.9	36.8	36.4	33.9	35.6
post-graduate	20.0	25.8	18.4	24.5	16.0	18.7	26.1	30.2
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
TOTAL	316	170	564	309	299	176	418	225

EXHIBIT 3-20

Distribution of Household Income - Existing-home Owners

	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>
under \$15,000	15.8%	14.4%	25.3%	22.6%	16.7%	13.5%	14.8%	13.8%
\$15 - \$25,000	36.7	36.5	28.5	28.9	32.1	33.5	24.0	25.3
\$25 - \$40,000	35.4	37.1	30.7	30.2	37.9	37.1	40.9	40.0
over \$40,000	12.1	12.0	15.5	18.3	13.3	15.9	20.3	20.9
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
TOTAL	311	167	557	301	293	170	425	225

EXHIBIT 3-21

Distribution of Number of Full-time Working Household Members - Existing-home Owners

	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>
0 persons	8.9%	7.1%	15.9%	17.2%	11.0%	11.9%	12.9%	13.3%
1 person	48.4	47.6	40.5	42.1	41.5	41.5	42.3	44.9
2 persons	33.9	38.2	35.9	35.0	39.8	37.5	34.3	33.3
more than 2	8.8	7.1	7.7	5.7	7.7	9.1	10.5	8.5
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
TOTAL	316	170	565	309	299	176	428	225

EXHIBIT 3-22

Distribution of Family Size - Existing-home Owners

	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>	<u>telephone</u> <u>survey</u>	<u>mail</u> <u>return</u>
1 person	3.8%	4.1%	8.5%	9.4%	4.7%	6.3%	8.9%	9.3%
2 persons	19.6	20.6	32.4	32.7	30.8	32.4	27.1	24.4
3 persons	22.8	20.6	22.3	23.0	22.4	19.3	21.5	21.8
4 persons	25.3	24.1	21.2	22.0	22.1	22.7	21.7	21.8
5 persons	19.6	21.8	8.8	7.8	12.4	11.4	13.3	14.2
6 or more persons	8.9	8.8	6.8	5.1	7.6	7.9	7.5	8.5
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	316	170	565	309	299	176	428	225

EXHIBIT 3-23

Fuel Currently Used for Water Heating - Existing-home Owners

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
natural gas	46.3%	45.4%	83.7%	76.7%	62.0%
electricity	23.1	48.3	13.1	22.5	28.5
oil	27.9	3.5	0.8	0.4	7.3
other	2.7	2.8	2.4	0.4	2.2
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	183	290	249	157	879

EXHIBIT 3-24

Estimated Price for Replacing Current Water Heater - Existing-home Owners

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
under \$200	23.5%	38.7%	32.4%	36.9%	33.6%
\$200 - \$300	39.3	40.1	45.0	41.6	41.6
\$300 - \$400	21.5	13.6	14.3	15.4	15.7
\$400 - \$500	7.5	4.2	7.5	4.5	5.9
over \$500	8.2	3.4	0.8	1.6	3.2
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	183	290	249	157	879
median:	\$200 - \$300				

EXHIBIT 3-25

Average Estimated Annual Water-heating Expense - Existing-home Owners

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
last year	\$ 246	\$ 199	\$ 131	\$ 158	\$ 177
next year	\$ 311	\$ 247	\$ 163	\$ 194	\$ 220
% increase	26%	24%	24%	23%	24%
in 1985	\$ 451	\$ 377	\$ 242	\$ 302	\$ 331
% increase	83%	89%	84%	91%	87%

EXHIBIT 3-26

Seriously Considered Alternate Water-heating System - Existing-home Owners

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
yes	36.0%	22.3%	14.9%	25.0%	23.5%
no	64.0	77.7	85.1	75.0	76.5
	100.0%	100.0%	100.0%	100.0%	100.0%

EXHIBIT 3-27

Average Likelihood of Purchase within Next Year - Existing-home Owners

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Base Price	15.8	11.9	10.8	12.5	12.3
25% Price Reduction	25.8	20.5	20.3	23.3	21.8
change	10.0	8.6	9.5	10.8	9.5
50% Price Reduction	33.9	26.9	26.1	30.1	28.4
change	18.1	15.0	15.3	17.6	16.1
50% Savings Increase	37.2	29.0	29.0	32.4	31.0
change	21.4	17.1	18.2	19.9	18.7
Increased Warranty	22.1	17.4	15.4	18.5	17.7
change	6.3	5.5	4.6	6.0	5.4

Note: Likelihoods are given on a 100-point scale.

EXHIBIT 3-28

Existing-home Owners' Attitude Statements - Mail Survey

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
1. I can currently obtain <u>reliable</u> and <u>dependable</u> solar energy equipment for home use.	2.5	2.5	2.5	2.4	2.5
2. I can currently obtain solar energy equipment that makes <u>economic sense</u> for home use.	2.7	2.8	3.0	2.7	2.8
3. Solar energy equipment will be widely used by homeowners in my area within the next five years.	3.5	3.1	3.2	2.9	3.1
4a. I understand the financial merits of solar energy systems.	2.4	2.5	2.4	2.3	2.4
b. I understand how solar energy systems work.	2.0	2.2	2.1	2.1	2.1
c. Solar energy systems can provide a lot of protection from future energy shortages.	1.9	2.0	1.7	1.8	1.9
d. A solar water heating system would greatly increase the resale value of my home.	2.6	2.6	2.8	2.6	2.7
e. If a solar energy system that I installed failed and needed major repairs or replacement, it could mean a financial disaster for my family.	2.9	2.9	3.0	3.0	2.9
f. Solar collectors would be very unattractive on my house.	2.9	2.9	3.0	3.2	3.0
g. It would be very easy to obtain financing for a solar energy system.	3.0	3.0	2.9	3.1	3.0
h. If a solar energy system that I installed gave less savings than I had expected, it could mean a financial disaster for my family.	3.1	3.1	3.1	3.3	3.1
i. Solar equipment would protect me from increasing energy costs.	2.6	2.5	2.6	2.4	2.5
j. I would vote for zoning restrictions to ban solar collectors from the front of houses in my neighborhood.	3.7	3.4	3.5	3.6	3.5

Scale: 1 = strongly agree
5 = strongly disagree

EXHIBIT 3-28 (continued)

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
4k. Manufacturers of solar systems are mostly little companies that are here today and will probably be gone tomorrow.	3.1	3.3	3.3	3.4	3.3
l. Solar energy equipment will produce maintenance nightmares for me.	3.3	3.3	3.3	3.4	3.3
m. I would admire a neighbor who installed solar equipment.	2.4	2.5	2.6	2.5	2.5
n. A political candidate who supports solar is progressive.	2.4	2.4	2.3	2.3	2.3
o. Technological advances will soon make currently available solar equipment outdated.	2.7	2.7	2.8	2.7	2.7
p. A solar water heating system might save me money in the long run, but the initial cost is just too high for me to consider buying one.	2.1	2.1	2.1	2.3	2.2
q. If more people were aware of the information shown in this questionnaire, more of them would buy solar energy systems.	3.0	3.0	3.1	2.9	3.0

Scale: 1 = strongly agree
5 = strongly disagree

EXHIBIT 3-29

Likelihood of Purchasing a Solar System - Existing-home Owners - Mail Survey

A. Likelihood of purchase next year - after exposure

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Very likely (1)	3.8%	2.9%	2.6%	0.7%	2.6%
Somewhat likely (2)	4.2	2.0	3.7	2.2	2.9
Unsure (3)	9.5	10.5	12.2	9.8	10.6
Somewhat unlikely (4)	12.5	6.2	12.0	9.3	9.7
Very unlikely (5)	70.0	78.4	69.5	78.0	74.2
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	164	256	202	133	755
mean:	4.4	4.6	4.4	4.6	4.5

B. Likelihood of purchase within 5 years - after exposure

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Very likely (1)	8.3%	12.1%	6.9%	9.3%	9.3%
Somewhat likely (2)	13.2	12.8	15.3	22.5	15.4
Unsure (3)	32.5	30.5	25.9	18.8	27.5
Somewhat unlikely (4)	15.5	10.5	13.7	18.9	14.0
Very unlikely (5)	30.5	34.1	38.2	30.5	33.8
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	167	260	222	147	796
mean:	3.5	3.4	3.6	3.4	3.5

EXHIBIT 3-30

Change in Mean Score - Before and After Exposure - Existing Home Owners -
Reliable and Dependable Solar-energy Equipment for Home Use

Do you believe that you can currently obtain reliable
 and dependable solar energy equipment for home use?

By Region

North East	-0.6
South	-0.5
North Central	-0.4
West	-0.4
Total Sample	-0.5

By Questionnaire Type

Short Deterministic	-0.4
Short Undeterministic	-0.5
Long Deterministic	-0.4
Before Exposure Mean	2.0
After Exposure Mean	2.5
N =	882

Scale: 1 = definitely can
 5 = definitely cannot

(a negative sign indicates unfavorable movement after exposure)

EXHIBIT 3-31

Change in Mean Score - Before and After Exposure - Existing-home Owners

Solar-energy Equipment that makes Economic Sense for Home Use

Do you believe that you can currently obtain solar energy equipment that makes economic sense for home use?

By Region

North East	-0.4
South	-0.4
North Central	-0.8
West	-0.7
Total Sample	-0.6

By Questionnaire Type

Short Deterministic	-0.9
Short Undeterministic	-0.8
Long Deterministic	-0.6
Before Exposure Mean:	2.2
After Exposure Mean:	2.8
N =	882

Scale: 1 = definitely can
5 = definitely cannot

(a negative sign indicates unfavorable movement after exposure)

EXHIBIT 3-32

Change in Mean Score - Before and After Exposure - Existing-home Owners
Solar-energy Equipment Widely Used in Five Years

Do you believe that solar energy equipment will be widely
used by homeowners in your area within the next five years?

By Region

North East	-0.4
South	-0.5
North Central	-0.5
West	-0.5
Total Sample	-0.5

By Questionnaire Type

Short Deterministic	-0.4
Short Undeterministic	-0.6
Long Deterministic	-0.4
Before Exposure Mean	2.6
After Exposure Mean	3.1
N =	882

Scale: 1 = definitely will
5 = definitely will not

(a negative sign indicates unfavorable movement after exposure)

EXHIBIT 3-33

Change in Mean Score - Before and After Exposure - Existing-home Owners
Financial Merits of Solar-energy Systems

I understand the financial merits of solar-energy systems.

By Region

North East	-0.3
South	+0.1
North Central	-0.2
West	+0.2
Total Sample	-0.1

By Questionnaire Type

Short Deterministic	+0.1
Short Undeterministic	0.0
Long Deterministic	-0.2
Before Exposure Mean	2.3
After Exposure Mean	2.4
N =	882

Scale: 1 = strongly agree
5 = strongly disagree

(a positive sign indicates unfavorable movement after exposure)

EXHIBIT 3-34

Change in Mean Score - Before and After Exposure - Existing-home Owners
How Solar-energy Systems Work

I understand how solar energy systems work.

By Region

North East	+0.2
South	+0.3
North Central	+0.3
West	+0.3
Total Sample	+0.3

By Questionnaire Type

Short Deterministic	+0.3
Short Undeterministic	+0.2
Long Deterministic	+0.4
Before Exposure Mean	2.4
After Exposure Mean	2.1
N =	882

Scale: 1 = strongly agree
5 = strongly disagree

(a positive sign indicates a better understanding after exposure)

EXHIBIT 3-35

Change in Mean Score - Before and After Exposure - Existing Home Owners

Likelihood of Purchase

	<u>By Region</u>	
	<u>within 1 year</u>	<u>within 5 years</u>
North East	-0.3	-0.4
South	-0.2	-0.4
North Central	+0.2	-0.5
West	-0.1	-0.7
Total Sample	-0.1	-0.5

By Questionnaire Type

	<u>within 1 year</u>	<u>within 5 years</u>
Short Deterministic	+0.1	-0.3
Short Undeterministic	-0.1	-0.7
Long Deterministic	0.0	-0.4
Before Exposure Mean	4.4	3.0
After Exposure Mean	4.5	3.5
N =	882	882

Scale: 1 = very likely
5 = very unlikely

(a positive sign indicates a higher likelihood after exposure)

2. New-home Buyers

Screening Statistics

In the new-home segment, data was collected from 1454 respondents through telephone interviews. Of these, 744, or 51.1 percent, returned the mail survey. Exhibit 3-36 shows the number of interviews in each of the four census regions.

Exhibit 3-37 shows, by region, the results of the series of solar-awareness questions, asked in the initial section of the telephone screening interview. The figures show that respondents from the West were much more aware of solar than respondents from other regions. The numbers were higher for Western respondents across all four questions, but the differences were especially wide (.99 significance level) on the "seen a solar-equipped home", "know anyone using solar" and "gone looking for solar" questions. Indeed, just under half, or 45.8%, of Western respondents reported having looked into solar. Southern and North Central respondents reported the fewest direct attempts to investigate solar.

Another interesting observation can be made from Exhibit 3-38, which compares new-home buyers to existing-home owners. The new-home respondents were much more aware of solar, had seen more installations, and had considered solar far more than existing-home respondents. Those who had looked were asked what kinds of solar-energy systems they had investigated: 55.8% said water heaters, 36.8% said space and water heaters and 13.8% said heat pumps.

Asked about the availability of solar equipment types in their areas (see Exhibit 3-39), new-home respondents gave answers that were

more accurate than the existing-home owners, as might be expected given their higher level of awareness. Over a quarter of respondents indicated, however, that they could buy solar electric generation or solar air conditioning for their homes and another 40% were "unsure" about these items. As in the existing-home segment, there appeared to be substantial confusion about what really was available.

Government incentives were known to over 60% of the sample with almost three-quarters of Western respondents aware of incentives. Again the numbers showed much higher awareness than in the existing-home sample (see Exhibit 3-40).

Exhibit 3-41 indicates, however, that new-home buyers have a low awareness of the actual value of the incentive. Of those who claimed to know about government incentives, 32.1 percent correctly identified the federal tax rebates, and of those, 22.6 percent gave an estimate that was within the range of what was then available (15 to 30 percent of gross price). In terms of the entire sample of new-home buyers, 7.3 percent were within the correct range.

When the new-home buyers were asked about their likelihood of purchasing a solar home or water-heating system in the next year, their responses were as shown in Exhibit 3-42A. As was true with the awareness numbers, the likelihood estimates were much higher for new-home buyers than for existing-home owners. In fact, 25.6% of the new-home buyers said they were very or somewhat likely to install solar within the next year, compared to 10.6% of homeowners, and 68.9% said they were very or somewhat likely to install within 5 years, compared to 42.0% of home owners. Western respondents reported likelihoods well

over the national average; 36.3% said they were very or somewhat likely to install within a year, and 79.7% within 5 years. Using the same measure, the North Central respondents lagged well behind the rest for the near term, and North Eastern respondents' likelihoods increased to closer to Western estimates in the longer term.

The next series of exhibits (Exhibits 3-43 to 3-47) shows the five attitude statements that were used in the telephone interview. The data show that attitudes among home buyers were quite prosolar. The Western and the North Eastern respondents showed the most favorable attitudes while the Southern and North Central respondents tended to lag somewhat behind. This general pattern appeared in all of these attitude measures, except in beliefs that solar would be used widely in the area in five years. There, surprisingly, the North Central respondents, even with their more favorable attitudes on other issues, were the most pessimistic.

Another curious result came from the same set of attitudinal exhibits. Exhibits 3-43 to 3-46 all indicate that over 60 percent of respondents either strongly agreed or moderately agreed with those attitude statements. (Sample means were in the range of 2.2 to 2.5.) Yet Exhibit 3-47 shows a marked decrease in respondents who strongly or moderately agreed (48.5 percent), with a corresponding increase in total sample mean (2.9). Respondents seemed to be saying that they could get reliable solar equipment that made financial sense to buy, but even so they did not expect it to be widely used.

Demographics of the sample are shown in Exhibits 3-48 to 3-52. Note the comparisons of demographic data between the full sample of

telephone screeners and the smaller sample of respondents who returned the mail survey. There were no significant differences between the two groups.

Mail Questionnaire Statistics

In the mail questionnaire for new-home buyers, each respondent was given information and then asked questions about two solar systems: a hot-water system and a space- and hot-water system. Related responses are presented, where possible, in the same exhibit.

Exhibits 3-53 and 3-54 show the data that respondents gave about their anticipated water and heating systems. Exhibit 3-53 displays the fuel that they expected to use. A large portion of the sample planned to use electricity -- 52.1% for water heating, much higher than the current incidence in existing homes, and 38.9% for space heating. Oil was planned on in very few situations outside the North East, but wood seemed to be gaining in popularity, as 15.2% of the sample said they planned to use it as their principal space-heating fuel.

Expected expenses for annual heating and water heating are shown in Exhibit 3-54. We infer that most respondents expected space-heating expenses to increase at a slower rate than water heating. Respondents from the North Central region expected the lowest rates of increase, while those from the South expected the highest.

Exhibits 3-55 and 3-56 show average likelihood of purchase of a solar water heater and a solar space and water heater, respectively. The likelihoods were for the following year, and were given for several scenarios including reduced price, increased savings and increased warranty.

On a regional basis, new-home buyers in the West were clearly more receptive to solar. The difference was substantial for both pieces of equipment, but was particularly wide (significant at .01 level) for water heaters. The South and North Central regions lagged behind in likelihood of purchase for water heaters at the base price, while the North East showed the lowest likelihood of purchase for space heating at the base price. At a 50% price reduction, however, all regions showed roughly the same likelihoods for both systems, with the exception of the West's much higher likelihood for solar water heaters.

Savings increase had as dramatic an impact on likelihood of purchase as price reductions: a 50% increase in savings produced about the same likelihood of purchase as did a 50% reduction in price. A lengthened warranty had only a minor effect on purchase likelihoods.

Note also that new-home buyers were far more receptive to solar than existing-home owners (see Exhibit 3-57). The likelihoods for purchasing a water heater in the new-home sample, for example, were more than twice those in the existing-home sample, as the exhibit shows (significant at .01 level). In addition, when the changes from base likelihoods are compared, we find that existing-home owners were less motivated by the changing economic scenarios to buy, i.e. their likelihoods changed by less on an absolute basis.

Exhibit 3-58 shows mean scores, by region, on the series of attitude questions in the mail survey. As we did among existing-home owners, we found a large degree of similarity across regions. Specific questions which showed strong regional differences are as follows:

- Question 3 Western respondents believed much more strongly than those from other regions that solar would be in widespread use within five years. Those in the South were the most skeptical, followed closely by the North East.
- Questions 4a and 4b Western respondents showed the highest level of understanding of the financial merits and mechanical workings of solar systems. The North East showed the least understanding of the financial aspects, while the South lagged in understanding how a solar system works.
- Question 4c Protection from future energy shortages was an advantage of solar that was perceived more strongly by Western respondents than by those in the rest of the country.
- Question 4j North East new-home buyers were least likely to restrict the use of solar by banning collectors from the fronts of buildings. Southerners were most likely to vote for such bans.

In comparing attitudes of new-home buyers with existing-home owners (see Exhibit 3-59) a number of interesting observations can be made. In general, new-home buyers were more prosolar. An important reason for this position may have been their attitudes about finances, and in particular their own financial situation. For example, new-home buyers believed more strongly than existing-home owners that solar could make economic sense for home use (Question 2c; new: 2.5/5.0, existing: 2.8/5.0). In addition, the initial cost of a solar system made less difference among new-home buyers, (Question 4p; new: 2.5/5.0, existing: 2.2/5.0). The zoning-ban question also showed a substantial difference between new-home and existing-home respondents, with the latter more likely to vote for a ban (Question 4j; new: 3.9/5.0, existing: 3.5/5.0). New-home buyers tended to believe that financing solar equipment would be more difficult (Question 4g), probably because of

their more current experiences with mortgages. The difference was significant, however, only in the North East (new: 3.4/5.0, existing: 3.0/5.0).

Exhibit 3-60 shows the distribution of after-exposure likelihood of purchase among new-home buyers.

Before-and-after Comparisons

Several questions were asked in both the telephone screener and the mail survey, giving the respondent the opportunity to revise his or her views based on the information that he or she received. The questions included five attitude issues and two likelihood-of-purchase probabilities; the comparison of the "before-and-after" results is shown in Exhibits 3-61 to 3-66.

Exhibits 3-61 to 3-63 show the same pattern of postexposure change we observed among existing-home owners. That is, in all regions there was a shift in attitudes in a direction unfavorable to solar after exposure.

Exhibits 3-61 and 3-63 show that North Eastern respondents shifted significantly less than respondents from other regions on the issues of whether or not reliable solar equipment is available and whether or not solar will be widely used within five years. North Central respondents shifted significantly more than others on whether or not currently available solar equipment makes economic sense (see Exhibit 3-62). Once again, this trend suggests that consumers hold favorable attitudes, but have little hard information.

In terms of understanding the financial merits of solar, we find that after exposure North Central respondents' understanding decreased substantially (see Exhibit 3-64). There was also a small decrease in the West. The understanding in the other two regions increased a small amount. The North Central and Western shifts can be explained in terms of increased uncertainty, rather than a real decrease in knowledge (see Section 3.C.1, "Before-and-after Comparisons," for further discussion). The same phenomenon appears in Exhibit 3-65, showing shifts in the understanding of the mechanical working of a solar system in the North Central region, but on this item the shift was very small.

Exhibit 3-66 shows changes in the likelihood-of-purchase estimates given by respondents for the following year and for the following five years. Only in the North East and South did likelihoods improve at all -- and there, only in the first year. Note that in these two regions understanding of the financial merits of solar also improved. Changes in the one-year column tended to be smaller than in the 5-year column, simply because the original or pre-exposure likelihoods were lower, resulting in less room for movement. Changes in the 5-year column were around 10 to 18 percent in an unfavorable direction. Once again, an explanation of the population as holding generally prosolar, proenergy savings attitudes coupled with little hard information about solar can account for the observed changes.

EXHIBIT 3-36

Return Rate - New-home Buyers

	<u>Telephone Interviews</u>	<u>Mail Questionnaires Returned</u>	<u>Return Rate</u>
North East	208	125	60.1%
South	602	248	41.2
North Central	275	166	60.4
West	369	205	55.6
TOTAL	<u>1454</u>	<u>744</u>	<u>51.1%</u>

EXHIBIT 3-37

Awareness of Solar - New-home Buyers

	<u>Yes</u>	<u>No</u>	<u>Unsure</u>
A. Heard of solar for home or water heating?			
North East	91.2%	8.8%	- %
South	83.0	17.0	-
North Central	86.1	13.9	-
West	88.3	11.7	-
TOTAL SAMPLE	86.5%	13.5%	- %
B. Seen a home equipped with solar panels?			
North East	73.4%	26.0%	0.6%
South	60.1	39.6	0.3
North Central	58.0	41.4	0.6
West	82.9	17.0	0.1
TOTAL SAMPLE	66.6%	32.9%	0.5%
C. Know anyone now using solar?			
North East	27.5%	70.9%	1.6%
South	22.9	76.9	0.2
North Central	32.1	67.5	0.4
West	45.7	54.3	0.0
TOTAL SAMPLE	30.6%	68.8%	0.6%
D. Actually gone looking for solar?			
North East	34.9%	65.1%	- %
South	26.8	73.2	-
North Central	24.7	75.3	-
West	45.8	54.2	-
TOTAL SAMPLE	31.5%	68.5%	- %

EXHIBIT 3-38

Comparison of Awareness of Solar for New-home Buyers and Existing-home Owners

<u>Percent responding "yes"</u>		
	<u>New-home buyers</u>	<u>Existing- home owners</u>
A. Heard of solar for home or water heating?		
North East	91.2%	81.0%
South	83.0	79.7
North Central	86.1	75.4
West	88.3	81.4
TOTAL SAMPLE	86.5%	79.1%
B. Seen a home equipped with solar panels?		
North East	73.4%	45.0%
South	60.1	39.3
North Central	58.0	46.4
West	82.9	56.0
TOTAL SAMPLE	66.6%	45.5%
C. Know anyone now using solar?		
North East	27.5%	20.7%
South	22.9	13.3
North Central	32.1	17.7
West	45.7	27.8
TOTAL SAMPLE	30.6%	18.8%
D. Actually gone looking for solar?		
North East	34.9%	9.8%
South	26.8	6.1
North Central	24.7	11.3
West	45.8	10.3
TOTAL SAMPLE	31.5%	9.1%

EXHIBIT 3-39

Availability of Types of Solar Equipment - New-home Buyers

Can you, in your area, buy
solar equipment for:

	<u>Yes</u>	<u>No</u>	<u>Unsure</u>
space heating	61.4%	17.1%	21.5%
providing electricity	25.3	34.5	40.2
heating water	64.3	14.8	20.9
air conditioning	26.7	33.3	40.0

EXHIBIT 3-40

Awareness of Government Incentives - New-home Buyers

Have you heard of any federal
government incentives?

	<u>Yes</u>	<u>No</u>	<u>Unsure</u>
North East	62.6%	36.6%	0.8%
South	55.0	41.1	3.9
North Central	59.0	38.7	2.3
West	74.8	21.9	3.3
TOTAL SAMPLE	61.4%	35.9%	2.7%

EXHIBIT 3-41

Awareness of Amount of Federal Incentives - New-home Buyers

	<u>Yes</u>	<u>No</u>	<u>Uncertain</u>
Heard of government incentives? (base = sample)	61.4%	35.9%	2.7%

32.1% correctly identified federal tax rebate.

Of these identifying the tax rebate:

4.5%	said rebate would pay 10% or less of system cost.
9.0%	15%
7.9%	20%
2.0%	25%
3.7%	30%
8.9%	35% or more
64.0%	didn't know

7.3% of the sample has some idea about what is really available (15 to 30% of gross price).

EXHIBIT 3-42

Likelihood of Purchasing a Solar System - New Home Buyers - Telephone Survey

A. Likelihood of purchase next year

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Very likely (1)	10.7%	8.1%	5.5%	23.4%	10.7%
Somewhat likely (2)	15.2	16.1	14.7	12.9	14.9
Unsure (3)	7.2	9.4	12.5	5.5	9.1
Somewhat unlikely (4)	17.4	17.6	18.4	18.1	17.9
Very unlikely (5)	49.5	48.8	48.9	40.1	47.4
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	274	393	347	228	1234
mean:	3.8	3.8	3.9	3.4	3.8

B. Likelihood of purchase within 5 years

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Very likely (1)	32.8%	35.0%	32.5%	57.7%	38.0%
Somewhat likely (2)	38.3	29.4	32.7	22.0	30.9
Unsure (3)	8.6	13.5	8.6	8.8	10.2
Somewhat unlikely (4)	4.7	10.4	13.4	3.8	8.8
Very unlikely (5)	15.6	11.7	12.8	7.7	12.1
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	268	388	345	227	1228
mean:	2.3	2.3	2.4	1.8	2.3

EXHIBIT 3-43

New-home Buyers' Attitude Statements - Telephone Interviews -
Financial Merits of Solar-energy Systems

I understand the financial merits of solar-energy systems.

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Strongly agree (1)	27.9%	25.9%	32.4%	38.7%	30.5%
Moderately agree (2)	32.2	34.8	27.4	40.6	33.2
Unsure (3)	7.0	3.7	5.6	6.0	5.4
Moderately disagree (4)	24.0	21.5	21.1	8.3	19.5
Strongly disagree (5)	8.9	14.1	13.5	6.4	11.4
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	272	392	347	227	1238
mean:	2.5	2.6	2.6	2.0	2.5

EXHIBIT 3-44

New-home Buyers' Attitude Statements - Telephone Interview -
How Solar-energy Systems Work

I understand how solar-energy systems work.

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Strongly agree (1)	27.3%	18.5%	19.3%	29.4%	22.6%
Moderately agree (2)	45.4	40.8	49.8	46.5	45.4
Unsure (3)	1.2	1.6	1.9	2.6	1.8
Moderately disagree (4)	14.8	23.9	19.0	14.4	18.8
Strongly disagree (5)	11.3	15.2	10.0	7.1	11.4
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	274	393	347	228	1243
mean:	2.4	2.8	2.5	2.2	2.5

EXHIBIT 3-45

New-home Buyers' Attitude Statements - Telephone Interview -
Reliable and Dependable Solar Equipment for Home Use

Do you believe that you can obtain reliable and dependable solar equipment for home use?

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Definitely can (1)	29.0%	30.4%	21.0%	44.6%	30.1%
Probably can (2)	39.6	38.3	40.2	32.2	38.0
Unsure (3)	15.6	11.5	15.9	12.6	13.8
Probably can not (4)	12.0	17.1	17.9	9.3	14.8
Definitely can not (5)	3.8	2.7	5.0	1.3	3.3
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	274	393	347	228	1242
mean:	2.2	2.2	2.5	1.9	2.2

EXHIBIT 3-46

New-home Buyers' Attitude Statements - Telephone Interview -
Solar Equipment that makes Economic Sense for Home Use

Do you believe that you can obtain solar equipment that makes economic sense for home use?

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Definitely can (1)	26.7%	27.0%	22.0%	36.8%	27.3%
Probably can (2)	41.0	37.8	40.8	28.6	37.7
Unsure (3)	13.6	10.4	10.9	12.9	11.7
Probably can not (4)	11.2	17.8	17.5	15.3	15.8
Definitely can not (5)	7.5	7.0	8.8	6.4	7.5
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	274	393	347	228	1243
mean:	2.3	2.4	2.5	2.3	2.4

New-home Buyers' Attitude Statements - Telephone Interview -
Solar-energy Equipment Widely Used in Five Years

Do you believe that solar energy equipment will be widely used by homeowners in your area within the next five years?

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Definitely will (1)	10.2%	22.3%	14.7%	35.0%	19.8%
Probably will (2)	24.8	25.2	33.0	33.1	28.7
Unsure (3)	7.5	3.8	2.6	4.9	4.5
Probably will not (4)	39.1	35.2	35.3	19.4	33.2
Definitely will not (5)	18.4	13.5	14.4	7.6	13.8
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	273	393	347	228	1241
mean:	3.3	2.9	3.0	2.3	2.9

EXHIBIT 3-48

Age Distribution - New-home Buyers

	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>telephone survey</u>	<u>mail return</u>	<u>telephone survey</u>	<u>mail return</u>	<u>telephone survey</u>	<u>mail return</u>	<u>telephone survey</u>	<u>mail return</u>
under 25 years	7.2%	7.2%	8.3%	6.9%	4.4%	5.4%	5.4%	4.9%
25 - 34	43.3	46.4	39.4	38.3	41.8	40.4	39.6	37.1
35 - 44	24.0	23.2	25.6	23.4	25.1	20.5	26.8	28.3
45 - 54	14.9	12.0	16.7	19.8	14.9	15.0	17.6	19.0
55 and over	10.6	11.2	10.0	11.6	13.8	18.7	10.6	10.7
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
TOTAL	208	125	602	248	275	166	369	305

EXHIBIT 3-49

Head-of-household Education-level Distribution - New-home Buyers

	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>telephone</u>	<u>mail</u>	<u>telephone</u>	<u>mail</u>	<u>telephone</u>	<u>mail</u>	<u>telephone</u>	<u>mail</u>
	<u>survey</u>	<u>return</u>	<u>survey</u>	<u>return</u>	<u>survey</u>	<u>return</u>	<u>survey</u>	<u>return</u>
grammar school	1.4%	0.8%	1.7%	0.8%	2.2%	1.8%	1.4%	1.0%
high school	30.3	30.4	36.7	34.7	35.6	36.7	31.7	33.2
college	37.5	37.6	38.7	37.9	35.7	32.0	43.6	38.5
post-graduate	30.8	31.2	22.9	26.6	26.5	29.5	23.3	27.3
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
TOTAL	208	125	602	248	275	166	369	205

EXHIBIT 3-50

Distribution of Household Income - New-home Buyers

	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>telephone</u>	<u>mail</u>	<u>telephone</u>	<u>mail</u>	<u>telephone</u>	<u>mail</u>	<u>telephone</u>	<u>mail</u>
	<u>survey</u>	<u>return</u>	<u>survey</u>	<u>return</u>	<u>survey</u>	<u>return</u>	<u>survey</u>	<u>return</u>
under \$15,000	12.0%	8.8%	11.6%	9.7%	5.9%	3.7%	8.5%	8.3%
\$15 - \$25,000	28.4	30.4	28.0	28.3	32.6	32.9	25.1	23.5
\$25 - \$40,000	41.3	44.8	35.1	34.8	34.8	38.4	39.6	40.7
over \$40,000	18.3	16.0	25.3	27.2	26.7	25.0	26.8	27.5
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
TOTAL	208	125	596	247	273	164	366	204

EXHIBIT 3-51

Distribution of Number of Full-time Working Household Members - New-home Buyers

	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>telephone survey</u>	<u>mail return</u>	<u>telephone survey</u>	<u>mail return</u>	<u>telephone survey</u>	<u>mail return</u>	<u>telephone survey</u>	<u>mail return</u>
0 persons	6.7%	7.2%	6.5%	4.8%	6.5%	6.0%	5.7%	3.4%
1 person	56.3	60.0	46.3	49.6	43.6	45.8	48.0	48.8
2 persons	32.2	28.0	40.9	38.7	42.2	40.4	39.6	40.0
more than 2	4.8	4.8	6.3	6.9	7.7	7.8	6.7	7.8
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
TOTAL	208	125	602	248	275	166	369	205

EXHIBIT 3-52

Distribution of Family Size - New-home Buyers

	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>telephone survey</u>	<u>mail return</u>	<u>telephone survey</u>	<u>mail return</u>	<u>telephone survey</u>	<u>mail return</u>	<u>telephone survey</u>	<u>mail return</u>
1 person	4.8%	6.4%	4.8%	3.6%	5.5%	7.2%	6.0%	6.8%
2 persons	25.5	24.0	28.2	29.4	29.1	30.1	24.1	26.8
3 persons	24.5	24.8	26.4	30.2	20.7	24.7	25.7	22.9
4 persons	26.9	28.8	23.6	22.6	27.6	27.7	27.6	28.8
5 persons	13.5	12.0	11.8	10.1	10.5	5.4	10.6	9.8
6 or more persons	4.8	4.0	5.2	4.1	6.6	4.9	6.0	4.9
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
TOTAL	208	125	602	248	275	166	369	205

EXHIBIT 3-53

Anticipated Fuel Usage - New-home Buyers

A. For Water Heating

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Natural gas	21.0%	23.8%	36.8%	50.1%	31.5%
Electricity	56.7	67.0	39.1	38.8	52.1
Oil	15.3	0.0	0.6	0.0	3.4
Other	7.0	9.2	23.5	11.1	13.0
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	151	241	204	126	722

B. For Space Heating

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Natural gas	19.2%	21.3%	33.0%	41.8%	28.0%
Electricity	24.9	59.3	26.1	38.5	38.9
Oil	26.6	1.2	7.6	0.6	8.2
Wood	22.2	11.3	15.8	13.4	15.2
Other	7.1	6.9	17.5	5.7	9.7
	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>	<u>100.0%</u>
N:	147	229	202	130	709

EXHIBIT 3-54

Average Estimated Fuel Expense - New-home Buyers

A. For Water Heating

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
next year	\$272	\$282	\$188	\$226	\$242
in 1985	444	522	291	360	408
% increase	63%	85%	55%	59%	69%

B. For Space Heating

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
next year	\$652	\$488	\$562	\$380	\$525
in 1985	1037	824	776	551	803
% increase	59%	69%	38%	45%	53%

EXHIBIT 3-55

Average Likelihood of Purchase within Next Year (Water Heater) - New-home Buyers

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Base Price	41.2	35.6	37.8	52.3	40.4
25% Price Reduction	55.2	52.2	51.2	65.6	54.9
change	14.0	16.6	13.4	13.3	14.5
50% Price Reduction	65.6	61.1	58.3	72.8	63.3
change	24.4	25.5	20.5	20.5	22.9
50% Savings Increase	65.9	62.2	60.0	72.6	64.2
change	24.7	26.6	22.2	20.3	23.8
Increased Warranty	47.8	46.9	45.3	58.8	48.7
change	6.6	13.3	7.5	6.0	8.3

Note: Likelihoods are given on a 100-point scale

EXHIBIT 3-56

Average Likelihood of Purchase within Next Year (Space and Water Heating) - New Home Buyers

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Base Price	30.1	32.5	33.4	39.7	33.5
25% Price Reduction	38.8	42.5	42.7	49.9	43.2
change	8.7	10.0	9.3	10.2	9.7
50% Price Reduction	50.3	50.6	52.4	58.6	52.5
change	20.2	18.1	19.0	18.9	19.0
50% Savings Increase	54.3	52.2	55.2	58.3	54.6
change	24.2	19.7	21.8	18.6	21.1
Increased Warranty	31.0	38.6	39.2	45.9	38.6
change	0.9	6.1	5.8	6.2	5.1

Note: Likelihoods are given on a 100-point scale

EXHIBIT 3-57

Comparison of Likelihood of Purchase within One Year
for New-home Buyers and Existing-home Owners

	<u>New Home Buyers</u>	<u>Existing Home Owners</u>
Base Price	40.4	12.3
25% Price Reduction	54.9	21.8
50% Price Reduction	63.3	28.4
50% Savings Increase	64.2	31.0
Increased Warranty	48.7	17.7

Note: Likelihoods given on a 100-point scale.

EXHIBIT 3-58

New-home Buyers' Attitude Statements - Mail Survey

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
1. I can currently obtain <u>reliable</u> and <u>dependable</u> solar-energy equipment for home use.	2.3	2.6	2.5	2.2	2.4
2. I can currently obtain solar-energy equipment that makes <u>economic sense</u> for home use.	2.6	2.6	2.6	2.4	2.5
3. Solar energy equipment will be widely used by homeowners in my area within the next five years.	3.1	3.3	2.9	2.6	3.0
4a. I understand the financial merits of solar-energy systems.	2.4	2.2	2.3	2.0	2.2
b. I understand how solar-energy systems work.	1.9	2.1	1.9	1.7	1.9
c. Solar energy systems can provide a lot of protection from future energy shortages.	2.0	1.9	1.9	1.6	1.9
d. A solar water heating system would greatly increase the resale value of my home.	2.4	2.5	2.6	2.4	2.5
e. If a solar-energy system that I installed failed and needed major repairs or replacement, it could mean a financial disaster for my family.	3.0	3.0	2.9	3.0	3.0
f. Solar collectors would be very unattractive on my house.	3.1	2.9	2.9	3.2	3.0
g. It would be very easy to obtain financing for a solar-energy system.	3.4	3.1	3.2	3.0	3.2
h. If a solar-energy system that I installed gave less savings than I had expected, it could mean a financial disaster for my family.	3.2	3.4	3.2	3.4	3.3
i. Solar equipment would protect me from increasing energy costs.	2.3	2.3	2.3	2.1	2.3
j. I would vote for zoning restrictions to ban solar collectors from the front of houses in my neighborhood.	4.2	3.7	3.8	3.9	3.9

Scale: 1 = strongly agree
5 = strongly disagree

EXHIBIT 3-58 (continued)

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
4k. Manufacturers of solar systems are mostly little companies that are here today and will probably be gone tomorrow.	3.4	3.2	3.4	3.4	3.3
l. Solar-energy equipment will produce maintenance nightmares for me.	3.5	3.3	3.4	3.6	3.4
m. I would admire a neighbor who installed solar equipment.	2.4	2.5	2.3	2.2	2.4
n. A political candidate who supports solar is progressive.	2.2	2.2	2.4	2.2	2.2
o. Technological advances will soon make currently available solar equipment outdated.	2.9	2.8	2.7	2.8	2.8
p. A solar water heating system might save me money in the long run, but the initial cost is just too high for me to consider buying one.	2.5	2.6	2.4	2.7	2.5
q. If more people were aware of the information shown in this questionnaire, more of them would buy solar-energy systems.	3.1	2.8	2.9	2.8	2.9

Scale: 1 = strongly agree
5 = strongly disagree

EXHIBIT 3-59

Comparison of Attitude Statements for New-home Buyers and Existing-home Owners

	<u>Existing Homes</u>	<u>New Homes</u>
1. I can currently obtain <u>reliable</u> and <u>dependable</u> solar-energy equipment for home use.	2.5	2.4
2. I can currently obtain solar-energy equipment that makes <u>economic sense</u> for home use.	2.8	2.5
3. Solar-energy equipment will be widely used by homeowners in my area within the next five years.	3.1	3.0
4a. I understand the financial merits of solar-energy systems.	2.4	2.2
b. I understand how solar-energy systems work.	2.1	1.9
c. Solar-energy systems can provide a lot of protection from future energy shortages.	1.9	1.9
d. A solar water-heating system would greatly increase the resale value of my home.	2.7	2.5
e. If a solar-energy system that I installed failed and needed major repairs or replacement, it could mean a financial disaster for my family.	2.9	3.0
f. Solar collectors would be very unattractive on my house.	3.0	3.0
g. It would be very easy to obtain financing for a solar-energy system.	3.0	3.2
h. If a solar-energy system that I installed gave less savings than I had expected, it could mean a financial disaster for my family.	3.1	3.3
i. Solar equipment would protect me from increasing energy costs.	2.5	2.3
j. I would vote for zoning restrictions to ban solar collectors from the front of houses in my neighborhood.	3.5	3.9

Scale: 1 = strongly agree
5 = strongly disagree

EXHIBIT 3-59 (continued)

	<u>Existing Homes</u>	<u>New Homes</u>
4k. Manufacturers of solar systems are mostly little companies that are here today and will probably be gone tomorrow.	3.3	3.3
l. Solar-energy equipment will produce maintenance nightmares for me.	3.3	3.4
m. I would admire a neighbor who installed solar equipment.	2.5	2.4
n. A political candidate who supports solar is progressive.	2.3	2.2
o. Technological advances will soon make currently available solar equipment outdated.	2.7	2.8
p. A solar water-heating system might save me money in the long run, but the initial cost is just too high for me to consider buying one.	2.2	2.5
q. If more people were aware of the information shown in this questionnaire, more of them would buy solar-energy systems.	3.0	2.9

Scale: 1 = strongly agree
5 = strongly disagree

EXHIBIT 3-60

Likelihood of Purchasing a Solar System - New-home Buyers - Mail Survey

A. Likelihood of purchase next year - after exposure.

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Very likely (1)	10.0%	4.4%	14.8%	12.2%	10.3%
Somewhat likely (2)	5.0	7.0	2.6	10.3	5.9
Unsure (3)	23.8	16.0	8.8	13.0	14.9
Somewhat unlikely (4)	10.4	10.9	7.2	15.9	10.5
Very unlikely (5)	<u>50.8</u>	<u>61.7</u>	<u>66.6</u>	<u>48.6</u>	<u>58.4</u>
	100.0%	100.0%	100.0%	100.0%	100.0%
N:	.32	172	185	113	60.3
mean:	3.9	4.2	4.1	3.8	4.0

B. Likelihood of purchase within 5 years - after exposure.

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>	<u>Total</u>
Very likely (1)	27.8%	13.7%	21.8%	32.0	22.1%
Somewhat likely (2)	17.3	26.1	21.1	32.0	23.9
Unsure (3)	26.6	28.8	22.8	17.2	24.7
Somewhat unlikely (4)	16.8	12.7	6.1	6.0	10.7
Very unlikely (5)	<u>11.5</u>	<u>18.7</u>	<u>28.2</u>	<u>12.8</u>	<u>18.6</u>
	100.0%	100.0%	100.0%	100.0%	100.0%
N:	145	203	174	114	655
mean:	2.7	3.0	3.0	2.4	2.8

EXHIBIT 3-61

Change in Mean Score - Before and After Exposure - New-home Buyers
Reliable and Dependable Solar-energy Equipment for Home Use

Do you believe that you can currently obtain reliable and dependable solar-energy equipment for home use?

By Region

North East	-0.2
South	-0.6
North Central	-0.6
West	-0.6
Total Sample	-0.5
Before Exposure Mean	1.9
After Exposure Mean	2.4
N =	747
Scale:	1 = definitely can
	5 = definitely can not

A negative sign indicates unfavorable movement after exposure.

EXHIBIT 3-62

Change in Mean Score - Before and After Exposure - New-home Buyers
Solar-energy Equipment that Makes Economic Sense for Home Use

Do you believe that you can currently obtain solar-energy equipment that makes economic sense for home use?

By Region

North East	-0.3
South	-0.2
North Central	-0.9
West	-0.4
Total Sample	-0.4
Before Exposure Mean	2.1
After Exposure Mean	2.5
N =	747

Scale: 1 = definitely can
2 = definitely can not

A negative sign indicates unfavorable movement after exposure.

EXHIBIT 3-63

Change in Mean Score - Before and After Exposure - New-home Buyers
Solar-energy Equipment Widely Used in Five Years

Do you believe that solar-energy equipment will be widely
used by homeowners in your area within the next five years?

By Region

North East	0.0
South	-0.5
North Central	-0.6
West	-0.7
Total Sample	-0.5
Before Exposure Mean	2.5
After Exposure Mean	3.0
N =	747
Scale:	1 = definitely will 5 = definitely will not

A negative sign indicates unfavorable movement after exposure.

EXHIBIT 3-64

Change in Mean Score - Before and After Exposure - New-home Buyers
Financial Merits of Solar-energy Systems

I understand the financial merits of solar-energy systems.

By Region

North East	+0.1
South	+0.3
North Central	-0.7
West	-0.2
Total Sample	+0.1
Before Exposure Mean	2.1
After Exposure Mean	2.2
N =	747
Scale:	1 = strongly agree 5 = strongly disagree

A positive sign indicates a better understanding after exposure.

EXHIBIT 3-65

Change in Mean Score - Before and After Exposure - New-home Buyers
How Solar-energy Systems Work

I understand how solar energy systems work.

By Region

North East	+0.1
South	+0.3
North Central	-0.1
West	+0.1
Total Sample	+0.1
Before Exposure Mean	2.0
After Exposure Mean	1.9
N =	747

Scale: 1 = strongly agree
5 = strongly disagree

A positive sign indicates a better understanding after exposure.

EXHIBIT 3-66

Change in Mean Score - Before and After Exposure - New-home Buyers
Likelihood of Purchase

Likelihood of Purchase

	<u>By Region</u>	
	<u>within 1 year</u>	<u>within 5 years</u>
North East	+0.2	-0.5
South	+0.5	-0.7
North Central	-0.4	-0.9
West	-0.3	-0.5
Total Sample	0.0	-0.7
Before Exposure Mean:	4.0	2.1
After Exposure Mean	4.0	2.8
N =	603	655

Scale: 1 = very likely
5 = very unlikely

A negative sign indicates a lower likelihood after exposure.

D. ANALYSIS

1. Model Development

Modeling for the residential segments was made to concentrate on explaining likelihood of purchase through attitudes, perceptions and demographics. Likelihood of purchase, l , was measured on an 11-point scale in the mail questionnaires (question 7 from the existing-home questionnaire; two questions, both numbered 5, from the new-home questionnaire). The scale was made to range from 0 to 100. Then $p = l/100 =$ probability of purchase.

A model was designed to predict logit-transformed first-year likelihood of purchase using a regression equation. Specifically, we attempted to fit a model of the form:

$$\text{logit} = \ln \left(\frac{p + 0.5}{1.5 - p} \right) = a_0 + a_1 x_1 + a_2 x_2 + \dots \quad (1)$$

where $a_0 =$ regression constant

$a_1 \dots a_n =$ regression coefficients

$x_1 \dots x_n =$ perceptual, attitude and demographic independent variables measures

The first step in modeling involved a reduction of the data to be used as independent variables. Correlation analysis showed substantial intercorrelation between attitude data, while price and savings data had, of necessity, been constructed with intercorrelation. We worked, for example, to include both the actual gross price and a net, after rebate price as independent variables.

Correlation analysis yielded sets of related independent variables with minimal intercorrelation. Each set was regressed against the

likelihood variable to generate coefficients for a linear combination of the original variable, which in turn was used as a "submodel" or "macro" in the main regression (a single x_1 in Eq. 1). The macros were developed using data from both new-home and existing-home respondents, that is, from about 3000 cases. Financial macros are displayed in Exhibit 3-67, and attitude macros in Exhibit 3-68.

The construction of the individual macros gives some insight into the structure of consumers' perceptions of solar energy. There appear to be nine dimensions which consumers use in the evaluation of active solar energy products, and in their decisions of whether or not to purchase solar:

Price	}	Financial macros
Savings		
Payback		
Inflation expectations		
Dependability	}	Attitude macros
Economics		
Risk		
Immediate social acceptance		
Long-term social acceptance		

In our study, there was no single simple number that people looked at in evaluating the financial benefits of a solar system; rather, they used four independent measures. Indeed, even these measures had different importances to different consumers, as the regional models described in Section 3.D.2 show. In addition, there was an attitude variable, "economics", that was superimposed on the hard facts and figures.

The price macro was composed of five separate questionnaire variables. Four of these had about the same weight; the other was much

EXHIBIT 3-67
Financial Macros

<u>Price Macro</u> <u>Variables</u>	<u>Weights</u>
respondent's stated gross price (from M5)	+0.083
questionnaire-supplied gross price	+0.012
questionnaire-supplied actual price	+0.099
respondent's stated actual price (from M7)	+0.089
respondent's stated actual price (from M5)	+0.079

<u>Savings Macro</u> <u>Variables</u>	<u>Weights</u>
questionnaire-stated estimate of first-year savings with respondent's fuel	+0.1416
questionnaire-stated estimate of first-year savings with gas	+0.1089
questionnaire-stated estimate of fifth-year savings with respondent's fuel	+0.1478
respondent's estimated first-year savings (from M6)	+0.311
respondent's estimated first-year savings (from M7)	+0.21
relative savings indicator (respondent's estimate $\div$ questionnaire stated)	+0.085

<u>Payback Macro</u> <u>Variables</u>	<u>Weights</u>
questionnaire-stated estimate of payback	+0.01497
questionnaire-stated estimate of payback against gas	+0.03698
inferred respondent's estimate (respondent's estimated price $\div$ savings)	+0.0043

<u>Inflation Macro</u> <u>Variables</u>	<u>Weights</u>
inferred gasoline inflation (from G10, G11)	+0.627
inferred fuel inflation (= M4C/M4B)	+0.00216

EXHIBIT 3-68

Attitude Macros

Dependability

Weights

can obtain reliable and dependable system	+0.1
will produce maintenance nightmares	-0.1
little companies; here today, gone tomorrow	-0.1

Economics

Weights

can obtain system which makes economic sense	+0.2
would greatly increase resale value	+0.3
protect from increasing energy costs	+0.2
too high initial cost	-0.3

Risk

Weights

repairs — financial disaster	+0.1
low savings — financial disaster	+0.1

Immediate Social Acceptance

Weights

unattractive	-0.2
vote for zoning restrictions	-0.2
admire a neighbor	+0.4
progressive politics	+0.3

Long-Term Social Acceptance

Weight

belief in solar being widely used	+1.0
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less important. The four were:

- (1) the "actual" price (gross price minus rebate) supplied by the questionnaire;
- (2) and (3) two measures of the price the respondent stated that he or she would actually have to pay (questions 5 and 7 in existing-home mail questionnaire; questions 3 and 5 in new-home mail questionnaire) -- these were gross price minus rebate numbers, but were estimates by the respondent of what a system would cost him or her, given his or her particular family size, usage rates and tax situation;
- (4) the gross price before tax rebates that the respondent stated that he or she would have to pay, once again in his or her particular family situation.

Of less importance was the fifth number, the average gross price for the state as supplied in the questionnaire.

The construction of this macro shows two interesting points. The first is that consumers understand the rebate system after it is explained to them (see Sections 3.C.1 and 3.C.2), and use the reduced, "actual" price rather than the gross price in their evaluation of solar. This fact highlights the importance of the rebates in the decision-making process. The second point is that individuals are able to interpret financial data and apply it to their own situations. Our questionnaire provided financial information that was specific to an "average" family of four, but respondents were able to superimpose their own needs on the given figures and arrive at a different number that they believed would be their own real cost (see Exhibit 3-69). Interestingly enough, a substantial number of respondents believed that they could obtain solar equipment for less than the estimates given in the questionnaire's information section.

EXHIBIT 3-69

Comparison of Consumer-expected Actual Price
to Actual Price Stated in Questionnaire

	<u>less*</u>	<u>stated</u>	<u>more*</u>	<u>total</u>
Existing Homes				
- water heating	45.0%	34.7%	20.3%	100%
New Homes				
- water heating	33.1%	42.2%	24.7%	100%
- space heating	33.1%	45.8%	21.0%	100%

* Consumer estimated that he or she could buy a system for less or more than the "average" price given in the questionnaire because of the family, usage or tax situations.

The savings macro followed the construction of the price macro fairly closely. The key variables in this macro were two measures of the respondent's estimate of his or her first-year savings using a solar system. These estimates came from a range scale (existing-home mail questionnaire, question 6; new-home mail questionnaire, question 4), and an actual statement of the estimate (questions 7 and 5 from the existing-home and new-home mail questionnaires, respectively). Together they were about twice as important as any other savings variable, which suggests the importance of keying on the first-year savings number in any marketing effect.

Other variables included in the savings macro were:

- (1) The questionnaire stated estimates of the first-year savings, assuming both the respondents' fuel and gas. The gas-related number produced a modulating effect.
- (2) The questionnaire stated estimate of fifth-year savings, using the respondents' fuel.
- (3) A "relative savings" indicator variable was constructed by dividing the respondent's estimated first-year savings by the figure stated in the questionnaire.

The payback macro was composed of three elements. The first two were the payback stated in the questionnaire against both the respondent's fuel and gas (once again, the latter had a modulating effect). The third variable was a payback figure computed by dividing the respondent's estimated savings into his or her estimated actual price. These numbers were used in the savings and price macros, discussed above.

Finally, the inflation macro combined two estimates of the inflation rate the respondent expected to see in the next 5 years. The

first, and most important, measure of inflation expectations was derived from general questions 10 and 11 in the mail survey, which asked about current cost and expected future cost of gasoline. Using these numbers, an actual inflation rate was calculated for each respondent. A second measure of inflation was obtained by dividing expected 1985 costs using the current fuel by current costs (existing-homes mail survey, question 4; new-homes mail survey, question 2) to give a rough idea of the overall cost increase expected for the particular application.

In addition to the financial macros, five attitude macros were developed. These "sub-models" or "factors," together with the financial macros, defined the perceptual framework in which consumers make decisions about active solar-energy systems. The five attitude dimensions, derived through correlation analysis, were:

- dependability
- economics
- risk
- immediate social acceptance
- long-term social acceptance

The individual variables from the questionnaires that made up each of these dimensions are shown in Exhibit 3-68.

Evaluation of dependability was derived from three attitude scales emphasizing maintenance and solar manufacturer reliability as well as a direct opinion about the availability of reliable solar equipment. The three scales carried equal importance.

Evaluation of economics included four questionnaire scales. Two were short term -- initial cost was too high (more important) and current equipment made economic sense (less important). Two were long

term -- solar would increase the home's resale value (more important) and protection from increasing energy costs would be provided (less important).

Attitudes toward risk were summarized by the possibility of financial disaster if a solar system failed and had to be replaced or if a solar system delivered less savings than originally expected. The two variables carried similar importance weights.

Attitudes toward solar acceptability were divided into two dimensions, immediate and long term. The short-term dimension was made up of attitudes about a neighbor who might be a solar innovator (most important), political candidates who support solar (important) and opinions about solar's attractiveness, expressed both directly and through desire for zoning restrictions (both less important). Long-term social acceptance was measured by the belief that solar would be widely used by home owners in the next five years.

Demographic variables were also included in the models. Those variables that were used in the final models were:

- age
- income
- education
- size of household
- sex of respondent

In addition, several other variables were included in the models:

- the dollar estimate for the respondent's next year fuel cost (for water heating or space and water heating, as applicable) using his or her current fuel,
- for new homes only, the dollar increase in the monthly mortgage payment, and
- for new homes only, number of years' warranty with the system.

2. Estimation/Fit

Twelve separate regression models were developed for the following market segments:

- existing homes, hot-water retrofit, in four regions,
- new homes, hot water, in four regions, and
- new homes, space and hot water combined, in four regions.

Analysis indicated that the regional models were significantly different; as a result a single, national model was not appropriate in any of the three categories. The models are displayed in Exhibits 3-70 to 3-75, while Exhibit 3-76 gives definitions of the variables in the models.

The models fit the data quite well. R^2 ranges from .25 to .39 among existing-home owners for solar water heating, from .44 to .53 for new-home buyers for water heating and from .34 to .54 for new-home buyers for space and water heating. It is not unexpected that the fit is less good among existing-home owners where a variety of additional considerations, unmeasured by this survey and probably highly individualistic, can be expected to have had a complicating effect on intentions. The model for likelihood of purchase among new-home buyers considering solar water heating displays the best fit, probably because the decision is more straightforward -- the system is relatively low cost, and can be installed with a minimum of effort and disturbance. For the same reason, the fit of the new-home buyer's space- and water-heating model is also good, but the larger size, higher cost and possibly more important function of the system lead to additional considerations, again, unmeasured, that would have complicated the decision-making process.

EXHIBIT 3-70

Regression Models - Probability of Purchase for Existing Homes

<u>Variable</u>	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>B</u>	<u>t-stat</u>	<u>B</u>	<u>t-stat</u>	<u>B</u>	<u>t-stat</u>	<u>B</u>	<u>t-stat</u>
MPRIC	-0.0005	-1.53	-0.0003	-3.55	0.0004	-2.41	0.0002	-3.18
MSAVE	0.003	19.17	0.002	12.82	0.001	7.79	0.0003	8.88
MPAYB	-0.194	-1.92	-0.0001	0.00	-0.333	-2.41	-0.448	-3.02
MINFL	0.101	2.43	0.165	5.13	-0.259	-2.96	0.124	3.60
GDE	0.0001	4.54	0.001	4.04	0.0003	3.19	0.0006	0.00
GEC	-0.020	-5.81	-0.022	-12.33	-0.021	-8.48	-0.020	-9.72
GRI	0.044	1.02	0.008	2.76	0.033	3.58	0.056	4.36
GSO	-0.015	-3.32	-0.010	-4.04	-0.002	-1.25	-0.006	-2.35
GGO	-0.050	-2.68	-0.080	-5.92	-0.045	-2.18	-0.148	-8.88
I2	0.011	1.28	-0.059	-1.58	-0.052	0.00	0.091	0.00
I3	-0.054	-1.02	-0.081	-1.97	-0.050	-1.87	0.096	2.01
S15	-0.046	-1.73	-0.029	-3.55	-0.091	-6.54	-0.059	-5.70
S16	-0.092	-3.19	-0.028	-1.58	0.023	0.00	0.047	2.35
S17	0.047	3.07	0.004	1.97	0.065	4.67	0.053	4.53
S20	-0.0007	0.00	0.078	5.52	-0.048	-1.62	-0.030	-1.34
S21	0.098	1.73	-0.147	-4.24	-0.082	-2.41	-0.008	0.00
M4B	0.0001	1.02	0.0003	4.54	0.0001	0.00	0.0002	3.18
Intercept	0.002		0.188		0.489		0.364	
N (weighted)=	472		1124		700		812	
R ² =	.392		.316		.252		.316	

EXHIBIT 3-71

Means and Standard Deviations for Existing-homes Probability-of-Purchase Equation Variables

<u>Variables</u>	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>mean</u>	<u>std. dev.</u>	<u>mean</u>	<u>std. dev.</u>	<u>mean</u>	<u>std. dev.</u>	<u>mean</u>	<u>std. dev.</u>
LOGIT	-0.432	0.646	-0.571	0.584	-0.621	0.528	-0.479	0.600
MPRIC	743.184	222.426	597.410	198.591	610.169	182.948	521.867	225.680
MSAVE	115.147	66.156	100.506	67.897	63.315	48.720	74.287	58.586
MPAYB	0.768	0.163	0.816	0.139	0.896	0.154	0.802	0.136
MINFL	0.056	0.175	0.028	0.224	0.048	0.188	0.043	0.205
GDE	3.932	2.072	4.125	1.907	4.091	2.320	4.335	1.935
GEC	11.356	6.206	11.982	6.281	13.091	6.465	10.980	6.395
GRI	6.170	1.755	6.292	1.974	6.194	2.155	6.483	1.888
GSO	3.271	6.388	4.199	6.971	4.549	6.721	3.887	7.108
GGO	3.254	1.107	3.199	1.115	3.229	1.170	2.788	1.097
I2	0.305	0.461	0.324	0.468	0.314	0.465	0.315	0.465
I3	0.339	0.474	0.352	0.478	0.343	0.475	0.345	0.476
S15	3.085	1.039	3.441	1.211	3.299	1.210	3.409	1.135
S16	2.814	0.813	2.819	0.844	2.686	0.835	2.946	0.873
S17	3.763	1.438	3.053	1.356	3.291	1.490	3.488	1.648
S20	2.539	0.828	2.471	1.037	2.544	0.911	2.685	0.973
S21	1.314	0.464	1.398	0.490	1.343	0.475	1.443	0.497
M4B	340.542	235.921	242.228	227.796	168.744	122.040	239.521	337.315

EXHIBIT 3-72

Regression Models, Probability of Purchase for New Homes, Hot-water Systems

<u>Variables</u>	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>B</u>	<u>t-stat</u>	<u>B</u>	<u>t-stat</u>	<u>B</u>	<u>t-stat</u>	<u>B</u>	<u>t-stat</u>
S6	-0.036	-5.07	-0.197	-8.25	-0.415	-15.56	-0.153	-4.14
WMPR	-0.0007	-7.24	-0.0006	0.00	0.0003	0.00	0.0002	2.65
WMSA	0.003	6.63	0.002	4.82	0.003	6.84	0.0005	8.41
WMPA	-1.682	-1.89	-1.692	-2.29	-2.310	-1.14	-0.864	-1.81
WMIN	2.145	1.35	6.609	5.80	2.337	1.43	3.734	0.00
WMORT	-0.039	-2.91	-0.241	0.00	-0.030	-4.20	-0.017	-3.24
GDE	0.0006	0.00	0.0006	1.18	0.001	1.98	0.0003	1.08
GEC	-0.035	-8.93	-0.038	-10.78	-0.028	-7.05	-0.037	-16.43
GRI	0.022	0.00	0.056	0.00	0.011	4.42	0.009	0.00
GSO	-0.005	-4.80	-0.002	-5.55	-0.020	-6.13	-0.012	-4.21
GGO	-0.005	-2.91	-0.133	-2.78	0.00001	1.43	-0.041	-1.55
S15	-0.054	-1.08	0.180	3.92	0.067	2.71	0.066	3.36
S16	-0.090	-1.62	0.059	2.29	-0.008	0.00	-0.008	0.00
S17	-0.074	-1.89	0.091	4.74	-0.129	-6.63	-0.030	-2.33
S20	0.130	5.14	0.140	4.90	-0.131	-2.71	-0.053	-2.20
S21	-0.027	0.00	-0.164	-3.10	0.094	4.13	-0.164	-4.08
W2B	0.0001	1.08	0.001	8.82	0.0007	5.20	0.0004	2.46
Intercept	0.686		-2.350		-0.483		0.279	
N (weighted) =	529		771		587		484	
R ² =	.439		.437		.532		.501	

EXHIBIT 3-73

Means and Standard Deviations for New-homes Probability-of-purchase Equation Variables (Hot Water)

<u>Variables</u>	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>mean</u>	<u>std. dev.</u>	<u>mean</u>	<u>std. dev.</u>	<u>mean</u>	<u>std. dev.</u>	<u>mean</u>	<u>std. dev.</u>
WLOGIT	-0.087	0.520	-0.097	0.555	0.061	0.523	0.137	0.527
WMPR	810.460	208.685	654.224	184.723	656.088	172.235	542.888	216.438
WMSA	152.126	59.695	165.618	81.533	100.970	51.594	116.516	70.896
WMPA	0.729	0.093	0.742	0.076	0.804	0.067	0.724	0.103
WMIN	0.110	0.030	0.111	0.039	0.093	0.033	0.091	0.038
WMORT	23.213	2.307	18.617	3.389	18.804	2.732	14.220	5.945
GDE	3.915	1.998	4.001	2.114	3.851	2.007	4.401	2.278
GEC	5.128	7.961	5.580	7.654	6.001	8.596	3.051	8.106
GRI	6.225	2.005	6.408	1.619	6.066	1.693	6.418	1.797
GSO	1.466	7.589	3.379	6.595	3.061	7.124	1.008	7.022
GGO	3.131	1.108	3.281	1.089	2.930	1.073	2.620	1.127
S15	2.558	1.094	2.674	1.264	2.781	1.163	2.943	1.151
S16	2.816	0.840	2.754	0.836	2.663	0.854	2.831	0.778
S17	3.352	1.407	3.080	1.211	3.183	1.184	3.212	1.440
S20	2.081	1.063	1.943	1.043	2.156	1.045	2.157	1.092
S21	1.215	0.411	1.335	0.472	1.365	0.482	1.325	0.469
W2B	271.733	188.517	281.527	215.735	188.347	156.663	225.705	159.808
S6	1.619	0.486	1.739	0.439	1.642	0.480	1.543	0.499

EXHIBIT 3-74

Regression Models - Probability of Purchase for New Homes, Space and Water-heating Systems

<u>Variables</u>	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>B</u>	<u>t-stat</u>	<u>B</u>	<u>t-stat</u>	<u>B</u>	<u>t-stat</u>	<u>B</u>	<u>t-stat</u>
S6	-0.109	0.00	-0.109	-4.85	-0.558	-14.64	-0.022	-3.75
SMPR	-0.0002	-4.32	0.00002	4.02	-0.0002	-1.09	-0.0002	-2.26
SMSA	0.002	6.13	0.0005	1.52	0.001	2.32	0.001	3.09
SMPA	-1.548	-5.17	-0.466	-1.52	-3.136	-5.45	-0.773	0.00
SMIN	1.726	0.91	0.130	5.91	2.031	1.36	5.851	7.85
SMORT	-0.006	-1.76	-0.021	-4.70	-0.169	-6.47	-0.009	-2.86
GDE	0.003	1.14	0.0007	1.52	0.004	1.91	0.005	0.00
GEC	-0.013	-7.27	-0.036	-10.00	-0.019	-7.43	-0.017	-7.67
GRI	0.021	0.00	0.050	3.26	0.019	1.09	0.048	3.09
GSO	-0.012	-2.56	-0.015	-5.31	-0.016	-4.23	-0.014	-2.97
GGO	-0.016	-1.14	-0.012	0.00	-0.004	-1.64	-0.010	0.00
S15	-0.021	-2.33	0.043	2.35	0.033	1.91	0.076	4.22
S16	0.113	4.66	0.021	0.00	-0.033	0.00	-0.106	-3.51
S17	-0.047	-3.35	0.045	2.88	-0.150	-8.18	-0.001	-0.95
S20	0.025	2.73	0.076	3.64	-0.117	-3.41	0.043	1.43
S21	0.235	1.36	0.118	2.88	0.028	0.00	-0.111	-2.56
S2B	0.0003	3.75	0.00003	0.00	0.0002	3.41	0.0001	1.19
Intercept	-1.486		-1.971		-0.345		-0.518	
N (weighted) =	373		664		537		409	
R ² =	.388		.345		.542		.445	

EXHIBIT 3-75

Means and Standard Deviations for New-homes Probability-of-purchase Equation Variables (Space and Hot Water)

<u>Variables</u>	<u>North East</u>		<u>South</u>		<u>North Central</u>		<u>West</u>	
	<u>mean</u>	<u>std. dev.</u>	<u>mean</u>	<u>std. dev.</u>	<u>mean</u>	<u>std. dev.</u>	<u>mean</u>	<u>std. dev.</u>
SLOGIT	-0.199	0.505	-0.228	0.545	-0.082	0.570	-0.036	0.538
SMPR	2506.361	831.489	1586.840	469.063	1721.467	464.149	1469.460	478.996
SMSA	323.590	121.536	238.595	178.148	213.389	95.198	251.607	155.697
SMFA	0.809	0.101	0.822	0.096	0.822	0.073	0.763	0.083
SMIN	0.107	0.031	0.109	0.040	0.093	0.033	0.089	0.037
SMORT	76.360	14.637	45.779	6.211	50.419	5.617	39.706	8.883
GDE	3.875	2.188	3.599	1.941	4.117	1.784	3.909	2.017
GEC	5.128	7.961	5.580	7.654	6.001	8.596	3.051	8.106
GRI	6.225	2.005	6.408	1.619	6.066	1.693	6.418	1.797
GSO	1.466	7.589	3.379	6.595	3.061	7.124	1.008	7.022
GGO	3.131	1.108	3.281	1.089	2.930	1.073	2.620	1.127
S15	2.558	1.094	2.674	1.264	2.781	1.163	2.943	1.151
S16	2.816	0.820	2.754	0.836	2.663	0.854	2.831	0.778
S17	3.352	1.407	3.080	1.211	3.183	1.184	3.213	1.440
S20	2.081	1.063	1.943	1.043	2.156	1.045	2.157	1.092
S21	1.215	0.412	1.335	0.472	1.365	0.482	1.325	0.469
S2B	651.806	400.636	488.250	363.144	562.116	344.543	379.580	294.168
S6	1.619	0.486	1.739	0.439	1.642	0.480	1.543	0.499

EXHIBIT 3-76

Variable Definition - Regression Analyses

LOGIT, WLOGIT*, SLOGIT*: dependent variable = $\ln\left(\frac{p + .5}{1.5 - p}\right)$

where p is likelihood of
of installation within
one year

MPRICE, WMPR, SMPR:	Price Macro
MSAVE, WMSA, SMSA:	Savings Macro
MPAYB, WMPA, SMPA:	Payback Macro
MINFL, WMIN, SMIN:	Inflation Expectation Macro -
GDE:	Dependability Attitudinal Macro -
GEC:	Economics Attitudinal Macro -
GRI:	Risk Attitudinal Macro -
GSO:	Immediate Social Attitudinal Macro -
GGO:	Long-Term Social Attitudinal Variable - belief that solar will be in wide-spread use in five years.
I1 } I2 } I3 }	- - - - - 1 to 5 scale: 1 = definitely will; 5 = definitely will not Indicator Variables for Questionnaire type I1 = short deterministic, I2 = short uncertain, I3 = long deterministic I1 = 1 if questionnaire is short deterministic 0 otherwise Similarly for I2, I3
S15:	Age of respondent
S16:	Level of education of head of household
S17:	Number of people living in household
S20:	Total household income, before taxes, previous year
S21:	Sex of respondent: 1 = male; 2 = female
M4B:	Respondents estimate of next year fuel bill for equipment being considered
WMURT, SMURT:	Additional monthly mortgage payment if water heater (W) or water and space heating (R) were included in mortgage
WARR:	For new homes only, warrantee period defined for the system
S6:	For new homes only, indicator variable for search: 36 = 1 if respondent had actually sought information = 2 otherwise

* Note: The variable that starts with an "S" is used in space-heating equation: the variables with "W" are used in water heating equations for new homes; M refers to water heating for existing homes.

3. Model Interpretation

The regression models from the last section can be used to estimate the relative importances of the independent variables in determining purchase likelihood. The exhibits in this section show these relative importances for selected variables. Section 3.E suggests how these results could be used in a marketing effort for residential solar systems.

Existing Homes, Hot-water Systems

Exhibit 3-77 lists the variables that showed the most importance, that is, explained the most variance, in each of the regional models for existing-home consumers' likelihood of purchase. As this exhibit indicates, there were two key variables included in all four regions: savings (MSAVE) and economic attitudes (GEC). Note that GEC was of secondary importance in the North East, but still explained more variance than any other variable except MSAVE in that region.

MSAVE is the savings macro (Section 3.D.1), and was constructed of estimates of first-year and fifth-year savings. Of these variables, the respondent's estimate of his or her first-year savings was the most important. This estimate was, then, the key variable in estimating likelihood of purchase: the higher the respondent believed his or her first-year savings would be, the more likely he or she was to purchase solar.

It is interesting to note in this regard that price itself, as represented by the price macro (MPRIC), was of only tertiary importance in the models. Previous work (RUPI, 1977) indicates that price is the most important issue. The current work suggests that consumers are now

EXHIBIT 3-77

Importance of Variables in Determining Purchase Likelihood
Existing Homes - Water Heating

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>
<u>Most Important</u>	MSAVE	MSAVE GEC	GEC MSAVE S15	GEC MSAVE GGO
<u>Secondary Importance</u>	GEC GDE GSO S16 S17	GAO S20 MINFL MYB S21	S17 GRI ADE	S15 S17 GRI
<u>Unimportant</u>	M4B GRI S20	S16 S17	S16 M4B	S20 GDE S21

willing to meet the price if an acceptable level of savings can be achieved. The relative unimportance of payback period (MPAYB) in the models further suggests that by and large consumers are not using even this relatively simple analytic measure of a system's financial performance, while the unimportance of expectations about inflation (MINFL) reinforces the idea that financial evaluation by consumers is unsophisticated.

Of course, price was not entirely left out of the decision criteria. It entered, coupled with savings, as a constituent of GEC, the economic attitude macro. In our study, the specific question that related to price was: "Regardless of savings the price is too high for me to consider buying." That this variable was included suggested that price was a factor, but apparently it could be overcome by sufficient near-term savings. Also included in the economic attitude macro were the ideas that a solar system would increase the value of one's home, that it would protect from future energy cost increases and that one could obtain a system that made overall economic sense.

Based on these models, the main consumer decision criteria appeared to be that a system should save a significant amount of expense in the short term, coupled with generally favorable attitudes toward solar economics.

Additionally, in the North Central region, age entered the model as an important variable: older respondents could be expected to have a greater likelihood of purchasing solar. In the West, long-term social attitudes were also of great importance: respondents who were most likely to purchase solar believed that it would be widely used in their

areas within five years. Those who did not expect solar to achieve widespread use were less likely to buy.

Variables of secondary importance in the models showed that in all regions except the South the number of people living in the household was important: the more people, the more likely the household was to consider solar. Education and short-term social acceptance were important in the North East. In the South, long-term social acceptance, household income, inflation expectations, estimated next-year cost to heat water, and sex all played a role; women, respondents with higher incomes, and those with higher inflation/cost estimates were more likely to buy solar. In the North Central region, perceptions of risk and dependability were of secondary importance. The model for the West also considered risk, and age was important there as well.

Looking at the variables in the models that were of least importance, we note that North East consumers apparently disregarded risk, as well as the amount they would expect to pay to heat water next year. Income was also unimportant. Education was unimportant in determining likelihood in the South or North Central regions; it was of very minor importance in the West. The number of people in the home was unimportant in the South, as well, while next year's water heating costs were unimportant in the North Central region. Income was not an important determinant of likelihood among Westerners, nor was sex. Western consumers also attached little importance to attitudes about the dependability of systems, presumably because they believed that they could obtain dependable systems.

New Homes Hot-water Systems

Exhibit 3-78 lists the variables that show the most importance, that is, explain the most variance, in each of the regional models for solar water heater purchase by new-home buyers. These models show less homogeneity than the existing-home models. The two key variables for existing homes -- savings (WMSA) and economic attitudes (GEC) -- were, however, also present among the important variables in the new-home models, although they were of only secondary importance in several regions.

In the North East, the price macro (WMPR) had major importance, indicating a strong price effect on likelihood of purchase in that region. The key issue affecting likelihood in the North East was economics, as measured by savings, price and economic attitudes. Family income (S20) was also important in the region, but not on the same level as system economics. Income entered the model with a negative sign, indicating that lower income families were more likely to show interest in solar than higher income families. Two other variables of secondary importance were the respondent's attitudes about solar's immediate social acceptability (GSO) and whether or not the respondent had already looked into solar (S6). Attitudes about risk (GRI) and dependability (GDE) were not important in estimation of likelihood in the North East, nor was the respondent's sex (S21).

Beside the two economic variables mentioned above, new-home-buying Southerners also attached weight to their estimate of their next year's water-heating cost (W2B). In addition, someone who had already looked for solar was more likely to buy than someone who had not (S6). At a

EXHIBIT 3-78

Importance of Variables in Determining Purchase Likelihood

New Homes - Water Heating

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>
<u>Most Important</u>	GEC WMPR WMSA	GEC W2B S6	S6	GEC
<u>Secondary Importance</u>	S20 S6 GSO	WMIN GSO S20 WMSA S17	GEC WMSA S17 GSO	WMSA
<u>Unimportant</u>	S21 GRI GDE	GRI WMORT WMPR	S16 WMPR WMPA	S16 GRI WMIN

lesser level of importance, a number of additional variables entered the model: the inflation macro (WMIN -- representing two inferred measures of the respondent's expectations about fuel inflation); the short-term social acceptability of solar attitude macro (GSO); family income (S20 -- with a positive sign, indicating higher income families had a higher likelihood); and the number of people in the household (S17).

Unimportant in the South were attitudes toward risk (GRI), anticipated increase in mortgage payment from a solar addition (WMORT) and price represented by the price macro (WMPR).

In the North Central region, the most important variable was S6, whether or not an individual had already looked into solar. Those who had looked were more likely to buy. Besides savings (WMSA) and economic attitudes (GEC), two other variables had secondary importance: the number of people in the household (S17 -- in this region smaller households were more likely to purchase) and attitudes about the short-term social acceptability of solar (GSO). Price and payback, as represented by their macros (WMPR and WMPA, respectively) were unimportant to North Central new-home buyers; level of education (S16) was also unimportant in explaining likelihood of purchase in the region.

In the West, new-home buyers' attitudes toward solar economics (GEC) was the key issue in explaining likelihood of purchase. Level of anticipated savings, represented by its macro (WMSA), was of secondary importance. Third-order contributions were made by attitudes toward short-term social acceptability, whether or not the home buyer had already looked into solar, and sex. Expectations about fuel inflation (WMIN) and attitudes toward risk (GRI) played no role, nor did the individual's level of education (S16).

New Homes, Space and Hot-water Systems

Exhibit 3-79 shows the variables that were most important, that is, explained the most variance, in each of the regional models for likelihood of purchase of space and hot-water systems among new-home buyers. As might be expected, the variables that were important in this situation were largely the same as for hot-water system purchase by the same segment. The situation which the new-home buyer faces is different from the situation of the existing-home owner only in the magnitude of price, savings, and increased mortgage payment, and variables related to these issues did indeed enter the models in some regions.

Once again, GEC, the macro representing economic attitudes toward solar, was important in all four regions, although on a secondary level in the North Central region. The savings macro (SMSA), however, was of major importance only in the North East. It was of very little importance in the other regions, showing only a third-order effect. Whether or not a new-home buyer had already looked into solar (S6) was of major importance in the North Central region, as it was in the new-home water-heating model, and of secondary importance in the South. It was not important in the North East.

In the North East, a third important variable was payback, as represented by its macro SMPA. This variable was of no importance to Western new-home buyers, and had a secondary effect in the North Central region. In a turn-around, inflation expectations (SMIN) were of major importance in the West, but of no importance in the North East. This variable played a secondary role in the South.

EXHIBIT 3-79

Importance of Variables in Determining Purchase Likelihood

New Homes - Space and Water Heating

	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>
<u>Most Important</u>	GEC SMSA SMPA	GEC	S6	SMIN GEC
<u>Secondary Importance</u>	S16 SMPR	SMIN GSO S6 SMORT	S17 GEC SMORT SMPA	S15
<u>Unimportant</u>	GRI S6 SMIN	S2B S16 GGO	S21 S16	GGO GDE SMPA

Price, as represented by the price macro SMPR, was of secondary importance in the North East and had a third-order effect elsewhere. Education (S16) had a second-order effect in the North East, but showed no importance in the South or North Central regions. Attitudes toward the risk (GRI) associated with solar systems were of no importance in the North East.

In the South, in addition to the effects mentioned above, attitudes about the short-term social acceptability of solar (GSO) were of secondary importance, although long-term social acceptability (GGO) played no role in determining likelihood of purchase. Increase in mortgage payments was of secondary importance, as well. Of no importance was the respondent's estimate of his or her next year's heating expenses (S20).

North Central new-home buyers attached a secondary importance to increased mortgage payments (SMORT), as well as payback and economic attitudes, as discussed above. An additional second-order variable in that region was number of people in the home -- smaller families had higher likelihoods of purchasing solar. Respondent's sex was unimportant in the North Central region.

In the West, a second-order effect was produced by age (S15). Increased age led to higher likelihood of purchase. Of no importance were attitudes toward the long-term social acceptability of solar, or toward the dependability of solar equipment.

Sensitivity Analysis

Exhibits 3-80 to 3-83 show the results of a sensitivity analysis of existing-home owners' likelihood of purchase to four key independent

variables: savings, economic attitudes, long-term social acceptability attitudes and price. In order to make the sensitivity runs commensurate, changes in each variable are in units of standard deviation from the baseline. The numbers shown in the table are thus suggestive of the relative sensitivity of likelihood of purchase to changes in savings, perceptions, and price.

For example, in Exhibit 3-80, one can see that in the North East an improvement in savings of 66 percent times its standard deviation would have about a 20 percent effect on likelihood of purchase, while the same relative change in price would have only a 12 percent effect.

EXHIBIT 3-80

Sensitivity Analysis:

North East

Price	Savings				Economic Attitudes			Long Term Social Acceptance Attitudes		
	0	+33%	+66%	+100%	+33%	+66%	+100%	+33%	+66%	+100%
0	1.00	1.10	1.21	1.32	1.07	1.13	1.20	1.03	1.05	1.09
+33%	1.06	1.16	1.27	1.38	1.13	1.19	1.26	1.09	1.11	1.15
+66%	1.12	1.23	1.33	1.44	1.19	1.25	1.32	1.15	1.17	1.21
+100%	1.18	1.29	1.39	1.50	1.25	1.31	1.38	1.21	1.23	1.27

Savings	Economic Attitudes			Long Term Social Acceptance Attitudes		
	+33%	+66%	+100%	+33%	+66%	+100%
0	1.07	1.13	1.20	1.03	1.05	1.09
+33%	1.18	1.24	1.31	1.14	1.17	1.20
+66%	1.28	1.34	1.41	1.25	1.27	1.30
+100%	1.39	1.45	1.52	1.35	1.38	1.41

Economic Attitudes	Long Term Social Acceptance Attitudes		
	+33%	+66%	+100%
0	1.03	1.05	1.09
+33%	1.10	1.12	1.16
+66%	1.16	1.18	1.22
+100%	1.23	1.26	1.29

EXHIBIT 3-81

Sensitivity Analysis:

South

Price	Savings				Economic Attitudes			Long Term Social Acceptance Attitudes		
	0	+33%	+66%	+100%	+33%	+66%	+100%	+33%	+66%	+100%
0	1.00	1.06	1.13	1.21	1.08	1.17	1.25	1.06	1.10	1.16
+33%	1.04	1.11	1.18	1.25	1.13	1.21	1.30	1.10	1.15	1.20
+66%	1.08	1.15	1.21	1.29	1.16	1.25	1.33	1.14	1.18	1.24
+100%	1.12	1.19	1.26	1.33	1.21	1.29	1.38	1.18	1.23	1.28

Savings	Economic Attitudes			Long Term Social Acceptance Attitudes		
	+33%	+66%	+100%	+33%	+66%	+100%
0	1.08	1.17	1.25	1.06	1.10	1.16
+33%	1.15	1.23	1.32	1.12	1.17	1.23
+66%	1.22	1.30	1.39	1.19	1.24	1.30
+100%	1.29	1.38	1.46	1.26	1.31	1.37

Economic Attitudes	Long Term Social Acceptance Attitudes		
	+33%	+66%	+100%
0	1.06	1.10	1.16
+33%	1.14	1.19	1.25
+66%	1.23	1.27	1.33
+100%	1.31	1.36	1.41

EXHIBIT 3-82

Sensitivity Analysis:North Central

Price	Savings				Economic Attitudes			Long Term Social Acceptance Attitudes		
	0	+33%	+66%	+100%	+33%	+66%	+100%	+33%	+66%	+100%
0	1.00	1.04	1.07	1.11	1.07	1.15	1.23	1.03	1.06	1.09
+33%	1.04	1.08	1.11	1.15	1.11	1.19	1.27	1.07	1.10	1.13
+66%	1.07	1.11	1.15	1.19	1.15	1.23	1.31	1.11	1.13	1.16
+100%	1.11	1.15	1.19	1.22	1.19	1.27	1.34	1.14	1.17	1.20

Savings	Economic Attitudes			Long Term Social Acceptance Attitudes		
	+33%	+66%	+100%	+33%	+66%	+100%
0	1.07	1.15	1.23	1.03	1.06	1.09
+33%	1.11	1.19	1.27	1.07	1.10	1.13
+66%	1.16	1.23	1.31	1.11	1.13	1.15
+100%	1.19	1.27	1.34	1.14	1.17	1.20

Economic Attitudes	Long Term Social Acceptance Attitudes		
	+33%	+66%	+100%
0	1.03	1.06	1.09
+33%	1.11	1.14	1.17
+66%	1.19	1.21	1.24
+100%	1.26	1.29	1.32

EXHIBIT 3-83

Sensitivity Analysis:

West

Price	Savings				Economic Attitudes			Long Term Social Acceptance Attitudes		
	0	+33%	+66%	+100%	+33%	+66%	+100%	+33%	+66%	+100%
0	1.00	1.01	1.01	1.02	1.06	1.11	1.17	1.06	1.12	1.18
+33%	1.02	1.02	1.03	1.04	1.07	1.13	1.19	1.08	1.14	1.20
+66%	1.04	1.04	1.05	1.06	1.09	1.15	1.21	1.10	1.16	1.22
+100%	1.06	1.06	1.07	1.08	1.13	1.17	1.23	1.12	1.18	1.24

Savings	Economic Attitudes			Long Term Social Acceptance Attitudes		
	+33%	+66%	+100%	+33%	+66%	+100%
0	1.06	1.11	1.17	1.06	1.12	1.18
+33%	1.16	1.12	1.18	1.06	1.12	1.19
+66%	1.07	1.13	1.18	1.07	1.13	1.19
+100%	1.08	1.13	1.19	1.08	1.14	1.20

Economic Attitudes	Long Term Social Acceptance Attitudes		
	+33%	+66%	+100%
0	1.06	1.12	1.18
+33%	1.12	1.18	1.26
+66%	1.17	1.23	1.29
+100%	1.23	1.29	1.35

E. CONCLUSIONS AND RECOMMENDATIONS

1. Results of Analysis

This section reviews the conclusions and issues that emerged from our tabulations and analyses. The decision-making and behavioral issues that arose suggest possible courses of action for solar marketers, as well as for commercialization programs under the sponsorship of federal or local government agencies.

The key obstacle we see to the rapid commercialization of active solar energy systems is the surprising confusion and lack of knowledge about solar in the general population. The resolution of these two problems is crucial if the full potential of solar as a source of energy for the nation is to be realized.

The problem is simple: 20 percent of the nation's home owners and 14 percent of new-home buyers have never heard of solar energy for home or hot-water heating. In our study sample, over half (54 percent) of the home owners and 45 percent of the home buyers did not understand the financial aspects of solar energy. Over half (55 percent) of the home owners and 36 percent of the home buyers had never heard of government incentives, either federal or state.

Even among consumers who stated that they had seen or heard about solar energy, there was considerable confusion about what was currently available. About half of the home owners and just over 60 percent of new home buyers who said they knew about solar were not aware or were unsure whether solar space or water-heating systems were for sale in their areas. And over 72 percent of home owners and 65 percent of new-home buyers who said they knew about solar said that they could, or are

unsure whether they could, buy solar-powered air conditioning and solar-powered electricity-generating equipment. One can infer from this result that many people do not distinguish various solar technologies -- the high-technology, experimental systems are confused with the more mundane systems that have been available and working for a number of years.

Only 21 percent of home owners and 32 percent of home buyers were aware of the federal tax rebate program. This number is surprisingly low when one considers that the survey was underway in February and March, 1980, shortly after the IRS had mailed Form 5695, "Energy Credits", to tax payers and during the time when most people were filing their tax forms.

Finally, in almost every case we encountered, consumers became significantly less prosolar in their attitudes after they had been exposed to some basic information about the system's operation and economics. And at the same time they reported that their understanding of these issues had risen.

These statistics point up the general lack of awareness and knowledge as well as the amount of confusion that exist over the various solar technologies. These problems must be resolved before a more finely tuned approach addressing specific marketing variables will have any major impact.

The solution to this primary problem lies in communications. People must be made aware of the solar-energy systems that are available today. Consumers must be made to understand that these systems are based on a tried and workable technology.

This particular solution -- a generic communication program -- is probably beyond the scope of any one firm's communications effort. We would recommend that it be undertaken with the sponsorship of a government agency or an industrial association.

Besides the awareness or knowledge problem that the data indicates, a number of other conclusions can be reached from this study:

- (1) Among potential buyers there is a lack of sophistication in the decision-making process.
- (2) Home owners appear to use a single financial criterion -- expected savings -- in their evaluation of solar-energy systems. Home buyers are more likely to consider other financial variables.
- (3) The other critical variable in the solar purchase decision-making process is the consumer's attitudes towards system economics.
- (4) Attitudes about solar's social acceptability, both short term and long term, are important. Consumers want to be sure that the concept is not a fad.
- (5) There are regional differences in the solar purchase decision-making process. Those residing in the West, and especially new-home buyers in the West, are the best potential market. The North East is the region with the second-highest overall potential, followed by the South, and finally the North Central region.
- (6) New-home buyers make up a segment with about twice as much potential as existing-home owners in terms of likelihood of purchase. The differential remains about the same in the short term (one year) and in the long term (five years).
- (7) Demographic variables do not generally appear to be good indicators of who is likely or unlikely to purchase solar equipment.

2. Recommendations

In terms of hastening the adoption of active solar-energy systems by residential consumers, we would consider actions for government

agencies or industry in terms of (a) product design, (b) communications, (c) distribution and (d) targeting. In other words, the right product has to exist, aimed at the right segment, and available to that segment. In addition, the segment must be made aware that the product exists, and that it can fulfill an existing need.

Product Design

Since savings is the critical determinant of likelihood of purchase, product efficiency is a major goal. This study suggests that design effort aimed at increasing solar fractions would pay off in increased acceptance by the market, assuming only minor accompanying differences in price and size. Varying warranty periods beyond five years does not appear to increase market acceptance; dependability tends to be of relatively small importance in the consumer's decision-making process.

Communications

The key communication effort needed in the residential market for solar has been discussed above (see Section 3.E.1): what is required is a major, generic communications program aimed at generating awareness and knowledge of commercially available solar technologies and government incentives.

The variables in attitudes that are important in the decision-making process suggest the content for product-oriented communications as well as generic messages: themes such as increase in a home's resale value or protection from future energy shortages come out of the economic attitudes that are important in the decision-making process. A

general theme stating that solar economics makes sense would appear to be more in line with what many consumers want to hear than with facts born out by hard numbers. Another area for communications is the social acceptability of solar. Consumers need to hear that there is a "band wagon" for them to get on; they need to be convinced that though solar is not widespread now, it will be used on more and more homes as the years go by.

Other communications themes can be suggested by variables specific to each region.

Distribution

There is no distribution problem for new homes -- a buyer of a new home looks to the builder to provide the mechanical systems in the house. As a result, builders are the distribution channel in the new-home segment.

In the existing-homes or retrofit segment we encounter more difficulty. When asked from whom they would like to buy a solar-energy system, assuming that they were going to purchase one, 71.3% of consumers said they wanted a specialized solar dealer (see Exhibit 3-84A). Only five percent reported that they would call a plumber. When a water-heating system needed replacement, however, almost two-thirds of the respondents said they would call a plumber (see Exhibit 3-84B). It seems to us that the most likely time to retrofit a system is at the time the old system has ceased to function. If this is the case, plumbers must be viewed as a potentially important channel of distribution. We do not necessarily see plumbers as distributors

EXHIBIT 3-84

The Distribution Problem for Existing Homes

A. From whom would you want to buy a solar energy system?

Solar Equipment Dealer	71.3%
Large Retailer (Sears)	11.9%
Utility Company/Dealer	9.3%
Plumber	5.2%
Other	<u>2.3%</u>
	100.0%

n = 805

B. If your present hot water system stopped working and had to be replaced, who would you call to do the work?

Plumber	64.2%
Utility Company/ Dealer	<u>36.8%</u>
	100.0%

n = 882

Respondents who say they would do the work themselves are not included in the numbers reported in this exhibit.

themselves, any more than they are distributors of particular brands of bathroom fixtures or faucets. Rather, we see them as important influencers in the decision-making process -- they are called in at the right time and they could arrive with the right information and knowledge about installation.

The retrofit market is large, roughly 50 million single-family residences; plumbers appear to be one key to tapping that market. To determine the viability of this particular channel, we suggest a study of plumbers' perceptions of solar and ways in which they might interface with solar manufacturers and distributors.

Targeting

Our analysis suggests that new-home buyers are the segment with the greatest potential for active solar. These consumers should be encouraged to seek solar as a part of their new homes. Clearly their builders are important influencers in the decision-making process. What is necessary is to build demand or "pull" while also influencing the builder to use solar in his speculative construction (see Section 6).

For further targeting, our regional analyses indicate that the primary solar markets are in the West and North East, followed by the South and North Central regions.

Demographic variables are generally not good indicators of who is or is not a likely solar purchaser. Rather, potential solar purchasers seem to come from all demographic strata, with some minor exceptions that are specific to regions.

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SECTION FOUR

ORGANIZATIONAL AND MANUFACTURING BUILDINGS

A. INTRODUCTION

In 1978, over one-third of U.S. energy use was for industrial purposes. A significant fraction of this spending was for water and space heating. As a result certain segments of what we will refer to here as the industrial market together constitute an important target for solar-energy systems.

Studying industrial adoption is not simple, as the sample selection section shows. The objectives of the work described in this chapter are:

- (a) to develop a baseline understanding of awareness, interest, and intent-to-purchase solar in the industrial market;
- (b) to map out patterns of HVAC decision making in those markets;
- (c) to indicate how HVAC equipment is evaluated -- what performance standards must HVAC equipment meet? -- and
- (d) to study likelihood of purchasing solar in this population, identifying the main points of leverage that could be used to improve that likelihood.

The section finishes with a series of conclusions and recommendations for ways to improve solar penetration in the manufacturing buildings, or industrial, market.

B. MEASUREMENTS

1. Instrument Design

The survey for industrial respondents was designed for administration in two parts. The first was a telephone interview, the second a follow-up mail survey. This two-part structure was implemented for a number of reasons:

- (1) It permitted us to provide each respondent with semitechnical descriptive material about solar-energy systems.
- (2) It provided an experimental design in which we could obtain before-and-after-exposure measures on key attitudinal and intent-to-purchase questions.
- (3) The amount of data to be collected was extensive and it appeared to be necessary to break the interview into two sections so as not to lose the participant's interest.
- (4) The joint telephone-mail administration established who the direct-mail nonrespondents were, as demographic and company data was collected in the telephone portion of the interview.

The study was designed to obtain data from participants in industry's HVAC purchase decision-making process. The questionnaire gathered information about these people's and their firm's:

- awareness and knowledge of active solar-energy systems,
- experience with solar systems,
- attitudes and beliefs about solar systems,
- likelihood of purchasing or installing an active solar system in the short term, and in the long term,
- HVAC investment criteria,
- HVAC decision-making processes, and
- company and individual demographics.

2. Instrument Pretest

The industrial questionnaire was pretested using both personal interviews (8) and a pilot study that included 190 telephone interviews. The personal interviews were used in much the same way the focus group was used in the residential sector -- to aid in the development of the description of solar systems. Here the respondents identified potential problems and helped in the clarification of many issues. In addition, these interviews provided input for the list of decision-making criteria used by industry that makes up a section of the survey, and to the construction of the decision matrix.

The pilot study involved a full test of the administration methods to be used in the final study. The test involved 190 individuals split evenly among SIC codes 20 to 38. Firms were selected at random from Dun and Bradstreet's Million Dollar Directory and Middle Market Directory. The respondents were screened by telephone, and, if they qualified and agreed to participate, the first portion of the survey was administered to them. Respondents in the telephone portion of the study were told that a questionnaire would be mailed to them within ten days, and a call-back appointment was made to "answer questions about the survey" and to encourage the respondent to complete the form. A postage-paid business reply envelope was enclosed for the respondent's convenience in returning the completed survey.

In all, 56 mail surveys (29.5 percent) were returned before the cutoff date for the pilot study. This return rate was lower than expected, however, and a major modification was made in the survey in an attempt to increase the number of returned questionnaires. This change

resulted in a substantial lengthening of the telephone interview, accompanied by a corresponding shortening of the mail questionnaire. The change allowed us to collect all critical information while the respondent was taking part in the telephone interview, so that it was of lesser importance if he or she returned the mail survey, and at the same time gave the respondent a less formidable document to fill out.

A number of preliminary analyses were run on the data collected during the pilot phase and those analyses suggested further modification of the questionnaire and sample, especially in the wording of questions about decision criteria.

3. Sample Selection

For the final questionnaire we narrowed our target segments down to seven SIC codes: 20, 22, 26, 27, 35, 36, and 38. The selection was based on the pilot analyses including those industrial categories that showed the greatest receptivity to solar energy.

The final sample was drawn from three mailing lists purchased from Alan B. Zeller, Inc. The lists, generated for the specific SIC Codes were:

- engineers, plant maintenance
- executives, plant supervisors, and
- manufacturers, rated \$500,000 or more.

These lists gave approximately 6,000 names, from which a random sample was drawn. In addition, each individual interviewed was asked to supply the names of one or two other individuals within his firm who

were also involved in the HVAC-purchase decision-making process. These names were added to the sample and an attempt was made to interview two individuals from each firm.

4. Questionnaire Administration

Two of the mailing lists used in the generation of the sample gave individual names. These people were telephoned directly. The third list gave company names. In this case interviewers called the office of the firm's president and asked for the name or names of people involved in the HVAC decision-making process. The individuals specified by the president's offices were then telephoned.

If a potential respondent passed the screening questions he or she was told about the survey -- its purpose, the data collection method and the time required -- and asked to participate. Those who agreed were then taken through the telephone questionnaire.

The telephone portion of the survey was completed by interviewers from the Valley Forge Information Service, Valley Forge Corporate Center, King of Prussia, Pennsylvania, 19406. The interviewers were thoroughly instructed in the administration of the questionnaire by Dialogue and VFIS supervisory personnel during sessions held before the telephone interviewing was started. Dialogue and VFIS people listened in on a number of interviews in progress for each interviewer, and made comments and suggestions for sharpening techniques on certain questions. The interviewers were thus made to understand the issues that Dialogue was trying to address in the questionnaire, and were better able to deal with those issues when a respondent had a problem understanding what was being asked. VFIS supervisory personnel worked fulltime on the project

while the interviews were underway to maintain a general consistency of asking questions across interviewers, and generally to insure that the interviewing was performed at a high level of quality.

At the conclusion of the interviews VFIS edited the questionnaire forms and sent them to Dialogue, which did the mail-out portion of the study.

The mail questionnaire was produced as a booklet containing:

- a letter of introduction and thanks for participation,
- a brief (one-page) description of two solar-energy systems,
- questions about likelihood of recommending solar or attitudes toward solar, or both,
- questions about the decision-making process in the firm, and
- further questions on company demographics.

Respondents received descriptions of two solar systems selected randomly from four possibilities:

- solar "domestic" water heating (see Exhibit 4-1)
- solar space and water heating (see Exhibit 4-2)
- solar air conditioning (see Exhibit 4-3)
- solar-assisted heat pump (see Exhibit 4-4)

In addition, the solar space heating and solar air conditioning systems were produced in two versions -- one for flat-plate and one for a concentrating-collector system. As a result seven different versions of the questionnaire were used.

Questionnaires were mailed as soon as possible to participants identified by VFIS. A postage-paid business-reply envelope was enclosed for convenience in returning the completed questionnaire.

Completed interviews, both telephone and returned mail, were examined for completeness and consistency, and were coded as necessary. Data was keypunched from the interview forms, 100-percent verified and placed on tape for computer use.

EXHIBIT 4-1

SOLAR DOMESTIC WATER HEATING

A solar domestic water heating system is composed of five elements: a collector array, hot water storage tank, transfer fluid circulating system (a pump, pipes and a heat exchanger), system controller and auxiliary heating source. (See Diagram.)

The flat plate collector array consists of a modular set of panels (collectors) installed in a location with maximum exposure to the sun at all times of the year. The collectors are mounted at an angle from the horizontal approximately equal to the installation latitude. Direct attachment to a roof of acceptable slope often produces an esthetically pleasing installation. Each flat plate solar collector is an insulated box, completely glazed on one side enclosing a flat black metal plate which contains closed channels for the passage of heat transfer fluid. In January of 1980 a flat plate collector could be purchased for between \$10 and \$20 per square foot. The thermal performance of flat plate collectors depends on many factors. However, a rule of thumb is that flat plate collectors will deliver the energy equivalent of 1 to 2 gallons of fuel oil, 1 to 2 gallons of fuel oil, 1 to 2 thousand cubic feet of natural gas, or 30 to 60 KWH of electricity per square foot of collector per year, at a delivered temperature of 150°F.

The insulated hot water storage tank is used as a method of retaining solar heat for use at night or on days when the sun is obscured by

clouds. The storage tank is usually sized to hold two days worth of normal heating requirement. In many installations, a thermostatic mixing valve is used in the delivery line from the tank to keep delivery temperature constant.

The transfer fluid system consists of a pump, heat exchanger and associated piping. To avoid problems of freezing and corrosion, glycol solutions are usually used as the transfer fluid. The transfer fluid pump is activated by the solar system controller and circulates the fluid across the collectors and through a heat exchanger at the storage tank.

The system controller operates the transfer fluid pump in response to thermostatic sensors. The controller measures the difference between collector and storage temperatures and starts the operation of the pump when a positive difference is measured.

The auxiliary heating source is placed downstream of the solar storage tank, and it is essentially a standard hot water heating system. This auxiliary source could be any type of water heater, from steam converter to electric resistance. The auxiliary heating system operates in response to the temperature of the water delivered from the solar storage tank.

EXHIBIT 4-2

SOLAR SPACE HEATING

A solar space heating system is composed of six elements. These are a collector array, hot water storage tank, transfer fluid circulating system, heat delivery system, solar system controller, and auxiliary heat source. (See Diagram.)

The flat plate collector array consists of a modular set of panels (collectors) installed in a location with maximum exposure to the sun at all times of the year. The collectors are mounted at an angle from the horizontal approximately equal to the installation latitude. Direct attachment to a roof of acceptable slope often produces an esthetically pleasing installation. Each flat plate solar collector is an insulated box, completely glazed on one side enclosing a flat black metal plate which contains closed channels for the passage of heat transfer fluid. In January of 1980 a flat plate collector could be purchased for between \$10 and \$20 per square foot. The thermal performance of flat plate collectors depends on many factors. However, a rule of thumb is that flat plate collectors will deliver the energy equivalent of 1 to 2 gallons of fuel oil, 1 to 2 gallons of fuel oil, 1 to 2 thousand cubic feet of natural gas, or 30 to 60 KWH of electricity per square foot of collector per year, at a delivered temperature of 150°F.

The insulated hot water storage tank is used as a method of retaining solar heat for use at night or on days when the sun is obscured by clouds. The storage tank is usually sized to hold two days worth of normal heating requirement. In many installations, a thermostatic mixing valve is used in the delivery line from the tank to keep delivery temperature constant.

The transfer fluid system consists of a pump, heat exchanger and associated piping. To avoid problems of freezing and corrosion, glycol solutions are usually used as the transfer fluid. The transfer fluid pump is activated by the solar system controller and circulates the fluid across the collectors and through a heat exchanger at the storage tank.

The heat delivery system in a hot water based solar space heating system can consist of any standard hot water unit. Fan tube convectors, fan coil units or reheat coils could be supplied by the solar heated waters. Standard circulating pumps and temperature controls are also used in solar heating systems. The only special requirements with a solar heating system is that the sizing of unit coils be matched to the temperature of the delivered hot water.

The system controller operates the transfer fluid pump in response to thermostatic sensors. The controller measures the difference between collector and storage temperatures and starts the operation of the pump when a positive difference is measured.

The auxiliary heating source is placed downstream of the solar storage tank, and it is essentially a standard hot water heat system. This auxiliary source could be any type of water heater, from steam converter to electric resistance. The auxiliary heating system operates in response to the temperature of the water delivered from the solar storage tank.

EXHIBIT 4-3

SOLAR ABSORPTION COOLING

A solar absorption cooling system contains three major components: a solar collector array, storage tanks, and an absorption chiller unit. (See Diagram.)

The flat plate collector array consists of a modular set of panels (collectors) installed in a location with maximum exposure to the sun at all times of the year. The collectors are mounted at an angle from the horizontal approximately equal to the installation latitude. Direct attachment to a roof of acceptable slope often produces an esthetically pleasing installation. Each flat plate solar collector is an insulated box, completely glazed on one side enclosing a flat black metal plate which contains closed channels for the passage of heat transfer fluid. In January of 1980 a flat plate collector could be purchased for between \$10 and \$20 per square foot. The thermal performance of flat plate collectors depends on many factors. However, a rule of thumb is that flat plate collectors will deliver the energy equivalent of 1 to 2 gallons of fuel oil, 1 to 2 thousand cubic feet of natural gas, or 30 to 60 KWH of electricity per square foot of collector per year, at a delivered temperature of 150°F.

The insulated hot water storage tank is used as a method of retaining solar heat for use at night or on days when the sun is obscured by clouds. The storage tank is usually sized to hold two days worth of normal heating requirement. In many installations, a thermostatic mixing valve is used in the delivery line from the tank to keep delivery temperature constant.

In addition to hot water storage, chilled water can be stored for later use in cooling building air when solar energy is not available.

same principal as a gas refrigerator, with the gas flame being replaced by solar heat. In the refrigeration cycle, a chilled liquid (usually water) expands to cool the building supply air. This liquid is then recompressed through a process of absorbing the lower pressure liquid vapor in a concentrated salt solution. The salt solution and water vapor is produced in a generator driven by solar-heated hot water. During sunless days or at night the system uses hot water storage tanks for driving heat, or draws on stored chilled water. One positive element of solar cooling is the strong correlation between available solar energy and cooling requirements.

As can be seen in the system diagram, the process starts in the generator which is filled with the absorber liquid (lithium bromide solution) and is heated by energy from the solar collector. The absorber boils, producing refrigerant vapor and concentrated absorbent. Heat is rejected from the refrigerant vapor by the cooling water, condensing it to a liquid. The liquid refrigerant flows through the expansion valve separating the High and Low pressure side to the evaporator. At the evaporator the drop in pressure boils the refrigerant producing refrigeration, which is applied to the cooling load. The cycle is completed at the absorber where the concentrated lithium bromide solution absorbs the coolant (water) vapor. The heat exchanger for the absorbent serves to preheat dilute absorbent and cool the concentrated absorbent.

The entire absorption system utilizes standard gas fired refrigeration technology with the generator modified to operate on the 200°F solar-heated water.

The actual air conditioning unit works on the

EXHIBIT 4-4

SOLAR ASSISTED HEAT PUMP

The major components of a solar assisted heat pump system are the collector array, transfer fluid system, solar storage, solar controller and heat pump. (See Diagram.)

The flat plate collector array consists of a modular set of panels (collectors) installed in a location with maximum exposure to the sun at all times of the year. The collectors are mounted at an angle from the horizontal approximately equal to the installation latitude. Direct attachment to a roof of acceptable slope often produces an esthetically pleasing installation. Each flat plate solar collector is an insulated box, completely glazed on one side enclosing a flat black metal plate which contains closed channels for the passage of heat transfer fluid. In January of 1980 a flat plate collector could be purchased for between \$10 and \$20 per square foot. The thermal performance of flat plate collectors depends on many factors. However, a rule of thumb is that flat plate collectors will deliver the energy equivalent of 1 to 2 gallons of fuel oil, 1 to 2 thousand cubic feet of natural gas, or 30 to 60 KWH of electricity per square foot of collector per year, at a delivered temperature of 150°F.

The transfer fluid system consists of a pump, heat exchanger and associated piping. To avoid problems of freezing and corrosion, glycol solutions are usually used as the transfer fluid. The transfer fluid pump is activated by the solar system controller and circulates the fluid across the collectors and through a heat exchanger at the storage tank.

The system controller operates the transfer fluid pump in response to thermostat sensors. The controller measures the difference between collector and storage temperatures and starts the operation of the pump when a positive difference is measured.

The insulated hot water storage tank is used as a method of retaining solar heat for use at night or on days when the sun is obscured by clouds. The storage tank is usually sized to hold two days worth of normal heating requirements. In many installations, a

thermostatic mixing valve is used in the delivery line from the tank to keep delivery temperature constant.

A heat pump uses the same three components as an air conditioner - an evaporator, compressor, and condenser. However, the cycle is reversed. In effect, a heat pump attempts to cool the outside, and in the process "pumps" heat to the indoor air. In a normal heat pump installation the indoor air absorbs heat from the refrigerant which obtains the heat from the outside air. In a solar-assisted unit the heat is obtained from the stored solar-heated fluid. The higher the temperature of the source fluid, the more efficient the heat transfer. This efficiency is measured by the COP (coefficient of performance). A COP of 2 means that one unit of electrical energy applied to the unit will move 2 units of heat across the unit.

When the temperatures of the solar storage and collector return line are lower than that which can be efficiently used for direct building heating, the solar-assisted heat pump is an effective heating system. In the hypothetical example shown in the system diagram, the heat pump alone would have a low COP (coefficient of performance) because the ambient temperature below freezing decreases the heat source and causes freezing problems on the outdoor coil. The solar system alone, as shown in the schematic, cannot produce transfer fluid temperatures high enough to provide useful heat to the building. However, when coupled in a system as shown in the schematic, the efficiency of both systems is improved.

The heat pump operates on a fluid which has a temperature elevated well above freezing. Even if the solar storage is kept as little as 20°F above ambient, the heat pump COP is improved (as long as the storage temperature is above 35°F). The solar collector efficiency is also improved over a direct solar heating scheme. Since a lower temperature transfer fluid is in use, the collector cover losses are less, increasing efficiency. The collectors can be used during periods of otherwise marginal sunshine such as at the beginning and end of the day and on partly cloudy days, which also increases solar system efficiency.

C. DATA DESCRIPTION

As noted earlier, 655 responses were received from the seven SIC codes chosen for final analysis. Of these individuals, 208 returned mailed questionnaires that were sufficiently complete to be included for analysis here. Note that no distributions of the characteristics of mail respondents were significantly different than those of the telephone responses and thus nonresponse bias has been ignored in this analysis.

The responses were distributed among seven major industrial groups as defined by the U.S. Standard Industrial Classification Code. The industries represented in the sample are shown in Exhibit 4-5.

Prior to this study, 50.4% of the respondents had seen or heard about the use of active solar-energy equipment for water heating or space heating or cooling for industry. Exhibit 4-6 shows that, of those who had previous knowledge of solar HVAC equipment, 77.1% had knowledge of domestic water-heating applications. A total of 2.1% of the 655 knew that their company was using a solar-energy system for some application. The distribution of those systems that were being used is also given in Exhibit 4-6.

Exhibit 4-7 gives the attitude of the sample toward solar-energy equipment in general. As a whole, industry disagreed with the statement that they could currently obtain reliable and dependable solar-energy equipment. Exposure to the solar-energy concept statement encouraged the sample to be more positive about solar energy. Beliefs about the reliability and dependability of water heating, space heating and heat-

pump cooling equipment were somewhat positive; beliefs about solar cooling equipment were quite negative. The response to the questions about obtaining solar equipment that makes economic sense was quite negative with solar cooling receiving the poorest response. Belief about solar energy being widely used in the next five years was quite low both before and after the respondents received the solar information. As a group, the respondents felt they understood both how solar systems work and the financial merits of the system; after receiving the questionnaire, they were a bit more confident in their knowledge than they were before.

For those respondents who considered themselves knowledgeable about the workings of solar-energy systems, Exhibit 4-8 shows the types of collectors they mentioned. (Respondents were not given a list.) Flat-plate collectors were the most widely known type.

Exhibit 4-9 shows the lack of receptivity to solar by industry in general before seeing specific product descriptions. There was a large increase in the stated likelihood of purchase as the time period to purchase increased from six months to two years, reflecting environmental uncertainty more than any other consideration.

Solar equipment must pass a number of purchasing criteria before it is considered acceptable by industry in general. The major criteria and standards used are given in Exhibit 4-10. A number of other questions, not reported in Exhibit 4-10, were asked of this group, including coefficient of performance, energy efficiency ratios, and seasonal energy efficiency ratios for the appropriate equipment.

In general, these measures were (a) used by a small number of the sample, less than 15%, and (b) understood by an even smaller percentage. For example, when asked about a minimum coefficient of performance for cooling, 14% of the respondents said they used that requirement. However, although the median COP required was given as 8.5, the responses ranged from 0 to 87 with a standard deviation of 22. We have no faith in the reliability of such responses and have therefore not reported the answers here. It is critical to note that some of these other efficiency measures should be used in evaluating HVAC systems and will not be used until the population is sufficiently familiar with their meanings.

To summarize the discussion of the nonfinancial criteria used, on average an industrial customer considering an HVAC system for purchase required that it (a) last at least 10 years, (b) carry a minimum of a 12-month warranty, (c) have been used by at least three other customers before, and (d) show expected maintenance cost of no more than 5% of the initial investment.

In addition, note that 47% of the respondents said they would only consider a system if the manufacturer maintained a local presence, and 34% said they would only consider purchase if they had had some experience with the manufacturer or vendor. For retrofit installations, only 6% of the respondents required that a system be replaced with an identical system and only 11% required that the same energy source be used. This finding was in contrast to pilot results from the Lilien et al. (1977) study of industrial solar-cooling adoption; reflecting a recent increase in flexibility in HVAC adoption habits in times of energy problems.

In terms of the financial criteria companies said they used in evaluating HVAC equipment, the payback method was the most commonly used one. Half the firms required a three-year payback or better on replacement of HVAC equipment. However, it is important to note that over half of the firms (62%) also used initial investment cost as a criterion. This criterion must be eliminated from consideration for solar to be a viable HVAC alternative. Two other investment criteria, net present value and internal rate of return, are also displayed in Exhibit 4-11; they were used by smaller proportions of the population (19% and 24%, respectively).

Let us consider now how the respondents ranked six key criteria in importance in making HVAC investment decisions. Exhibit 4-12 shows that the respondents rated operating and maintenance cost and reliability as having highest importance, followed by initial cost. Of lesser importance was life-cycle cost, showing that individuals had not been able to integrate operating costs with first cost in their understanding of solar economics. Of still lesser importance was supplier reputation and convenience of installation.

Consider now the evaluation of particular HVAC systems. Each respondent was sent descriptions of two solar HVAC systems and asked to evaluate them. Exhibit 4-13 summarizes these results. Since no differences were found between flat-plate and concentrating collector perception, results were combined here. Solar space heating and water heating had similar profiles. The most striking difference was between these heating systems and space cooling. By and large, relative to space or hot water heating, space cooling was perceived as (a) requiring

major retraining of personnel, (b) inflexible (not expandable or modular), (c) difficult to install and maintain, (d) difficult to integrate into the building, (e) too complex, and (f) too expensive. Solar-assisted heat pumps were, by and large, perceived as having problems of intermediate difficulty relative to space cooling.

We should not be surprised, then, to see that solar water heating and space heating were given the highest ratings for likelihood of purchase, with heat pumps third and solar cooling last (see Exhibit 4-14). For the sample as a whole, if the systems were to meet all of the operating and financial requirements of the firm, 15.5% gave at least an 80% chance of purchasing solar water heating, while only 7.7% gave an 80% chance of buying solar cooling.

In U.S. industry, who decides on HVAC equipment? Exhibit 4-15 shows that, for the sample as a whole, inside the firm, general management and production or maintenance engineers had the most influence in the decision-making process, with plant or factory managers of somewhat lesser but still significant importance. Financial controllers were important, but only in the evaluation stage of the decision process.

External personnel were important as well, with HVAC engineering firms and architects being important, especially in the identification stage of the decision process. Section 4.D.2 gives more details on how the decision-making process varied, depending on SIC code.

Exhibit 4-16 gives the breakdown of the distribution of the job responsibilities of the respondents. The greatest percentage of respondents were plant and maintenance engineers, with production

engineering and plant or general management the next most important job functions. Thus our sample tapped the attitudes of those individuals most likely to be involved in the decision-making process for HVAC equipment. (See Section 5 for an analysis of the attitudes of HVAC engineers and architects.)

The next few exhibits give some personal, descriptive information about the respondents. Exhibit 4-17 shows their attitudes toward new technologies. That exhibit suggests that their personal behavior was more varied than their behavior on the part of the company; on a personal level, more respondents took new product risks (16.8% vs. 11.2%) and more took a wait-and-see attitude (51.8% vs. 32.0%) than when acting on the part of the company. Exhibits 4-18A to D give some other demographics of the sample. The bulk of the respondents had supervisory responsibilities, with over 60% of them having over 10 people reporting to them. Half had worked for their present company for 11 or more years. Their educational degrees were mostly engineering and most were college graduates. The sample was fairly evenly distributed in age in the over-35-year-old categories.

Finally, we give a brief description of the companies these respondents represented. For the purpose of answering the questionnaire, the respondents were asked at what level in their organization final HVAC decisions were typically made. 62% responded at the corporate level; 12% responded at the divisional level; and 26% responded at the individual plant level. We refer to the level above as the HVAC "decision unit."

In terms of number of plants, the decision units reported a median level of 2, with 95% responding 15 or fewer, but 1% reported over 100 separate plant locations. In terms of square footage, half the decision units reported 186,000 square feet of plant area or more; 5% responded that they had over 20,000,000 square feet. 72% of the respondents reported that all of this space was company owned, but 10% reported leasing 100% of the space.

Exhibit 4-19 gives the average breakdown of plant area by major census region. As expected with manufacturers, the sample was concentrated in the North, the North East in particular. Half the firms in the sample expected new plant area to grow 5% per year or faster, while 40% expected no growth.

Half the companies reported sales of \$9.5 million or more, with 5% reporting over \$320 million in sales. Half the companies had 270 or more employees, with 5% reporting 4200 or more employees.

Exhibit 4-20 shows the anticipated shift in the firm's energy use for those firms (28%) expecting to see a shift. Oil was expected to be used less (as was, surprisingly, wood, coal and gas). Electricity and other sources of energy were expected to be used more. The percentages reflected a perceived trend to using less energy in general.

Exhibit 4-21 shows that the firms anticipated replacing about 15% of all HVAC equipment in the next 5 years. More than half the firms reported no plans for HVAC replacement.

Exhibit 4-22 gives the distribution of primary fuel used in three main HVAC applications. Across the sample, electricity was the dominant

fuel for space cooling, while gas was most frequently used for space heating. For water heating, gas was most important, but electricity was quite important as well, recording over 30% of the applications.

Finally, the respondents were asked what average annual rate of fuel cost increase they expected their firm to see between now and 1985. Half the firms expected their fuel costs to go up by more than 15% annually, and 75% expected at least a 30% annual increase.

EXHIBIT 4-5

Industry Distribution

	<u>Code</u>	<u>% of Sample</u>
Food and kindred products	20	15.6
Textile-mill products	22	12.2
Paper and allied products	26	15.0
Printing and publishing	27	14.7
Machinery except electrical	35	13.6
Electrical and electronics machinery and equipment	36	15.3
Measuring, analyzing and controlling equipment	38	13.6

n = 655

EXHIBIT 4-6

Industrial Solar Power System Knowledge and Use

<u>Solar System</u>	<u>Previous Knowledge of Industrial Application</u>	<u>Company Uses System</u>
Domestic water heating	77.1%	0.8%
Process water heating	59.9%	0.8%
Space heating	67.4%	0.5%
Space cooling	48.1%	0.0%

EXHIBIT 4-7

Attitudes about Solar-energy Equipment

	<u>Pre</u>	<u>Post</u>			
		<u>Water Heating</u>	<u>Water Heating</u>	<u>Space Cooling</u>	<u>Heat Pump</u>
We can currently obtain reliable and dependable solar-energy equipment (post = a particular system)*.	3.32**	2.86	3.28	2.88	2.90
			<u>2.98 (mean)</u>		
We can currently obtain solar-energy equipment (post = a particular system)* that makes economic sense.	3.57	3.45	3.69	3.44	3.38
			<u>3.49 (mean)</u>		
Solar-energy equipment will be widely used in our industry in the next five years.	3.49		3.36		
I understand the financial merits of solar-energy systems.	2.32		2.22		
I understand how solar energy systems work.	2.00		1.71		

* In the "post" questionnaire, the respondent was asked the question with regard to a particular system.

** Responses are on a 5-point scale in which 1 = strongly agree and 5 = strongly disagree

EXHIBIT 4-8

Knowledge of Collector Types

<u>Type of Collector</u>	<u>Percent of Respondents Mentioning</u>
Flat Plate	30.9%
Concentrator	14.7%
Evacuated Tube	12.3%
Trickle Collector	11.9%
Air Collector	15.8%
Selective	2.5%
Nonselective	1.4%

n = 285

EXHIBIT 4-9

Likelihood of Solar Purchase

	<u>In 6 months</u>	<u>In 2 years</u>
Very Likely	2.4%	10.4%
Somewhat Likely	3.0%	24.8%
Unsure	3.7%	15.0%
Somewhat Unlikely	8.5%	20.8%
Very Unlikely	82.4%	29.1%

n = 328

EXHIBIT 4-10

HVAC System Purchasing Requirements

	<u>Median Requirement</u>	<u>% Using</u>
Minimum Expected Life	10 years	80%
Minimum Warranty Period	12 months	74%
Minimum Number of Previous Successes	3	67%
Maximum Annual Maintenance Cost	5% of investment	46%
Require Manufacturer Have Local Presence	-	47%
Purchase Only if Had Experience with Manufacturer or Vendor	-	34%
For retrofit:		
Require Same Type System	-	6%
Require Same Energy Source	-	11%

EXHIBIT 4-11

HVAC Financial Criteria

<u>Method</u>	<u>% Use***</u>	<u>First Quartile*</u>	<u>Median</u>	<u>Third Quartile**</u>
Payback	81%	2 years	3 years	5 years
Net Present Value Method	19%	17%	13%	10%
Internal Rate of Return	24%	40%	20%	15%
Initial Investment	62%			

* Read: "75% of the respondents find this level acceptable."

** Read: "25% of the respondents find this level acceptable."

*** Note: Some companies use several methods and column sums to more than 100%.

EXHIBIT 4-12

Importance of Investment Criteria

	<u>Mean Importance Rating*</u>
Initial Cost	2.93
Supplier Reputation and Service	4.03
Operating and Maintenance Cost	2.53
System Reliability	2.71
Convenience of Installation/Operation	4.91
Life Cycle Cost	3.87

*Average rank order of importance -- range is from 1 to 6.

EXHIBIT 4-13

Solar System Evaluation*

	<u>Water Heating</u>	<u>Space Heating</u>	<u>Space Cooling</u>	<u>Solar- Assisted Heat Pump</u>
1. The system produces reliable output.	4.81	4.79	4.57	4.58
2. Adoption of the system protects against power failures.	2.84	2.46	2.50	2.38
3. Performance of the system is sensitive to climatic conditions.	6.04	6.03	5.81	5.55
4. The system is made up of field proven components.	4.87	4.74	4.56	4.79
5. Adopting the system conveys the image of a modern, innovative company.	4.95	4.94	5.10	4.81
6. The system requires a major retraining effort.	3.51	3.79	4.24	4.03
7. The system's initial cost is acceptably low.	2.93	2.90	2.84	2.79
8. The system protects against fuel rationing.	4.35	4.33	4.43	4.08
9. In adopting this system, we would do our part in reducing pollution.	4.93	5.15	4.71	4.62
10. System components produced by several manufacturers can be substituted for one another.	5.05	5.12	4.58	4.96
11. The system can easily be extended to meet increased HVAC needs.	4.70	4.52	4.15	4.49
12. The system is easily installed.	3.78	3.78	3.31	3.62
13. The system has too many concepts that have not been fully tested.	3.76	3.85	4.14	3.93
14. System components are easily accessible for maintenance and repair.	5.06	4.84	4.32	4.48
15. The system leads to considerable energy savings.	5.21	5.32	5.10	4.84

* Responses on a scale of 1 to 7, where:

1 = strongly disagree

7 = strongly agree

EXHIBIT 4-13

Solar System Evaluation* (continued)

		<u>Water Heating</u>	<u>Space Heating</u>	<u>Space Cooling</u>	<u>Solar- Assisted Heat Pump</u>
16.	The system is easily integrated into an industrial building.	4.22	4.18	3.65	3.97
17.	The system is too complex.	2.87	3.03	3.79	3.34
18.	The system's operating cost is acceptably low.	5.34	5.19	4.78	4.54
19.	The system offers a state-of-the-art solution to HVAC needs.	4.19	4.22	4.42	4.45
20.	The system increases the noise level in the plant.	1.83	1.34	2.26	2.38
21.	The system makes use of currently unproductive areas in industrial buildings.	4.51	4.26	4.07	4.34
22.	Adoption of this system will increase construction delays.	3.70	3.84	3.96	3.87
23.	The system is modular.	5.38	5.33	4.80	5.11
24.	Service for the system will be quick and easy.	4.47	4.11	3.31	3.55

* Responses on a scale of 1 to 7, where:

1 = strongly disagree
7 = strongly agree

EXHIBIT 4-14

Purchase Probabilities

	Mean Purchase Likelihood* In a New <u>Building Environment</u>	Percent of Sample Giving 80% or more <u>Chance of Purchase</u>
Solar Water Heater	48.5%	15.1%
Solar Space Heater	43.6%	11.8%
Solar Absorption Cooling	33.9%	7.7%
Solar-Assisted Heat Pump	40.9%	10.3%

* Assuming the system met all the operating and financial requirements of the firm.

EXHIBIT 4-15

Mean Structure of Organizational Buying Process
for HVAC Equipment in Sample

	Decision Phases Decision Participants	1 Identification of HVAC alternatives		2 Financial and technical evaluation*	3 Final equipment and source selection**
		New Installation	Retrofit Installation		
INTERNAL COMPANY PERSONNEL	Production engineer	1.8 %	1.3 %	1.7 %	2.2 %
	Plant or maintenance engineer	20.4 %	25.4 %	19.2 %	22.8 %
	Design engineer	6.3 %	7.4 %	5.8 %	6.2 %
	Plant or factory manager	9.4 %	11.4 %	11.2 %	12.1 %
	Financial controller or accountant	3.7 %	4.8 %	15.8 %	5.3 %
	Procurement or purchasing officer	1.4 %	1.3 %	3.7 %	4.7 %
	General management	24.0 %	22.8 %	27.3 %	34.3 %
	Other (specify)	2.3 %	2.8 %	3.1 %	1.1 %
EXTERNAL PERSONNEL	HVAC/Engineering firm	14.3 %	11.1 %	7.8 %	6.2 %
	Architects	10.1 %	3.8 %	1.7 %	3.4 %
	HVAC equipment manufacturers/vendors	6.3 %	7.9 %	2.7 %	1.7 %
	COLUMN TOTAL	100 %	100 %	100 %	100 %

*Decision phase 2 generally involves evaluation of all alternative HVAC systems that meet your company's needs, while

**Decision phase 3 involves only the alternatives (generally 2-3) retained for final selection.

EXHIBIT 4-16

Distribution of Job Responsibilities

	<u>Mean % of Time</u>
Production Engineering	10.3
Plant or Maintenance Engineering	38.7
Design Engineering	7.3
Plant or Factory Management	12.8
Financial Control/Accounting	2.6
Procurement/Purchasing	8.8
General Management	10.8
Other	8.7

EXHIBIT 4-17

Attitude Toward New Technology

	<u>Acting For Company</u>	<u>Acting Personally</u>
Likes to be at the Frontier of Technology	11.3%	16.8%
Quick to Adopt Carefully Monitored Installation	56.7%	31.4%
Wait-and-See Attitude, Until Product is Proven	32.0%	51.8%

EXHIBIT 4-18A

Number of People Reporting to Respondent

Less than 0	6.3%
1 - 3	6.3%
4 - 10	25.5%
11 - 30	28.8%
Over 30	33.1%

EXHIBIT 4-18B

Education Concentration

Math/Science	12.4%
Engineering	61.4%
Business	20.3%
Liberal Arts	5.9%

EXHIBIT 4-18C

Level of Schooling

High School	21.6%
College	56.8%
Post-graduate	21.6%

EXHIBIT 4-18D

Age Distribution

Less than 25	3.4%
25 - 34	17.3%
35 - 44	28.8%
45 - 54	23.1%
Over 55	27.4%

EXHIBIT 4-19

Geographic Distribution of Plant Area

North East	44.7%
North West	24.1
South East	17.0
South West	14.2

EXHIBIT 4-20

Shift in Anticipated Energy Sources
for Companies Reporting a Shift

<u>Energy Source</u>	<u>Use Less</u>	<u>Use More</u>	<u>n*</u>
Oil	84.6	15.4	117
Gas	53.2	46.8	156
Electricity	40.0	60.0	115
Coal	61.5	38.5	39
Wood	55.3	44.7	38
Other (including solar)	17.1	82.9	35

* Note: The number in each column reflects the number who expect to change their use, either up or down, of that particular fuel.

EXHIBIT 4-21

Expected System Replacement in the Next Five Years

	<u>Mean % Replacement</u>	<u>Percent Anticipating No Replacement</u>
Space Heating	14.5%	54.9%
Space Cooling	15.5%	52.7%
Water Cooling	15.4%	58.8%

n = 621

EXHIBIT 4-22

Primary Fuel Use for HVAC Applications

<u>Fuel</u>	<u>Application</u>		
	<u>Space Heating</u>	<u>Space Cooling</u>	<u>Water Heating</u>
Oil	20.7%	0.5%	13.8%
Gas	65.0%	8.3%	51.5%
Electricity	10.0%	90.1%	30.3%
Coal	2.2%	0.0%	2.2%
Wood	0.0%	0.0%	0.0%
Other	2.1%	1.1%	2.2%

D. ANALYSIS

1. HVAC Investment Criteria

As noted in Section 4.C, although a number of HVAC investment criteria were offered to the respondents, only three -- payback period, warranty period, and economic life -- were reliably answered and used by a sufficient subset of the population to include in a model of HVAC investment criteria.

Exhibits 4-23A, B and C give trade-off curves for the three criteria for the industrial sample. Prior to constructing these curves, the investment criteria distribution was tested to see if it was common across SIC codes. The result was as follows:

- Warranty period and economic-life requirement did not vary by SIC code.
- Payback requirement varied as follows:
 - SIC 35 (nonelectric machinery) found longer payback periods acceptable.
 - SIC 36 and 38 (shorter life-cycle electronic equipment and instruments businesses) required shorter payback.
 - All other SIC codes required intermediate payback.

The exhibits thus reflect the above groupings: SIC's 35, 36 and 38 and the other SIC codes respectively.

An example of how to read these curves is as follows: consider an HVAC system, marketed to SIC 35 (Exhibit 4-23A) with a 10-year life, a 10-month warranty and a 5-year payback. The system would be acceptable to $.063 \times .40 = .025$ or 2.5% of the market. If the system life were 40 years instead, it would be acceptable to $.129 \times .40$ or 5.1% of the market. All other curves can be read similarly.

EXHIBIT 4-23A

Acceptability Table and Curve - SIC 35

<u>Warranty (months)</u>	<u>Economic Life (years)</u>										
	<u>3</u>	<u>4</u>	<u>5</u>	<u>8</u>	<u>10</u>	<u>12</u>	<u>15</u>	<u>20</u>	<u>25</u>	<u>30</u>	<u>40</u>
1	.000	.000	.002	.002	.008	.008	.011	.015	.016	.016	.016
2	.000	.000	.002	.003	.011	.012	.016	.022	.023	.023	.023
3	.000	.000	.005	.007	.022	.023	.031	.042	.044	.045	.045
4	.000	.000	.005	.008	.024	.025	.033	.046	.048	.049	.049
5	.001	.001	.011	.016	.051	.053	.070	.097	.101	.102	.103
6	.001	.001	.013	.019	.060	.063	.084	.116	.121	.122	.123
10	.001	.001	.014	.020	.063	.066	.088	.121	.127	.128	.129
12	.004	.005	.064	.093	.294	.307	.408	.562	.589	.593	.597
15	.004	.005	.065	.093	.295	.309	.410	.565	.592	.596	.600
18	.004	.005	.065	.093	.296	.310	.410	.566	.593	.597	.601
24	.004	.006	.073	.105	.334	.349	.463	.639	.669	.673	.678
25	.004	.006	.074	.106	.335	.351	.465	.642	.671	.676	.681
27	.004	.006	.074	.106	.336	.352	.466	.643	.673	.678	.683
30	.004	.006	.075	.107	.339	.355	.471	.650	.680	.685	.690
36	.004	.007	.079	.114	.362	.379	.502	.692	.725	.730	.735
60	.004	.007	.080	.114	.363	.380	.504	.695	.728	.733	.738
84	.006	.009	.105	.150	.476	.499	.661	.912	.954	.961	.968
90	.006	.009	.105	.151	.480	.503	.667	.919	.962	.969	.976
120	.006	.009	.108	.155	.492	.515	.683	.942	.986	.993	1.000

EXHIBIT 4-23B

Acceptability Table and Curve - SIC 36, 38

Warranty (months)	Economic Life (years)										
	<u>3</u>	<u>4</u>	<u>5</u>	<u>8</u>	<u>10</u>	<u>12</u>	<u>15</u>	<u>20</u>	<u>25</u>	<u>30</u>	<u>40</u>
1	.000	.000	.002	.002	.008	.008	.011	.015	.016	.016	.016
2	.000	.000	.002	.003	.011	.012	.016	.022	.023	.023	.023
3	.000	.000	.005	.007	.022	.023	.031	.042	.044	.045	.045
4	.000	.000	.005	.008	.024	.025	.033	.046	.048	.049	.049
5	.001	.001	.011	.016	.051	.053	.070	.097	.101	.102	.103
6	.001	.001	.013	.019	.060	.063	.084	.116	.121	.122	.123
10	.001	.001	.014	.020	.063	.066	.088	.121	.127	.128	.129
12	.004	.005	.064	.093	.294	.307	.408	.562	.589	.593	.597
15	.004	.005	.065	.093	.295	.309	.410	.565	.592	.596	.600
18	.004	.005	.065	.093	.296	.310	.410	.566	.593	.597	.601
24	.004	.006	.073	.105	.334	.349	.463	.639	.669	.673	.678
25	.004	.006	.074	.106	.335	.351	.465	.642	.671	.676	.681
27	.004	.006	.074	.106	.336	.352	.466	.643	.673	.678	.683
30	.004	.006	.075	.107	.339	.355	.471	.650	.680	.685	.690
36	.004	.007	.079	.114	.362	.379	.502	.692	.725	.730	.735
60	.004	.007	.080	.114	.363	.380	.504	.695	.728	.733	.738
84	.006	.009	.105	.150	.476	.499	.661	.912	.954	.961	.968
90	.006	.009	.105	.151	.480	.503	.667	.919	.962	.969	.976
120	.006	.009	.108	.155	.492	.515	.683	.942	.986	.993	1.000

EXHIBIT 4-23C

Acceptability Table and Curve - SIC 20, 22, 26, 27

<u>Warranty (months)</u>	<u>Economic Life (years)</u>										
	<u>3</u>	<u>4</u>	<u>5</u>	<u>8</u>	<u>10</u>	<u>12</u>	<u>15</u>	<u>20</u>	<u>25</u>	<u>30</u>	<u>40</u>
1	.000	.000	.002	.002	.008	.008	.011	.015	.016	.016	.016
2	.000	.000	.002	.003	.011	.012	.016	.022	.023	.023	.023
3	.000	.000	.005	.007	.022	.023	.031	.042	.044	.045	.045
4	.000	.000	.005	.008	.024	.025	.033	.046	.048	.049	.049
5	.001	.001	.011	.016	.051	.053	.070	.097	.101	.102	.103
6	.001	.001	.013	.019	.060	.063	.084	.116	.121	.122	.123
10	.001	.001	.014	.020	.063	.066	.088	.121	.127	.128	.129
12	.004	.005	.064	.093	.294	.307	.408	.562	.589	.593	.597
15	.004	.005	.065	.093	.295	.309	.410	.565	.592	.596	.600
18	.004	.005	.065	.093	.296	.310	.410	.566	.593	.597	.601
24	.004	.006	.073	.105	.334	.349	.463	.639	.669	.673	.678
25	.004	.006	.074	.106	.335	.351	.465	.642	.671	.676	.681
27	.004	.006	.074	.106	.336	.352	.466	.643	.673	.678	.683
30	.004	.006	.075	.107	.339	.355	.471	.650	.680	.685	.690
36	.004	.007	.079	.114	.362	.379	.502	.692	.725	.730	.735
60	.004	.007	.080	.114	.363	.380	.504	.695	.728	.733	.738
84	.006	.009	.105	.150	.476	.499	.661	.912	.954	.961	.968
90	.006	.009	.105	.151	.480	.503	.667	.919	.962	.969	.976
120	.006	.009	.108	.155	.492	.515	.683	.942	.986	.993	1.000

It is important to note that Exhibits 4-23A, B and C only give product acceptability. The way to read these charts is: "If everyone in SIC 35 were aware of a specific HVAC system and considered it for purchase, and everyone who found it acceptable bought it, the specific HVAC system would command x% of the market."

The information here should be used to determine the criteria solar must meet to be acceptable in these markets.

2. The Industrial HVAC Decision-making Process

The decision matrix (Exhibit 4-15) gives us a tool that we can use to see if there are patterns of decision-making processes for HVAC equipment that are different between the different SIC codes. In order to study this issue, the following procedure was used:

- (a) mean levels of decision-process involvement by job responsibility were developed for each SIC code;
- (b) a correlation matrix was developed, measuring the similarity between different SIC code-based decision processes (see Exhibit 4-24); and
- (c) the resulting correlation matrix was analyzed using complete linkage-cluster analysis to produce two clusters (see Exhibit 4-25).

(Note that Appendices 7, 8 and 9 give details of the procedure and supports the use of complete linkage-cluster analysis for this purpose.)

Exhibits 4-26A and B give the mean levels of involvement for each job category in the two clusters. The differences in the two patterns are clear; relative to cluster one, cluster two saw:

- greater involvement of plant, maintenance and design engineers, and
- lesser involvement of general managers and architects,

EXHIBIT 4-24

Correlations Between Decision Structures
According to Industry Classification

	<u>SIC 22</u>	<u>SIC 26</u>	<u>SIC 27</u>	<u>SIC 35</u>	<u>SIC 36</u>	<u>SIC 38</u>
<u>SIC 20</u>	0.86	0.79	0.78	0.83	0.74	0.77
<u>SIC 22</u>		0.85	0.84	0.85	0.89	0.87
<u>SIC 26</u>			0.75	0.70	0.87	0.85
<u>SIC 27</u>				0.91	0.74	0.89
<u>SIC 35</u>					0.70	0.86
<u>SIC 38</u>						0.84

EXHIBIT 4-25

Complete Linkage Cluster Analysis of
Decision Making Process for HVAC Equipment

EXHIBIT 4-26A

Pattern of Decision-process Involvement:
Industry Cluster One (SIC 20, 27, 35, 38)

		1		2	3
Decision Phases Decision Participants		Identification of HVAC alternatives		Financial and technical evaluation	Final equipment and source selection
		New Installation	Retrofit Installation		
1	Production engineer	2.0	1.4	1.4	2.3
2	Plant or maintenance engineer	15.2	19.3	16.2	19.1
3	Design engineer	4.1	4.8	4.3	4.4
4	Plant or factory manager	10.5	12.7	12.0	12.4
5	Financial controller or accountant	3.9	5.9	16.2	4.7
6	Procurement or purchasing officer	1.3	1.3	3.5	5.5
7	General management	27.0	27.1	30.3	32.3
8	Other	1.6	3.6	3.8	2.8
9	HVAC/Engineering firm	14.3	11.4	8.6	8.9
10	Architects	13.0	4.6	1.5	5.5
11	HVAC equipment manufacturers/vendors	7.1	7.9	2.2	2.2

EXHIBIT 4-26B

Pattern of Decision-process Involvement:Industry Cluster Two (SIC 22, 26, 30)

	Decision Phases Decision Participants	1 Identification of HVAC alternatives		2 Financial and technical evaluation	3 Final equipment and source selection
		New Installation	Retrofit Installation		
1	Production engineer	1.7	1.4	2.2	2.0
2	Plant or maintenance engineer	26.2	32.1	22.1	27.2
3	Design engineer	9.4	10.7	7.1	8.1
4	Plant or factory manager	8.1	10.1	10.4	12.1
5	Financial controller or accountant	3.3	3.6	15.1	5.8
6	Procurement or purchasing officer	1.5	1.3	3.8	3.9
7	General management	19.7	18.1	24.1	26.8
8	Other (specify)	3.6	1.2	3.0	3.0
9	HVAC/Engineering firm	14.2	10.8	7.1	7.8
10	Architects	7.2	2.8	1.8	1.8
11	HVAC equipment manufacturers/vendors	5.1	7.9	3.3	1.5

throughout the decision-making process. HVAC equipment manufacturers should target their messages, then, to different individuals in the decision-making process depending on the SIC code being marketed to.

As we will see in Section 4.D.4, the relative involvement of plant or maintenance engineer versus general management is a key determinant of solar receptivity. As a general indicator of solar receptivity by cluster, note the results in Exhibit 4.27. Here we see that cluster two had a significantly higher likelihood of solar equipment purchase in the next two years: 38.9% in that cluster said they definitely would purchase, versus 32.4% in the other cluster. The results for the percent who will definitely not purchase solar were even more striking.

Thus, it appears from this analysis that:

- SIC's 22, 26, and 36 had similar decision-making structures for HVAC equipment,
- these industry groups were significantly more receptive to solar-powered HVAC equipment than the other industry groups.

3. The Structure of Industrial HVAC Respondents' Perception

Exhibit 4-13 gives a summary of solar HVAC system ratings for the industrial respondents. Psychological theory suggests that most individuals structure their attitudes in a smaller number of more complex dimensions. Factor analysis (discussed in Appendix 1) is a technique used to identify and characterize those dimensions.

The correlations between items and across product-types were subjected to factor analysis (principal component analysis). Prior to

EXHIBIT 4-27

Likelihood of Purchase of Solar
in the Next Two Years by Industry Cluster

	<u>Percent</u> <u>Who Definitely</u> <u>Will Purchase</u>	<u>Percent</u> <u>Who Definitely</u> <u>Will Not Purchase</u>
Cluster 1 (SIC 20, 27, 35, 38)	32.4	32.1
Cluster 2 (SIC 22, 26, 36)	38.9	22.9

this analysis, the perceptual spaces were tested to determine if:

- (a) the structure of attitudes differed significantly by SIC code, and
- (b) the structure of attitudes differed by principal job category.

Both these hypotheses were tested and rejected at the 0.10 level using the test described in Appendix 1.

Exhibit 4-28 gives the factor pattern for a five-factor solution, following a quartimax rotation (which gave a more readily interpretable solution than the more common varimax rotation). These five factors explained 54% of the variance in the original items. We interpreted them as follows:

Factor 1: Solar problems: items 6, 12, 14, 16, 17

Factor 2: Solar reliability: items 1, 3, 4, 13

Factor 3: Solar as state of the art: items 5, 15, 18, 19

Factor 4: Solar benefits and ease of use: items 2, 22

Factor 5: Solar flexibility: items 8, 9, 10, 11, 21.

As we will see in the next section, the way the various solar systems were evaluated along these dimensions played a large part in explaining industry's likelihood of purchase.

4. The Structure of Industrial Solar Preference

There was a wide range of variability in the response that was given to the question: "Assuming that the system met all of the operating and financial requirements of your firm, what is the likelihood that you would recommend that your firm purchase such a system for a new installation?" Note that this question was (a) system

EXHIBIT 4-28

Industrial Sample - Factor Analysis of Solar Perceptions

	<u>Factor 1</u> <u>Solar</u> <u>Problems</u>	<u>Factor 2</u> <u>Solar</u> <u>Relia-</u> <u>bility</u>	<u>Factor 3</u> <u>Solar</u> <u>State of</u> <u>the Art</u>	<u>Factor 4</u> <u>Solar</u> <u>Benefits/</u> <u>Ease</u>	<u>Factor 5</u> <u>Solar</u> <u>Flexi-</u> <u>bility</u>
1. The system produces reliable output.	0.13	<u>-0.45</u>	0.45	0.032	0.087
2. Adoption of the system protects against power failures.	0.099	-0.14	-0.017	<u>0.67</u>	0.34
3. Performance of the system is sensitive to climatic conditions.	-0.090	<u>0.70</u>	0.005	-0.15	0.30
4. The system is made up of field proven components.	0.27	<u>-0.49</u>	0.24	-0.33	0.32
5. Adopting the system conveys the image of a modern, innovative company.	0.26	0.048	<u>0.56</u>	-0.088	0.14
6. The system requires a major retraining effort.	<u>-0.51</u>	0.13	0.16	0.15	-0.006
7. The system protects against fuel rationing.	0.019	-0.079	0.38	0.056	<u>0.65</u>
8. In adopting this system, we would do our part in reducing pollution.	0.15	0.054	0.19	0.11	<u>0.70</u>
9. System components produced by several manufacturers can be substituted for one another.	0.43	-0.10	-0.10	-0.23	<u>0.54</u>
10. The system can easily be extended to meet increased HVAC needs.	0.27	0.16	0.47	-0.24	<u>0.48</u>
11. The system is easily installed.	<u>0.62</u>	0.18	0.16	-0.18	0.081
12. The system has too many concepts that have not been fully tested.	-0.36	<u>0.43</u>	-0.30	0.47	0.031
13. System components are easily accessible for maintenance and repair.	<u>0.74</u>	-0.017	0.20	0.16	0.17
14. The system leads to considerable energy savings.	0.042	-0.16	<u>0.83</u>	-0.060	-0.017

EXHIBIT 4-28

Industrial Sample - Factor Analysis of Solar Perceptions (continued)

	<u>Factor 1</u>	<u>Factor 2</u>	<u>Factor 3</u>	<u>Factor 4</u>	<u>Factor 5</u>
	<u>Solar</u>	<u>Solar</u>	<u>Solar</u>	<u>Solar</u>	<u>Solar</u>
	<u>Problems</u>	<u>Relia-</u>	<u>State of</u>	<u>Benefits/</u>	<u>Flexi-</u>
		<u>bility</u>	<u>the Art</u>	<u>Ease</u>	<u>bility</u>
15. The system is easily integrated into an industrial building.	<u>0.65</u>	0.32	0.35	0.046	-0.078
16. The system is too complex.	<u>-0.56</u>	-0.037	-0.38	-0.13	-0.10
17. The system's operating cost is acceptably low.	0.29	-0.15	<u>0.66</u>	0.059	0.20
18. The system offers a state-of-the-art solution to HVAC needs.	0.15	0.13	<u>0.62</u>	-0.021	0.29
19. The system makes use of currently unproductive areas in industrial buildings.	0.15	0.26	0.22	0.19	<u>0.53</u>
20. Adoption of this system will increase construction delays.	-0.23	0.009	0.008	<u>-0.67</u>	-0.076
21. The system is modular.	<u>0.61</u>	-0.15	0.15	0.067	0.13
22. Service for the system will be quick and easy.	<u>0.67</u>	-0.19	0.085	0.012	0.13
Percent variance explained by the factor	16%	7%	14%	7%	10%

specific -- the above referred to a particular system, either space heating, hot-water heating, space cooling or solar-assisted heat pump, and (b) was likelihood-of-purchase conditioned on acceptability. Thus, a projection of actual likelihood of purchase could only be made for systems that met the financial, economic-life and warranty requirements detailed in Section 4.D.1.

Exhibit 4-29 outlines the two-step procedure we used for analysis here: system feasibility analysis, followed by likelihood of choice given system feasibility. Exhibit 4-30 outlines the structure of the model we built in this section. In particular there were four main classes of variables that were hypothesized to impact in likelihood of solar purchase or recommendation:

- Personal attitudes: understanding of financial and economic merits of solar systems, attitudes toward risk, and so on.
- System characteristics: as summarized by the factors, as well as several other important characteristics.
- Firm characteristics: the size organization and innovativeness of the firm.
- Personal characteristics: demographics, including age and job status, as well as position in the firm.

In addition, there may be differences in the structure of the probability-of-purchase equation due to (a) the specific system seen, (b) the SIC code of the respondent, and (c) the geographic region of the respondent.

EXHIBIT 4-29

Overall Structure of Analytical Approach

EXHIBIT 4-30

Structure of Likelihood of Purchase Analysis

We hypothesized the following relationships.

- HA. Personal-attitude hypotheses: Likelihood of recommending a solar system would be higher for people who felt they:
- HA.1 understood the financial merits of solar systems,
 - HA.2 understood the operations of solar systems, and
 - HA.3 were not at risk if they recommended an HVAC system that did not work as well as promised.
- HB. System characteristics: Likelihood of recommending a solar system would be higher:
- HB.1 the more favorably the solar system was seen on the five perceptual factors,
 - HB.2 the more the system seemed to make economic sense, and
 - HB.3 the more reliable the system seemed.
- HC. Firm characteristics: Likelihood of recommending solar would be higher for firms:
- HC.1 with centralized HVAC decision-making structures (generally large firms),
 - HC.2 with a heavy involvement of the prosolar plant engineers in the HVAC decision-making process,
 - HC.3 with a light involvement of general management in the HVAC decision-making process, and
 - HC.4 that liked to be innovative.
- HD. Personal demographics: Individuals would be more likely to recommend a solar-energy system if:
- HD.1 they were younger, and
 - HD.2 they were engineers rather than general managers.

We hypothesized a model of the following sort:

x = likelihood of recommending a specific solar HVAC system,
in %, from 0 to 100.

then $y = x/100$ = probability of recommendation

Let

$$\text{logit} = \ln \left(\frac{y + .5}{1.5 - y} \right) = a_0 + \sum_1 a_1 Z_1$$

where Z_1 are the characteristics and perceptions noted above.

Before performing the analysis, we had to test whether the equation we estimated was the same:

- (a) for each system,
- (b) for each SIC code, and
- (c) for each geographic region.

Each of these hypotheses was tested and rejected at the $\sigma = .05$ level, using the Chow test (see Appendix 1 for details of the test.) Did this mean that, for example, the likelihood of adopting solar water heating was the same as the likelihood of adopting solar cooling? Not at all -- rather it meant that the large differences we saw in Exhibit 4-14 could be explained by the way people perceived the product. In fact, it suggested that our measurement procedure had been generally successful, as there were no characteristic system-specific differences remaining to be explained.

Although there were no structural differences by SIC codes, statistical tests showed that SIC 26 -- Paper and Allied Products -- was generally more solar receptive than could be explained by perceptual or organization variables. Aside from this fact, there were no system-

specific, SIC-code or regional differences that were not captured in the classes of variables HA to HD listed above. Of the hypotheses listed above, all were confirmed directionally by our analysis except:

- Factor 2 -- solar reliability -- was captured by another direct question (RELIABILITY, below) and added no explanatory power to the model.
- Job-category of the respondent -- an effect partially captured in the measures of those involved in HVAC decisions in the firms.

Exhibit 4-31 gives the results of the analysis. An ordinary least squares regression was used to estimate model parameters. A test of residuals confirmed their normality, justifying the use of the estimation procedure.

Exhibit 4-32 gives operational definitions of the variables in the model and Exhibit 4-33 gives means and standard deviation of those variables.

EXHIBIT 4-31

Equation Explaining Likelihood
of System Recommendation for Industrial Respondents

<u>Variable</u>	<u>Coefficient</u>	<u>t-Stat</u>
SIC26	.172	2.07
ECONRISK	-.065	-2.31
INNOV	-.095	-2.01
AGE	-.069	-2.55
ECONSENSE	-.124	-3.90
RELIABILITY	-.074	-2.18
RINUNDER	-.092	-2.70
OPERUNDER	-.092	-2.05
CENTRALIZATION	-.097	-2.56
PLTENG	.00089	2.67
GENMNG	-.00183	-5.92
FACTOR1	.051	3.28
FACTOR3	.045	2.40
FACTOR4	.138	5.58
FACTOR5	.068	2.98

INTERCEPT

1.763

 $R^2 = .38$ $F = 12.36$ $PROB > F = .0001$ $n = 314$

Note: Dependent variable is

$$\ln\left(\frac{p + .5}{1.5 - p}\right),$$

where p is likelihood of system recommendation.

Variable Definitions -Industrial Probability-of-purchase Equations

- SIC26 = $\begin{cases} 1 & \text{if company is in SIC 26} \\ 0 & \text{otherwise} \end{cases}$
- ECONRISK = Rating on scale: How significant would it be if a recommended HVAC system proved less economical than projected,
 1 = would not affect position/credibility
 :
 5 = would highly endanger position and credibility
- INNOV = Firm's innovativeness:
 1 = like to be first to experiment with new products/processes
 :
 3 = take a wait-and-see attitude
- AGE = Age of respondent:
 1 = < 25
 2 = 25 - 34
 3 = 35 - 44
 4 = 45 - 54
 5 = 55 +

The next four variables are scale rated from

- 1 = strongly agree
 :
 5 = strongly disagree

- ECONOSENSE = Rating on: "We can currently obtain an * system that makes economic sense for our company."
- RELIABILITY = Rating on: "We can currently obtain a reliable and dependable * system for use in our company."

* = particular system rated: space heating; space cooling; water heating; or heat pump

- FINUNDER = Rating on "I understand the financial merits of solar-energy systems."
- OPERUNDER = Rating on "I understand how solar energy systems work."

EXHIBIT 4-32

Variable Definitions -

Industrial Probability-of-purchase Equations (continued)

- CENTRALIZATION = Indication of where in the organization HVAC decisions are typically made:
1 = corporate level
2 = divisional level
3 = plant level
- PLTENG = Level of involvement of Plant Engineers in HVAC decision process: sum of percent involvement in identification of alternatives, evaluation and selection.
- GENMNG = Level of involvement of General Managers in HVAC decision process: sum of percent involvement in identification of alternatives, evaluation, and selection.
- FACTOR1,3,4,5, = Factor scores on factors explained in Section 4.D.3.

EXHIBIT 4-33

Statistics for Variables in
Probability-of-purchase Equations

<u>Variable Name</u>	<u>Mean</u>	<u>Standard Deviation</u>
SIC26	0.177	0.38
ECONRISK	2.92	1.17
INNOV	2.25	0.64
AGE	3.54	1.16
ECONSENSE	3.66	1.17
RELIABILITY	3.11	1.13
FINUNDER	2.27	1.01
OPERUNDER	1.75	0.82
CENTRALIZATION	1.64	0.88
PLTENG	89.95	100.88
GENMNG	101.04	111.80
FACTOR1	-0.30	3.70
FACTOR3	-0.28	3.31
FACTOR4	0.08	1.59
FACTOR5	-0.29	2.49

To summarize these results, our model said that industrial HVAC adopters were more likely to adopt solar as follows:

- Most important relationship

- if they believed it made economic sense;
- if there was a low level of general manager involvement in the HVAC decision process; and
- if they strongly perceived solar benefits and its ease of use.

- Relationships of intermediate importance

- if they perceived that solar problems were not significant;
- if plant engineers were involved in a major way in the HVAC decision process;
- if they understood the financial merits of solar;
- if they perceived solar as a flexible technology; and
- if the decision maker was younger.

- Relationships of lower importance

- if they perceived solar as "state of the art";
- if personal risk of recommendation was low;
- if they believed in the reliability of the system;
- if they understood the operations of solar-energy systems;
- if they were in the paper and allied products industry;
- if their firm considered itself innovative; and
- if decisions were centralized.

E. CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

The data and analysis presented here lead to the following conclusions:

- (1) Potential industrial users of solar HVAC equipment were aware of how the systems work and understood the financial merits of the systems.
- (2) In general, respondents were not receptive to solar HVAC equipment, with very few giving any significant likelihood of system adoption.
- (3) Impressions of solar cooling systems in general were fairly negative; solar cooling was the most unfavorably rated, followed by heat pumps and solar space heating. Solar water heating received the most favorable ratings.
- (4) To be generally acceptable to the sample, solar HVAC systems would need to demonstrate a 3- to 5-year payback, last at least 10 years, carry at least a 12-month warranty, and show maintenance costs of no more than 5% of the initial investment.
- (5) Key decision participants for HVAC equipment within organizations were plant or maintenance engineers and general managers. Engineers were more favorably disposed toward solar than were managers; SIC codes 22, 26, and 36 show decision processes that involved engineers more heavily and were more pro-solar than the other SIC codes.
- (6) In terms of likelihood of recommendation, some key correlates were
 - (a) belief in economic sense,
 - (b) belief in solar benefits and ease of use,
 - (c) belief in solar flexibility, and
 - (d) an understanding of the financial merits of solar (life-cycle costing concepts)

The precise way these variables were measured has been discussed in detail in this chapter.

2. Recommendations

With respect to having solar HVAC systems adopted in the industrial sector, we consider actions for marketers or for the government in terms of (a) product design, (b) communications, and (c) targeting. In other words, to penetrate the market, the right product has to exist, aimed at the right market segment which has been convinced of certain key issues with respect to solar.

Product Design

Payback period and warranty or reliability are key decision dimensions. Solar will not be considered for an application unless it has short payback and long life. Let us consider a target of 10% of the market. To have the potential to meet that target, a solar system must last 20 years, offer a 12-month warranty and have an 8-year payback. Under these conditions, 10% of the HVAC market would consider such an HVAC system. Design targets must be in the 3- to 5-year payback range, however, to see significant penetration.

Communications

A variety of noneconomic dimensions affect solar receptivity. Of most importance are the beliefs that solar systems are (a) protection against full rationing and power failures and (b) that solar is "easy to install and use," that is, does not cause construction delays, involves minimal retraining, has modular systems, has no major maintenance problems, and so on. These issues are critical in affecting solar receptivity.

Targeting

Our analysis suggests that a firm is more likely to be receptive to solar if:

- (a) it has plant or maintenance engineers involved in the HVAC decision-making process;
- (b) it does not have top managers involved in the HVAC decision-making process;
- (c) HVAC decisions are made centrally;
- (d) the decision-makers are younger; and
- (e) the firm is in the paper and allied products industry.

SECTION FIVE

HVAC ENGINEERS AND ARCHITECTS

A. INTRODUCTION

In our industrial analysis, we found that HVAC engineers and architects accounted for over 20% of the decision-making responsibility for new industrial buildings. In the residential and commercial markets, that influence was even higher -- HVAC engineers and architects exerted major influence in the identification and selection of HVAC alternatives.

In New England alone, there are well over 3,000 HVAC contracting establishments. These establishments tend to be small, but their influence in the HVAC equipment selection process is substantial.

The objective of this chapter are to:

- (a) identify and measure the attitudes of this influential group toward solar-energy alternatives;
- (b) measure the likelihood of their specifying solar for various applications in the future;
- (c) quantify the decision criteria that are used in the evaluation of HVAC systems;
- (d) characterize the "solar recommender" -- the HVAC engineer or architect who is most predisposed to solar.

The chapter concludes with a set of observations and recommendations for permitting solar to penetrate this important market segment more rapidly.

B. MEASUREMENTS

1. Instrument Design

Prior interviewing experience with architects and HVAC engineers indicated that these groups tend to be well aware of solar applications, and in many cases up to date on equipment design and availability. This high level of awareness has come about because of the frequent inclusion of material about solar in most of the professional journals read by these individuals. Because the base level of information in the segment is high, it was decided that there was no need to provide this group with descriptive material about active solar energy systems as was done in the residential, industrial, and builder segments. In addition, it was felt that the high level of technical understanding in this segment went beyond the kind of general descriptive material that was provided to the other segments, and would have required discussion of equipment for specific applications. This kind of specific application-oriented material was beyond the scope of the current study.

For these reasons, the questionnaire was designed as a telephone survey -- the individual respondent was telephoned, screened, and if appropriate, asked to participate. If he or she agreed, the survey was administered in full at that time, or, if the respondent was busy, an "appointment" was made for a call at a later time.

The survey was designed to learn the extent of each participant's knowledge about solar, as well as of any experience his or her firm had.

In addition, questions were designed to understand:

- the respondent's attitudes toward solar,
- the respondent's likelihood of specifying solar for various applications in the future, and
- the decision criteria that the respondent used in evaluating HVAC systems, as well as their relative importances.

In addition, various demographic measures about both the firm and the respondent were collected.

2. Instrument Pretest

The questionnaire was pretested on a sample of 80 architects and HVAC engineers. The interviews were collected as the following indicates:

	<u>Region</u>	
	<u>North East</u>	<u>South West</u>
HVAC consultants	20	20
Architects	20	20

The pretest led to a small number of changes in wording on certain questions, either to make the questions more understandable to the audience or to convey a more specific meaning. In addition, a number of changes that facilitated the administration of the instrument were suggested by the Valley Forge Information Service personnel working on the project.

3. Sample Selection

The sample used for the HVAC/architects portion of the study came from several sources. HVAC engineers were selected from:

- 1) the membership list of ASHRAE, and
- 2) the subscription file of Heating, Piping, and Air Conditioning.

Architects were selected from the membership roster of the American Institute of Architects.

Names for the sample were taken randomly from the lists, stratified by region. Individuals so selected were telephoned and screened for qualifications. Specifically, an individual qualified only if he or she worked directly with clients in the selection or evaluation of heating or air conditioning equipment.

If a particular individual was not qualified or could not take part in the study, he or she was asked for the name of another person in the same firm who would be appropriate for the purpose of the study. In this way the random distribution of firms that arose from selection of names from the membership subscription lists was maintained.

4. Questionnaire Administration

After screening to insure that a potential respondent was qualified, he or she was asked to participate in the study. If he or she indicated that a different interview time was better, an "appointment" was made for a call-back at that time.

The interviewer then took the respondent through the questions, recording the answers on a precoded questionnaire form.

Two series of questions, the first a series of statements with an agree-disagree Likert scale, and the second, a list of evaluation criteria with an importance-rating scale, were systematically rotated to avoid bias.

The interviewers, who were from the Valley Forge Information Service, King of Prussia, Pennsylvania 19406, were briefed both for the pretest and for the final questionnaire administration by members of the Dialogue staff. A Dialogue staff person together with a Valley Forge supervisor then listened in on a number of calls with each interviewer, using equipment designed for that purpose. The Dialogue and Valley Forge supervisors were thus able to make further suggestions about each interviewer's style, and to develop an interviewing pattern that was consistent across interviewers.

At the conclusion of the interview respondents were offered a summary of the results if they wished them.

Completed interviews were returned to Dialogue where they were examined for completeness and consistency. Necessary coding was also done at this time. A few questionnaires that were found to be incomplete or had other problems associated with them were returned to Valley Forge, which called back the respondent to clarify the questionable response. The data was then keypunched, 100-percent verified, and placed on tape for computer analysis.

C. DATA DESCRIPTION

As noted earlier, the purpose of the HVAC/architect analysis was to determine how these important influencers felt about solar energy and what criteria they used in deciding about HVAC systems.

For the purpose of this and subsequent sections, we will use the terms:

"architect" to refer to the 212 respondents who said their firm's main activity was architecture or design,

and

"HVAC" to refer to the 185 respondents who reported that their firm's main activity was contracting or HVAC consulting.

The sample was made up of 398 respondents, half of whom were ASHRAE members (American Society of Heating, Refrigeration and Air Conditioning Engineers) and half of whom were AIA members (American Institute of Architects).

1. Awareness and Attitudes toward Solar

Virtually all of the respondents (99.2%) reported that they were aware of how solar-energy systems worked. This was not an unexpected finding with this population. In fact, 80.2% of the respondents reported having sought information about solar energy from a solar equipment manufacturer or dealer.

Exhibit 5-1 shows the breakdown of the types of solar-energy systems about which the respondents reported asking for information; hot water and space cooling were the most frequently mentioned, with space cooling and process water heating mentioned less frequently.

Exhibit 5-2, interestingly, shows that a large fraction of the population (over 75% for domestic hot water) had considered solar for some application. That same exhibit shows that 38% of the respondents in fact had specified solar for some domestic hot-water application.

Exhibit 5-3 shows the amount of the firm's business that was solar related. That exhibit suggests that 4% of the responding firms had 25% or more of their business solar related.

Exhibit 5-4 reflects the general level of satisfaction these individuals reported their clients perceived with solar. From 76% to 86% reported their clients were either moderately or very satisfied with solar in each case.

Exhibit 5-5 gives a measure of the unaided awareness this group had of types of solar collectors. Flat-plate and air collectors seemed to be the best known.

Exhibit 5-6 gives awareness of solar systems suppliers by those individuals who felt knowledgeable enough to rate the manufacturers on the basis of reliability and economy of system. Manufacturers with nine or more mentions were given in the exhibit; all well-known manufacturers were perceived to produce reliable products, but there was significant evidence that most systems were perceived to be uneconomical.

The next several exhibits map the respondents perceptions about how the solar industry will evolve and what their role will be in that industry. Exhibit 5-7 shows that the group was fairly optimistic about solar, with 65.5% of architects and 52.0% of HVAC consultants feeling that solar definitely or probably would be widespread in the next five years. This and subsequent exhibits show that, in general, architects felt more positive about solar than did HVAC consultants.

Exhibit 5-8 gives the respondent's likelihood of recommending solar for some application in the next year and in the next five years. Here we see that 64% and 90% architects said they were very or somewhat likely to recommend solar for some application in the next year and in the next five years respectively. The HVAC consultants reported 55% and 79% would recommend solar in the next year and in the next five years.

Exhibit 5-9A gives the solar application for the "very-likely-to-recommend" group from Exhibit 5-8. Exhibit 5-9A shows that water heating was the most likely application. Exhibit 5-9B gives the type of building that the application was likely to be in. Both architects and HVAC consultants reported commercial applications to be the most likely. Exhibit 5-9C suggests that most applications would be for new buildings.

Exhibit 5-10 gives the level of agreement/disagreement with a number of statements about solar energy. Several items are of interest here. One hypothesis suggested by many people in the solar-energy area is that architects, who are more prosolar than HVAC consultants, are innovators. Item g in Exhibit 5-10 measures that concept: there was no difference between groups. Rather, items i, j, m, p and r seemed to be the ones that related to architects' positive attitude toward solar. The biggest difference registered on these scales was item m: "The widespread use of solar-energy systems would be the best way for the nation to achieve energy independence." In other words, architects seemed to have a positive attitude toward solar because of their ethical beliefs about solar rather than because of any strong personal innovativeness. They did not seem to perceive the same level of service problems with solar (Item r) as did the HVAC people.

Let us consider the criteria these groups used when evaluating HVAC in general for recommendation to clients. As seen in Exhibit 5-11,

there was not much difference between groups in the choice of financial criteria used, with payback period being the most common criterion and net percent value the next most common criterion for both HVAC and architects.

Exhibit 5-12 gives the criteria used to select HVAC systems and the minimum level of those criteria considered crucial. Here we see that economic life and warranty period were considered heavily by most respondents, with 10 years and 12 months the median requirements, respectively. Architects seemed to be more willing to take a risk: fewer (41% vs. 48% of HVAC respondents) required seeing prior successful installation. Those that did require prior successes required seeing fewer, on average (3 vs. 5 for HVAC). And more architects (64% vs. 53% for HVAC) would consider a system even if they had no prior experience with the vendor.

Exhibit 5-13 gives the mean importance ratings for various criteria for HVAC decisions. There were few differences between the groups; in general, the importance of issues can be grouped as follows:

- Highest importance:
 - maintenance cost
 - ease of maintenance
 - availability of fuel
 - future cost of fuel
- Moderate importance:
 - expected life
 - producer reputation
- Lesser importance:
 - previous experience with system producers
 - ease of installation
 - initial cost
 - warranty period
 - modularity of components

The next few exhibits give a description of the sample. Exhibit 5-14 gives the distribution of firm sizes. The median number of professionals in an HVAC organization was 3; in an architect's organization it was 5. Clearly, these were small firms. The number of installations varied widely; for the sample as a whole, the mean number of installations was 67, with a range of 1 to 3000. Exhibit 5-15 gives a description of how the HVAC business was broken down. HVAC did proportionally more of their business in commercial and industrial buildings; architects were proportionally more active in municipal and government buildings and in residential work.

The geographic breakdown in the sample is displayed in Exhibit 5-16. Because the initial, pilot study was done only in the Northeast and the Southwest, the representation from those regions was proportionately higher.

Finally Exhibit 5-17 gives the age distribution of the respondents. Both groups were centered in their early 40's, with concentration of architects there a bit heavier than those of HVAC consultants.

EXHIBIT 5-1

Kinds of Solar-energy Systems about which
Respondents Reported Searching for Information

Domestic Water Heating	83.1%
Process Water Heating	42.3%
Space Heating	74.9%
Space Cooling	49.3%

n = 319

EXHIBIT 5-2

Consideration/Specification of
Solar-energy Systems

	<u>Considered</u>	<u>Specified</u>
Domestic Water Heating	75.6	38.2
Process Water Heating	30.4	14.9
Space Heating	66.1	32.9
Space Cooling	36.7	13.8

EXHIBIT 5-3

Amount of Business Solar Related

None	54.0%
Less than 5%	28.4%
5% to 25%	13.6%
More than 25%	4.0%

n = 398

EXHIBIT 5-4

Perceived Client Satisfaction with Solar

	<u>Over-All</u>	<u>Water Heating</u>	<u>Process Heating</u>	<u>Space Heating</u>	<u>Space Cooling</u>
Very Satisfied	29%	34.6%	36.4%	47.8%	40.0%
Moderately Satisfied	46%	46.1%	50.0%	34.8%	26.7%
Unsure	16%	13.5%	9.1%	6.5%	13.3%
Moderately Dissatisfied	6%	5.8%	4.5%	10.9%	20.0%
Very Dissatisfied	3%	0	0	0	0
	(n = 100)	(n = 52)	(n = 22)	(n = 46)	(n = 15)

EXHIBIT 5-5
Awareness Levels of Types
of Solar Collectors

Flat Plate	46.5%
Concentrator	18.3%
Evacuated Tube	15.6%
Trickle Collector	9.5%
Air Collector	23.1%
Selective	4.0%
Nonselective	2.8%
Other	31.2%
None	22.6%

(n = 398)

EXHIBIT 5-6
HVAC/Architects' Perception of Solar System
Manufacturer Economy and Reliability

	<u>Reliable</u>	<u>Unreliable</u>	<u>Economical</u>	<u>Uneconomical</u>
Sunworks	8		4	4
Grumman	13	1	6	6
Raypack	10		6	3
PPG	13		6	6
Solaron	20	1	11	8
Lennox	25		18	5
Northrup	8		5	4
Revere	22		13	6
Owens/Corning	4		3	3
American	5		3	1
GE	13		8	3
Honeywell	5		4	2

Companies with 9 or more unaided mentions are listed here.

EXHIBIT 5-7

Will Solar Energy Systems Be Widely
Used in the Next Five Years?

		<u>Architects</u>	<u>HVAC</u>
Definitely Will	Fairly Certain	27.5	21.7
	Pretty Sure	9.0	11.2
Probably Will		29.1	20.9
Unsure		2.3	4.5
Probably Will Not		24.5	33.3
Definitely Will Not		7.7	10.2

n = 398

EXHIBIT 5-8

Likelihood of Recommending Solar
for Some Application

	(a) In The Next Year		(b) In The Next Five Years	
	<u>Architects</u>	<u>HVAC</u>	<u>Architects</u>	<u>HVAC</u>
Very Likely — 100% Sure \ Pretty Sure	25.6	17.3	44.5	31.6
	14.8	6.8	22.5	15.0
Somewhat Likely	23.5	30.8	22.5	32.3
Unsure	6.0	4.5	5.5	5.3
Somewhat Unlikely	13.7	10.5	3.8	7.5
Very Unlikely	16.4	30.1	1.2	8.3

n = 398

EXHIBIT 5-9A

Most Likely Application for Solar

88%	Water Heating
64%	Space Heating
23%	Solar Absorption Cooling
46%	Solar Assisted Heat Pumps

EXHIBIT 5-9B

In What Kind of Building Will the Solar Application Be?

	<u>Architect</u>	<u>HVAC</u>	<u>Total</u>
Residential	68	49	60
Industrial	28	36	31
Commercial	69	86	76
Municipal/Govt.	29	32	30
Hospitals	18	24	20
Other	5	9	7

EXHIBIT 5-9C

New or Retrofit?

90%	New
49%	Retrofit

n = 221

EXHIBIT 5-10

Agreement or Disagreement with a Number of
Statements about Solar Energy

	<u>Architects</u>	<u>HVAC</u>
a. HVAC can currently produce cost effective solar-energy systems.	3.3	3.2
b. HVAC manufacturers can currently produce reliable and dependable solar-energy systems.	2.6	2.5
c. If my firm recommended a solar HVAC system that proved less <u>economical</u> than we expected, it could harm our reputation.	2.1	2.0
d. If I, personally, recommended a solar HVAC system that proved less <u>economical</u> than projected, it could ruin my career.	3.5	3.4
e. If my firm recommended a solar HVAC system that proved less <u>reliable</u> and <u>dependable</u> than projected, it could harm our reputation.	2.3	2.4
f. If I, personally, recommended a solar HVAC system that proved less <u>reliable</u> and <u>dependable</u> than projected, it could ruin my career.	3.4	3.3
g. I find it interesting and exciting to be the first one in my area to try a new product.	2.7	2.7
h. My firm is known in the industry as one that only specifies or recommends systems that are "tried and true".	2.3	2.4
i. The federal government should finance the development of markets for solar energy.	3.3	3.6
j. Day in and day out, solar-energy systems can provide a significant fraction of a building's HVAC needs.	2.1	2.5
k. Solar HVAC systems are too complex.	3.3	3.4
l. Specifications of solar HVAC systems will lead to construction delays.	3.6	3.6
m. The widespread adoption of solar-energy systems would be the best way for the nation to achieve energy independence.	2.9	3.5
n. A solar HVAC system user conveys a modern, innovative image.	1.9	2.2
o. Solar HVAC systems incorporate too many concepts that have not been fully tested.	3.0	3.1
p. I like the concept of using solar energy for HVAC applications.	2.0	2.4
q. Solar HVAC systems protect against fuel rationing.	2.9	3.1
r. Solar HVAC systems are difficult to service.	3.0	3.3

Answers are on a 5-point scale, where: 1 = strongly agree
5 = strongly disagree

EXHIBIT 5-11

Financial Criteria Used in Evaluating
HVAC Systems for Clients

	<u>Percent Using</u>	
	<u>Architects</u>	<u>HVAC</u>
Payback Period	61.0	68.4
Net Present Value of Investment	30.0	27.0
Initial Investment Cost Only	6.1	1.7
Other	2.9	2.9

EXHIBIT 5-12

Criteria Used in Selecting HVAC Equipment
Threshold Acceptability

<u>Criterion</u>	<u>Median Level of Threshold Acceptability</u>		<u>Percent Using Criteria</u>	
	<u>Architects</u>	<u>HVAC</u>	<u>Architects</u>	<u>HVAC</u>
Minimum Life (Years)	10	10*	84%	77%
Minimum Warranty (Months)	12	12	84%	89%
Number of Prior Installations	3	5	41%	48%
Agree to Consider if No Prior Experience with Vendor	-	-	64%	53%
For Heating Minimum percent Conversion Efficiency	60%	75%	46%	50%
For Cooling, Minimum Coefficient of Performance	4.0	3.0	45%	44%
Minimum Profit Margin	8%	11%	48%	68%

* Read this as: "Half of HVAC professionals require at least a 10 year life for a system they will recommend."

EXHIBIT 5-13

Mean Importance Ratings for
Various HVAC Decision Criteria

	<u>HVAC</u>	<u>Architects</u>
Expected Life	1.45	1.36
Producer Reputation	1.37	1.40
Previous Experience with Producers' Products	1.65	1.59
Ease of Installation	1.57	1.61
Component Modularity	1.85	1.27
First Cost	1.57	1.56
Warranty Period	1.62	1.55
Maintenance Costs	1.38	1.26
Availability of Fuel	1.35	1.35
Future Fuel Costs	1.28	1.25

1 = highest importance
2 = moderate importance
3 = not important

standard error of the mean = .03 to .05

EXHIBIT 5-14

Number of Architects or Engineering
Professionals Employed by Firm

	<u>Architects</u>	<u>HVAC</u>
0 - 2	19.0%	38.3%
3 - 4	24.0	16.4
5 - 11	26.7	23.5
12 - 30	13.8	10.4
30 +	16.5	11.4

EXHIBIT 5-15

Mean Percentage of Business Associated with . . .

	<u>Architects</u>	<u>HVAC</u>
Municipal or Government Building	20%	16%
Hospitals	5%	6%
Industrial Buildings	11%	19%
Commercial Buildings	31%	37%
Multiple Family Residences	8%	5%
Single Family Residences	14%	10%
Other	11%	7%

EXHIBIT 5-16

Mean Geographic Breakdown
of Firms' Business

	<u>Architects</u>	<u>HVAC</u>
North East	32	36
South East	21	15
South West	28	32
North West	19	17

EXHIBIT 5-17

Age Distribution

	<u>Architects</u>	<u>HVAC</u>
Under 25	1%	3%
25 - 34	20%	25%
35 - 44	32%	24%
45 - 59	25%	29%
Over 55	22%	19%

D. ANALYSIS

1. HVAC Investment Criteria

Although a number of HVAC investment criteria were offered to the respondents, only three -- payback period, warranty period, and economic life -- were answered reliable enough, and by a sufficient subset of the population, to include in a model of HVAC investment criteria.

Exhibits 5-18, 5-19, and 5-20 give trade-off curves for the HVAC/architects sample. Prior to constructing these curves, the distributions were tested to see if they were consistent across the two populations and by user type. Although no significant differences were reported by HVAC vs. architects, differences were found by type of client/user:

- Government/hospital (Exhibit 5-18)
- Commercial/industrial (Exhibit 5-19)
- Residential (Exhibit 5-20)

The charts and curves are to be used as the following example illustrates:

What is the maximum market potential in the commercial - industrial market for a solar HVAC system with

- o a 36-month warranty
- o a 12-year economic life, and
- o a 12-year payback period?

The result is calculated by taking the entry in the third row and fifth column of Exhibit 5-19A (59.7) and multiplying it by the ordinate from Exhibit 5-19B that is associated with a 12-year payback (9%). The market potential for such a system would thus be

$$.09 \times 59.7 \text{ or } 5.4\%$$

EXHIBIT 5-18A

Government/Hospitals -- Trade-off Matrix

<u>Economic Life (years)</u>	<u>Warranty (months)</u>					
	<u>1 - 4</u>	<u>5 - 11</u>	<u>12 - 23</u>	<u>24 - 36</u>	<u>37 - 59</u>	<u>60 or more</u>
1 - 4	11.3	11.3	15.3	16.9	18.5	18.5
5 - 9	14.5	16.1	24.2	25.4	27.0	27.0
10 - 14	17.8	18.4	39.4	45.8	47.4	57.1
15 - 19	19.4	21.0	54.9	61.3	64.5	74.2
20 - 24	24.2	25.8	71.0	78.1	84.5	94.2
25 or more	24.2	25.8	74.2	82.3	88.7	100.0

EXHIBIT 5-18B

Government/Hospitals -- Trade-off Curve

EXHIBIT 5-19A

Commercial/Industrial -- Trade-off Matrix

<u>Economic Life (years)</u>	<u>Warranty (months)</u>					
	<u>1 - 4</u>	<u>5 - 11</u>	<u>12 - 23</u>	<u>24 - 36</u>	<u>37 - 59</u>	<u>60 or more</u>
1 - 4	6.3	6.9	18.8	20.5	22.2	24.4
5 - 9	9.1	10.3	33.0	37.0	38.7	42.0
10 - 14	12.5	13.7	51.2	58.0	60.5	71.0
15 - 19	13.6	15.3	56.8	63.6	65.8	80.1
20 - 24	15.9	18.2	69.3	76.1	78.9	96.6
25 or more	16.5	18.7	71.6	78.4	81.8	100.0

EXHIBIT 5-19B

Commercial/Industrial -- Trade-off Curve

EXHIBIT 5-20A

Residential -- Trade-off Matrix

<u>Economic Life (years)</u>	<u>Warranty (months)</u>					
	<u>1 - 4</u>	<u>5 - 11</u>	<u>12 - 23</u>	<u>24 - 36</u>	<u>37 - 59</u>	<u>60 or more</u>
1 - 4	5.0	11.7	18.4	20.1	21.8	23.3
5 - 9	6.7	15.0	33.3	40.0	45.0	48.3
10 - 14	8.3	18.3	45.0	55.0	61.7	66.7
15 - 19	10.0	20.0	51.7	68.4	76.7	83.3
20 - 24	11.7	21.7	56.7	73.4	81.7	95.0
25 or more	11.7	22.3	61.7	78.4	86.7	100.0

EXHIBIT 5-20B

Residential -- Trade-off Curve

The number calculated here (5.4%) represents an upper bound on the potential market for a solar HVAC system with the above shown characteristics. The actual market, as opposed to the potential market, that solar would see would depend on sellers' ability (a) to distribute solar systems, (b) to make potential buyers aware of the products and (c) to penetrate the market. The potential for any other combination of system characteristics can be calculated similarly.

2. The Structure of HVAC/Architect Attitudes

In the previous section, Exhibit 5-10 displayed the level of agreement or disagreement with a number of statements about solar energy made by the sample. Perceptual theory suggests that although a large number of questions can be asked about solar energy, concern can be summarized in a small number of hidden or latent factors. Thus, the observable or manifest variables are represented as a formation of a smaller number of latent factor variates.

The objective of our principal component analysis here is to find new axes that explain most of the variance in the data. The principal factor analysis approach is explained more fully in Appendix 1.

3. HVAC/Architects' Perceptions

Exhibit 5-21 gives the factor loadings for the builders' analysis, following a varimax rotation. A question here is whether HVAC's and architects used the same number of dimensions and perceptual structure to summarize their feelings about solar. That hypotheses was tested, using a procedure found in Choffray and Lilien (1980), Appendix 6.2. The hypothesis of different perceptual spaces was rejected at the .05 level.

EXHIBIT 5-21

The Structure of HVAC/Architect Attitudes

	<u>Factor 1</u>	<u>Factor 2</u>	<u>Factor 3</u>	<u>Factor 4</u>	<u>Factor 5</u>
a. HVAC manufacturers can currently produce cost effective solar energy systems.	0.024	0.180	-0.051	<u>0.736</u>	0.100
b. HVAC manufacturers can currently produce reliable and dependable solar energy systems.	-0.001	-0.005	-0.303	<u>0.766</u>	-0.051
c. If my firm recommended a solar HVAC system that proved less <u>economical</u> than we expected, it could harm our reputation.	<u>0.666</u>	-0.020	-0.035	-0.054	-0.031
d. If I, personally, recommended a solar HVAC system that proved less <u>economical</u> than projected, it could ruin my career.	0.838	0.010	0.176	0.034	0.125
e. If my firm recommended a solar HVAC that proved less <u>reliable</u> and <u>dependable</u> than projected, it could harm our reputation.	<u>0.749</u>	0.079	-0.065	0.034	-0.003
f. If I, personally, recommended a solar HVAC that proved less reliable and dependable than projected, it could ruin my career.	<u>0.782</u>	-0.029	0.157	-0.005	0.121
g. I find it interesting and exciting to be the first one in my area to try a new product.	-0.139	0.098	0.107	0.473	<u>-0.574</u>
h. My firm is known in the industry as one that only specifies or recommends systems that are "tried and true."	0.138	0.034	0.123	0.175	<u>0.759</u>
i. Solar-energy systems are a flash in the pan and will never be widely adopted.	0.094	<u>0.561</u>	0.079	-0.150	-0.021
j. Solar HVAC systems currently can produce reliable output.	0.084	0.365	-0.226	<u>0.367</u>	-0.131
k. Solar HVAC systems are too complex.	0.006	-0.100	<u>0.703</u>	0.020	0.022
l. Specifications of solar HVAC systems will lead to construction delays.	0.022	0.088	<u>0.706</u>	-0.037	0.093

EXHIBIT 5-21

The Structure of HVAC/Architect Attitudes (continued)

	<u>Factor 1</u>	<u>Factor 2</u>	<u>Factor 3</u>	<u>Factor 4</u>	<u>Factor 5</u>
m. Installing solar HVAC systems insures against power failures.	-0.023	<u>0.788</u>	0.052	0.069	0.002
n. A client with a solar HVAC system conveys a modern, innovative image.	0.115	<u>0.470</u>	-0.060	0.135	-0.444
o. Solar HVAC systems incorporate too many concepts that have not been fully tested.	0.108	0.039	<u>0.521</u>	-0.273	0.250
p. It is our patriotic duty to recommend the adoption of solar HVAC equipment.	-0.018	<u>0.711</u>	-0.130	0.111	-0.042
q. Solar HVAC systems protect against fuel rationing.	-0.094	<u>0.623</u>	0.059	0.213	0.045
r. Solar HVAC systems are difficult to service.	0.105	-0.004	<u>0.688</u>	-0.257	-0.211
Variance explained by the factor:	12.7%	11.9%	10.6%	9.3%	6.8%

To summarize the results here, we note that when thinking about issues that were important to HVAC's and architects when deciding about adopting solar, the issues could be grouped as follows:

F1: solar risk	Items c, d, and f
F2: solar citizenship	Items i, m, n, p, q
F3: solar problems	Items k, l, o, r
F4: solar readiness, believability	Items a, b, j
F5: personal innovativeness	Items g, h

These five factors represented 51.3 percent of the variance in the original set of 18 items.

4. Predicting Solar Recommendation

Let us use the perceptual variables and other individual variables to try to explain likelihood of solar recommendation. We asked each architect or HVAC consultant:

Q1: "Is it likely or unlikely that your firm will specify solar heating or cooling equipment for some application in the next year?"

and

Q5: "(As above). . . in the next five years?"

This question yielded stated intent to recommend as opposed to actual likelihood of recommendation. These stated intentions almost always overestimate actual likelihood. However, the two quantities are generally monotonically related (see Morrison, 1979, for some examples in a purchasing environment).

We thus tried to explain likelihood of future recommendation, knowing that our major objective was to determine the variables most closely related to stated likelihood, rather than to predict likelihood itself.

For our likelihood-of-recommendation scales, Q1 and Q5 were six-point scales, running from 1 = 100% certain to 6 = very unlikely. We transformed these variables to:

$$Q1^* = \frac{6 - Q1}{5} ; Q5^* = \frac{6 - Q5}{5}$$

or, roughly probability of purchase. We modeled Q1* and Q5* as

$$Q^* = \frac{1}{1 + e^{-\sum a_i x_i}}$$

i.e. as a logistic shape, where $[x_i]$ were independent variables.

We hypothesized the following:

- General hypotheses

The likelihood of recommending solar was related to

- past specification history,
- solar attitudes,
- region, and
- personal/firm characteristics.

- Particular hypotheses:

Solar intent to install would be greater:

- for past specifiers;
- for architects than for HVAC consultants;
- for individuals who had actively sought solar information in the past;

- for individuals who used payback-period calculations in selecting equipment, as opposed to first cost only;
- for older individuals, who were more likely to be seeking a "change" from historical patterns of recommendation;
- if the individual was located in the South, the North East, or the South West;
- if the individual's "solar citizenship" was high;
- if he felt the problems of solar were unimportant;
- if he believed in solar readiness; and
- if he was personally innovative.

Prior to studying these relationships, it is necessary to consider if:

- (a) the equations and coefficients for architects and HVAC consultants were the same, and
- (b) there were significant regional differences in the structure of the equation.

To test for these effects, we checked to see if there was a statistical "loss" (of fit) in combining the data into a single equation, or whether separate equations were required for each subgroup.

The results showed that we could not reject the hypothesis of equality of coefficients at the .05 or even the .25 level. This suggested that we could analyze our data in a single equation.

Exhibit 5-22 gives the results of the analysis. An ordinary least squares regression was used on a pair of transformed variables:

$$P1 = \ln \left(\frac{Q1* + .5}{1.5 - Q1*} \right) ; P5 = \ln \left(\frac{Q5* + .5}{1.5 - Q5*} \right) ;$$

The normality of the residuals showed that the use of ordinary least squares was acceptable.

EXHIBIT 5-22

Probability of Installing Solar
for HVAC Consultants and Architects

	Likelihood of in Next Year		Likelihood of in Next Five Years	
	<u>coefficient</u>	<u>t-stat</u>	<u>coefficient</u>	<u>t-stat</u>
Intercept	-.69	-4.89	.13	1.18
F ₂	-.130	-4.01	-.133	-5.44
F ₃	.097	3.15	.086	3.71
F ₄	-.095	-2.83	-.054	-2.11
F ₅	.076	2.37	.023	.92
ARCH	.25	3.96	.21	4.28
Active	.294	3.63	.21	3.36
Spec	.516	7.81	.27	5.32
Payback	.075	1.17	.048	.97
Age	.078	2.38	.018	.74
	R ² = .39		R ² = .37	
	n = 278		n = 278	

Exhibit 5-23 defines the variables used in the equation and Exhibit 5-24 gives the means and standard deviations of the variables.

Note that most of the coefficients were significant at conventional levels of significance and that most of the earlier hypotheses were confirmed by the analysis. Of interest is the fact that we did not find any significant regional differences -- the differences in attitudes could be explained by past specification or search behavior.

In comparing the two equations, we note:

- (a) the relative importance of the dependent variables was changed little between the equations;
- (b) likelihood of specifying in 5 years was much higher than in one year (as seen by the higher intercept); and
- (c) only the coefficient of solar citizenship was much higher for the 5-year equation than for the one-year equation.

Let us consider, now, the likelihood of specifying solar in the one-year equation. Here, the t-statistics gave a rough yardstick of the importance of each of the independent variables in predicting future specification patterns. The independent variables could be classified into three categories of importance.

- Highest importance

- past specifier (SPEC)
- solar citizenship (F2)

An individual's past actions were his best indicator of future intentions. Solar citizenship (see Section 5.D.1 for details) was the most important attitude variable associated with solar specification items.

EXHIBIT 5-23

Variable Defining -- Probability of Recommending
Solar by HVAC Consultants and Architects

Dependent variables:

$$P1 = \ln \left[\frac{Q1* + .5}{1.5 - Q1*} \right]$$

$$P5 = \ln \left[\frac{Q5* + .5}{1.5 - Q5*} \right]$$

where Q1*, Q5* are the probabilities of installing
in 1 year and 5 years respectively.

F2 = Respondent's rating on "solar citizenship".

F3 = Respondents belief about the depth of solar problems.

F4 = Respondents attitude toward the believability of solar
energy and solar readiness.

F5 = Personal innovativeness of the respondent.

ARCH = $\begin{cases} 1 & \text{if respondent is an architect} \\ 0 & \text{if respondent is an HVAC consultant} \end{cases}$

Active = $\begin{cases} 1 & \text{if respondent has actively sought information} \\ & \text{about solar energy} \\ 0 & \text{otherwise} \end{cases}$

SPEC = $\begin{cases} 1 & \text{if respondent has specified solar energy for} \\ & \text{some application} \\ 0 & \text{otherwise} \end{cases}$

Paybacks = $\begin{cases} 1 & \text{if payback or a net present value method of} \\ & \text{evaluation is used for HVAC systems by the} \\ & \text{respondent} \\ 0 & \text{if initial investment cost only is used} \end{cases}$

Age = age category of the respondent:

- 1 = under 25
- 2 = 25 - 34
- 3 = 35 - 44
- 4 = 45 - 50
- 5 = over 55

EXHIBIT 5-24

Means and Standard Deviations
of Variables Used in the Equation

<u>Variable</u>	<u>Mean</u>	<u>Standard Deviation</u>
P1	.226	.640
P5	.643	.468
F2	-.199	.96
F3	-.036	.99
F4	.097	.91
F5	-.032	1.03
ARCH	.565	.50
Active	.806	.39
Spec	.448	.498
Payback	.640	.481
Age	3.35	1.07

Intermediate importance

Four variables were of roughly equal importance, somewhat below the first group:

- architect indicator
- active seeker
- solar problems perception(F3)
- solar believability (F4)

Architects, as a group, were considerably more prosolar than HVAC consultants. This went even beyond their more active "solar-citizenship" position. Individuals who had actively sought information about solar energy were highly disposed to be specifiers in the future. In terms of attitude, those who perceived solar problems as relatively unimportant and who believed that solar was ready were strongly disposed to be specifiers as well.

• Lesser importance

The last three variables were of lesser importance in predicting specification behaviors.

- personal innovativeness (F5)
- age
- payback

Individuals who were personally innovative were more likely to specify solar in the short term. Older professionals were more likely to specify solar, and professionals who used payback or net present-value method for evaluating HVAC alternatives were more likely to specify solar than those who used first cost only.

We conclude that although there was much unexplained variability, some due to inherent measurement variation, a single model has been developed that isolates key variables explaining the likelihood of specifying solar by HVAC consultants and architects.

E. CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

The analysis of the responses of architects and HVAC engineers is quite interesting since they exert strong influence in the selection of HVAC equipment, though they do not actually purchase equipment. The data and analysis presented in this chapter lead to the following conclusions.

- (1) HVAC's and architects were well aware of solar energy and understood solar merits. In fact, over a third of the sample specified a solar-energy system for some application.
- (2) Architects were more prosolar than HVAC's; the key difference in solar receptivity was linked to belief in the need for solar to lead the nation to energy independence.
- (3) The most common economic criterion used was payback period. To be acceptable to half of the individuals, a 10-year life and a 12-month warranty were required.
- (4) The key criteria for HVAC decisions were, interestingly, maintenance cost and fuel costs, with initial cost being rated as of lesser importance.
- (5) In terms of likelihood of recommending solar, the key indicators were
 - (a) past action - past specifier,
 - (b) solar citizenship ("Is solar an answer to our energy problem?"),
 - (c) profession (architect or not), and
 - (d) perception or belief about solar.

2. Recommendations

The HVAC/architect group is of critical importance in influencing HVAC decisions. The product must be designed to meet their needs and they must be convinced of solar viability. They are aware of solar as a group and know it works.

Product Design

The payback period on solar is critical for recommendation. It must be short, (3 to 5 years), although some applications permit long economic lives. Systems should have at least a 12-month warranty and last at least 12 to 15 years to be viable. The system must be designed to provide few or no problems in terms of maintenance. Maintenance problems eliminate a solar system from further recommendation considerations.

Communications

There are several key perceptual variables that relate closely to solar recommendation. To influence this group, it must be convinced that solar is (a) an important technology and (b) a valuable way of achieving energy independence. Individuals must also be convinced that solar is "here", that it is a currently viable technology leading to few problems.

The communication of these messages is a big job. Nonetheless, these perceptual variables explain about half the variance in the likelihood of purchase equations -- they represent critical roadblocks on the path to solar recommendation.

SECTION SIX
BUILDER/DEVELOPERS

A. INTRODUCTION

According to the Project Independence Report, over 8 million single-family dwellings will be added to the U.S. residential inventory during the 1980's. Most of these dwellings will be built by the over 300 thousand "construction" establishments that report having a payroll. The industry is not highly concentrated -- half the establishments build 20 homes or fewer per year. The sheer numbers of establishments and their diversity presents an important challenge to penetration by the solar-energy industry.

The objective of our study of builder/developers is to develop a baseline of:

- awareness or use of solar-energy products and the availability of government incentives,
- history of solar installation and behavioral or organizational correlates,
- plans or likelihood of future solar installations,
- current attitudes and opinions about solar, and
- a demographic profile of the solar installer or non-installer.

Following a description of the data and its analysis, this section concludes with a series of recommendations for making solar HVAC systems more attractive to builder/developer.

B. MEASUREMENTS

1. Instrument Design and Pretest

The questionnaire for home builders was designed for face-to-face administration at the 1980 NAHB Exposition. This method of administration was selected as the most cost-effective means of reaching a large cross-section of the target audience, since early work indicated that there would be substantial difficulty in trying to reach builders by telephone and in getting them to spend more than a few minutes with the interviewer. Questions were included in the survey to obtain data about builders':

- awareness or use of solar and government incentives,
- history of solar installations,
- plans or likelihood of future solar installations,
- attitudes and opinions about solar,
- views of clients' opinions about solar, and
- "demographics," including firm size, location, markets and job responsibilities.

Because of the personal interviewing method used in the administration, several questions included visual aids to display various scales, lists of criteria, and so on.

The questionnaire was reviewed by several architect/builders in the Boston area, and was pretested on a small sample of 12 Eastern Massachusetts builders. The review and pretest led to several changes of language in certain questions, making those questions more specific through use of vocabulary standard in the building trade.

2. Sample Selection

Interviews were conducted with 256 builder-attendees at the National Association of Home Builders Exposition in Las Vegas, Nevada, January 18 to 21, 1980. Attendees were screened to be certain that they or their firm built single-family residential homes on speculation. Mobile-home-only firms were not interviewed.

The sample was thus drawn from a show audience of 9,622 single family residential builders. At least one percent of this number came from each of 37 states and the District of Columbia. The number of single-family dwelling units completed by the attendees broken down by size is shown in Exhibit 6-1, and the size of their firms, broken down by number of employees, is shown in Exhibit 6-2. In addition, the builders reported an average sales volume in 1979 of \$7.2 million, against average building materials purchased in 1979 at \$2.8 million. (The sales and material costs reported were somewhat higher than single-family residences would account for, since apartment builders were included in these figures.)

3. Questionnaire Administration

Dialogue leased a 10 by 20 foot booth at the exposition. Signs indicated that the booth was being used for a study of builders' opinions about solar energy, and gave a general description of the study. Attendees were intercepted in front of the booth, screened (see above) and, if qualified, invited to participate. If an individual agreed he or she was brought into the booth and seated with an interviewer, who then went through the questionnaire with him or her. Responses were entered on a precoded questionnaire form. The interview took between 25 and 45 minutes, depending on the individual being interviewed.

The booth itself was set up with eight interview stations. A ninth interviewer worked to intercept individuals as they passed the booth. The interviewers were thoroughly instructed in the administration of the questionnaire by Dialogue personnel during a session held before the opening of the exposition. Interviewers were then asked to administer the questionnaire to each other while the Dialogue staff listened in, and then made comments and suggestions. As a result the interviewers understood many of the issues that Dialogue was trying to address in the questionnaire and were better able to deal with those issues when a respondent had a problem understanding what was being asked. In addition, a Dialogue representative remained at the booth throughout the exposition to assist interviewers, answer additional questions as they arose, maintain a general consistency of asking questions across interviewers, and generally to insure that the interviewing was performed at a high level of quality.

Interviewers were provided by Las Vegas Research and Demonstration Services, 400 North Norlen Street, Las Vegas, Nevada, 89107.

At the conclusion of the interview, respondents were offered a summary of the results if they wished them and were asked to agree to provide names of new-home buyers in their area for the residential new-home portion of the study.

Completed interviews were returned to Dialogue, where they were examined for completeness and consistency, and where all necessary coding was done. The data was then keypunched, 100-percent verified, and placed on tape for computer analysis.

EXHIBIT 6-1

Number of Single-family Units Completed in 1979

1 - 5	20%
6 - 10	16
11 - 25	26
26 - 50	17
51 and over	<u>21</u>
	100%

EXHIBIT 6-2

Size of Builders' Firms

Number of Employees

1 - 19	60%
20 - 49	15
50 - 249	16
250 or more	<u>9</u>
	100%

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6-4b

C. DATA DESCRIPTION

The builders' study was aimed at examining builders' reactions to major solar technologies. The objective was to determine solar awareness, perceived advantages and barriers to solar, to map builders' understanding of market forces and to find out builders' expectations of how solar would impact in their industry.

The study included responses from 256 builders. In the data description that follows, n, the sample size, refers to that number of builders who responded to the particular question (generally less than 256).

Exhibit 6-3 gives the number of single-family homes, both spec built and custom, but excluding mobile homes, that the builder's company built in 1979. The distribution corresponds well to census bureau statistics of the housing industry; 75% of the sample built 47 or fewer homes in 1979 while the top one percent of the sample built between 1700 and 6100 homes.

The average builder built two-thirds of his houses on speculation. The range of responses indicated that the percent of spec-built houses varied for our sample from zero to 100%.

The residential construction volume for these builders also varied widely, from the 3% of the respondents who reported no residential construction sale volume at the low end, to a high of \$800,000,000. The median reported volume was \$1.2 million and the mean volume was \$20 million.

Exhibit 6-4 shows the regional breakdown of the sample by the four U.S. census regions. Here our sample was weighted somewhat in favor of the Southwest, reflecting the heavier new-home construction volume there.

Exhibit 6-5 gives the breakdown of home building types, with the sample reflecting a tendency toward building middle-priced houses.

Exhibit 6-6 reflects the most usual selling price of a spec-built house as reported by the sample. The two most frequently noted ranges were \$50K to \$70K and \$70K to \$90K respectively.

In terms of the primary kind of fuel used for space heating in spec-built homes, gas was the most common; 53% of the respondents reported using gas, 40% reported using electricity, and most of the rest reported using oil. For heating hot water, 54% reported gas, 42% reported electricity, 20% reported oil, and 2% reported solar.

The respondents reported the installation of a central air conditioning system in 65% of the homes. In addition, 60% of the respondents reported having installed a heat pump.

In terms of installing active solar-energy systems, 22% of the sample reported having installed a solar-energy system, 55% reported having considered installing, but not actually installing a solar-energy system, and 23% reported never having considered installing a solar-energy system. Exhibit 6-7 gives the details, including the solar product that was actually installed. Far and away the most common solar product, with 85% of solar installers reporting, was an active solar water heater.

In addition, Exhibit 6-7 notes that 75% of past installers planned to install again.

Of the 256 builder/developers interviewed, 55 had installed some form of active solar-energy system. The type of equipment used, satisfaction level experienced and problems encountered are summarized below.

Let us consider the responses of those 55 builder/developers who had installed solar. The 48 who had installed solar water heaters mentioned the manufacturers listed in Exhibit 6-8.

When asked about problems with systems, some typical comments were:

"Back-up system failed to work; the company was out of business. I had to put up my own money, around \$200."

"Contractor went out of business. The solenoids were not functioning properly and when the power went off the water backed up and flooded the house."

"It's a controller malfunction. Have trouble getting the parts for the system - on order and still waiting."

"Lack of adequate information and instructions from manufacturer."

Other concerns expressed included leaks, freezing, control systems failure, installation problems, and lack of maintenance on the part of home owners.

The satisfaction levels of the respondents showed 74% being either very or moderately satisfied.

For pool heaters, the only manufacturer mentioned was Solaron, with all respondents reportedly either very or moderately satisfied.

Exhibit 6-9 gives the responses of solar space-heating installers, with 38% reporting being either very or moderately satisfied with the system.

Some comments about the installations included:

"Condensation of insulated glazing units"

"Control box that continued to burn out.
Replaced boxes three times and finally
lost interest."

Finally, Exhibit 6-10 details the responses of the solar-assisted heat pump installers, half of whom reported being either very or moderately satisfied with the system.

Some comments about the heat-pump system included:

"Water would freeze; back up in system that worked perfectly."

"Mechanical failure (of heat pump)."

For the solar installers as a group, 22% reported using some kind of federal or state incentives to reduce their own cost of installation of solar. 42% reported that home owners used some form of incentive to reduce the cost of purchasing the home. For 68% of the home buyers who relied on government incentive, the builders felt the incentive was either very or moderately important in getting the purchaser to buy the house.

For their most recently spec-built solar house, 42% of the builders reported doing some form of fuel-savings analysis. Exhibit 6-11 shows that payback analysis was by far the most common form used by builders who did do some form of analysis.

For noninstallers, Exhibit 6-12A shows the reported availability of solar systems in the builders' area. Most reported that solar water heaters at least were available there. Most also seemed to feel they knew how solar systems worked (see Exhibit 6-12B).

Now let us consider some differences between the several groups: the installers, considerers, and those who had not considered. Exhibit 6-13 indicates that installers were proportionally more likely to be

found in the South, including the Southeast and the Southwest.

Installers tended to be larger builders, with a greater number of units, and to be builders of luxury homes. Installers also gave a much higher stated probability of installing again in 1980.

Exhibit 6-14 gives the attitudes of builder/developers toward solar energy on five key questions. Installers tended to believe that solar was reliable and economical more than the other groups, and they also believed it would be widely used in the next five years. Finally, no major patterns were seen in the differences between the groups in whether it was easy to get financing for solar or whether solar would be here today and gone tomorrow.

Next, Exhibit 6-15 gives the results of a question on the marketability of a house with a solar system. Most builders felt that \$3500 added to the market price of a home would make the home somewhat difficult to sell; they were even less optimistic about selling a home with an \$8500 solar space and water heating system built in. In both these cases, the prior installers were more optimistic about the marketability of the homes than the noninstallers.

Now let us consider the builders' attitudes toward solar demand in the area. Exhibit 6-16 suggests that 32% of the builders perceived a moderate or strong demand for solar water heaters, while 14% felt there was moderate or strong demand for solar space-heating systems.

Exhibit 6-17 gives the criteria that builders found important when considering the use of a solar-energy system on a house. The issues of most importance, as stated by builders, seemed to be reliability of

equipment and ease of installation. Of least importance was the profit margin on the system and the use of equipment by other builders in the area.

Exhibit 6-18 reflects what builders felt consumers found important in considering solar. The top priority items were yearly savings, operating cost and initial cost. Builders in general felt consumers were not overly concerned about good citizenship and the effect on the environment.

In addition to these items, builders gave the following other criteria that they thought their customers used:

Prestige/"keeping up with the Jones's"	6 mentions
Government tax incentives	6 "
Convenience, low maintenance	3 "
Efficiency standards, comparative efficiency	3 "
Access to direct sunlight	3 "
Quick, reliable repair service	2 "
Recommendation/reputation of builder/developer	2 "
Simplicity of system, how it works	1 "
Education program part of buyer package	1 "
Buying from one dealer, not in parts	1 "
Unaccessibility of collectors to vandalism	1 "

Exhibit 6-19 shows responses when the builder was asked to place himself in the position of a solar product manufacturer. In that situation, keeping a fixed marketing budget in mind, builders were asked what they would do to increase sales. The three most important marketer actions seen by the builders were to improve system performance, to have the product certified, and to advertise financial benefits. Items seen of least importance were to sell components only, to advertise nonfinancial benefits and build sturdier collectors.

In addition to the above, respondents volunteered the following recommendations to solar manufacturers:

More product/market research	6 mentions
Reduction of price (respondents mentioned this even though it was one of the choices they already decided on importance of)	6 "
Obtaining government backing/subsidies, tax incentives	5 "
Proof of product; dependability studies (i.e. from certified utility suppliers, UL)	3 "
Providing additional financing/a "solar bank," specifically for loans for solar products	3 "
Providing better information dissemination	3 "
Adopting industry-wide restriction and acceptance codes	2 "
Using testimonials from other users in ads	2 "
Remaining independent of utility companies	1 "
Controlling installation	1 "
Promoting lower-technology systems	1 "
Stressing increased value of home	1 "
Talking to local NAHB associations	1 "

Finally, we have some information about the respondents. Exhibit 6-20 gives the principal job responsibility of the respondent. Most indicated that construction management or general management was their major responsibility. Exhibit 6-21 shows information on the designers of spec-built houses, controlled primarily by the respondents and outside architects. Exhibit 6-22 suggests that the builder was the primary decision maker for energy systems.

Exhibit 6-23 shows who was of secondary importance in the selection of an energy system. Outside contractors appeared to be the only important secondary influences in the selection of energy systems.

Exhibit 6-24 shows builders' attitudes toward keeping up with new developments in solar cooling and solar-assisted heat-pump technology. Most builders agreed that it was worth their while to keep up with these new developments.

Finally, Exhibit 6-25 shows the technical or trade periodicals this group read most regularly. Professional Builders, Home Building, Housing, and Home headed the list.

EXHIBIT 6-3

Number of Homes Built in 1979

Percent of group		Number of homes
25		0 - 8
25		9 - 20
25		21 - 47
25	20	48 - 300
	4	300 - 1700
	1	1700 - 6100

mean = 111

median = 20

n = 256

EXHIBIT 6-4

Regional Building Breakdown, by Main Region

23%	North East
18%	South East
26%	North West
33%	South West

EXHIBIT 6-5

Home Building-type Breakdown

Entry-Level Houses	23%
Middle-Price Houses	44%
Luxury Houses	33%

EXHIBIT 6-6

Purchase Price of a Typical Spec-built House

\$ 30 - 50K	14%
50 - 70K	31%
70 - 90K	23%
90 - 110K	9%
110 - 130K	8%
130 - 150K	5%
150K+	10%

EXHIBIT 6-7

Solar Energy Installation

EXHIBIT 6-8

Solar Water-heater Installers

Manufacturers Mentioned

Rheem - Rudd
Smith
State Manufacturer
Southwest Enertech
Grumman
Revere/National Homes
Heliotherm
Geottle
Solar One
Mor-Flo Industries
Reynolds Aluminum (plate collectors)
Solar Hart
Energy Systems, Inc.
Solar Services
Sunstream (tank)
Solaron

Satisfaction Levels

Percent of Respondents

Very satisfied -	48%
Moderately satisfied -	26%
Neither satisfied nor dissatisfied -	11%
Moderately dissatisfied -	7%
Very dissatisfied -	8%

EXHIBIT 6-9

Solar Space-heating Installers

Manufacturers Mentioned

Solaron
Mor Flo
Energy Systems, Inc.
Grumman
Colorado Solar Air
Solar Tech

(n = 13)

Satisfaction Levels

Percent of Respondents

Very satisfied -	15%
Moderately satisfied -	23%
Neither satisfied nor dissatisfied -	30%
Moderately satisfied -	23%
Very dissatisfied -	9%

EXHIBIT 6-10

Solar-assisted Heat-pump Installers

Manufacturers Mentioned

Carrier
Trane
Singer
Colorado Solar Air

Satisfaction Level

Percent of Respondents

Very satisfied -	13%
Moderately satisfied -	37%
Neither satisfied/dissatisfied -	13%
Moderately dissatisfied -	13%
Very dissatisfied -	24%

EXHIBIT 6-11

Type of Savings Analysis Reported Done for Spec-built Homes

Fuel Savings/Year	38%
Payback Analysis	76%
Cash Flow Analysis	14%
Other	15%

Multiple mentions lead to a sum
greater than 100%

n = 21

EXHIBIT 6-12A

Reported Availability of a Solar System

(Noninstallers) n = 201

Solar Water Heating	67%
Solar Space Heating	53%
Solar Assisted Heat Pumps	31%
None	

EXHIBIT 6-12B

Reported Knowledge about the System

(Noninstallers)

"I know a lot about ..."

Solar Water Heating	2.6*
Solar Space Heating	2.6
Solar Assisted Heat Pump	2.8

1= Strongly agree

5= Strongly disagree

EXHIBIT 6-13

Some Builder/Developer Group Differences

Region:	<u>Installed Active Solar</u>	<u>Considered (But not Installed)</u>	<u>Not Considered</u>
Percent in North East	21	27	24
South East	20	14	21
North West	18	25	34
South West	<u>41</u>	<u>34</u>	<u>21</u>
	100	100	100
Size (Median Number of Units, 1979)	26	20	18
Percent Luxury Homes	33	26	26
Probability of Installing, 1980	80%	30%	10%

EXHIBIT 6-14

Attitudes of Builders toward Solar

	A Installed	B Considered	C Not Considered
Can solar equipment for home use be obtained?	2.8	2.6	2.4
Does solar make economical sense for home use?	2.5	1.9	1.8
Can easy financing for a solar purchase be arranged?	2.0	1.9	1.9
Are solar manufacturers mostly small, "here-today, gone-tomorrow" companies?	2.2	2.0	2.3
Will solar be widely used within 5 years?	2.5	2.3	2.1

Results on a scale of 1-5, 1 = strongly disagree

.
.
.

5 = strongly agree

EXHIBIT 6-15

Attitudes toward the Marketability of Solar Homes

	<u>Installed</u>	<u>Considered</u>	<u>Not Considered</u>
Ability to sell a home with a \$3,500 solar water heater.	2.9*	3.1	2.9
Ability to sell a home with a \$8,500 space heater.	2.4*	2.2	2.1

* 1-7 scale, 1 = no demand

4 = demand unaffected

7 = can sell immediately

EXHIBIT 6-16

Builders' Impression of Solar Demand

	<u>Strong Demand</u>	<u>Moderate Demand</u>	<u>Slight Demand</u>	<u>No Demand</u>
Solar Water Heating	7%	25%	50%	18%
Solar Space Heating System	4%	10%	55%	31%

(n = 250)

EXHIBIT 6-17

Builders' Criteria in Considering Using Solar Equipment for a Spec-built Home

	<u>top</u> <u>priority</u>	<u>high</u> <u>priority</u>	<u>medium</u> <u>priority</u>	<u>low</u> <u>priority</u>
1. Profit margin on solar equipment	10%	12%	47%	31%
2. Performance reliability of solar equipment	65	26	5	4
3. Ease of installation	31	45	18	6
4. Amount of change from usual building schedules	16	35	37	12
5. Likely customer demand for solar equipped houses	29	36	23	12
6. Installation of solar equipment by other builders in the area	5	15	38	42
7. Building regulations	23	24	25	28
8. Availability of solar equipment	36	36	18	10
9. Willingness of subcontractors to participate in solar installation	27	32	23	18
10. Reliability of suppliers	54	28	10	8
11. Availability of fully integrated solar equipment	37	34	19	10
12. Government certification of solar equipment	23	20	24	33

EXHIBIT 6-18

Builders' Perceptions of What Consumers Find Most Important
When Considering Solar for Their Home

	<u>top</u> <u>priority</u>	<u>high</u> <u>priority</u>	<u>medium</u> <u>priority</u>	<u>low</u> <u>priority</u>
1. System's expected life	41%	44%	13%	2%
2. Initial cost	55	34	10	1
3. Warranty period	46	38	14	2
4. Operating and maintenance cost	53	36	9	2
5. Number of successful installations	26	35	28	11
6. Payback period	45	35	16	4
7. Effect on home appearance	19	36	35	10
8. Yearly savings on energy costs	64	27	7	2
9. Effect on the environment	11	19	35	35
10. Good citizenship	8	13	28	51
11. Protection from fuel shortages	34	35	21	10

EXHIBIT 6-19

Builders' Recommendations for Solar Marketers' Actions

(What Builders Would Do as Solar Marketers)

	<u>would</u> <u>definitely</u> <u>do</u>	<u>would</u> <u>probably</u> <u>do</u>	<u>might or</u> <u>might</u> <u>not do</u>	<u>would</u> <u>not do</u>
1. Install demonstration units	45%	34%	19%	101%
2. Avertise nonfinancial benefits (energy independence, and so on)	25	32	32	11
3. Sell components only	11	19	39	31
4. Advertise financial benefits	57	31	9	3
5. Reduce price	23	28	33	16
6. Lengthen warranty	24	33	36	7
7. Sell integrated systems	39	38	19	4
8. Provide how-to workshops for installers	52	30	13	5
9. Sell directly to the builder or enduser	38	30	22	10
10. Build sturdier collectors	24	40	31	101
11. Improve system performance	62	28	9	1
12. Sell through local distributors	33	34	23	10
13. Advertise in trade publications	39	34	22	5
14. Have my product certified by the appropriate agencies	61	22	10	7
15. Advertise to the general public	52	31	12	5

EXHIBIT 6-20

Principal Job Responsibility of Respondent*

Construction Management	23%
Sales/Marketing Management	6%
Technical Management/Engineering	2%
Financial Responsibilities	5%
Procurement or Purchasing	2%
General Management	12%
Other	4%

* Percent of sample who spent 50% or more of their time on this task. (Note that most respondents split their time between these tasks so that the sum is well under 100%.)

EXHIBIT 6-21

Who Designs Spec-built Single-family Homes?

Respondent	53%
Staff Architect	14%
Outside Architect	41%
Other	12%

EXHIBIT 6-22

Who Chooses Energy System Installed in Spec-built Home?

Respondent	81%
Staff Engineer	4%
Outside Engineer	4%
HVAC Contractor	8%
Other	18%

Note: Multiple mentions make sum greater than 100%.

EXHIBIT 6-23

Who Else is Involved in the Decision-making Process for Energy Systems (Secondary Influences)

No One	44%
Staff Architect	4%
Outside Architect	4%
Firms Owners/Officers	10%
Legal/Financial Staff	4%
Contractors	16%

EXHIBIT 6-24

Interest in Keeping Abreast of New Energy Systems

	<u>Would Definitely Be Worthwhile</u>	<u>Would Be Moderately Worthwhile</u>	<u>Would Be Slightly Worthwhile</u>	<u>Would Not Be Worthwhile</u>
Solar Assisted Heat Pump Technology	66%	20%	7%	7%
Solar Cooling Technology	56%	18%	13%	13%

EXHIBIT 6-25

Technical and Trade Publication Read Most Regularly

<u>Professional Builder</u>	73%
<u>Commercial Building</u>	8%
<u>Home Building</u>	35%
<u>Housing</u>	55%
<u>Builder</u>	35%
<u>Multi-Family (News)</u>	2%
<u>House & Home</u>	2%
<u>Solar Age</u>	2%
<u>Practical Building</u>	1%
<u>Multi-Houses</u>	1%
<u>Hudson Publications</u>	1%

D. ANALYSIS

1. The Structure of Builders' Attitudes

In the previous section we described builders' attitudes toward what is important to themselves in choosing solar, what they felt were important to consumers, and what they felt were appropriate marketer actions. Perceptual theory suggests that, although between 11 and 15 concerns were mentioned in each case, these concerns can be summarized in a smaller number of hidden or latent factors. In other words, the observable or manifest variables are represented as function of a smaller number of latent factor variates.

Let us consider, for instance, the interrelationships among a set of a dozen items: the purpose of principal component analysis is to find a small number of axes which capture most of the information in the original variables (see Appendix 1 for details).

Builders' Perceptions

Exhibit 6-26 gives the factor loadings for the builders' analysis following a varimax rotation.

In summarizing builders' perceptual patterns, we note that the issues important to builders when deciding whether to adopt solar can be grouped as follows:

B1: Reliability	Items 2, 10, 11
B2: Area receptivity	Items 5, 6, 8, 9
B3: Ease of installation	Items 3, 4
B4: Regulations	Items 7, 12
B5: Profit margin	Item 1

These five factors represent 66.7% of the variance in the original set of 12 items.

EXHIBIT 6-26

The Structure of Builders' Perceptions

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
1. Profit margin on solar equipment	0.052	0.062	-0.003	0.091	<u>0.966</u>
2. Performance reliability of solar equipment	<u>0.761</u>	0.011	0.229	-0.046	0.017
3. Ease of installation	0.358	-0.057	<u>0.743</u>	0.119	-0.062
4. Amount of change from usual building schedules	-0.045	0.185	<u>0.839</u>	0.024	0.051
5. Likely customer demand for solar equipped houses	0.253	<u>0.688</u>	0.035	-0.162	0.111
6. Installation of solar equipment by other builders in the area	-0.149	<u>0.732</u>	-0.037	0.254	-0.122
7. Building regulations	0.063	0.421	0.053	<u>0.555</u>	0.216
8. Availability of solar equipment	0.474	<u>0.544</u>	0.143	0.097	0.112
9. Willingness of subcontractors to participate in solar installation	0.398	<u>0.597</u>	0.204	0.050	0.085
10. Reliability of suppliers	<u>0.791</u>	0.249	0.144	-0.092	0.086
11. Availability of fully integrated solar equipment	<u>0.724</u>	0.126	-0.146	0.264	-0.022
12. Government certification of solar equipment	0.043	-0.039	0.084	<u>0.851</u>	0.002

Variance explained by the factor

Builders' Attitudes about Consumers' Criteria

Builders were asked 11 questions about what criteria they thought their customers used when considering the purchase of a solar system. Exhibit 6-27 gives the factor loadings for the consumers' analysis following a varimax rotation. The following three dimensions emerged from this analysis:

C1: Reliability	Items 1, 3, 4, 5
C2: Good citizenship	Items 9, 10, 11
C3: Economics	Items 6, 8

Home appearance, Item 7, was omitted from factor analysis due to its poor distributional properties.

These three factors represented 49.8 percent of the variance in the original set of items.

Recommendations for Manufacturer Action

Finally, builders were asked what they would do if they were a solar product manufacturer. Exhibit 6-28 gives the factor loadings for that analysis, following a varimax rotation.

The recommendations to solar product manufacturers can be grouped as follows:

MF1: Advertising	Items 2, 4, 13, 15
MF2: Improving performance	Items 10, 11
MF3: Improving terms	Items 1, 5, 6
MF4: Making builder's job easier	Items 7, 8
MF5: Distribution system	Items 9, 12

Two original items, "see components only" and "have product certified," were omitted because of poor distributional properties.

These five factors explained 61% of the original variance between the items. (These factor analysis results were generally confirmed independently by using a hierarchical cluster - analysis procedure.)

EXHIBIT 6-27

The Structure of Builders' Perceptions about Consumer Attitudes

	Factor 1	Factor 2	Factor 3
1. System's expected life	<u>0.805</u>	0.039	0.020
2. Initial cost	-0.066	-0.040	<u>0.684</u>
3. Warranty period	<u>0.518</u>	0.157	0.313
4. Operating and maintenance cost	<u>0.582</u>	0.099	0.239
5. Number of successful installations	<u>0.744</u>	0.180	-0.080
6. Payback period	0.286	0.006	<u>0.612</u>
8. Yearly savings on energy costs	0.115	0.140	<u>0.759</u>
9. Effect on the environment	0.117	<u>0.811</u>	0.131
10. Good citizenship	0.052	<u>0.877</u>	-0.054
11. Protection from fuel shortages	0.184	<u>0.634</u>	0.038
Variance explained by the factor	17.8	17.4	14.6

Note; Item 7 was omitted due to its uninterpretable distribution.

EXHIBIT 6-28

The Structure of Builders' Perceptions of
Recommendations to Solar Product Manufacturers

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
1. Install demonstration units	0.015	0.031	<u>0.582</u>	0.198	0.120
2. Advertise non-financial benefits (energy independence, etc.)	<u>0.587</u>	0.284	0.082	-0.061	0.039
4. Advertise financial benefits	<u>0.753</u>	-0.112	0.083	0.066	-0.035
5. Reduce price	0.162	0.010	<u>0.820</u>	-0.179	-0.045
6. Lengthen warranty	0.176	0.281	<u>0.653</u>	0.331	-0.032
7. Sell integrated systems	-0.009	0.029	0.151	<u>0.837</u>	0.068
8. Provide how-to workshops for installers	0.224	0.174	0.036	<u>0.694</u>	-0.060
9. Sell directly to the builder for installers	0.270	0.136	-0.092	0.138	<u>-0.695</u>
10. Build sturdier collectors	0.183	<u>0.860</u>	0.118	-0.005	-0.004
11. Improve system performance	0.050	<u>0.804</u>	0.060	0.235	0.035
12. Sell through local distributors	0.211	0.135	-0.016	0.101	<u>0.803</u>
13. Advertise in trade publications	<u>0.578</u>	0.092	0.022	0.212	0.407
15. Advertise to the general public	<u>0.573</u>	0.200	0.174	0.168	-0.142
Percent of variance explained	1.835	1.674	1.533	1.530	1.342

2. Characterizing the Solar Installer

Our data classified builders as (1) installers, (2) considerers, or (3) nonconsiderers. The differences between groups (1) and (3) were the most extreme, but how did they differ?

Concept: Past installers could be distinguished from nonconsiderers according to a variety of

- demographic,
- structural, and
- perceptual variables.

Discriminate analysis is a tool that can be used to classify or predict the group membership of individuals. In essence we look for a line that separates the groups. The line is of the form

$$y = a_1x_1 + a_2x_2$$

where the parameters a_1 and a_2 are chosen to maximize the ratio of variance between means on the y axis to variance within groups on the y axis. Although discriminate analysis shows some superficial similarity to multiple regression, the methods used for finding the coefficients and the underlying assumptions differ greatly. Exhibit 6-29 gives an illustration of how the variable "y", above, should be integrated.

Here, if a builder received a score or y value greater than k^* , he was more likely to be a solar installer than a noninstaller. The function $y = a_1x_1 + a_2x_2$ was chosen to separate these groups as much as possible.

But what variable or characteristics were most critical in separating installers from noninstallers? Our hypotheses are summarized

EXHIBIT 6-29

Interpretation of Discriminate Analysis

below:

Builders were more likely to be installers if they:

- built large numbers of custom homes,
- had architects involved in the energy-system selection process,
- were located in the Southwest,
- built expensive homes, and
- felt solar made economic sense.

Builders were less likely to be installers if they:

- were located in the Northwest,
- felt solar manufacturers were small operations,
- felt consumers were highly concerned about reliability,
- found area receptivity important, and
- were concerned about regulatory restrictions.

Exhibit 6-30 gives the results of the discriminant analysis corresponding to the hypotheses mentioned above. Exhibit 6-31 gives the variable definitions.

Exhibit 6-32 gives the means and standard deviations for the variables included in discriminant analysis.

Note that all of the variables confirm the original hypotheses and are all statistically significant at conventional levels. Thus, the ability of these variables to explain the differences between installers and noninstallers was quite satisfactory.

EXHIBIT 6-30

Discriminate Function: Solar Installers vs. Nonconsiderers

<u>Variable</u>	<u>Standardized Coefficient</u>	<u>Approximate F-Statistic</u>
LNCSE	.242	8.91
ARCHITECT	.955	7.58
SW	.656	8.54
MQ4B	.738	8.30
Q20	-.327	9.00
NW	-.587	6.50
Q22	.131	5.96
CF1	.307	7.00
BF2	.472	8.43
BF4	.394	8.76
constant	.208	

Variable Definition, Discriminate Analysis

- LNCSH: Natural log of the number of custom homes built in 1979 by the builder
- ARCHITECT: { 1 if an architect was involved in process of choosing an HVAC system for spec home for the builder
0 otherwise
- SW: { 1 if the major portion of the builders' business was in the South West
0 otherwise
- MQ4B: Typical price of a spec-built house for the builder (standarized within the region)
- Q20: Agreement with the statement, "A manufacturer can provide solar energy that makes economic sense for home use."

1 = strongly agree; 5 = strongly disagree

- NW: { 1 if the major portion of the builders' business was in the North West
0 otherwise
- Q22: Agreement with the statement, "Manufacturers of solar systems are mostly little companies that are here today and will probably be gone tomorrow."
1 = strongly agree; 5 = strongly disagree
- CF1: Builders' belief about the importance of reliability to the home owner
- BF2: Builders' rating of receptivity of market area as a key item in their decision to use solar
- BF4: Builders' rating of building regulations and government regulation as critical factors in their decision about whether or not to install solar

EXHIBIT 6-32

Discriminate Function Variables: Group Means/Standard Deviations

<u>Variable</u>	<u>Installers</u>		<u>Nonconsiderers</u>	
	<u>Mean</u>	<u>Std Dev</u>	<u>Mean</u>	<u>Std Dev</u>
LNCSH	1.273	2.681	0.598	2.227
ARCHITECT	0.111	0.317	0.034	0.184
SW	0.389	0.492	0.241	0.432
MQ4B	0.210	1.014	-0.200	0.831
Q20	2.537	1.397	3.241	1.247
NW	0.204	0.407	0.379	0.489
Q22	2.704	1.436	2.672	1.289
CF1	0.100	0.847	-0.093	0.875
BF2	0.150	0.926	-0.148	0.878
BF4	0.363	1.003	-0.119	0.814

3. Predicting Solar Installation

The previous section took a retrospective look at the solar installation history of builders; now we look towards the future. With the idea of predicting likelihood of installation of solar in 1980, we asked such a question of each of the builders. Stated likelihood of purchase or installation almost always overestimates actual likelihood; the two quantities, however, are generally monotonically related (see Morrison, 1979, for some examples).

Thus we tried to explain stated likelihood of future installation, understanding that our objective was to determine the variables that were most closely related to stated likelihood and not to predict likelihood of installation.

Our likelihood-of-installation, LI, was a 6-point scale, ranging from 1 = definitely, to 6 = no chance. We transformed that variable to

$$P = \frac{6-LI}{5}.$$

or, roughly, probability of purchase. We modeled P as

$$P = \frac{1}{1 + e^{-\sum a_i x_i}}$$

that is, as a logistic shape, where $[X_i]$ were independent variables.

Exhibit 6-33 illustrates the shape of this function with one independent variable.

In particular, we hypothesized the following:

EXHIBIT 6-33

Illustration of Probability-of-Installation Model

- General hypothesis:

The likelihood of installing solar in 1980 was related to:

- past history of installation or consideration;
- characteristics of the firm;
- region; and
- attitudes toward solar.

- Particular hypotheses:

Intent to install solar in 1980 would be greater:

- if the builder was a past installer;
- if the builder was a past considerer;
- if the builder believed the systems were reliable;
- if the builder believed they made economic sense;
- if the builder believed they would be widely used in five years;
- if the builder felt aesthetics were unimportant to home owners;
- if the builder felt good citizenship was important to the home owner;
- if there was no HVAC contractor involved in the HVAC selection process;
- if the builder was not concerned about solar-specific regulation;
- if the builder was elsewhere than in the North East (other regional variables were picked up earlier).

A first set of questions that had to be asked were:

- (a) Were the equations and coefficients for installers, considerers and nonconsiderers the same statistically?
- (b) Did the four main regions have equations that were the same statistically?

Exhibit 6-34 shows how this structural analysis was tested. We tested to see if we could explain all the builder data in a single model (with perhaps an indicator variable for builder status and region) or if we needed to develop separate equations for each subgroup.

The results showed that we could not reject the hypotheses of equality of coefficients at the .05 (or, indeed, at the .15) level -- hence we could analyze intent to install as one sample group.

Exhibit 6-35 gives the results of the analysis. Note that ordinary least squares was used on a transformed value of n , i.e. $\ln \left(\frac{P + .5}{1.5 - P} \right)$; test of normality of the residuals showed that the use of ordinary least squares was acceptable here.

Exhibit 6-36 defines the variables and Exhibit 6-37 gives the means and standard deviations of the variables.

Note that most coefficients are quite significant at conventional levels of significance and that the hypotheses stated above are confined by the analysis. Given the broad cross-sectional nature of these data, the fit of the equation is quite good.

The t -statistics gave us a rough yardstick of the importance of the variables in predicting future solar installation. Of highest importance in predicting future solar installation was the past status of the builder -- a past installer was most highly likely to install in the future, a past considerer next most likely, and a past nonconsiderer, least likely. Of approximately equal importance was the builder's feeling about the inevitability of solar (Q.23).

Structural Analysis Illustration

A. Structural Difference

B. Structural Equivalence with Intercept Shift

EXHIBIT 6-35

Probability of Installation in 1980 Results

<u>Variable</u>	<u>Coefficient</u>	<u>t-Statistic</u>
Intercept	.287	
Q19	-.079	-2.2
Q20	-.118	-3.5
Q23	-.165	-5.1
BF4	.076	-1.7
CF0	.147	3.6
CF2	-.126	-3.0
CONTRACT	-.239	-1.7
CONSID	.554	5.7
INSTALL	.810	6.7
NEAST	-.231	-2.5

N = 243

$R_2 = .45$

Variable Definitions - Probability of Installation -- 1980 Model

DEPENDENT
VARIABLE:

$$\text{Logit} = \text{LN}\left(\frac{P + .5}{1.5 - P}\right)$$

where P = likelihood of installation in 1980

- Q19: Belief about manufacturers' abilities to provide reliable solar energy
- Q20: Belief about manufacturers' ability to provide economical solar energy
- Q23: Belief that solar energy would be widespread in 5 years
- BF4: Builder concerns about regulation
- CF0: Builders' feelings that aesthetics were not important to home buyers
- CF2: Builders' feelings that home buyers found good citizenship important
- Contract: $\begin{cases} 1 & \text{if an HVAC contractor was involved in the process of selecting an HVAC system for spec-built homes} \\ 0 & \text{otherwise} \end{cases}$
- CONSID: $\begin{cases} 1 & \text{if respondent was a past considerer of solar (but not an installer)} \\ 0 & \text{otherwise} \end{cases}$
- INSTALL: $\begin{cases} 1 & \text{if respondent installed solar in the past} \\ 0 & \text{otherwise} \end{cases}$
- NEAST: $\begin{cases} 1 & \text{if principal portion of respondent business was from the North East} \\ 0 & \text{otherwise} \end{cases}$

EXHIBIT 6-37

Means/Standard Deviations of Probability-of-Installation Equation Variables

<u>Variable</u>	<u>Mean</u>	<u>Standard Deviation</u>
LOGIT	-0.303	0.815
Q19	2.477	1.176
Q20	3.021	1.297
Q23	2.687	1.355
BF4	-0.007	0.941
CF0	0.021	0.995
CF2	-0.018	0.968
CONTRACT	0.091	0.288
CONSID	0.539	0.410
INSTALL	0.222	0.417
NEAST	0.247	0.432

The next group of variables were more or less equal in importance:

- belief that solar made economic sense,
- belief that home buyers were concerned about good citizenship, and
- belief that home buyers were less concerned about aesthetics.

The remaining variables were of lesser importance:

- belief about solar reliability,
- concern about regulations,
- whether an HVAC contractor was involved in the decision-making process, and
- Northeast indicator variable.

We conclude that, although much of the variability in intent to purchase solar in the future remains unexplained, a fairly simple model has been developed which isolates many key variables explaining builders' intentions to install solar in 1980.

E. CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

Builder/developers represent HVAC decision-making opportunities in one of the largest segments of potential solar use -- the new-home market. The data and analysis presented in this chapter lead to the following conclusions:

- (1) Builders were aware of solar-energy systems. In fact, 22% of our sample reported having installed an active solar-energy system, while another 55% reported considering having a solar HVAC system installed.
- (2) Past installers were more likely to be found in the South West, to be large builders, and to be builders of higher-priced houses.
- (3) In distinguishing between installers and noninstallers, critical discriminating factors were:
 - building large numbers of custom homes,
 - South West location,
 - having architects involved in the HVAC selection process, and
 - feeling that solar made economic sense.
- (4) Builders were less likely to install if:
 - they felt that solar manufacturers were small operators,
 - they felt consumers were highly concerned about reliability,
 - they were concerned about regulatory problems, and
 - they were located in the North West.
- (5) In predicting the future installation of solar equipment, the most important correlates, besides past installation history, were:
 - belief that solar made economic sense, and
 - belief that home owners were not concerned about aesthetics.

2. Recommendations

The builder/developer group can exert strong leverage in the solar adoption process. In particular, we should consider (a) the kind of product they require, (b) the way to communicate the product benefits to them, and (c) how to determine a target market.

Product Design

Over three-quarters of the builders said that they did payback analysis on their investments for spec-built homes. In other words, solar has to be perceived by the consumer as worth the extra investment. If it is not perceived as advantageous, the house will not sell. The two top priority items for solar adoption deal with performance and supplier reliability. If the builder is convinced the house will sell with solar he will adopt it only if it (a) works and (b) does not cause him maintenance problems.

Communications

To generate receptivity among builders, it is necessary to convince them that (a) solar makes economic sense, (b) home buyers are concerned about good citizenship, and (c) aesthetics are not critical in the house-buying decision-making process. They will also be more likely to install if they are convinced that solar is inevitable, that is, that solar is "now" and not just a chance for the future.

Finally, installers do not see regulatory problems as being difficult -- noninstallers do. The "ease of regulations" issue therefore needs to be addressed as well.

The above issues represent a series of targets and challenges for the emerging solar-energy industry and for the Department of Energy.

Targeting

Our analysis indicates that when trying to sell solar products more success will be had with the following market segment:

- southern or southwestern location,
- large builders of custom homes, preferably expensive homes, and
- builders who have architects involved in the energy-system selection process.

Of course, if the builder has previously installed a solar system, he will be a superior target in the future.

SECTION SEVEN

COMMERCIAL/INSTITUTIONAL SEGMENTS

In the commercial or institutional market, 183 personal and telephone interviews with owners or operators of small businesses were conducted across the country. Interviewing concentrated on three businesses with large apparent hot-water needs -- laundries, low-rise motels, and car washes -- and on one institutional market -- hospitals. The majority of the interviews in the car-wash segment were conducted with car-wash owners, equipment manufacturers, and distributors at the International Car Wash Association Convention in Las Vegas Nevada, January 28 and 29, 1980. The laundry, motel, and remaining car-wash interviews were conducted in Utah, Arizona, Florida, California, Texas, Kansas, Massachusetts, Wisconsin, and South Carolina. Interviews with hospitals were conducted in Massachusetts.

An open-ended interview was designed to gather information about current and future fuel usage, purchase-information needs for hot-water heating systems in general and solar systems specifically, and the purchase decision-making process in each organization. The interview also explored owner or operator awareness of solar products and attitudes toward solar, ending in a discussion of recommendations to facilitate the adoption of solar. The findings in each of these areas are summarized below. These findings are presented first for the commercial businesses, and then for hospitals separately.

A. COMMERCIAL BUSINESSES

Coin laundries, as opposed to dry cleaners, have a large need for hot water. While large commercial laundries now use primarily cold water for washable items, coin-operated laundries continue to use hot water. One coin-op owner interviewed explained that customers still believe hot water cleans better than cold, despite the claims of the new cold-water detergents. Some owners of small coin-operated laundries expressed concern over rising fuel prices and said they might be forced out of business because their customers would not be willing to pay \$1.00 per load, a price they saw as inevitable given their expectations of fuel inflation.

The car-wash industry seems to be especially suited to solar since cars are washed primarily during daylight hours. While most car washes in our sample used large amounts of hot water, some car wash owners in the southern regions were switching to cold-water washes because of rising fuel costs. Although many owners seemed to be sold on cold-water washes, others felt that the quality of the job was much lower than with hot water. This was especially so in the North where cars have to be cleaned of salt and sand in the winter months. Owners felt that a cold-water detergent had not yet been developed that was effective against this kind of dirt. The industry is currently studying the problem through an association.

Hot water in car washes is necessary for hot waxing. Hot water is also used in self-service washes because the dirt removal is not aided by mechanized scrubbers and brushes. One owner interviewed felt that

the industry was definitely headed in the direction of self-service washes because of rising equipment and fuel costs. Another owner, however, pointed out that self-service operations needed more property space and, because of rising real-estate costs, especially in urban areas, many owners were continuing with full-service operations.

The Self Service Car Wash News recently listed ten all-solar self-service washes. All were privately financed.

Motels require large amounts of hot water for domestic uses as well as for pool heating. Owners have very little control over the amount of water used for domestic purposes. Most motel owners or operators interviewed said they used natural gas for water heating and were so far pleased with it but they were concerned about the rapidly rising costs of all fuels. Other fuel expenditures involved heating and air conditioning, with many motels operating individual electric heaters and air conditioners in each unit to decrease overall energy costs. The price of electricity and oil were seen to be rising more rapidly than the price of gas, so most motel owners or operators anticipated sticking with gas for water heating in the next year, and probably over the next five years as well.

It was found that some localities restrict the use of nonrenewable energy resources for swimming-pool heating. More will probably do so over the next four years. Solar swimming-pool heating appears to be a viable market that is already functional in the West, and to lesser extent in the South.

1. Fuel Usage

Most of the owners or operators interviewed were currently using natural gas for water heating. They felt that gas was still the cheapest fuel and, for the most part, were satisfied with it. All of those interviewed anticipated an increase in fuel prices, anywhere from 15 to 50% over the next year, but said they would continue using their present fuel. Most felt they would be using their present fuel five years from now as well, unless there was a dramatic increase in their fuel costs relative to cost increases of alternative fuels.

2. Awareness and Attitudes of Solar and Government Incentives

All of the business owners interviewed were aware of solar energy. Some had actually looked into solar products for their homes or businesses. Of those who had looked into solar, most found the initial cost to be too high; some had had bad experiences with dealers or salesmen who did not follow through after the initial contact. One laundry owner planned to install a solar water heater but was astonished to find Miami's building code at that time would not allow solar collectors to be mounted on roofs. While the code has since been changed, the gas water heater he installed at that time will not need to be replaced for at least five years. The owner did, however, plan to install a solar system at that time. In another example, a car-wash owner in Bountiful, Utah, had called a solar firm to get an estimate. An engineer visited his 4-bay self-service wash and "took measurements," but never called back with further information.

On the positive side, a motel owner in Tucson had designed and built a solar heater for his pool, and planned to design one for hot

water for the motel if the pool heater was a success. Five other motel owners had looked into solar heaters for their pools: three currently had solar pool heaters and one found a gas heater to be cheaper. Several respondents had investigated solar for home use. One couple who owned a motel in Tucson and who had found solar to be too costly to install in their motel had plans to build a passive solar home in the foothills outside of Tucson. They were having trouble, however, getting their blueprints approved by the county because of the unconventional design. And the La Quinta motor-hotel chain was in the process of conducting its own solar evaluation study. This chain had simply installed solar on six of its facilities, and was conducting an in-house evaluation of the costs and savings.

Some respondents mentioned some commercial or institutional solar installations they were aware of or had visited. These installations included a school in Santa Clara, Utah; the El Dorado Hospital in Tucson, Arizona; a fruit farm near Tucson; road-side rest stops near Madison, Wisconsin; and the La Quinta Inns in Midvale, Utah, and Las Vegas, Nevada. One manager of a Rodeway Inn said that the Rodeway Inn organization had an energy consultant in Dallas who was monitoring the La Quinta Inn, with the idea of adopting solar in Rodeway Inns if the La Quinta project was successful.

Most of those interviewed knew that government incentives in the form of tax credits of some kind were available, but specific information about the incentives was only known by a few people. Some respondents indicated that, although they were not aware of specific information about incentives, they were sure that the incentive would be

too small to make a solar installation economically feasible for them.

In general, the attitude toward solar energy was positive.

Although many owners or operators did not seem confident in their knowledge about solar, especially in applications to their businesses, most felt that solar was an important alternative source of energy. Many were skeptical that solar technology was developed enough for widespread use. And because of the need for back-up systems, they felt the use of solar could not guarantee energy independence from gas, oil, or electricity. The majority of those interviewed, however, would like to see solar developed and implemented further as an alternative energy source.

3. Information Needs or Conditions for Purchase

The most important factor in evaluating any water-heating system in all three business areas was the initial cost of equipment and installation. Small business operate on limited capital and owners cannot afford large capital outlays or the current high financing charges. The respondents who were aware of government tax incentives for solar viewed the rebates as insignificant compared to the total cost of the solar system. Most owners or operators simply dismissed solar as an alternative due to the high initial cost involved.

Payback period is an important decision variable in these commercial markets. Most people interviewed indicated that a 3-year to 5-year payback period would be acceptable, given that most other capital equipment such as washing machines or car-wash equipment has a similar payback period, although some cited current paybacks of new equipment in their industries as low as one year. A 3-year to 5-year payback, or

less, was also desirable because of the transient nature of some of these businesses. Motel owners often move on after a relatively short period and want a return on their investment before they sell the business. Many laundry operators rent the building or space and require a payback period in line with, or a shorter time period than, the lease. While car washes may be a longer term investment than the other two businesses, among those interviewed the 3-year to 5-year payback was still seen as desirable. Very little attention was focused on increased resale value of a solar-equipped business.

In our sample, cost of fuel was also considered in evaluating a water-heating system. As mentioned above, most of the respondents currently were using natural gas and seemed satisfied with it. Even if the cost of gas rose more than expected in the next five years, the respondents said they would change to either an electric or oil system rather than solar. The consensus was that all three fuels would have to rise considerably in price before a solar system would appear to be an attractive alternative.

Another concern of the owners or operators involved the maintenance of a water-heating system. A long warranty seemed not to be required, since warranties on other capital equipment are short. The exception was in the car-wash business which has reliably longer warranties on equipment. Recovery and down time, directly related to availability of parts and service, were especially important factors in laundries and car washes, where the entire operation of the business relied upon the availability of hot water. As a result, car-wash owners insisted on availability of efficient, qualified local repair service of the kind

they expected from their system manufacturers. Laundry owners, however, tended to do much of their repair work themselves; as a result, they were less likely to mention a repair service as an important decision variable.

In evaluating solar water-heating systems in particular, physical space requirements became important factors. Owners expressed concern about whether or not they had sufficient space for the large storage tank required in a solar system, in addition to the space requirements of the back-up system. Respondents also questioned the weight of the collectors on the roof and the subsequent stress on the building structure. Many buildings in these industries are inexpensively constructed, and such fears may be realistic. Integration of a solar system with the present water heating system was another concern.

A big concern for all three operations (motels, laundries, and car washes) was continuous production, that is, whether high water temperatures, at least 160°, could be maintained for long periods of time, given the high demand for very hot water in these businesses. The integration of a solar system with a conventional backup seemed not to be well understood.

Another problem noted was the danger of freezing, especially in northern and high altitude regions. The manager of the La Quinta Motel in Midvale, Utah, said the panels of the solar hot-water system had frozen and as a result many had been replaced. Adequate protection against freezing must be provided.

4. The Decision-making Process

In small businesses, the owner or operator was most likely to be the sole decision-maker in a major capital equipment purchase. A few respondents said they would bring in outside help (primarily HVAC consultants) to evaluate a solar purchase; most, however, indicated they would seek out information themselves from solar distributors and manufacturers. They also indicated that information found in their industry's trade journals would be highly regarded, with descriptive articles being more likely to influence them than advertisements.

Most laundry and motel owners or operators said they would rather purchase solar equipment from solar distributors than from a dealer in many other kinds of capital equipment. A local solar distributor with an established name and good reputation was seen favorably; some of those interviewed expressed a fear of "fly-by-night" companies. Laundry owners definitely preferred a specialized solar dealer, seemingly wishing not to deal with laundry-equipment distributors any more than necessary. Car-wash owners, however, expressed more of an interest in having solar equipment sold from within the industry. These owners indicated they wanted to purchase from a solar specialist affiliated with a reputable car-wash equipment dealer or manufacturer or even directly through such a dealer or manufacturer. An owner satisfied with a dealer's current capital equipment and service would trust that dealer to handle only reliable solar equipment and fulfill its servicing needs.

Car-wash equipment distributors also expressed interest in becoming solar distributors as well, because they liked to contract for a package installation. Given their experience in plumbing installations, the

combination could be a good one. Before representing the manufacturer, car-wash equipment distributors wanted to be sure that he would back them up with training courses and immediate parts supply, in the same way car-wash equipment manufacturers do.

5. Conclusions and Recommendations

The small commercial operations studied relied heavily on hot water used in large amounts. They also operated on small capital budgets and margins. Due to these constraints, the businesses were suffering greatly from increasing fuel costs, and ways to cut these costs were of grave concern. Without exception, the owners or operators were using, or soon switching to, the fuels they felt were least expensive for their operations. They remained, however, very receptive to new ideas and ways to reduce the cost of heating water.

By and large, the respondents were aware of solar water-heating systems. They viewed solar energy as a good alternative energy source in the face of rising traditional fuel costs. There were, they felt, two primary criticisms of solar systems: 1) the initial cost was too high for their small business capital; and 2) the systems were not tested and proven enough and the industry not established enough to provide reliable equipment and service.

To deal with the first criticism, respondents suggested that the government provide larger tax credits and, through industry-specific communication programs, attempt to increase awareness of those incentives already available. They also mentioned long-term low-interest loans as another means of reducing overall cost. This solution, however, may not be attractive to the more transient owners of small businesses such as motels.

Another suggestion for dealing with the impact of the high initial cost was to stress the importance of the long-term investment in terms of projected fuel costs and savings over time. While many small businesses tended to think in terms of the short-run because of their transient association with the business, owners of businesses such as car washes and motel or hotel chains regarded long-term savings as more important than initial cost. To these owners, the long-term advantages of solar equipment were an attractive selling point.

Many suggestions were made for overcoming the perceptions of unreliability and solar systems being untested or for resolving perceived service and maintenance problems. The major suggestion was a call for demonstration programs. Owners showed a willingness to travel substantial distances at their own expense to view new products in their industry, especially when these products could help add to the bottom line. But they tended to be skeptical of government involvement, and instead wanted to see demonstrations monitored by the industry and its associations. Almost without exception they said they would be willing to become personally involved in a demonstration.

A further comment called for the endorsement of solar manufacturers by industry associations. Each of these industries has several such associations. There is an association-sponsored car-wash research institute which is interested in solar and has industry-wide credibility. Many independent motels belong to associations or chains which provide them with product test results and business recommendations. A favorable test or recommendation from such an organization could have considerable effect among its members.

A final recommendation was that solar system manufacturers and distributors display at conventions, showing a system design that is applicable to the specific industry. Ideally this would be a design that had operated in its particular use for a long enough period to generate a documented record of savings.

B. HOSPITALS

A preliminary study to assess the potential marketability of solar hot-water and space-heating systems in the hospital sector was conducted in eastern Massachusetts. The purpose of this study was to determine the size and growth characteristics of the hospital market and then to identify the principal people in hospital organizations who would be involved in the decision to purchase a hot-water or space-heating system. Initial library research suggested that the hospital decision-making process could be quite different depending on whether the hospital was government-operated or privately operated. Five separate hospital categories were selected and telephone interviews were conducted with individuals at hospitals in each of these categories to determine differences in the decision-making process.

We found that hospitals are confronted with a maze of institutional regulations and organizational hierarchies. Such a structure tends to impede the purchasing process of large capital-expenditure items, and solar hot-water and space-heating systems certainly qualify as large investment items. Consequently, in assessing the potential marketability of solar in the hospital sector, we felt it was important to identify those people in the organizational hierarchy who have the greatest influence on the decision whether to buy a solar or conventional system. Furthermore, we felt the impact of institutional regulations on potential solar adoption should be estimated. It was also important to identify those characteristics of hospitals which could differentiate their susceptibility to solar adoption.

In 1975 there were a total of 7,156 registered hospitals in the United States. This number has diminished only slightly since that time. Almost all new hospital construction, therefore, has occurred at existing hospital sites: there has been relatively little construction of entirely new, independent hospitals. The most important segmenting characteristic of these hospitals is the type of control or ownership that directs them. Exhibit 7-1 presents the distribution of hospitals according to how they are controlled:

EXHIBIT 7-1

Distribution of All Hospitals by Type of Control

	<u>Federal</u>	<u>Private nonprofit</u>	<u>Private (for profit)</u>	<u>State and local gov.</u>	<u>Total</u>
Number of Hospitals	382	3562	906	2306	7156
Percentage	5%	50%	13%	32%	100%

The breakdown of hospitals by the type of control is especially important because it creates differences in the decision-making process.

The best information available to us indicated that new construction dollars were spent proportionately between public and private hospitals. (Private hospitals include all private nonprofit and "for-profit" facilities. Public hospitals are all government hospitals.) Thus, about \$3.35 billion was spent on private and about \$1.82 billion was spent on public new-hospital construction. Although federal hospitals account for only 5% of all hospitals, 9% of all new construction in place in 1978 was at federal facilities. This was up dramatically from 5% in 1975. This may have been a temporary spending spurt or it may have signaled on-going growth.

We found that 85% of all hospitals are general hospitals, 7% are psychiatric, and the remaining 8% are split up among a variety of speciality types. Psychiatric hospitals are considerably larger than most general hospitals, averaging 555 beds compared to 170 beds.

The Department of Energy sponsors several national programs to promote solar adoption by schools, hospitals and other nonresidential facilities. In Massachusetts, the DOE-funded organization directing these programs is the Massachusetts Office of Energy Resources (MOER). MOER has control over federal grant money for solar projects and is able to pay as much as 50% of any hospital expenditure on a solar system. Only limited funds exist, however. To qualify for funds, a hospital must hire a professional engineer, either in-house or an outside consultant, who is knowledgeable about solar systems, to conduct a technical assistance audit. DOE has established MOER-type organizations in all 50 states. Although their functions and effectiveness vary from state to state, these organizations operate similarly to MOER. The degree of solar awareness and receptivity to solar adoption is sure to increase due to such programs.

1. Market Segmentation

Library research on hospital organization structures confirmed that the decision-making process in a hospital varied according to whether its control was government or private. Five hospital categories were identified as fundamentally different in their decision-making process for purchases of large capital expenditure items. There were:

- (1) federal (V.A. hospitals, servicemen hospitals, Indian hospitals),

- (2) private nonprofit,
- (3) private (for profit)
- (4) state government, and
- (5) local government.

Telephone interviews with hospital administrators from each of these five hospital categories provided valuable information as to who would be involved in the decision to purchase a new hot-water or space-heating system. The interviews also sketched out the organizational structure through which such a decision would pass. Although it was our intention to interview only those administrators who had been involved in such a decision in the past two years, this screening requirement turned out to be too stringent. We therefore chose to interview at random hospitals in the eastern part of Massachusetts. Administrators identified other participating individuals in the decision-making process and these people were also interviewed. A list of open-ended questions was compiled prior to the interviews to help guide the interviewer to cover the same relevant issues in each discussion.

Since the interviews were conducted only in Massachusetts, some results of this study cannot be generalized to the country as a whole. While we feel that our findings about hospital decision processes are applicable to all U.S. hospitals, there are many differences in solar legislation across states which this study did not capture. Thus we may find that in certain states solar systems are required of all new hospital facilities. A more comprehensive study can determine this information and also assess the likelihood of other states adopting similar legislation. We strongly recommend that this information be collected.

The remainder of this section is dedicated to outlining the decision-making process for the purchase of hot-water and space-heating systems in eastern Massachusetts hospitals. Our efforts primarily focused on the private nonprofit and state and local government hospitals since these hospitals constitute a large proportion of all U.S. hospitals.

Private Nonprofit Hospitals

Interviews with the administrator, plant facilities manager and several board of trustees members at Sancta Maria Hospital in Cambridge and Symmes Hospital in Arlington furnished us with the following decision-making process description. Both hospitals reported decision-making processes which were remarkably similar.

According to those we interviewed, the director of plant facilities is the first to recognize the need for a new system or major overhaul. (There is an annual state inspection which recommends the continued use or need for repurchase of a system.) At no time does the director consider replacing the system with solar if the system is performing within expectations. Once the need is recognized, the director of plant facilities apprises the administrator of the situation. The administrator advises the director of plant facilities to hire an outside registered professional engineer to help evaluate different systems. After so doing, the plant director then evaluates the alternatives himself, perhaps obtaining opinions from other nearby hospital plant engineers. After deciding on the alternative he likes best, he requests proposals from two or three contractors. The plant director again meets with the administrator and recommends one system

and suggests several alternatives. If the administrator approves the plant director's recommendation, the expenditure is written into the hospital budget to be reviewed by the finance committee. The finance committee is generally made up of several trustees and the administrator. If the finance committee approves the expenditure, then the board of trustees must vote on it at one of their quarterly meetings. It is not unusual for the administrator, the finance committee and even the board of trustees to return a recommendation and specify that certain additional information be collected. Generally, all capital expenditures over several thousand dollars are subjected to this procedure.

One potentially important external factor is that hospitals must submit a Determination-of-Need (DON) form to the state for all capital expenditures over \$150,000. The state, therefore, has the power to veto an expenditure already approved by a hospital board. (States other than Massachusetts may not utilize this procedure.)

The chart below summarizes the decision-making process stages and participants for private nonprofit hospitals:

Decision-making Process Stages and Participants

<u>Stages of decision process</u>	<u>Decision-making process participants</u>
Recognition of need	Plant manager, engineer
Search for alternatives	Administrator, director outside consultant
Evaluation of alternatives	Finance committee -- trustee members
Preliminary budget approval	Board of trustees
System and contractor selection	Architects and building contractors

Federal Hospitals

Over half of all federal hospitals belong to the Veterans Administration system. It was therefore deemed appropriate that the one federal hospital we research be a VA hospital. The VA hospital we chose is located in West Roxbury, Boston.

In the decision-making process for this hospital, there are two reasons a hot-water or space-heating system is replaced: 1) the system is no longer meeting minimum standards and could only do so after a major overhaul; or 2) another system has proved better economically. The second reason apparently applies only to the hot-water system. The VA hospital uses different decision-making processes depending on whether the size of a capital expenditure is above or below \$100,000. If the expenditure is less than \$100,000, an in-house budget committee can give final approval or veto a proposal. The process is considerably more complicated if the cost is over \$100,000. In this case final approval rests with the central funding office in Washington.

Basically, once the need for a new system is recognized, the engineering department searches for alternatives, evaluates them and presents a project request to the director. A space committee may also need to approve the expenditure if new space is to be used. Once the director approves the request it must be approved by the budget committee. The proposal then leaves the hospital and is worked over by a regional association of VA hospitals. Finally it reaches Washington where the central funding office has the final say. These projects are not approved as much on merit as on priority: if another VA hospital is in desperate need for a major facelift, for instance, then that hospital

may receive priority over a hospital which wants a solar system. Furthermore, VA hospitals are ineligible for DOE grants because they are federally funded. The "through-Washington" approval process is time consuming and it is not surprising that a large number of VA project expenditures are priced at just under \$100,000. Solar hot-water systems, being much less expensive than solar space-heating systems, probably have a better chance of adoption.

All federal hospitals are automatically required to look into solar. This particular hospital did so when it needed a space-heating replacement several years ago. According to the chief engineer the cost of the system was excessive.

Local Hospitals

We found that the decision-making process for the purchase of a solar hot-water or space-heating system at a local hospital is divided into two distinct parts. The first is at the hospital level: the hospital decides whether or not it wants to invest in a solar system. If the decision is "yes" and the investment cost is greater than \$150,000, the decision process moves to the second level. Federal law requires all hospital expenditures over \$150,000 to go through the Determination of Need (DON) process before final approval.

At the hospital level, the decision-making process proceeds as follows: the chief engineer identifies the need and develops a proposal for a solar system. He oversees the investigation and researches the possibilities of solar as well as alternative sources of hot-water and space heating. Technical requirements, cost savings, and overall feasibility are some of the factors considered. At this point an

outside consultant may be brought in. A list of alternatives is written up and the chief engineer recommends one to the Commissioner of Health and Hospitals, a city official in charge of all city-owned hospitals and health-care facilities. The commissioner studies the proposal, sometimes does more research on it, and decides which, if any, alternative to pick. The alternative chosen then proceeds to the board of trustees.

Once approved by the board, the decision is final if the expenditure is less than \$150,000. However, in the event of it being over this amount (which is likely for a solar space-heating system) an application for Determination of Need (DON) must be filed. Now the process becomes slow and complicated as it becomes involved with state and federal bureaucracy. The application from the hospital goes directly to three places simultaneously: the local health-system agency for federal Determination of Need (DON), the Department of Public Health of the state, and the state energy office.

Final approval or rejection of the project comes from the Public Health Council of the Department of Public Health. Representatives from 1) the regional level, acting as spokespeople for the final recommendation of the federal DON process, 2) the state level, voicing the final recommendations of the state DON process, and 3) the hospital, present their cases before the nine-person review council which makes the final decision.

State Hospitals

The state's decision-making process is similar to the local hospitals' procedure in that it also can be divided into two distinct

parts, the hospital level and the state level.

Upper management at the hospital involved in the decision-making process includes: the steward, in charge of the "hotel" or nonmedical aspects of the hospital (that is, heating, electricity, food, and so on); the controller, in charge of the business aspects of the hospital; the chief engineer; and the executive director, the highest-ranking person at the hospital. The proposal for a solar system or other system originates from the steward or the chief engineer. Additional information gathering is carried out by a member of the engineering staff or one of the steward's assistants. The controller studies the financial and business aspects of the project. After reviewing all the information and alternatives the steward decides which heating system to recommend to the executive director. This is the key decision because the executive director usually approves the steward's recommendations. If the investment involves an expenditure of over \$150,000, a DON application must be filled out and the project is considered a capital outlay project. Funds for these investments do not come out of the hospital's normal yearly budget, but a special budget for major long-term investments.

Capital outlay projects must go through the federal DON process initially and then seven levels of the state government before getting final approval. As is the case for local hospitals, the Public Health Council, influenced largely by the federal DON recommendation, decides whether or not to approve the project. Unlike the local hospitals, however, this is by no means the final step. From here the capital outlay project must still go through seven levels of state review before ultimate approval.

In the final stage of the approval process the application for the capital outlay project goes to the State House. A rejection at this stage eliminates the project permanently. If approved, the application becomes a part of the total capital-outlay project budget. On the way to final approval, the budget must be approved by committees in both the Senate and the House, by the Legislature, and finally by the governor.

Private "For-profit" Hospitals

Private, profit-motivated hospitals have a more direct, streamlined decision-making process than state, local, federal, or private nonprofit hospitals. Their independence allows them to avoid much regulatory red tape. In an effort to keep health care costs down for the consumer, however, the federal government requires that a DON application be filled out for expenditures over \$150,000.

At the hospital level it is the chief engineer who initiates the idea of solar or other systems as a possible answer to the facility's hot-water or space-heating needs. His staff research past cases where solar, for instance, was used, do their own studies on solar, look at other alternatives, and possibly bring in an outside consultant. An executive committee, composed of the president, chief administrator, and associate administrators, votes as a group to make the final decision.

2. Awareness of and Attitudes toward Solar

Currently, hospitals are very aware of the advantages solar energy offers. The atmosphere is such that hospital officials are almost forced to be conscious of solar. In addition, in all hospitals, especially public ones, there is a constant drive to cut costs of all types.

Despite all this encouragement, solar energy is not used to provide hot water or space heating at many hospitals. The main drawback to the adoption of solar is that it is unproven. Hospital officials are fully aware of the many advantages of solar, but the lack of numbers of successful cases raises doubts about reliability and makes such an investment too risky. The benefits of solar are seen, but few hospitals are willing to take the chance and become one of the first to use a solar system.

SECTION EIGHT

CONCLUSIONS AND DIRECTIONS FOR FURTHER WORK

A. INTRODUCTION

The objective of this project has been to develop a comprehensive evaluation of the level of solar knowledge, attitudes and likely behavior among HVAC decision makers. As such, the results and analyses stand by themselves in value -- they provide clear direction for action both by government policy makers and by private industry for making solar HVAC systems most attractive.

There are two key directions that this work should take to make it more valuable for DOE policy makers:

- a) Integration of market-acceptance criteria with solar product performance goals. Our analysis shows what solar must deliver in terms of performance standards to be acceptable to certain fractions of various markets. This is one piece in a feasible planning structure that can help define the level of government support needed to meet DOE penetration goals.
- b) Behavioral tracking. Some of the most important information for energy planning cannot be collected in a cross-sectional study; in addition, time trends are required. Time trends in attitude, awareness and intentions to purchase solar could help give early indication of the success or failure of future government programs and give guidance about what private sector or government action are most successful in supporting solar.

We develop these directions for future work in detail below.

B. INTEGRATED PLANNING STRUCTURE FOR ACTIVE SOLAR

Information on market potential market needs and technological feasibility of active solar should be put together to develop a coherent set of performance goals for active solar products.

A conceptual view of the process we envision is presented in Exhibit 8-1. Specifically this conceptualization breaks down as follows

- (1) Box 1, an assessment of asset market needs, is the focus of this work.
- (2) Box 2, an assessment of the current HVAC market place, is an objective of Part A of this study, A Survey of the HVAC Market.
- (3) Box 3 takes the Part A market-size trends, combines them with the parametric market needs identified here, and specifies the size, over time, of HVAC market segments. This would be a new work.
- (4) Boxes 4 and 4a represent the technology assessment problem, which is the responsibility of systems development. What cost/performance combinations, by segment, can active solar promise? SERI and the national labs should be able to provide this information (Box 4a).
- (5) Box 5 represents matching supply with demand, over time. Given the market size and the fraction of the market that would find each particular design configuration acceptable, what potential market would exist for each feasible product at future points?
- (6) The rest of the boxes deal with the assessment of:
 - (a) whether that market potential is great enough to meet program goals, and
 - (b) if not, what level of government support, over time, is required to raise the market potential sufficiently.

An integrative set of tasks need to be completed to make use of the work that is now underway in the active solar commercialization program;

EXHIBIT 8-1

Integrative Program Planning Structure for Active Solar

these steps are:

- (a) specification of format for Part A trend results, to dovetail with the market data presented here;
- (b) assessment of market needs in an integrated fashion from step a (Box 3);
- (c) specification of the input requirements from SERI and the national labs (from Box 4a) so that the analysis in Box 5 can be performed;
- (d) given Step c, integration of the supply side and the demand side in Box 5 to produce "optimal product configurations," or performance goals (these are in the form of a series of trade-off charts, detailed below); and
- (e) finally, assuming that the market goals are not met by expected solar-equipment performance, development of a procedure to re-evaluate market potential under various levels or channels of federal support.

Five tasks are required to do this analysis:

- Task A Format Specification for Conventional HVAC Market

This task would specify an in-put format so that the Part A team could provide the number of HVAC units, by type, which will be installed in each sector over time. Performance trends (such as increases in efficiency) as well as trends in first cost would be required as well.

- Task B: Market-need Assessments

Integrating Boxes 1 and 2 would give us market needs by segment over time.

The result of Dialogue's analyses (Box 2) are market share-potential trade-off curves, such as those depicted in Exhibit 8-2. As part of its work, Dialogue has identified those dimensions that are of importance to HVAC-purchase decision makers, and how organizations in

EXHIBIT 8-2

Sample Market Trade-offs for a Specific Segment (e.g. SIC X)

EXHIBIT 8-3

Sample Trade-off Curve (SIC X for a Y-ton Cooling Unit)

key market segments trade off those characteristics in making product choices. The details of this work are presented in Sections 4 and 5.

- Task C: Format Specification for Labs/SERI Supply Data

In order to develop a solar market potential, we need to know what performance can be provided by manufacturers. Production trends, experience efficiencies and assumed technological breakthroughs need to be incorporated in the estimates.

A range of estimated (including optimistic, pessimistic, and best guess) performance parameters must be provided by SERI and the national labs for:

- (a) each technology,
- (b) each target date (1985 or 1990, for instance), and
- (c) different possible annual production rates.

The input requirements from the national labs for this task need to be specified, naming the dimensions and the assumed production rates for each technology. From this in-put, technological production curves that look like those illustrated in Exhibit 8-4 can be developed.

- Task D: Market Potential Evaluation

Once Tasks A, B, and C are completed, parametric market potential estimates can be provided. In particular, a system configuration can be specified that will maximize the market potential for the system, given a particular government support program. Exhibit 8-5 illustrates how the material from Exhibits 8-3 and 8-4 can be integrated.

- Task E: Re-evaluation Procedure

Exhibit 8-5 shows that the design specifications needed to meet

EXHIBIT 8-4

Sample Performance Curves for Two Technologies With and Without Federal Support

EXHIBIT 8-5

Integrated Supply and Demand Curves Specify Designs that Maximize Market Potential

Note; Here there is

- a) no potential for a system without support;
- b) a potential of 1000 units with support level 1 -- the payback or economic-life requirements for that system are specified at Point 1; and
- c) a potential of 2000 units with support level 2 (Point 2).

varying potential goals shift according to the level of support that is provided. This task would develop the computer procedure needed to:

- (a) input a market penetration goal, and
- (b) estimate the minimum support and product specifications needed to meet that goal.

The integrative work suggested here would put much of the data collected in this project into important, operational use. In addition, it would form a bridge between technology-development studies and market-assessment studies that would lead to earlier market penetration for solar products.

C. BEHAVIORAL TRACKING FOR IMPROVED MARKET ANALYSIS

In order to make fullest use of evolving consumer attitudes and levels of information, that information must be captured over time in a systematic, scientifically sound manner and analyzed accordingly. There are several major objectives for a careful consumer-monitoring system:

- (a) to measure changes in the level of solar awareness, attitudes, and consideration in a geographic area;
- (b) to determine expected sales acceleration in the area, using intent-to-purchase measures as leading indicators for long-term sales;
- (c) to act as a measurement-procedure unit to determine the effects of new solar adoption on existing attitudes and levels of awareness and interest;
- (d) to provide data for the design of further government support programs (such as what price and other incentives would have to be to allow the system to be bought), and for input into technology-diffusion analyses;
- (e) to continue to act as an identifier of early potential adopters of solar, and
- (f) to provide design feedback from future potential buyers so that product improvements could proceed more rapidly.

In order to meet these objectives, field measurements obtained in a most efficient way are required. In particular, we need to measure effects of environmental changes over time. Controlled measurement demands pre- as well as post-action measures to evaluate the effect of market activities. Using Campbell and Stanley's [1963] notation, let us call O an observation (attitude measurement) and X a treatment or exposure (to a solar installation, or solar information). Most studies

of solar effects of this kind are of the "one-shot-case-study" type:

(1) $X \ O$

As has been pointed out frequently "such studies have such a total absence of control as to be of almost no scientific value" (Boring [1954]).

A popular design to control both for external effects and for internal validity is the pre-test and post-test control-group design:

(2)
$$\begin{array}{cc} R & O_1 & X & O_2 \\ R & O_3 & & O_4 \end{array}$$

where R refers to randomized assignment to groups. The effect of X, exposure to a demonstration site, for example, is read here as

$$(O_2 - O_1) - (O_4 - O_3)$$

A typical tracking study, used in advertising assessment for consumer products, uses a modified version of design 2, called (2a):

(2a)
$$\begin{array}{cc} R & O_1 & (X \ O_2) \\ R & O_3 & O_4 \end{array}$$

Here, exposure to a solar site, such as seeing a commercial, and so on, is self-reported. Such a design is threatened with biased misclassification ("Did you see X?"), but careful separation of the probe for X-exposure and probe for O_2 during the interview can minimize this source of bias.

If we view (X_i) as a set of random stimuli occurring at different times to different segments of the public ($\{X_i\}$ might include a midwestern natural-gas shortage, a Middle East embargo, a change in solar incentives, and so on), it becomes clear that a design like (3):

	Area		Time →	
	1	O_{11}	O_{12}	O_{13}
(3)	2	O_{21}	O_{22}	O_{23}
	3	O_{31}	O_{32}	O_{33}

must be in the field already to capture these effects. For this reason, a post-survey methodology cannot be used to evaluate the effect of planned or environmental change.

Thus a carefully designed natural random sample must be in the field at all times to read the effect of uncontrollable events on changes in solar attitudes and awareness as well as to read the effect of the field experiment unit.

How should that sample survey be designed? The normal tracking-study design is as in (4):

		Time →	
(4)	$R(X O_{11})$	$R(X O_{12})$	
	$R(X O_{21})$	$R(X O_{22})$	

Here, separate random samples are developed at each time point. Group averages can be compared, but changes in attitudes at the individual level cannot be measured because different individuals are involved. We suggest a variation of (4) that alleviates this problem. Let us

consider one region only and let the superscript A, B, and so on refer to cohort, or group studied in (5):

$$\begin{array}{rcccl}
 & \text{Time} = 1 & \text{Time} = 2 & \text{Time} = 3 & \\
 & R O_2^A & & & \\
 (5) & R O_1^B & (X O_2^B) & & \\
 & & R(X O_2^C) & (X O_3^C) & \\
 & & & R(X O_3^D) \dots &
 \end{array}$$

Here, cohort B is remeasured at 2; cohort C is remeasured at 3; and so on. The embedded design:

$$R O_1^A \dots R(X O_2^C) \dots R(X O_3^D)$$

is identical with a single row of design (4); in addition, we have the important remeasurment of changes within a cohort, $O_2^B - O_1^B$ for example.

These changes are useful when doing modeling at the individual level. Suppose we wish to model

$$\text{Change in solar preference} = (\text{pref}_t - \text{pref}_{t-1})$$

$$= a_1 \cdot \text{life-style index} + a_2 \cdot \text{exposed to site (yes or no)} + \dots$$

Then we must have individual observations to estimate a_1 and a_2 ; the aggregate estimates provided by design 4 will not work.

The importance of modeling at the individual level follows from the observation that if we have 10 regions, then with design 4, we have 10 observations:

$$O_{12} - O_{11} = \Delta_1, \dots, \Delta_{10}.$$

With individual modeling, we might have a natural sample of several thousand observations. The additional degrees of freedom for estimation allow much more modeling flexibility and development of more useful information.

An important point to re-emphasize is that the common design (4) is embedded in design (5). All information available from (4) can be obtained from (5) plus much more resulting from evaluation of effects at the individual level.

Variations on (5) are possible where portions of the cohort are re-measured after varying lengths of time. This design is useful when the wearing out of various program effects is being tested.

Note that design (5) also allows for controlled experimentation, by direct mail for example, to random subsets of the group between the first and the second measurement, similar to our pre- and post-studies.

The key point is that with such a design in the field, the effect of any changes in the environment (such as oil price changes, shortages, and so on) can be evaluated quickly and accurately.

D. CONCLUSION

As with many studies, much of importance has been accomplished, but, as explained above, much more needs to be done to make best use of the information collected here. To obtain the most from this information, an integration of existing technical and behavioral information is needed and a replication of this study over time is required. In this way, the most information can be derived from this and related studies to aid in DOE energy-policy planning and projections.

APPENDIX 1

METHODOLOGY TO ASSESS DIFFERENCES
IN EVALUATION CRITERIA
BETWEEN GROUPS OF DECISION PARTICIPANTS

Source: Market Planning For New Industrial Products
by Jean-Marie Choffray, Gary L. Lilien
Appendix 6.2

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MARKET PLANNING FOR NEW INDUSTRIAL PRODUCTS

The methodology proposed here assumes that individuals who belong to a given group, -- say design engineers, purchasing officers, and the like -- share the same set of evaluation criteria. The methodology then addresses two questions.

- First, is the dimensionality of the evaluation space the same for different categories of decision participants? That is, do different groups of decision participants use the same *number* of evaluation criteria in their assessment of product alternatives?
- Second, assuming that the dimensionality of the evaluation space is the same for different groups of participants, are their *evaluation criteria* essentially similar?

A.6.2.1 MACRO STRUCTURE OF THE METHODOLOGY

Exhibit 6.16 outlines the methodology. The input to the analysis are the attribute ratings obtained for each of several product alternatives from each decision participant surveyed. Variance-covariance matrices of the ratings obtained on all attribute scales are computed for each group. These covariance matrices are computed across product alternatives assuming that the evaluation criteria derived for each group of decision participants are the same for all products in the class. This approach has been suggested and implemented by Urban (1975) in the consumer goods area; it increases the number of degrees of freedom for estimation of the evaluation criteria for each group.

The methodology proceeds as follows. First, a test for equality of all decision groups' covariance matrices is performed. This allows for an early detection of differences in the way individuals in each of these groups structure relevant product attributes into higher-order evaluation criteria (*C*). If the hypothesis of equal covariance matrices is accepted, the correlation matrix between perceptual ratings is computed across all individuals and factor analyzed (*D*). The dimensionality of the evaluation space is determined (*E*), and the composition of the evaluation criteria common to all categories of decision participants is appraised (*F*). In this case, the analysis concludes with no substantial differences across categories of decision participants in the evaluation criteria.

Rejection of the hypothesis of equal covariance matrices across decision groups suggests differences in evaluation spaces. Separate factor analyses are then performed (*G*). The dimensionality of the evaluation space is determined for each group (*H*). Inequality of dimensionality (*I*) indicates substantial differences (*L*).

On the other hand, when some groups have an evaluation space of the same dimensionality, additional tests for the equality of evaluation criteria are necessary (*J*). If all evaluation criteria are found to be identical, these groups have a common evaluation space and a factor analysis of their pooled correlation matrix is now required (*D*). If at least one of their evaluation criteria is different, the analysis con-

Exhibit 6.16. Outline of evaluation space methodology.

MARKET PLANNING FOR NEW INDUSTRIAL PRODUCTS

cludes at the existence of heterogeneous evaluation spaces across the decision groups with the given dimensionality.

A.8.2.2. MICRO STRUCTURE OF THE METHODOLOGY: TEST FOR EQUALITY OF VARIANCE COVARIANCE MATRICES

The hypothesis of equality of covariance matrices across groups of participants is tested with Box's criterion (1949).

Let Σ_d denote the population covariance matrix for decision group d and S_d be the unbiased estimate of Σ_d based on n_d degrees of freedom. Then, the hypothesis

$$H_0 : \Sigma_1 = \dots = \Sigma_D$$

of equality of covariance matrices across all D groups can be tested by a modified generalized likelihood-ratio statistic.

When H_0 is true, the test statistic is

$$M = \sum_{d=1}^D n_d \ln |S| - \sum_{d=1}^D n_d \ln |S_d|$$

where S is the pooled estimate of the covariance matrix:

$$S = \sum_{d=1}^D n_d S_d / \sum_{d=1}^D n_d$$

Under the assumption of multinormality of the perceptual ratings, the quantity M , when multiplied by appropriate scale factors, is approximately distributed as an F -variate whose degrees of freedom are a function of the parameters D , N , and n_d . (See Cooley and Lohnes, (1971), and Morrison (1976)), for a discussion of this test).

Box's test is very powerful, however. A Monte Carlo study found that the power of the test increases not only as the inequality of the covariance matrices increases, but also as the sample size or the number of variates increases (Greenstreet and Connor, 1974). Thus, rejection of the hypothesis of equality of groups' variance-covariance matrices by the Box criterion should be used only as an indicator of possible differences in evaluation spaces. Indeed, as common factor analysis does not make use of all information present in these matrices, it is possible that the

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evaluation spaces are similar even though the hypothesis of equality of covariance matrices is rejected.

Test for the Determination of the Number of Evaluation Criteria to be Retained for Each Participant Group: Our methodology uses common factor analysis to derive the evaluation space of the decision participant groups. But, how many factors should we retain? Rummel (1970) reviews a number of rules-of-thumb that have been developed to deal with this problem. These rules are very subjective, however, and are often subject to theoretical objections.

Here, we propose to use the parallel analysis technique (Humphreys and Ilgen, 1969) that provides an objective criterion for the determination of the dimensionality of evaluation spaces. The method involves factoring a second correlation matrix identical in the number of variables and observations to the original data matrix but obtained from randomly generated normal deviates. Montanelli and Humphreys (1976) provide a method of estimating the expected values of the latent roots of random data correlation matrices with squared multiple correlations on the diagonal. The following general equation predicts the size of these eigenvalues very accurately ($R^2 \approx .99$):

$$\log \lambda_i = a_i + b_i \log (N-1) + c_i \log \left\{ \frac{K(K-1)}{2} - (i-1)K \right\}$$

where i is the ordinal position of the eigenvalue, a_i , b_i and c_i are regression coefficients, N is the number of observations and K is the number of original variables.

The comparison between the actual and the zero-information eigenvalues provide a simple quantitative criterion for the determination of the dimensionality of the corresponding evaluation space. Exhibit 6.17 illustrates this approach for production engineers.

Test for the Similarity of Evaluation Criteria When Several Participant Groups Have an Evaluation Space of Same Dimensionality: When some groups have an evaluation space of the same dimensionality (Step I in the methodology), an additional test for the similarity of evaluation criteria is necessary. In terms of our factor analysis methodology, the problem is that of the relation between several factor solutions obtained in different samples from the same battery of variables. Although the problem is receiving increasing attention in the mathematical psychology literature (Joreskog, 1971; Please, 1973), no general solution has been found to date. As Harman, (1976) concludes in his recent review of the literature on the subject, "The empirical approach, employing indices of proportionality of factors . . . seems not inappropriate at this time for the identification of factors across different studies . . . (involving the same set of variables in different samples)."

Our approach to testing the equality of evaluation criteria is different from that typically used in the literature. Instead of attempting to assert the similarity between factor structure matrices, we concentrate on the similarity between predictive equations used to assess factor scores. Our test then compares pairs of factor measurement equations obtained from different samples (Choffray and Lilien, 1978).

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Exhibit 6.17. Determination of dimensionality of evaluation space for production engineers.

Consider two regression models.

$$(1) \quad Y_1 = X_1 \beta_1 + \epsilon_1$$

$$(2) \quad Y_2 = X_2 \beta_2 + \epsilon_2$$

where Y_i is $(n_i \times 1)$, X_i is $(n_i \times K)$, β_1 and β_2 are vectors of coefficients and ϵ_1, ϵ_2 are vectors of disturbances. The null hypothesis, $\beta_1 = \beta_2$, gives rise to the reduced model:

$$(3) \quad Y = \begin{Bmatrix} X_1 \\ X_2 \end{Bmatrix} \beta + \epsilon$$

If we let e_1, e_2 and e be residual vectors associated with least squares estimation of (1), (2) and (3), respectively, then Chow (1960) shows that, under the null hypothesis,

$$(4) \quad C = \left\{ \frac{e'e}{e_1'e_1 + e_2'e_2} - 1 \right\} \frac{N - 2K}{K}$$

is distributed as F with $K, (N - 2K)$ d.f. (where $N = n_1 + n_2$).

Common factor analysis expresses each observed variable $\{x_k, k = 1, \dots, K\}$ as a

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linear combination of a small number of common factors $\{f_r, r = 1, \dots, R\}$ with $R \leq K$ plus a unique factor y_k

$$(5) \quad x_{ki} = \sum_{r=1}^R a_{kr} f_{ri} + u_k y_{ki}$$

where a_{kr} and u_k are the factor pattern coefficients, and subscript i refers to a particular individual in the sample ($i = 1, \dots, N$).

The factors $f_r, r = 1, \dots, R$, however, are hypothetical *unobserved* constructs. In the case of most common factor analysis techniques, the factor scores have to be estimated indirectly. Linear regression on the original variables ($x_k, k = 1, \dots, K$) is often used for this purpose – Harman (1976). The model may be expressed as follows:

$$(6) \quad f_{ri} = \sum_{k=1}^K \beta_{rk} x_{ki} + \epsilon_{ri}$$

where β_{rk} is the regression coefficient – or factor score coefficient – of factor f_r on variable x_k .

When the common factors are orthogonal, Harman (1976) shows that ρ_r^2 , the coefficient of multiple correlation associated with the estimation of factor f_r , can be calculated as

$$(7) \quad \rho_r^2 = \sum_{k=1}^K b_{rk} a_{kr}$$

where the b_{rk} 's are least squares estimates of the β_{rk} 's and $\{a_{kr}, k = 1, \dots, K; r = 1 \dots R\}$, are the correlations between the variable x_k 's and the factor f_r 's.

Under the usual assumptions of the common factor analysis model, it can be shown that:

$$(8) \quad \sum_{i=1}^N (f_{ri} - \hat{f}_{ri})^2 = N(1 - \epsilon_r^2)$$

We can then use (8) in (4), as $\sum_{i=1}^N (f_{ri} - \hat{f}_{ri})^2$ is the sum of the squared residuals

e'_{re} , associated with the estimation of the factor scores f_r .

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Hence, the statistic

$$(9) \quad C_r = \left\{ \frac{N(1 - \rho_r^2)}{n_1(1 - \rho_{r1}^2) + n_2(1 - \rho_{r2}^2)} - 1 \right\} \frac{N - 2K}{K}$$

can be used to test the equality of a specific factor obtained from the same set of variables in two different samples, where

ρ_{r1}^2, ρ_{r2}^2 are the squared multiple correlations associated with the estimation of factor r in sample 1 and 2 respectively,

ρ_r^2 is the squared multiple correlation associated with factor r in the pooled sample, and

$$N = n_1 + n_2$$

In terms of our methodology, Exhibit 6.18 outlines the steps involved in the computation of the test statistic, C_r , for assessing the similarity between evaluation criteria from different groups and an evaluation space of the same dimensionality. The exhibit involves only two groups, but the method is general and can be readily extended to any number of groups.

Assume that step 1 in the product evaluation space methodology led to the identification of R factors for groups 1 and 2. After rotation by the VARIMAX criterion, these factors provide the respective evaluation criteria. Call these evalua-

Exhibit 6.18. Outline of the procedure for assessing interdecision group differences in evaluation criteria.

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Exhibit 6.19 Varimax rotated factor matrices for corporate engineers and plant managers

Item Number	Corporate engineer		Plant manager		Pooled sample	
	Factor 1	Factor 2	Factor 1	Factor 2	Factor 1	Factor 2
1	-0.726	-0.169	-0.037	-0.798	-0.783	-0.102
2	0.338	0.135	0.521	0.366	0.336	0.355
3	0.439	0.208	0.165	0.595	0.476	0.221
4	-0.776	-0.307	-0.287	-0.877	-0.810	-0.305
5	0.166	0.612	0.589	-0.026	0.087	0.616
6	-0.781	0.027	-0.208	-0.352	-0.603	-0.081
7	0.011	0.750	0.750	0.327	0.130	0.734
8	0.237	0.779	0.633	0.321	0.250	0.738
9	-0.388	0.202	0.127	-0.620	-0.483	0.148
10	0.571	0.408	0.420	0.407	0.496	0.418
11	0.830	0.407	0.227	0.727	0.780	0.344
12	0.320	0.692	0.788	0.284	0.293	0.729
13	0.253	0.350	0.703	-0.062	0.216	0.512
14	0.537	0.134	-0.227	0.445	0.490	0.011
15	0.082	0.471	0.772	-0.047	0.031	0.584
16	-0.180	0.458	0.604	0.057	-0.093	0.533
17	-0.486	0.079	-0.312	-0.487	-0.476	-0.090
Percent of Common Variance*	.59	.23	.57	.26	.59	.24
Coefficient of Determination	.902	.845	.897	.915	.879	.841

*The percentage of common variance is defined in terms of the principal axes solution.

Source: Choffray, 1977

Exhibit 6.20 Test for factor equality for plant managers and corporate engineers

	F-ratio	Degrees of freedom
A. Matched Factors: Plant Managers f_1 Corporate Engineers f_2	1.46	(17,119)
B. Matched Factors: Plant Managers f_2 Corporate Engineers f_1	2.14*	(17,119)

*Significant at .01 level.

Note: f_i represents the i^{th} factor in the original varimax solution for the corresponding decision group.

Source: Choffray, 1977

tion criteria $f_1^1, f_2^1 \dots f_R^1$ and $f_1^2, f_2^2 \dots f_R^2$, for group 1 and group 2 respectively and let $\rho_{11}^2, \rho_{12}^2 \dots \rho_{1R}^2$ and $\rho_{21}^2, \rho_{22}^2 \dots \rho_{2R}^2$ denote the coefficients of determination associated with the estimation of these factors.

To assess the similarity between pairs of potentially similar factors, we first compute the reduced correlation matrix between the K perceptual items in the pooled sample. The same number of common factors R are extracted and a VARIMAX rotation is performed to ensure both uniqueness and maximum interpretability. Let $f_1, f_2 \dots f_R$ and $\rho_1^2, \rho_2^2 \dots \rho_R^2$ denote the resulting evaluation criteria and their associated coefficients of determination in the pooled sample. Exhibit 6.19 gives the results of this procedure for corporate engineers and plant managers, where there are two factors.

Next, similar evaluation criteria are matched. Several methods can be used for this purpose. Usually, simple visual inspection of the three VARIMAX rotated factor structures and/or the use of simple matching coefficients will suffice to isolate potentially similar factors. Let f_q^1, f_h^2 and f_R denote such a set of potentially similar factors for group 1, 2 and the pooled sample, respectively.

We can then compute the statistic C_r by Equation 9. When the value for C_r exceeds $F: (K, N - 2K; \alpha)$ where α denotes the level of significance of the test, the null hypothesis of equality of factor score coefficients, $H_0: \beta_q^1 = \beta_h^2$ is rejected. This leads to the conclusion that the two factors f_q^1 and f_h^2 are different. Exhibit 6.20 gives the results of this test for our solar cooling sample.

APPENDIX 2

A NOTE ON DISCRIMINANT ANALYSIS

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A Note on Discriminant Analysis

In many situations that arise in marketing we are interested in how two (or more) groups differ. In this project, we have focused on differences between solar recommenders and non-recommenders. We wish to predict whether a particular individual is most likely to be a solar recommender, or to identify those characteristics most closely related to category definition.

For solar recommendation, assume that solar citizenship and size of firm distinguish between solar installers and non-installers. Exhibit A2.1 gives an example, with the data from the two groups separated on the basis of a linear discriminant line. (Also shown for two of the points is their projections in y-axis perpendicular.) A "good" discriminant line is one that separates the point into homogeneous groups -- reminder and non-reminder. This will be achieved when the means of the two groups or this y-axis are separated as much as possible.

With two variables, x_1 and x_2 , the objective is to find a linear discriminant function (assuming equal variance of the two groups):

$$y = a_1x_1 + a_2x_2$$

that will discriminant between the two groups. The parameters, a_1 and a_2 , are chosen to maximize the ratio,

$$\frac{\text{variance between means on the y-axis}}{\text{variance within group on the y-axis}}$$

Superficially, discriminant analysis shows similarity to multiple regression in the sense that both methodologies use a linear equation to predict the dependent variable. But with regression analysis, the parameters are chosen to minimize the sum of squares, while with discriminant analysis the parameters are chosen to maximize the ratio of between group to within - group variance. Methodologically, we collapse the space into a single dimension. This new dimension or axis is found by computing a set of weights for the original axes to maximize the ratio of between-group to within-group variance.

The magnitude of the coefficient of the discriminant function depends on the scale used for measuring its associated variable. In structural analysis, we would like to say which variables discriminate better -- these results could have important policy implications. These can be computed by evaluating "standardized variable" computed by

$$a_j^* = a_j / \sigma_j,$$

where σ_j is the standard deviation, of the j^{th} variable.

If $|a_j^*| > |a_k^*|$, then variable j is a better discriminator than variable k -- i.e., it is "more important" in determining which group an individual is most likely to belong to.

For more details see Lachenbruch [1975].

Discriminant Analysis Example

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APPENDIX 3

CONSUMER FOCUS GROUP REPORT

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Summary of Results of Focus Group - November 29, 1979

The group was composed of five men and five women. All were homeowners except one man, who is getting ready to build a home.

All participants were aware of solar energy, although few knew much about it or had seen a system installed. One woman has a passive solar system for space heating and uses a wood stove as a back-up. The man building a home had done some looking into solar, but because of prohibitive cost, will probably go with wood heating and possibly a passive device on the back of the house. If he does decide on solar, he will probably go with a water heating device.

Responses to the confidence statements, "I know a lot about the financial aspects of solar devices" were negative. The general consensus was that solar is not feasible economically. Responses to "I know a lot about how a solar device works" were mixed. About three people in the group had looked into solar and had a grasp on how it works, although one man was not sure what the difference is between passive and active.

When asked what their information needs are in terms of solar, the following points surfaced:

- How does the system work? How does it work in relation to the back-up system? How much do you have to rely on the back-up system?
- Is solar feasible in this climate? What happens when there is a stretch of cloudy weather? Will the pipes freeze? How can I be sure the system works effectively?
- Where in cycle of development am I buying in?
- What does it cost? What am I going to save?

The description of solar water heaters presented to the group seemed to be well-understood. Some additional information suggested for inclusion was:

- recovery time
- storage tank used - what is it insulated with?
- how hot the water will actually get

The following concerns about solar were mentioned:

- cost of system
- is it feasible in the climate?
- there should be a guarantee on the system (10 years was marked as being standard for any other kinds of system)
- is the savings worth the initial investment?
- the collectors should be reinforced so they are not easily breakable
- what about snow and freezing rain on the collector?

Some suggestions for marketing solar were:

- advertise simplistically
- cut cost
- young people should be target group
- show the long-term savings
- give demonstrations, model home, etc.
- show it as a viable, tested product
- low-interest loans

When asked what they thought a system would cost, most people had no idea. The three who knew something about solar came up with about \$2000 and up for water heating. These same three people knew of the HUD grants of \$400 and of the tax rebate, although they thought the rebate was much lower than presented in the financial presentations. In fact, they found it very hard to believe the figure quoted.

Two versions of the financial presentation were given to the group, one short and one long. Reactions were mixed, but most wanted the more detailed information presented in the long version. However, several women in the group said they just flipped through the pages and didn't know what to do with the numbers; they felt more confused when confronted with so many numbers. A suggestion was made to give the short version with lots of footnotes or appendices containing the more detailed information. They suggested eliminating some of the numbers - especially upper and lower bounds.

A major problem with the financial information was that the group thought that the numbers quoted were not believable. The tax rebate, as already mentioned, was not believed. Several people also questioned the figures showing savings against a gas system. One man said the long version antagonized him more because it assumed too much and he didn't believe the numbers. People got

the impression they were being "snowed". They wanted evidence of where the numbers came from. They also wanted totals for the column of figures that were shown. They wanted to know what the replacement cost would be. One woman went through and figured sums of savings, payments, etc. and was convinced more than ever that solar is infeasible. She claimed she paid \$60 for her gas water heater and pays minimal gas bills (she uses passive solar & wood for heating). When the rate of inflation of fuel costs was pointed out to them, the numbers seemed a little better to them. But most of the people in the group didn't process the numbers at all and claimed the "average" person does not consider all costs when making a major purchase - they want to know what their monthly payment will be and if they can afford it or not. A suggestion was made to do a case study of an "average" family and present their use and cost of a solar device in terms of income, heating needs, etc.

Despite the negative aspects brought out concerning cost, most of the group seemed very receptive to the idea of solar. They indicated they would consider it if they could believe it were economically feasible and if they felt confident that the technology had been fully developed and tested.

APPENDIX 4

DETERMINATION OF NUMBER OF INTERVIEWS PER STATE

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Determination of Number of Interviews Per State

Interviews were allotted to states based on a composite measure of likely solar market potential. This measure can be expressed as a multiplier for each state which represents both the portion of national solar market potential represented by that state and the fraction of total interviews we conducted in that state.

potential.

The composite measure of market potential was based on two criteria (shown in Table 1):

- 1980 population of citizens 21 and over (obtained through Dialogue's demographic forecasting system)
- A solar receptivity measure described below.

These two components were multiplied and normalized to give the solar market potential.

The solar receptivity measure shown in Table 1 includes state ratings on six attributes which have an important effect on the adoption of solar systems:

- insolation
- degree days
- average (weighted) fuel cost
- future availability of primary fuel
- average income
- local incentives

In generating the index the following assumptions were considered to be favorable for solar adoption:

- high insolation - implies availability of sunshine
- high number of degree days - implies greater need for heating fuel
- high average fuel cost - implies higher likelihood that solar will be cost competitive
- low future availability of primary fuel - implies a need to find alternative sources for heating
- high average income - implies financial ability to support market
- strong local incentives - implies local support leading to an encouraging overall climate for solar adoption

These six attributes were weighted, on the basis of expert opinion, to reflect their relative importances to solar adoption. The specific indices were then calculated as follows:

$$\text{Growth Potential Index (for } j\text{th city)} = \sum_i \gamma_{ij}$$

where γ_{ij} = the growth attribute i for city j .

$$\text{Solar Potential Index (for } j\text{th city)} = \pi \sum_i \sigma_{ij}^{w_i}$$

where σ_{ij} = the solar potential attribute i for city j

and w_i = the weight factor for attribute i

The values of the γ_{ij} 's and the σ_{ij} 's were obtained primarily from A Location Matrix Plan for Residential Solar Heating and Cooling Program * (A.D. Little). Growth and solar potential indices were calculated for 104 cities, nationwide.

The indices for the cities were then averaged for the appropriate states and the receptivity for the state with maximum solar receptivity (Arizona) was scaled to equal 100.

The multiplier which gives the number of interviews per state was then calculated as the normalized product of receptivity and population.

MULTIPLIERS FOR STATES

<u>State</u>	<u>Solar Receptivity</u>	<u>Population</u> <u>[1980, 21 and over]</u>	<u>Multiplier</u>
AL	65.3	2465	.139
AZ	100.0	1652	.143
AR	54.3	1480	.070
CA	95.3	15004	.124
CO	92.3	1835	.015
CT	83.8	2139	.015
DE	82.7	392	.028
FL	99.7	6726	.058
GA	91.3	3389	.027
ID	85.7	571	.042
IL	69.7	7412	.045
IN	58.0	3504	.018
IA	65.6	1940	.011
KS	57.9	1560	.008
KY	53.8	2328	.011
LA	69.1	2475	.015
ME	74.8	743	.005
MD	89.8	2876	.022
MA	80.1	4040	.028
MI	80.8	5991	.042
MN	50.7	2646	.012
MS	54.9	1511	.007
MO	49.1	3253	.014
MT	52.9	519	.002
NB	52.1	1058	.005
NV	94.9	433	.004
NH	65.0	576	.003
NJ	83.7	5071	.037
NM	88.2	778	.006
NY	74.3	12171	.078
NC	80.2	3805	.026
ND	29.8	427	.001
OH	71.4	7076	.044
OK	75.1	1914	.012
OR	83.9	1651	.012
PA	56.8	8152	.040
RI	58.7	650	.003
SC	88.1	1926	.015
SD	30.4	453	.001
TN	68.9	2913	.017
TX	94.7	8420	.070
VT	76.7	771	.005
VA	87.4	3514	.026
WA	61.9	2431	.013
WV	63.8	1249	.007
WI	75.8	3139	.021
WY	77.5	266	.002

APPENDIX 5

CUSTOMIZATION BY STATE

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EXHIBIT A 5-1

Customization by State

	<u>Gross Price</u>	<u>Collectors</u>	<u>Savings (%)</u>		<u>Year 1 Savings (\$)</u>		
			<u>Lower</u>	<u>Upper</u>	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
1. Alabama	2600	4	60	80	149	188	51
2. Alaska	-	-	-	-	-	-	-
3. Arizona	2300	3	60	80	156	227	53
4. Arkansas	2600	4	65	85	146	226	66
5. California	2300	3	60	80	156	227	53
6. Colorado	3300	4	70	90	179	283	53
7. Connecticut	3300	4	45	65	128	256	91
8. Delaware	3300	4	50	70	132	226	27
9. Florida	2600	4	70	90	179	283	56
10. Georgia	2600	4	60	80	149	188	51
11. Hawaii	-	-	-	-	-	-	-
12. Idaho	3300	4	70	90	179	283	53
13. Illinois (Col.)	2900	3	45	65	121	180	30
14. Indiana	2900	3	45	65	121	180	30
15. Iowa	2900	3	45	65	121	180	30
16. Kansas	2900	3	45	65	121	180	30
17. Kentucky	2900	3	45	65	121	180	30
18. Louisiana	2600	4	65	85	146	226	66
19. Maine	3300	4	45	65	128	256	91
20. Maryland	3300	4	50	70	132	226	27
21. Massachusetts	3300	4	45	65	128	256	91
22. Michigan	2900	3	40	60	112	162	26
23. Minnesota	2900	3	40	60	112	162	26
24. Mississippi	2600	4	60	80	149	188	51
25. Missouri	2900	3	45	65	121	180	30
26. Montana	2900	3	45	65	129	171	25
27. Nebraska	2900	3	45	65	129	171	25
28. Nevada	3300	4	70	90	179	283	53
29. New Hampshire	3300	4	45	65	128	256	91
30. New Jersey	3300	4	45	65	128	256	91

EXHIBIT A 5-1 (continued)

	<u>Gross Price</u>	<u>Collectors</u>	<u>Savings (%)</u>		<u>Year 1 Savings (\$)</u>		
			<u>Lower</u>	<u>Upper</u>	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
31. New Mexico	2300	3	60	80	156	227	53
32. New York (Bos.)	3300	4	45	65	128	256	91
33. North Carolina	2600	4	65	85	159	226	46
34. North Dakota	2900	3	45	65	129	171	25
35. Ohio	2900	3	40	60	112	162	26
36. Oklahoma	2600	4	65	85	146	226	66
37. Oregon (GJ)	3300	4	70	90	179	283	53
38. Pennsylvania	3300	4	50	70	132	226	27
39. Rhode Island	3300	4	45	65	128	256	91
40. South Carolina	2600	4	65	85	159	226	46
41. South Dakota	2900	3	45	65	129	171	25
42. Tennessee	2600	4	60	80	140	188	51
43. Texas	2600	4	65	85	146	226	66
44. Utah	3300	4	70	90	179	283	53
45. Vermont	3300	4	45	65	128	256	91
46. Virginia	3300	4	50	70	132	226	27
47. Washington (GJ)	3300	4	70	90	179	283	53
48. West Virginia	3300	4	50	70	132	226	27
49. Wisconsin	2900	3	40	60	112	162	26
50. Wyoming	2900	3	45	65	129	171	25
51. Illinois (Mad.)	2900	3	40	60	112	162	26
52. New York (NYC)	3300	4	45	65	134	299	127
53. Oregon (Seattle)	3300	4	40	60	112	27	73
54. Washington (Sea.)	3300	4	40	60	112	27	73

EXHIBIT A 5-2

State Tax Credits for Solar Energy Systems

1. Alabama	AL	NONE	26. Montana	MT	OTHER
2. Alaska	AK	-	27. Nebraska	NE	NONE
3. Arizona	AZ	(35%, \$1000)	28. Nevada	NV	NONE
4. Arkansas	AR	OTHER	29. New Hampshire	NH	NONE
5. California	CA	OTHER	30. New Jersey	NJ	NONE
6. Colorado	CO	OTHER	31. New Mexico	NM	(25%, \$1000)
7. Connecticut	CT	NONE	32. New York	NY	NONE
8. Delaware	DE	OTHER	33. North Carolina	NC	(25%, \$1000)
9. Florida	FL	NONE	34. North Dakota	ND	(10%, no max)
10. Georgia	GA	NONE	35. Ohio	OH	(10%, \$1000)
11. Hawaii	HI	-	36. Oklahoma	OK	(25%, \$2000)
12. Idaho	ID	OTHER	37. Oregon	OR	(25%, \$1000)
13. Illinois	IL	NONE	38. Pennsylvania	PA	NONE
14. Indiana	IN	NONE	39. Rhode Island	RI	OTHER
15. Iowa	IA	NONE	40. South Carolina	SC	NONE
16. Kansas	KS	(25%, \$1000)	41. South Dakota	SD	NONE
17. Kentucky	KY	NONE	42. Tennessee	TN	NONE
18. Louisiana	LA	NONE	43. Texas	TX	NONE
19. Maine	ME	(25%, \$1000)	44. Utah	UT	(10%, \$1000)
20. Maryland	MD	NONE	45. Vermont	VT	(25%, \$1000)
21. Massachusetts	MA	OTHER	46. Virginia	VA	NONE
22. Michigan	MI	OTHER	47. Washington	WA	NONE
23. Minnesota	MN	(20%, \$2000)	48. West Virginia	WV	NONE
24. Mississippi	MS	NONE	49. Wisconsin	WI	(10%, \$1000)
25. Missouri	MO	NONE	50. Wyoming	WY	NONE

States with no tax credit = NONE

States with percentage P tax credit up to a maximum of M = (P%, \$M)

States with tax credit calculated differently = OTHER

EXHIBIT A 5-3

State Tax Credits for States using
Method other than Fixed Percentage to a Maximum

3. Arkansas - Tax Deduction -- We used a 6% tax rate.
5. California -- Rebate = 55% of the gross price up to a maximum rebate of \$3000. However, the federal tax rebate is then deducted from this amount.
6. Colorado - Tax Deduction -- We used a 8% tax rate (Colorado has a graduated state income tax.)
8. Delaware -- Rebate = \$200 fixed tax credit.
12. Idaho - Tax Deduction -- We used a 7.5% tax rate.
21. Massachusetts - Rebates 35% of the gross price after the federal rebate is subtracted. Maximum rebate is \$1000.
22. Michigan -- 25% of the first \$2000, 15% of the next \$8000.
26. Montana -- 5% of the first \$1000, 2.5% of the next \$3000.
39. Rhode Island - Rebates 19% of the federal rebate.

APPENDIX 6

WEIGHTING OF RESIDENTIAL SAMPLE

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Weighting of Residential Sample

A total of four different weights were used in the analysis of the residential data:

- weight for existing homes screener respondents
- weight for existing homes mail out respondents
- weight for new homes screeners respondents
- weight for new homes mail out respondents

The number of respondents in each of these four groups was determined for each of four regions:

- North East
- South
- North Central
- West

(where the four regions were defined by the U.S. Department of Commerce, Bureau of the Census) and within these regions by income level:

- under \$15,000
- \$15,000 - \$24,999
- \$25,000 - \$39,999
- \$40,000 and up

Each questionnaire was then assigned a weight such that:

- the weighted proportion of respondents in a particular region with a particular income would match the census data for that proportion in the U.S, and
- the sum of weights would add to the true number of individuals in each group.

The census figures for these proportions (from Money Income in 1970 of Households in the United States, Series P-6 No. 121, Issued February, 1980) are:

Income Region	<u>North East</u>	<u>South</u>	<u>North Central</u>	<u>West</u>
less than \$15,000	7.9	15.1	1.1	6.7
\$15,000 - \$24,999	6.5	9.4	8.8	5.2
\$25,000 - \$39,999*	3.4	4.4	4.4	3.1
\$40,000 and up*	3.1	4.1	3.7	3.0

(Note: If one denotes the above population fractions by p_i , $i = 1, 2, \dots, 16$ and $p_1 + \dots + p_{16} = 1$ and denotes the actual number of respondents in each category for a particular group by n_i , $i = 1, 2, \dots, 16$ with $n_1 + \dots + n_{16} = N =$ total number of respondents for that group, then the weight used is simply:

$$w_i = \frac{p_i N}{n_i} \quad .)$$

* These numbers arrived at using linear interpolation of supplied income ranges (\$25,000 - \$49,999 and \$50,000 and above).

APPENDIX 7

DEVELOPMENT OF THE DECISION MATRIX

Source: Market Planning New Industrial Products
by Jean-Marie Choffray, Gary L. Lilien
Appendix 4.1

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DEVELOPMENT OF THE DECISION MATRIX

A.4.1.1 THE PROBLEM

Little is known about how to measure the role played by different decision participants in industrial buying decisions. Studies typically involve the survey of a large cross-section of firms. There, aggregate frequencies of purchasing process involvement, by industry, are computed for each of several organizational functions -- Scientific American (1969); Buckner (1967); Stevens and Grant (1975).

Some studies also measure the relative influence of different decision participants (Weigland, 1968; McMillan, 1973; Grashof and Thomas, 1976; Silk and Kalwani, 1978). Most report the poor reliability of self-reported data about personal influence. Breaking influence into more specific areas improves the reliability of the measurements -- Patchen (1963); Corey (1971). Kelly's (1974) work tends to support that hypothesis. He concludes that there is little disagreement between decision participants about who in the organization had performed any of five major functions.

Available research suggests that work aimed at measuring involvement in the industrial purchasing process should

- Be limited to a single product at a time. This maximizes the chance of identifying interorganizational variation in the purchasing process without the risk of contamination from differences in product characteristics (Kelly, 1974).
- Break the decision process into managerially meaningful areas of influence. This improves the reliability of self-reported data (Patchen, 1963; Corey, 1971).
- Recognize that the measurement of the involvement or noninvolvement of participants in the purchasing process leads to more reliable results than the measurement of their relative influence. (Grashof and Thomas, 1976; Silk and Kalwani, 1978).

A.4.1.2 THE DECISION MATRIX

We propose a set of criteria for a measurement instrument designed to assess purchasing process involvement. The instrument should be:

- *Specific*: the instrument should be flexible enough to adapt to different products.
- *Simple*: the instrument should be understandable and unambiguous.
- *Robust*: the instrument should prevent nonsensical answers of the type "in our company all functions would be involved in all stages of the purchasing process for this product."
- *Economical*: the instrument should be administrable through standard marketing survey methods.
- *Internally valid*: independent measurements within the same firm should lead to similar results.

Here, we propose a "decision matrix" as such a measurement instrument. A decision matrix is a double-entry table whose rows list categories of individuals involved in the decision process in customers' organizations and whose columns list the stages in the decision process. The respondent indicates what percentage of the task-responsibilities for each stage in the process belongs to each category of decision participant in his organization. The request for constant-sum information forces respondents to specify only those decision participant categories that play a substantial role in each phase of the decision process or whose involvement in a specific phase is certain. A less constrained version of this method that did not request constant-sum information was used in several other studies. (See for instance Buckner, 1967, *Scientific American*, 1969).

APPENDIX 8

MICROSEGMENT FORMATION BY CLUSTER ANALYSIS

Source: Market Planning For New Industrial Products
by Jean-Marie Choffray, Gary L. Lilien
Appendix 4.2

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MARKET PLANNING FOR NEW INDUSTRIAL PRODUCTS

The microsegmentation approach developed here uses agglomerative hierarchical clustering methods. These methods use as input a dissimilarity – or similarity – matrix in which each cell describes the degree of dissimilarity between any two entities in the sample. We first show how to develop similarity indices.

A.4.2.1 SIMILARITY MEASURES

Let x_{ijh} denote the entry in row j and column h of the decision matrix answered by company i . This value represents the percentage of the task-responsibilities associated with decision phase, h , $h = 1 \dots H$, associated with participant j , $j = 1 \dots J$, in the adoption process for company i , $i = 1 \dots I$. We have:

$$x_{ijh} \geq 0 \text{ for all } i, j, h$$

$$\sum_{j=1}^J x_{ijh} = 1 \text{ for all } i, h$$

A participant category, say j , is said to be involved in phase h of the purchasing process for company i whenever:

$$x_{ijh} > \epsilon$$

Now we face the problem of defining ϵ . Two possible choices are:

- We can set $\epsilon = 0$. This would be reasonable in view of the request in the decision matrix for constant sum estimates of involvement in each phase of the decision process. Respondents are actually forced to mention only those categories of participants whose involvement they are sure of. (Appendix 4.3 describes the convergent validity of this approach.)
- Alternatively, we can set $\epsilon = \theta$, where θ is a function of the reliability of the measurements obtained with the decision matrix. For example, θ could be set at the 95 percentile of the empirical distribution of observed discrepancies between decision process involvement estimates obtained from different individuals in the same firm. In this case $x_{ijh} > \epsilon$ is equivalent to being 95% certain of involvement by individual j in phase h in firm i .

Let:

$$\delta_{ijh} = \begin{cases} 1 & \text{if } x_{ijh} > \epsilon \\ 0 & \text{if } x_{ijh} \leq \epsilon \end{cases}$$

The pattern of involvement of various groups of participants in the decision process for a given firm i can then be viewed as a $(J \times H)$ - dimensional vector Δ_i containing only 0's and 1's:

MICROSEGMENT FORMATION BY CLUSTER ANALYSIS

$$\Delta_i = \{\delta_{i11}, \dots, \delta_{iJ1}, \delta_{i12}, \dots, \delta_{iJ2}, \dots, \delta_{i1H}, \dots, \delta_{iJH}\}$$

One such vector characterizes each firm in the sample.

The choice of a similarity index is now equivalent to measuring the associations between two vectors of binary variables. Hence, we are mostly limited to matching coefficients, many of which have been used widely in numerical taxonomy – Sokal and Sneath (1963); Bijnen (1973).

Our analysis makes it preferable from the standpoint of interpretation to use dissimilarity measures rather than similarity measures. We therefore suggest the following dissimilarity coefficient between two firms, r and s , using the decision matrix data:

$$D_{rs}^2 = \sum_{j,h} (\delta_{rjh} - \delta_{sjh})^2$$

This coefficient may be viewed as a member of a more general class of distance functions involving the relationships between sets of (0,1) entities (Curry, 1976). As such, D_{rs}^2 satisfies the properties of nonnegativity, symmetry and the triangle inequality required of distances (Restle, 1959). It may therefore be used as metric input in any subsequent analysis.

A.4.2.2 MODIFICATION OF DECISION MATRIX DATA TO ACCOUNT FOR REPORTING BIAS

We assume above that the results in the decision matrix, $\{x_{ijh}\}$, are reported without bias, even if reported with error. In constructing the δ_{ijh} this is not a serious problem. However, if we wish to use the data in their original, metric form (for the multiperson choice model or if a different dissimilarity measure is to be constructed), we must eliminate respondent bias.

The main source of respondent bias is overstatement of the respondent's own role with the (consequent) understatement of the role of other decision participants. We need to use the following three assumptions to arrive at a simple solution to the problem.

Assumption 1: (Respondent Independence) On average, the importance of an individual (i.e., x_{ijh}) in the process, given that $x_{ijh} > 0$, should be the same independent of the category of the responding individual. This means that it should not matter who (what job category) in an organization completes the decision matrix – the importance of, say, the purchasing agent should be the same whether he completes the matrix himself or an engineer completes it.

Assumption 2: (Job-Bias Independence) The degree of personal bias associated with the reporting of importance is, on average, independent of

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job title. This assumption can be relaxed if the analyst can replace it with approximate estimates of individual bias (see below).

Assumption 3: (Company-Bias Independence) Similar to Assumption 2, here the degree of personal bias associated with the reporting of importance, is, on average, independent of specific company or organization. This assumption can be relaxed if multiple measures within the same organization can be developed.

Following these assumptions we proceed as follows. First, fix h , the column of the decision matrix; the procedure is applied to each column independently and sequentially. Let x_{ij} be job category j 's involvement as specified by a respondent from company i .

Define the following:

$$(1) \quad y_{kj} = \frac{\sum_{i \in \{k\}} x_{ij}}{\sum_{i \in \{k\}} \delta_{ij}}, j, k = 1, \dots, J$$

where

$\{k\}$ is the set of all respondents, $i = 1 \dots I$

whose participant category is k , $k = 1 \dots J$.

and

$$\delta_{ij} = \begin{cases} 1 & \text{if } x_{ij} > 0 \\ 0 & \text{otherwise} \end{cases}$$

Thus, we have a total of I respondents. Each belongs to one of J participant categories. We sum the levels of involvement and divide by the number of nonzero entries. y_{kj} can be interpreted, then, as the average involvement of decision participant category j as seen by members of decision participant category k . We now look for a transformation of $\{y_{kj}\}$, call it $\{a_{kj}\}$, to $\{y_{kj}^*\}$. Our ideal, transformed y_{kj}^* has, by assumption, the following properties:

$$(2) \quad y_{kj}^* = y_{wj}^* \text{ for all } k, w, j$$

and

$$\sum_j y_{kj}^* = 1 \text{ for all } k$$

We apply our transformation in the following manner: Let

MICROSEGMENT FORMATION BY CLUSTER ANALYSIS

$$y_{kj}^* = a_{kj} y_{kj}$$

Then (2) yields:

$$(3a) \quad a_{kj} y_{kj} = a_{wj} y_{wj} \text{ for all } k, w, j$$

$$(3b) \quad \sum_j a_{kj} y_{kj} = 1 \text{ for all } k$$

Equation (3a) represents $J^2 - J$ independent equations, and equation (3b) adds 1 independent equation. The $J - 1$ other equations are reduced to an equivalent equation by the application of (3a). Thus we have $J^2 - J + 1$ independent equations in J^2 unknowns. Assumption 2 adds the following $J - 1$ conditions.

$$(3c) \quad a_{11} = a_{22} = \dots = a_{JJ}$$

If we wish to drop assumption 2, we need to add a different set of $J - 1$ conditions. In general:

$$(3d) \quad a_{22} = k_2 a_{11}, a_{33} = k_3 a_{11}, \dots, a_{JJ} = k_J a_{11}$$

If the analyst wishes to assume that purchasing agents (Category 1) overstate their importance by 50% more than do engineers (Category 2), that is equivalent to $a_{22} = 1.5 a_{11}$ or $k_2 = 1.5$. Assumption 2 is a default condition with $k_i = 1$ for $i = 2, \dots, J$.

If we wish to drop assumption (3) through the use of multiple measures in the same organization, equation (1) is modified, redefining $\{k\}$ as:

$\{k\}$ is the set of all respondents whose participant category is k , $k = 1, \dots, J$ and who are employed in organizations m , $m = 1, \dots, M$.

In this case, the analysis follows, with completely independent adjustments performed for each organization m , $m = 1, \dots, M$.

Now, this system will have an interpretable solution for realistic $\{y_{kj}\}$ as long as all $y_{kj} > 0$. Zero values for y_{kj} lead to unbounded solutions in the set of equations (3a). Eliminating rows and columns with zero entries (usually job categories of negligible importance in the decision process) will eliminate this problem.

Going back to our original matrix, we can now modify the x_{ij} as follows:

$$(4) \quad x_{ij}^* = \frac{x_{ij} a_{k(i),j}}{\sum_j x_{ij} a_{k(i),j}}$$

where $k(i)$ refers to the job category that respondent i belongs to. The results of equation (4) are then a set of involvements, uncontaminated by respondent bias.

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A.4.2.3 HIERARCHICAL CLUSTERING FOR MICROSEGMENT FORMATION

We now face the problem of grouping organizations, using whatever measure of interorganizational similarity we have chosen. For this purpose, we use cluster analysis.

The general problem addressed by cluster analysis is how to partition a heterogeneous set of entities—in our case, industrial firms—into mutually exclusive homogeneous subsets. To solve this problem, many cluster analytic models portray the entities as points in a metric space and search for regions in this space characterized by a high density of points. Clusters are formed from entities that are close to one another, but distant points become members of different clusters. An excellent review of cluster analysis is provided by Hartigan (1975).

The microsegmentation procedure developed here uses agglomerative hierarchical clustering methods. These methods form clusters by grouping most similar entities in the same clusters. They generate solutions that can be graphically presented as hierarchical trees or dendrograms.

Agglomerative hierarchical clustering methods have two advantages over other clustering methods. First, they do not require any information about the number or composition of clusters. Second, they provide a visual representation of intracluster formation that can help interpret the clusters.

At each stage in the clustering process agglomerative methods form new clusters that minimize some function of intercluster distances. The dissimilarity matrix is then recomputed to express the relationship between the new clusters and the remaining entities. The main difference among agglomerative clustering algorithms is found here: some define intercluster distances that assume only ordinal dissimilarity measures (see for instance Johnson, 1967); others assume an underlying metric and algebraically manipulate intercluster distances. (See for example Ward, 1963). Both classes of methods are used here.

The use of cluster analysis for industrial market microsegmentation requires that several problems be solved (Choffray, 1977). These include:

1. Tests on the sensitivity of cluster analysis results to extreme observations or outliers.
2. Tests on the nonrandomness of the structure observed in a dissimilarity matrix, and the determination of the number of clusters to be retained.
3. Determination of the nonuniqueness of the clustering solution retained.

The major steps of the microsegmentation procedure are as follows:

Step 1: Computation of the Dissimilarity Matrix for the Macrosegment.

This step involves the computation of the dissimilarity matrix using the measure D^2_{rs} defined earlier. Each entry in this matrix expresses the difference between firm r and firm s in the composition of their buying centers.

MICROSEGMENT FORMATION BY CLUSTER ANALYSIS

Step 2: Identification of Outliers.

This step involves identification of outliers, organizations whose decision process bears little resemblance to that of other organizations. Inclusion of such organizations in any of the microsegments retained would reduce intrasegment homogeneity and make it harder:

- to get a good description of the pattern of involvement within the microsegment, and
- to determine the link between microsegment membership and other observable organizational characteristics.

Following Blashfield (1976), single linkage cluster analysis is used to identify outliers. This method defines the distance between a new cluster t — made up of firm n and v — and some other cluster w — as:

$$d_{tw} = \min(d_{nw}, d_{vw})$$

Hence, the quantity d_{tw} is the distance between the two *closest* members of cluster t and w .

A cluster identified by single linkage analysis is a group of entities such that every member of the cluster is more similar to at least one member of the same cluster than it is to any member of any other cluster. As a result, single linkage analysis has the tendency to form long clusters that are weakly connected. This property, called chaining, provides a powerful tool to identify firms that share little similarity with the rest of the sample. After examination of the decision process of these firms, they are removed from the analysis and their purchasing decision process is the object of a separate analysis.

For example, in the solar cooling case, 10 extreme companies were identified. They appear at the lower end of the hierarchical classification in Exhibit 4.14. Careful analysis of these 10 companies — clusters 5, 6 and 7 — eliminated them from further consideration.

Step 3: Nonrandomness of the Data Structure.

The next step concerns the nonrandomness of the data structure and the determination of the number of clusters.

This question is nontrivial. Cluster analysis methods, designed to form groups of similar entities in a data set, are very successful even when the entities are randomly generated.

As noted by Fleiss and Zubin (1960), a key defect in most clustering procedures is the absence of a statistical model. Some theoretical work has recently appeared in the literature and involves the application of graph theory to cluster analysis — Hubert (1974). Ling (1973) proposes a probability theory of cluster analysis. He recognizes, however, that no compelling argument justi-

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Exhibit 4.14. Single linkage cluster analysis for total sample.

fies his particular choice of model, and that in most real situations the conditions required by his model are not entirely satisfied.

In the absence of a satisfactory statistical model, simulation is recommended to investigate the nonrandomness of the structure observed in a dissimilarity matrix and to determine a statistically significant range of clustering solutions.

The idea behind the simulation approach is that a researcher is not interested in a pattern of cluster formation that does not substantially differ from that which would be obtained if the dissimilarities had been generated independently.

Fast cluster analysis programs (Dalziel, 1974) are generally available and relatively cheap to use. Moreover, it is our experience that cluster analytic solutions obtained from randomly generated dissimilarities are quite stable, so that a small number of simulations (5-10) is usually sufficient to get an estimate of the expected number of clusters and an estimate of the standard deviation of that number at various clustering levels.

MICROSEGMENT FORMATION BY CLUSTER ANALYSIS

Exhibit 4.15. Results of the simulation study of the number of clusters: solar cooling study.

Exhibit 4.15 reproduces the results of the simulation analysis performed for the industrial air conditioning system microsegmentation.

This simulation involved cluster analyzing 10 dissimilarity matrices whose individual entries were generated randomly from the same empirical distribution of observed dissimilarities.

The number of clusters obtained from the observed dissimilarity matrix at various clustering levels departs significantly from the number that would be observed at these levels under the null hypothesis. Interestingly enough, the zero information trace intersects the observed trace, indicating that:

- The actual data are characterized by a larger number of small, closely connected clusters.
- As the clustering proceeds, the dissimilarity matrix for the 108 companies contains significantly fewer clusters than would be observed under the random model hypothesis.

MARKET PLANNING FOR NEW INDUSTRIAL PRODUCTS

Therefore, meaningful structure exists in our data. Decision process similarities between industrial organizations in our sample typically leads to a smaller number of microsegments than would be observed under a random model. Interpreted in another way, the simulation results indicate that within the range ($50 < n_{\alpha} < 4$), where n_{α} is the number of clusters assumed, the data contain substantially more connected clusters—as evidenced by the smaller clustering level—than under the null hypothesis.

When we consider these results—which indicate that a four cluster solution represents the fewest clusters that significantly depart from the random model—together with the parsimony objective of the microsegmentation methodology, it appears that a four cluster solution is a reasonable choice.

In case no clustering level is found that significantly departs from the random model, the analysis should conclude that microsegmentation is infeasible.

Step 4: Cluster Invariance Analysis.

This step involves the cluster membership invariance. There are two main reasons why cluster analytic solutions are not unique even when the researcher has decided upon the final number of clusters to be retained in his analysis. The first one has to do with the way a clustering method handles tied dissimilarities.

The second reason for the indeterminacy of cluster analytic solutions occurs because clustering algorithms assume different scaling properties of the dissimilarity measures and compute distances between cluster entities differently. As a result, different methods lead to different cluster composition except for extremely stable clusters. Which of the many algorithms available should you use?

To date no answer has been provided. Each clustering technique has its advocates and its critics (see the discussion by Anderberg, 1973). Very few empirical studies compare relative performances. A recent analysis by Blashfield (1976), however, suggests that some of these methods might be more accurate than others in recovering clusters generated under a mixture model involving several different populations.

For our purposes, the question of indeterminacy of cluster solutions is of considerable importance. The nature of dissimilarity measures defined over a finite set of binary variables (typically $J \times H$ variables in the decision matrix) suggests that tied dissimilarities will occur in any data set of reasonable size. In addition, the microsegments must be very stable, if the remaining analysis is to make sense.

We suggest here using several clustering algorithms in parallel and analyzing the composition of the resulting clusters. If the set of clusters retained are indeed real, their composition will vary little across clustering methods. This criterion of composition invariance across clustering models has also been proposed by Everitt (1974).

MICROSEGMENT FORMATION BY CLUSTER ANALYSIS

For this purpose, we suggest three common agglomerative clustering models. Interested readers are referred to Hartigan (1975), Anderberg (1973), and Dalziel (1974) for more complete descriptions of these algorithms.

Complete Linkage Cluster Analysis: According to this method, a cluster is defined as a group of entities in which each member is more similar to all members of the same cluster than it is to members of any other cluster. At each clustering stage, after cluster u and v have been merged, the dissimilarity between the new cluster — say t — and some other cluster w is determined by:

$$d_{tw} = \max(d_{uw}, d_{vw})$$

An advantage of complete linkage analyses over most other clustering methods is that it requires only ordinal dissimilarity measures. The solution is therefore invariant under a monotonic transformation of the dissimilarity matrix.

A main criticism of complete linkage analysis, however, is that as an entity cannot join a cluster until it obtains a given similarity level with all members of this cluster, the probability of a cluster obtaining a new member becomes smaller as the size of the cluster increases. This property, known as space-diluting (Lance and Williams, 1967), means that the effective distance between a cluster and some nonmember increases as the size of the cluster increases.

Average Linkage Cluster Analysis: Average linkage analysis represents a compromise between single linkage analysis — which characterizes a cluster by the longest link needed to connect any of its members to some other one — and complete linkage analysis.

In average linkage analysis, a cluster, t , is characterized by the mean of the distances between all pairs of distinct items within the cluster:

$$\text{size of cluster } (t) = \frac{2}{n_t(n_t - 1)} \sum_{r \neq s \in t} d(r, s)$$

where n_t is the number of entities in t and the summation is over all pairs of points $r \neq s$ in t . A cluster is then defined as a group of entities in which each member has a greater mean similarity with all members of the same cluster than it does with all members of any other cluster.

Sneath and Sokal (1973) claim that average linkage cluster analysis is the best hierarchical method yet proposed. Evidence suggests, however, that this method is more likely than some other clustering methods to form nonconformist groups as the sizes of the clusters increase (Williams, Clifford and Lance, 1972).

Minimum Variance Cluster Analysis: Ward (1963) and Ward and Hook (1963) have described a general method of hierarchical clustering that, at each step, maximizes an objective function reflecting an investigator's particular purpose. Although the method is general and encompasses most other hierarchical methods, Ward illustrates it with an error sum of squares objective function that is better known than his general procedure.

The objective of this latter method is to find at each stage of the classification

MARKET PLANNING FOR NEW INDUSTRIAL PRODUCTS

process the two clusters that minimize the increase in the total within cluster error sum of squares. A recent analysis of the relative performance of alternative cluster analytic methods by Blashfield (1976) suggests that this technique is consistently most accurate in recovering data generated under a mixture model involving several different populations.

Exhibit 4.16 gives a comparative analysis of the degree of convergence between four clustering methods used in the solar cooling study. A conservative analysis would now only consider those organizations that were classified consistently across clustering methods.

Step 5: Microsegment Characteristic Analysis.

The final step of the microsegmentation methodology concerns the identification of differences across microsegments in terms of:

- the general pattern of decision participants involvement, and
- the external characteristics of the firms they each comprise.

These questions can be addressed through the use of either univariate (Scheffe, 1959) or multivariate (Morrison, 1976) analysis of variance methods.

Of more interest is the use of the external characteristics of a firm to assess

Exhibit 4.16. Comparative analysis of the degree of convergence between four clustering methods

	Complete linkage	Average linkage	Minimum within variance	Minimum increase in within sum of squares
Complete Linkage	—	—	—	—
Average Linkage	62% (93.89)	—	—	—
Minimum Within Variance	61% (99.18)	87% (232.05)		
Minimum Increase in Within Sum of Squares	64% (127.99)	84% (213.60)	86% (213.60)	

Upper Number: Percentage of Consistent Classification

Lower Number: Chi-Square Estimate with 9 d.f.

MICROSEGMENT FORMATION BY CLUSTER ANALYSIS

the likelihood that it belongs to a given microsegment. For this purpose multivariate discriminant analysis can be used. The problem addressed by this statistical method is the prediction of which group an entity belongs to on the basis of a set of prediction variables. Let a firm's discriminant score Z_i be a linear function of some of its external characteristics ($x_j, j = 1 \dots J$). Such characteristics might be its size, level of decentralization, and so forth.

We thus have:

$$\begin{aligned} Z_i &= b_0 + b_1 x_{i1} + b_2 x_{i2} + \dots + b_J x_{iJ} \\ &= b_0 + \sum b_j x_{ij} \end{aligned}$$

Determination of the discriminant coefficients ($b_0 \dots b_J$) is made in such a way as to maximize some function of the distance between groups in the discriminant space. Affifi and Azen (1972) and Lachenbruch (1975) provide excellent reviews of the statistical foundations of discriminant analysis.

In the solar cooling study, a four group multivariate discriminant analysis was performed to predict microsegment membership. (See Choffray, 1977) The model led to 47% correct classification. This is considerably more than would have been obtained by randomly assigning the companies to four segments of sizes equal to those retained in the analysis ($c_{pro} = 27\%$).

APPENDIX 9

VALIDITY OF DECISION MATRIX MEASUREMENTS

Source: Market Planning For New Industrial Products
by Jean-Marie Choffray, Gary L. Lilien
Appendix 4.3

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VALIDITY OF DECISION MATRIX MEASUREMENTS

The analysis of purchase involvement and the study of interfirm differences requires assessment of the validity of the measurements obtained with the decision matrix.

A common denominator of most validity concepts is that of agreement or convergence between independent approaches. (Ayer, 1956; Campbell and Fiske, 1959). Suppose that several decision participants in the same organization filled out the decision matrix separately. The extent of the agreement between these individuals about the categories of individuals involved in the phases of the purchasing process is a measure of the convergent validity of the measurement procedure.

To investigate measurement validity, decision process involvement was measured twice, with different individuals, in several firms. Two products were studied in this validity analysis: the industrial cooling system (12 firms), and an intelligent computer terminal (13 firms).

We used two approaches to assess the convergent validity of the decision matrix measurements. The first, a simulation approach, considers if separate measurements in the same firm agree more than separate measurements in different organizations. The second method, investigating the ability of respondents to discriminate between decision phases, is developed in detail in Choffray (1977).

We use the following notation

$$V = (v_i, v_i') : i = 1, \dots, N_1$$

denotes the subsample of N_1 companies for which two measurements (v_i, v_i') were obtained with the decision matrix. We call this sample the validation sample.

$$C = v_j^* : j = 1, \dots, N_2$$

denotes the subsample of N_2 companies for which only one measurement was obtained with the decision matrix. We call it the main sample.

A.4.3.1 SIMULATION APPROACH TO VALIDATION

Here we use both the validation sample and the main sample. Our objective is to see if agreement between separate measurements of involvement in the same firm is significantly higher than measurements in different firms.

We are concerned here with measuring involvement of different categories of decision participants in the decision process and not with measuring the extent of their involvement.

Our analysis is as follows. First, we compute the similarity s_i between each pair (v_i, v_i') of measurements in the validation sample. The quantities v_i and v_i' are vectors of binary variables reflecting the involvement or noninvolvement

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of categories of participants in phases of the decision process in company i . Then, we compute an average similarity index:

$$S = \frac{1}{N_1} \sum_{i=1}^{N_1} s_i$$

Next, we generate the distribution of the statistic S under the hypothesis of mutually independent measurements. For this purpose, the main sample is augmented by adding one observation chosen randomly from each pair (v_i, v_i') in the validation sample. This augmented sample – called the Analysis Sample – includes $N = (N_2 + N_1/2)$ observations and represents independent measurements because each is from a different firm. The similarity coefficient among all different pairs of observations in the analysis sample is computed. There are $N(N-1)/2$ such similarities from which samples of size N_1 are drawn randomly, with replacement. Each of these samples leads to an estimate of S .

The results of the simulation analysis for the solar cooling data and the intelligent terminal data are reported in Exhibit 4.17. These results are based on 5000 samples of size N_1 drawn randomly under H_0 . They indicate a substantially higher degree of agreement between separate measurements in the validation sample than in random samples of the same size generated under H_0 . In view of the standard deviation of the distribution of the average similarity index under H_0 , and the fact that none of the 5000 samples generated in both studies had an average similarity higher than that in the validation sample, H_0 is rejected at $\alpha < .001$. Hence, separate measurements obtained with the decision matrix in the same organization show a substantially higher degree of convergence than would be expected if these measurements had been obtained independently.

Exhibit 4.17 Results of the simulation approach to the validation of the measurements obtained with the decision matrix

	Industrial cooling system	Intelligent terminal
Average similarity index in the validation sample	$S = .825$ ($N_1 = 12$)	$S = .783$ ($N_1 = 13$)
Mean of the distribution of the average index of similarity under H_0	$E(S) = .641$	$E(S) = .652$
Standard deviation of the distribution of the average index of similarity under H_0	$\sigma(S) = .035$	$\sigma(S) = .037$

VALIDITY OF DECISION MATRIX MEASUREMENTS

A.4.3.2 CONVERGENT AND DISCRIMINANT VALIDATION

An important question is whether respondents can discriminate between decision phases in terms of decision-participant involvement. The method used is a variant of the convergent and discriminant validation approach proposed by Campbell and Fiske (1959). It was developed to assess the validity of psychological tests, but the method is quite general and has been used in a variety of different research settings. The procedure requires an understanding of the Campbell and Fiske (1959) approach, beyond the scope of this work. Choffray (1977) develops the procedure in detail. Application of the procedure to the two data sets shows significant ability to discriminate between decision phases.

APPENDIX 10

HVAC DISTRIBUTION SYSTEM OVERVIEW

A10-1

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PRELIMINARY OUTLINE

OVERVIEW OF HVAC DISTRIBUTION SYSTEM

(Note: The Information presented below is based on a limited number of interviews. It should not be used publicly until confirmed by additional sources -- particularly the estimates of mark-ups and commissions.)

A. WHY SYSTEM OF INTEREST TO SOLAR INDUSTRY

Two Reasons Why Solar Manufacturers Should Understand Existing HVAC Distribution System:

- First, to plug into this system and use existing distribution channels to the maximum extent possible;
- Second, to learn how successful HVAC manufacturers have secured motivated representation at the local level. What type of services the manufacturer might provide; what types of commission structures characterise the industry, etc.

B. ROLE OF PARTICIPANTS IN HVAC DISTRIBUTION SYSTEM

1. Manufacturers of Components and Equipment
 - Over 700 manufacturers who either produce all major components in-house or assemble components from over 500 supporting suppliers;
 - May provide demonstrations, installation and service training, technical assistance, financing.
2. Wholesales/Distributors/Factory Outlets
 - Stock and sell equipment, parts and other supplies to contractors, developers, industrial users; Only rarely involved in retail sales;
 - Most wholesalers are independent; however, some manufacturers own and operate their own distribution outlets;

- Cooperation between the manufacturers and the wholesalers varies. Some participate in co-operative advertising, training and two-way flow of information on products. In most cases, the manufacturer requires a minimum inventory. May also require exclusive distribution to the degree possible under law;
 - Services provided by the wholesaler may include trade credit, quotation, design and general business assistance; others merely sell merchandise without providing any supplementary services;
 - A typical wholesaler will stock between 4,000 to 5,000 items. An estimated 25 to 35 percent of wholesaler costs are directly associated with maintaining this inventory. As a rule, those items kept in stock are those for which a proven demand exists and which turn over rapidly.
3. Manufacturer Agents
- Agents may be independent salesmen or work directly for the manufacturer;
 - The independent agent covers a certain sales territory for one or several manufacturers and products, generally on a commission basis. They are used by the manufacturers as a selling arm to reach wholesalers and contractors. Visits are also made to consulting design engineers, architects, developers and end users. They try to influence the market wherever there is an opening;
 - The representative employed by the manufacturer may work on commission, commission plus salary, or salary plus bonus. In other cases, the agent may buy the equipment from the manufacturer and resell it to the contractors or developer;
 - The manufacturer's agent seldom maintains an inventory. However, many provide technical assistance and specialized service capability.
4. Consulting Engineers
- Consulting engineers work with both contractors and with owner/operators to design and specify larger, more complex HVAC systems. "Base" bidding, under which a specific product(s) is specified but alternatives may be acceptable, is the predominant method for going out to bid. However,

both "open" bidding (no specification by product name) and flat bidding (no substitution of alternative products acceptable) are also used extensively;

- According to the American Consulting Engineers Council, about 500 design engineering firms have heavy involvement in the HVAC "comfort control" field.

5. Contractors

- Contractors sell, install and service equipment. A few are still "single line" contractors dealing in one line of equipment and one type of end use. However, most of the 63,000 contractors active in heating/cooling and plumbing sell a variety of equipment to residential, commercial and industrial users. But they do tend to specialize: 15,000 are primarily involved with heating, 8,000 with air conditioning, and 6,000 with refrigeration; the balance and majority specialize in plumbing equipment;*
- Contractors purchase equipment from a wholesaler, an agent, or the manufacturer himself and charge the end user a mark-up;
- In recent years, there has been a decided trend for contractors to avoid plan and bid work and to seek negotiated deals with owner/developer --i.e., to by-pass the consulting engineer. (Except public jobs where competitive bidding is required);
- May have formal relation with manufacturer or simply shop around and buy equipment as needed for a given job.

C. HOW PRODUCT GETS TO MARKET

1. As can be seen from Figure 1, HVAC manufacturers get their product to market in a variety of ways. Some prefer to work through independent intermediaries, some own their own distribution outlets, and branch stores or employ their own local salaried agents. In some instances, the producer chooses

* Air-Conditioning, Heating and Refrigeration News.

Figure 1: The HVAC Distribution System
From Manufacturer to Market

A10-6

Source: Adapted from Air-Conditioning, Heating and Refrigeration News Brochure

to sell to the end user directly; other manufacturers -- even if approached directly by a large developer -- may still pay their affiliated wholesaler or agent his standard commission or mark-up.

2. The main distribution channel flows directly from manufacturer to wholesaler, to contractor. On a volume basis, perhaps 75 to 80 percent of all sales are made through the wholesaler. However, as suggested above, primarily standardized, large volume products are handled via this route. Novel or larger pieces of equipment (e.g., air conditioners of more than 5 to 10 ton capacity) are generally ordered through a manufacturers agent.
3. The wholesaler's mark-up when going after high-volume homebuilder trade, may be as low as 10 to 12 percent; may even go as low as 3 to 5 percent where he doesn't physically handle the merchandise but merely facilitates the order. For "add-on", replacement market, margin may be in the 18 to 30 percent range. On average, the distributors gross margin (as a weighted average of builder and add-on business) is probably between 18 and 22 percent:

A retail dealer generally realizes a mark-up somewhere in the 25 to 30 percent range. The typical commission for a manufacturer's agent is about 7 to 8 percent, again depending on the item.

D. SOME IMPLICATIONS FOR SOLAR MANUFACTURERS

1. Ultimately most active solar system products (collectors, packaged DHW systems, etc.) should lend themselves to distribution through established wholesalers.
2. Initially, however, manufacturers should not waste much energy in trying to convince wholesalers to inventory their products. Wholesalers are not oriented to creating demand for a new product. (At this point in time, they can only be expected to keep a catalogue on hand, and to place orders on request.)
3. Most engineers will play a passive role. The field is highly competitive, causing them to go with the most familiar solution with the least risk and cost. A standard contract does not include budget for researching an alternative technology such as solar.

4. The key to gaining entry to any large regional market will be to recruit established manufacturer representatives or agents who:

- are motivated to get out and ring doorbells;
- already have credibility with local engineers, contractors, developers and operators;
- can recruit and help set up and train a network of local contractor/retail dealers.

In effect, need agents willing to go after residential business until market matures enough to be handled through wholesalers. Agents will have on-going lead role in promoting sales to commercial/industrial sectors.

PRELIMINARY OVERVIEW

COMMERCIAL SEGMENT

Commercial Markets

Interviewing began in January, 1980, in the commercial market. Forty-five personal interviews were conducted with owners/operators of small businesses in three commercial segments: motels (30), laundries (11), and car washes (4). In addition, car wash owners, distributors, and manufacturers were interviewed extensively at the International Carwash Association Convention in Las Vegas, January 28 and 29, 1980. Results of this first group of commercial interviews are highlighted below.

Awareness of Solar/Government Incentives

All of those interviewed were aware of solar. Most knew that some government incentives or tax credits were available, but specifics about the incentives were not known. Owners were also not generally aware of how solar could be adapted to their particular business situation.

Some commercial/institutional solar installations were known to a few respondents. Among those mentioned were a school in Santa Clara, Utah; the LaQuinta Inns in Midvale, Utah (one of six solar LaQuinta Inns); and the El Dorado Hospital in Tucson, Arizona.

Attitudes About Solar

For the most part, those interviewed were positive about solar. They believe that solar is the up-and-coming source of energy and they would like to see the government push for its development and implementation.

Some respondents seemed skeptical about how solar could be applied to their businesses, but could definitely see it for home use. A number of motel owners had actually

looked into solar equipment for their businesses. Five motel owners had looked into it for heating their pools: three currently have solar pool heaters, one found a gas heater to be cheaper, and one is designing his own solar pool heater (if it works for the pool, he will design one to take over the space and water heating of the rest of the motel). Other owners who looked into solar found the initial cost to be too high.

Information Needs

People first want to know about costs and savings. The real bottom line for small business owners is "how much will it cost me?" since small businesses tend to have capital expenditure constraints.

Other information needs included payback period and maintenance costs. Specific information is needed for a particular application: how much space is needed, what kind of back-up system is needed, what happens when there is limited sun, how much storage is necessary and will the building support the panels.

Conditions/Evaluation of Purchase

Initial cost of a system is the determining factor for most owners. Small motel or laundry owners cannot afford to install a solar system as it involves a large initial investment. Tax credits available at present were viewed as insignificant in relation to the total cost of a system.

Other factors involved in a decision to purchase include the payback period. Respondents are looking for a 3 - 5 year payback. This number is arrived at for several reasons. First, 3 - 5 years is in line with (in fact, somewhat over) the payback period now obtainable from functional capital equipment (washing machines, car wash equipment). Second, ownership turn-over occurs rapidly in all of these businesses.

Respondents want their investment paid back by the time they sell the business. They do not consider the increased sale value of a solar-equipped business in their evaluation of solar economics. Finally, among laundries, many respondents rent their locations and want payback before the termination of their leases.

Another factor in the purchase decision is the cost of alternative fuels. Most operators we talked to are using gas for space and water heating and solar would be considered if the price of gas were to rise enough to make it economically attractive.

In small operations, the owners would be the sole decision makers. In some cases, owners said they would consult outside people, but would mainly deal with solar manufacturers/distributors. They would want to deal with local businesses who have established good reputations. In addition, there was a substantial number of operators who say they would prefer to purchase their water heating equipment (solar or otherwise) through the same distributor that they purchase their other capital equipment (laundry machines, car wash equipment). Reasons for this are satisfaction with current industry suppliers and the expectations of fully integrated service.

APPENDIX 11

LITERATURE REVIEW:
ACTIVE SOLAR HEATING AND
COOLING CONSUMER-BASED
MARKET STUDIES

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SUMMARY

The purpose of the literature review was to identify advantages and limitations of existing solar hot water (HW), and space heating (SH) studies with respect to methodological approach, sampling plan, measurement techniques and market penetration models. Particular attention to study methodologies was paid in order to build on their successes in our current study design. Studies most useful for us were those that measured attitudes toward and awareness of solar energy, and to a lesser extent, those that made estimates of solar market penetration over time.

This review has two sections:

1. Detailed review of seven studies, singled out because their designs are especially relevant to the methodological issues arising in the study; and
2. A brief review of seventeen other reports that are also related, but which are of less direct importance, to our present study design.

Existing studies report unanimously that consumers' sensitivity to the initial cost of solar is the most important determinant of demand. In the current study we therefore attempt to be acutely attuned to financial considerations.

The solar adoption process, however, appears to be inherently different across several substantial market segments (residential, industrial, institutional). Since many issues important for the residential market will not be important for industrial or institutional prospects (and vice versa) separate surveys for each market segment are necessary. Past studies have interviewed husband-wife teams in the residential market and this approach clearly seems best. Identifying the important solar decision-makers in the industrial and institutional markets, on the other hand, is difficult. Fortunately, a study reviewed in the literature search*, has laid the groundwork for identifying key personnel in the decision process and then determining the stages in the decision process in which these individuals participate and their relative importance in those stages. This structure seems well-suited for our data collection effort.

* A Socio-Economic and Marketing Study for a Standard Fomento Factory in Puerto Rico.

The residential, industrial and institutional markets are only part of the total picture. As several studies we reviewed state, the attitudes of builder/developers and HVAC consultants are also critically important. The current study must assess the impact these decision influencers have on solar adoption and determine the relationship between their attitudes and their probability of recommending solar.

Two of the studies reviewed were directed by Jerome Scott of the University of Delaware. Scott used conjoint analysis to measure changes in solar adoption as initial cost, monthly fuel savings and collector location are varied. These studies produced some interesting findings but were limited because many factors with potentially important effects on solar adoption were not included in the models. Unfortunately, conjoint analysis becomes impractical when many factors must be considered. Thus, the current study will not use this form of analysis. Instead, this study will concentrate on the linkage between attitudes about financial, esthetic and other considerations of solar and the purchase probabilities consumers have for solar.

A recommendations section has been included at the end of each of the studies reviewed. These recommendations for the current study were suggested by both the advantages and deficiencies of these previous studies.

An Attitudinal Survey of the Home Market for Solar Devices

Vincent N. Campbell

September 1977

I. Introduction

The objective of this study was to estimate attitudes toward and perceptions of solar space and water heating devices. Measurements of consumer, builder/developer and lender attitudes were made and the impact of their attitudes on solar adoption were assessed. A simple market penetration model was developed.

Specifically, homeowners attitudes toward purchases of solar were recorded for:

1. New homes with solar space and hot water heating
2. Retrofit solar heating
3. Retrofit solar hot water heating

The study uses four decision stages to categorize respondents and then estimate market penetrations. The four decision stages are:

1. Favorable attitude toward buying solar
2. Being in the market for solar
3. Actively seeking to buy solar
4. Succeeding in purchasing solar

By reducing the base of all home owners by the estimated percentage of potential buyers who do not pass at each decision stage, market penetration was estimated. The estimates were made for three possible outcomes:

1. Solar and conventional costs are equal in the long run
2. Solar space and hot water heating averages \$20/month more than conventional systems -- solar water heating averages \$5/month more than conventional.
3. Solar space and hot water heating costs \$20/month less than conventional systems -- solar water heating averages \$5/month more than conventional.

II. Methodology

379 telephone interviews were completed among residential homeowners. The respondents were selected from four representative geographical areas in the United States, areas which were considered distinctly different according to economic and social contexts. Previous to the telephone interview, 75% of the respondents received a 3 page letter describing solar heating in the home, listing the advantages and disadvantages and showing diagrams and drawings of solar systems. The other 25% were read a 3 sentence description of solar home heating systems at the beginning of the interview. All respondents replied to the same questionnaire.

Builder/developers and lenders were also contacted by telephone and their attitudes and perceptions of solar measured. Although the consumer may be willing to enter the market, progressive cooperation from the institutional segment must be achieved or market penetration will stall. To identify current and potential institutional barriers, a preliminary review of existing literature was made. Limited resources restricted telephone and personal interviews to a small number of builder/developers and lenders in the Washington, D.C. area.

III. Major Findings

Homeowners stated the following important reasons as to why they would be for or against using solar:

- To conserve energy and other fuels
- Lower utility bills and fuel costs savings
- Initial and maintenance costs too high
- Newness and unproven quality of solar
- Possible performance problems

In addition, homeowners indicated a need for information and advice on solar. From the viewpoint of builder/developers the major barrier to the accelerated installation of solar heating in new homes is their inability to obtain adequate warranties and guarantees on equipment and workmanship. The study found that there is a great uncertainty in predicting how builder/developers will act, and since builder/developers exert a major influence on the selection decision for the type of heating system to be used, it becomes more difficult to accurately estimate market penetration of solar. Probability assessments of how favorably builder/developers would act toward solar were made and incorporated in the model to estimate the fraction of those seeking to buy solar-equipped homes who will succeed in doing so.

The study analysis detected a greater willingness among natural gas users to switch to solar energy than oil users: 71% to 62% for potential new home buyers and 54% to 33% for retrofitters. Respondents were asked if installing solar heating would demand too much time and effort -- 91% of Californians interviewed said no, compared to 57% of all respondents from the four geographical areas combined. Several other statistical differences emerged in the study:

1. Respondents expecting to buy a home in the next two years favored solar more than those who never expect to buy another home (84% versus 62%)
2. Younger respondents were slightly more willing to buy solar devices than the older ones. (This is probably related to 1. above.)
3. Higher income respondents were somewhat more interested in retrofitting home heating and water heaters although income was found unrelated to interest in buying a new home.
4. Solar attitudes were generally higher among respondents who received and read the solar letter as opposed to those who received the letter but did not read it. There were no essential attitudinal or purchase intention differences between respondents who received the 3 page letter and those who only read a 3 sentence description.

Finally, an inquiry of lenders showed that lending institutions pose no prior deterrent to the borrower insofar as solar heating is concerned.

IV. Study Advantages

The incorporation of builder/developer influences in the market penetration model seems to be an important and necessary step in providing accurate estimates of solar adoption potential. Furthermore, the assessment of institutional influence on solar penetration seems imperative for a complete view of the market. Thus, interviews with lenders found pieces in the overall market puzzle.

V. Study Disadvantages

The sample sizes involved in the study were very small and are the cause of the study's primary disadvantage, uncertainty of results. This is particularly true of the builder/developer and lender samples. The homeowner sample was drawn from four representative areas in the United States (New York City, Nobles County in Southwest Minnesota, Santa Clara County, California, and Washington, D.C. area). The areas were chosen for their differences in economic and social contexts. No allowance for insolation differences was made which appears to be a serious oversight.

Lastly, the study emphasis was placed on attitudinal questions and not the market penetration model. Consequently, the market penetration model recieved little attention and was made too simplistic to give meaningful results. The survey questions used to develop the model were very general and the sample size was too small to pick up differences in individual preferences. Model estimates, based on aggregate figures, would not pick up these differences.

VI. Recommendations

Since builder/developers and lenders could exert considerable influences on solar adoption, the new study should dedicate significant amounts of time and research to those areas. Specifically, questionnaires should be developed to address in-depth the important issues just touched on in this present study. Furthermore, the cost savings scenarios used in this study were limited to only three outcomes (+ \$20/month, \$0/month, - \$20/month) which this new study should enlarge upon to assure completeness as well as to gain an understanding of how demand will change with costs savings. It will also be important to measure how much effect non-cost variables (such as length of warranties) will have on demand.

Several minor questions from this study seem appropriate to use in the new study:

1. What type of home heating fuel do you currently use?
2. Your total household income last year?
3. Would the installation of solar heating demand too much of your time and effort?
4. What is you age?

Other issues addressed by the study and reported in the major findings section of this review are basic to any study on solar and will be incorporated in the new survey. These include cost, performance and warranty issues.

Market Study: Solar Consumer Survey and Marketing

Recommendations - State of Missouri

Department of Natural Resources Solar Program

1979

I. Introduction

This study was conducted primarily to determine those factors which motivate consumers to purchase solar. Current solar owners in Missouri were asked a battery of questions focused generally on financial considerations and concerns. In addition, some attitudinal questions were also rated by these owners. A profile of the early solar purchaser is drawn from demographic data.

Secondarily, the study questionnaire collected information on the types and locations of solar installations in Missouri.

II. Methodology

If current solar owners from four large Missouri cities (St. Louis, Kansas City, Columbia, Springfield) were personally interviewed using a standardized questionnaire. 48 of these owned active solar systems; the others, passive.

Three methods were used to elicit responses from owners:

Method 1: Eight assumptions were made about what might motivate consumers to purchase solar. Respondents were questioned about these assumptions which are: the current energy situation, the availability of the federal tax credit, the "need" or desire for energy independence, home investment, pollution free energy, cost, psychological benefits, and desire to appease guilt feelings.

Method 2: Specific events may have triggered the final purchase decision. Respondents were questioned concerning the following list of events: utility rate increases, gas shortages, new home construction, moving residences, start of new business venture, need to replace existing mechanical system, impatience with social response to energy and/or environmental problems.

Method 3: Respondents made their own list of reasons for purchasing solar.

III. Major Findings

The average solar owner was a white male, 44 years old, with a small family; upper-middle class income; a college graduate and professionally employed. Most homes fell in the \$70,000 - \$80,000 price range. 60% of the installations were do-it-yourself jobs. For many owners one or two heating seasons were needed to fine tune their solar systems so as to provide maximum efficiency. According to the owners, of those groups involved in solar installation, only carpenters were a persistent problem and they simply because of their unwillingness to follow instructions.

In spite of economic and social concerns, owners seem to have been motivated to purchase solar for its status symbol.

Institutional roadblocks appear to have been problems for some of the owners. These include in particular, taxing and building code authorities, insurance and lending institutions and public utilities.

45% of the owners said that they replaced electricity with solar, 25% said natural gas, 19% reported propane gas and 11% gave other fuels. 61% (46) stated that they had not done any kind of payback analysis for their systems. Of those who did, the most frequent payback periods were 8-10 years.

The five most used sources of information on solar for owners before they purchased were:

	<u>Number of Respondents</u>
1. Other individuals	60
2. Books	48
3. Magazine articles	46
4. Government publications	32
5. Literature from solar companies	31

41% of the owners complained, however, that information on solar was hard to come by.

IV. Study Advantages

A sample of current solar owners can be invaluable for determining the key issues which potential purchasers must contact when making their decisions. The use of personal interviews was especially well-suited for identifying the major factors in a solar purchase decision.

V. Study Disadvantages

Unfortunately, there was no attempt made to separate the sample into active and passive owners: the study results are therefore not generalizable to just active systems. Furthermore, respondents were innovator types and as such cannot represent the general population. Thus, while this study might be useful for learning how to attract innovators to solar, it is probably unable to identify concerns of other types of potential buyers.

Solar owners themselves were by far the people most responsible for installing solar systems.

<u>Number of Respondents</u>	<u>Persons Installing Solar System</u>
33	Solar Owner
11	Builder
9	A/C and Heating Company
8	Solar Company
5	Carpenter
7	Contractor, sub-contractor
2	Other

Most respondents thought that appraisers and real-estate sellers would view solar favorably. While 89% (67) of the owners said that the energy situation directly influenced their decision to purchase solar, 83% (12) claimed that the federal tax credit did not influence their decisions. Only 37% (28) owners qualified for the credit, however.* The study suggests that although the respondents expressed economic concerns, the underlying motivation for their purchasing of solar was the status it gave.

V. Recommendations

The tact to find the motivating factors behind decision to purchase solar is of course fundamental. Some of the issues raised in this study seem useful for identifying homeowners with innovator tendencies. The independent, status seeking characteristics of many of the solar owners in this study would be particularly useful attitudinal ideas to measure in the current study.

* The report gives contradictory results for this figure. One table suggests that only 28 owners did not qualify for the credit.

A Socio-Economic and Marketing Study
for a Standard Fomento Factory
in Puerto Rico

September 1977

By OR/MS Dialogue, Inc.

I. Introduction

The purpose of the study was to assess the U.S. market for industrial, solar-powered, cooling systems. The study attempted to isolate issues of product awareness, product design trade-offs, and product perceptions that related to market potential.

II. Methodology

With the objective of finding the market potential for solar cooling, the new construction industrial market was isolated, through focus group interviews, as the area of most interest for detailed analysis.

Two surveys were administered: one to decision-makers inside firms and one to HVAC personnel in outside firms.

A sample of firms was selected from various directories to meet the following criteria:

- (a) industrial firms
- (b) in SIC codes where the manufacturing activity requires cooling for control of industrial processes;
- (c) which carry out a substantive portion of their productive activity in the southern portion of the country.

A two step procedure was used to select individuals: first, a member of the top management team was contacted by mail, with a brief description of the study. The individual was asked to return the names of individuals who would be involved in the decision process for HVAC equipment. These individuals received copies of the questionnaire. A follow-up questionnaire was sent to those individuals who did not return the questionnaire after a month. A total of 212 companies were represented in the national sample.

The HVAC sample was constructed directly from the ASHRAE mailing list. The same two-step sampling procedure was used and is described above. A total of 195 were represented in the HVAC sample.

Each individual, both in the company and in the HVAC sample, received a questionnaire with essentially the same structure:

Section 1 requests background information about the firm's respondent. Questions about company size, growth rate, main activity and need for industrial air conditioning are found here. Section 2 is concerned about measuring the requirements that companies have for their air conditioning equipment. Issues of maximum acceptable initial investment and operating costs as well as other financial/technological considerations are also found there. The second section ends with the measurement of the relative importance of the various requirements of the company in terms of air conditioning equipment. In Section 3, respondents are exposed to three industrial air conditioning alternatives -- ABSAIR, COMAIR, SOLABS -- and their perceptions recorded. ABSAIR is a Standard Absorption Cooling System; COMAIR a Standard Commercial Cooling System and SOLABS, a Solar Absorption Cooling System. Section 4 requests the respondent to state his preferences for these three alternatives. Two methods are used for this purpose: preference rankings and constant-sum paired comparisons. This section also requests information about various dimensions of risks (air conditioning system's economics and reliability) as perceived in the adoption of a new industrial air conditioning system. Section 5 requests information about involvement in the adoption process for a new industrial air conditioning system. A "decision matrix" is used which requests what percentage of the task-responsibilities associated with each phase of the adoption process is that of each category of decision participants. Section 6, finally, is concerned with the respondent's personal characteristics, including his age, background, job title, etc.

In order to analyze these data a four stage model is used, looking at the likelihood of considering solar cooling, the likelihood of solar cooling being feasible if it were considered, the likelihood of solar cooling being an individual's choice and, finally, the probability of group (or organizational) selection of solar cooling.

The data on the structure of the decision process were used for market segmentation.

III. Major Findings

The study pointed to a number of key results that are important in the marketing of solar cooling:

1. Initial cost is a key stumbling block for solar cooling: a system offered at \$4000/ton of cooling commands a market 1/10 of what it would be at \$2000/ton and 1/30 of what it would be at \$1000/ton.
2. In the range of 1-3 years, market potential is not affected by warranty period.
3. Most companies require 4-5 successes before they would consider the system.
4. An improvement of system life from 15 to 20 years raised market potential by 50%.
5. Within companies, top managers and corporate engineers are the most influenced. The key messages aimed at these groups should stress:
 - trade-offs between first costs and operating costs and
 - potential for providing the company with a reliable and energy saving a/c system.
6. HVAC consultants are key external influences and should be told that:
 - the system is easy to maintain and install and
 - experience with the system would give the firm competitive advantage.
7. Plant managers are most influenced by the issues of payback and that the system protects against power failures.
8. Production engineers will be most affected by stressing low operating cost and the challenging nature of the new technology.
9. Finally, the companies of highest purchase potential are those which:
 - need a/c for process cooling and stand to have inventories if cooling is lost through rationing or power failures, and for which

- satisfaction with their current system is low,
- economic risk is low,
- the consequences are minimal if the system is less reliable than projected,
- the company size is large with only a small part requiring a/c,
- there are few separate plants, but with sun belt location.

IV. Study Advantages

The study showed not only what the industrial potential of solar cooling is now, but what it would be under various scenarios (different cost and design configurations). Rather than conjoint analysis, disjoint analysis methods (developed especially for the study) mapped market potential. The study also explicitly included the heterogeneity and the multi-person nature of the industrial purchasing process.

V. Study Disadvantages

Clearly, 200 organizations cannot represent all of American industry, even though the sample is national. The study had no follow-up to determine if those people who gave a high likelihood of purchasing solar in fact did anything about it (got literature, considered further, etc.).

The study was limited to solar cooling, a low-potential technology, and hence most results showed low potential.

Finally, the analysis is static, and does not incorporate any diffusion phenomena.

VI. Recommendations

Most of the methodology used in this study will be employed in the current analysis. One key point that has been neglected is the nature of solar diffusion. This study, (and the current one), are static. The time-phased nature of demand generation has been ignored.

Purchase intent has to be limited to actual purchase via follow-up questions -- determining whether those who say they "definitely will buy" actually purchase.

A follow-up study of those who participated in this study might be advisable.

SOLAR ENERGY INCENTIVES ANALYSIS:

Psycho-economic Factors Affecting the Decision Making of Consumers and the Technology Delivery System.

January 1978

Prepared for DOE, Contract No. EX-76-6-01-2534

I. Introduction

The purpose of this study was to identify the economic and behavioral processes which affect investment decisions for solar HVAC systems by various segments of the solar Technology Delivery System (TDS) and by ultimate users. The TDS is the series of steps which lead to a functioning HVAC solar system end product. These steps include financing, manufacturing, distributing, building and installing. The study focused on the TDS as well as on the important commercial and private resident behavioral functions - study findings are not generalizable to the national situation.

II. Methodology

The primary method of gathering data was the Decision Analysis Panel. Twenty-one panels were held in four defined regions of the country: the Northeast, Middle Atlantic, Southeast, and Far West. Two groups were clearly defined within each decision panel: those who are part of the Technology Delivery System (TDS), and consumers. Within these broad groups were the subgroups: TDS, consisting of manufacturers of solar equipment, distributors, architects and engineers, builders and installers, and government energy officials; while consumers consisted of private homeowners and commercial building owners and managers.

Decision analysis panels consisted of small group meetings of 6 to 9 members, with homogeneous groups representative of the TDS or market segment to be studied, or with heterogeneous groups representing related elements in the TDS. Attendance was voluntary. Panels met one time for an intensive two hour session. The sessions began by participants filling out a brief questionnaire. This provided a demographic profile of each group, focused attention immediately on the discussion topic, and captured relevant attitudes of the participants before they became influenced by group discussion. The panel members' susceptibility to change of attitude was a significant indicator of the strength of conviction and the nature of the relationship between the elements in the TDS. Since not every TDS or consumer segment could be interviewed in each part of the country, regional information was increased by individual telephone interviews and literature search.

Data was analyzed not only to reveal attitudes and likely behavior, but also to provide information concerning the dynamic process of decision making: what forces and processes operate to change or confirm attitudes and behavior toward solar energy and to the specific characteristics of solar systems.

III. Major Findings

Homeowners complained that information on solar is not readily available. Many anticipate buying a new house at some future date and are therefore less willing to invest in equipment with long-term payoffs. Some homeowners expressed a fear that prospective buyers might be scared away by too high a price placed on a solar home. There are six decision makers who can possibly influence a consumer's final decision:

1. Other consumers who are perceived to be like himself
2. Large residential developers
3. Nationally reputable housing equipment suppliers
4. The media
5. The government
6. Parents (for the young home purchasers)

A homeowner will be much more likely to buy solar if some of those decision makers advocate or use solar. Other important issues which surfaced are fairly standard and have already been mentioned in other reviews.

Commercial consumers were most concerned with initial costs and the possibility of obsolescence (cost of equipment may fail or efficiency improve). They were further apprehensive of investing in a non-developed industry and question why government has not taken an active part in the industry.

IV. Study Advantages

The use of decision analysis panels to obtain data has the special advantage of being able to measure the relative influences of decision participants in the decision process. This seems to be an excellent way of obtaining a first look at the major issues which will need to be addressed. The alternative method of data collection is a focus group interview. In comparison, focus groups present only predetermined

issues for consideration, whereas decision analysis panels single out that specific aspect of the general discussion topic most relevant to that specific panel.

V. Study Disadvantages

Although the study addresses a large number of issues and presents a comprehensive overview of the behavior and attitudes of people in the solar decision process, it was not designed to measure the quantitative relationships between attitudes and perceptions with purchase intention. Thus, the study falls short of giving concrete answers to important questions.

VI. Recommendations

Since homeowners exhibit confusion over solar capabilities and limitations, it is well advised to include some descriptive material on solar in the new study questionnaire to clear up any misconceptions. Both homeowners and commercial/industrial consumers expressed fears that current solar technology could be superceded in a few years and were therefore wary of purchasing a system at this time. This potential purchase inhibition should be measured in the new study. Also, the six influential decision makers listed in the major findings section seem to be keys to a consumer's purchase decision and questions need to be asked to determine how much influence each exerts on that decision.

Federal Incentives for Solar Homes:
An Assessment of Program Options

RUPI
July, 1977

I. Introduction

The primary purpose of this study was to evaluate the potential of alternative federal financial incentives for accelerating the rate of solar energy adoption. The incentives considered included income tax credits, tax deductions, low interest loans, and rebates. The markets addressed were retrofit water heating for private residential homes, water-heating in newly built homes, and combined space-water heating in newly built homes. Research was conducted during late 1976 and early 1977.

II. Methodology

The most important methodological thrust of the RUPI study was its emphasis on a market research survey as a means of providing data for calibrating a demand simulation model. The survey involved in-depth interviews with 1500 existing and prospective homeowners living in or near eight major American cities: Boston, Philadelphia, Jacksonville, Columbus Ohio, Nashville, Houston, Tucson and San Jose. These cities, selected a wide spectrum in terms of climate, energy costs and growth rate. The questionnaire consisted of three major parts:

1. Measurement of general attitudes toward solar, respondent innovativeness, and level of solar awareness.
2. Exposure to a concise description of a solar energy system.
3. Measurement of probability of purchase under varying prices, savings, and financial incentives.

A simulation model was used to project demand for a particular market over an eight-year period. The model included four primary phenomena:

1. Potential size of the market, i.e., number of homeowners,
2. "bandwagon effect", whereby innovators are copied by the mainstream homeowner as more sales occur,
3. level of awareness, and
4. individual purchase probability.

Individual purchase probabilities were calculated using a sub-model calibrated from the survey data. This model explicitly included incentive effects, price, savings, and demographic factors as well as consumer perceptions of solar reliability and financial feasibility. The probability of purchase model was calibrated using ordinary least squares regression. The full simulation model was calibrated using more simple curve-fitting procedures and educated judgment.

III. Key Findings

The key findings of the RUPI study can be summarized as follows:

1. Given very favorable predispositions, measured in the survey, and coupled with conservative estimates of future energy costs increases in consumer awareness, strong sales are predicted over the next 8 years. For example, sales of retrofit water heating systems should increase at a rate of 50% per year. Much of this increase would come in the final four years of the forecast period (1981-1985), buoyed principally by growth in awareness.
2. Financial incentives could have a major impact upon solar energy sales. However, the incentive must be "non-trivial". For example, in comparison with the baseline case (no incentive available), a 20% credit would result in 20% more sales by 1982, 30% results in 45% more, 40% results in 93% more, and a 50% tax credit would yield 167% more sales. A 50% credit would be quite expensive, but the demand analysis indicates that a credit in the 30-40% range is needed to bring about meaningful results.
3. Outright grants are slightly more effective than tax credits in bringing about sales. For example, in order to increase sales of hot water systems 50% above 1982 baseline projections, a 27% grant would be needed. The same effect would require a 33% tax credit. The advantage of the grant is clearly its immediacy.
4. Loans are less effective than rebates and tax credits in increasing sales. For example, in order to increase sales of retrofit water heating systems 50% above 1982 baseline projections, a 15% interest rate, 20 year loan would be required. A 30% rebate could do the same job. Perhaps more importantly, a 39% rebate could increase sales 100% over baseline levels while no loan would be able to have this impact.

5. Financial considerations, price and savings in particular, will be of prime importance in affecting future sales.
6. While both savings and price are important, price is generally more crucial than savings. This was especially true for new homeowners considering the purchase of full space and water heating systems. However, it also held generally for existing homeowners considering a retrofit water heating system.
7. On a general basis, predisposition for solar was equally high among all income groups. In many situations (particular cities and markets), however, it was found that interest peaked among an upper-middle income group (i.e., \$25,000-\$40,000 annual income) and was lower among high and middle to low income groups.
8. Perceptions and attitudes play an important role in determining receptivity to solar. These include beliefs of reliability and financial feasibility, and general attitudes toward new products.

IV. Advantages of the Study

The major strong point of the RUPI study is its rigorous integration of consumer survey data into a sophisticated simulation model. The use of survey data clearly allowed for a depth of understanding not obtainable from engineering or economics-based analysis of demand. For example, it became apparent that initial cost will be a substantial barrier, irrespective of the financial "rationality" of investing for the purpose of realizing future savings.

Another strongpoint of the study is that it included a wide set of variables in addition to the purely financial factors. Although the study readily concludes that cost and savings are the most important factors, other more marketing-oriented variables could be crucial. These include the level of consumer awareness, consumer beliefs of system reliability, and bandwagon effects. An understanding of these variables gives planners more options for increasing demand (i.e. spend \$1,000,000 to increase awareness rather than \$5,000,000 on a tax credit).

V. Limitations of the Study

To some extent, the RUPI study seemed to have drowned in its own rigor. For example, it was realized that the area of probability of purchase models would differ across geographic regions, across markets and across financial incentives. This was of course important to

recognize, but the result was that a total of 120 regression models had to be calibrated. This task appeared to be unwieldy, as evidenced by the fact that some of the individual models were statistically weak.

While recognizing the importance of price and savings, relatively little was learned about what could be done to make the financial merits of solar appear more attractive. The emphasis of the RUPI study was on implementing financial incentives that would objectively make solar more attractive. The question arises, however, as to whether a communications campaign could be as effective at much lower cost. By demonstrating the importance of attitudes in determining sales, the RUPI study shows that such a campaign could have dramatic effects. However, the practical details of how to impact upon consumer attitudes with communications was not addressed.

As noted earlier, an important plus for the RUPI study was its concentration on the consumer. This, however, also gave rise to a significant limitation: the study neglected the issue of availability and distribution channels. The RUPI models implicitly assumed that solar was available for those who wanted it. This may simply not be true. In addition, the role of customer service and the importance of distribution under a well-known name (i.e., Grumman Sunstream) might be crucial.

A final limitation of the study was that it was purely a static study used to make dynamic inferences. For example, strong assumptions were made on the patterns by which awareness and other attitudes would grow over the eight years of the forecast period. Although these assumptions were quite reasonable, they were not directly supportable by the data. There was little the researchers could have done to rectify this problem, as this type of shortcoming is common to all studies in which data is collected on a snapshot basis. The snapshot is far better than nothing at all, but it is limited.

VI. Recommendations for Future Research

The RUPI study provides significant evidence that financial considerations are key to the adoption of solar energy devices. Future research must concentrate on how the financial merits of solar energy can be made more appealing. There are two principal strategies that need attention:

1. Optimal pricing within the bounds dictated by materials cost, and
2. Effective communication of the existing merits of solar energy.

The RUPI study dealt with price-savings trade-offs effectively. Future research should essentially replicate the RUPI approach: estimate price and savings elasticities based upon respondent-stated likelihood of purchase under varying levels of these variables. In addition, advantage should be taken of the "natural experiment" that recently occurred as a result of a doubling in oil costs. This increase has essentially doubled the savings available for solar energy users substituting for oil. An analysis of recent sales trends of solar devices should be undertaken. Research should be able to detect some movement toward solar devices. This analysis would have at least two advantages:

1. Providing a basis for validating the results of survey work, and
2. providing a feel for the dynamic effects of changes in the objective financial picture for solar.

As noted earlier, the RUPI study did not address the issue of how best to communicate the financial merits of solar energy. The question of communication may be crucial if it is found that there is little leeway for price decreases or that the recent savings increase has had little effect upon sales. The key problem could be that the financial merits of solar have not been clearly presented to the consumer. Several questions need to be addressed:

1. Does it make a difference who presents the financial picture for solar? (i.e., is government the best spokesperson, or should manufacturers or neighbors be used?)
2. Does the amount of financial information presented to the consumer have an impact? Perhaps consumers will gain confidence in the financial feasibility of solar if they see a lot of detail on the topic.
3. Does raising the possibility of future energy cost increases make solar more attractive, or does this paralyze the consumer in fear?
4. What are the best media vehicles for advertising solar? Does solar need the impact of television or the depth provided by print? The answer to this question is certainly related to the amount-of-information issue.

The above question could be addressed using both laboratory and market tests. For example, each respondent to a survey could be presented with a different financial package, varying in terms of information source, detail, and home. As another example, actual spot television time could be purchased in one city, versus newspaper and

magazine ads in another city. Although cost would preclude the conducting of a full-scale campaign, relatively inexpensive tests might be achievable using small local television stations or regional editions of magazines.

The RUPI study also demonstrated the importance of consumer awareness and beliefs, without learning anything about how these change over time. It would be fruitful to utilize the identical measurement instruments employed in the RUPI study to measure the current level of awareness and beliefs, and how these have changed over a period of three years. These statistics would have implications for communications design. In fact, a periodic re-measurement would greatly improve our ability to link consumer stated likelihood-of-purchase information with actual purchase behavior.

As noted earlier, the RUPI study failed to examine the role of other actors in the solar market place, including manufacturers, builders, and distributors. Future research should attempt to discern the best methods for distributing solar, and where the current distribution system is weak.

Consumer Demand Analysis: Solar Heating and Cooling of Buildings

J.E. Scott, University of Delaware

I. Introduction

The purpose of this study was to assess the extent of homeowner awareness of solar technologies and to estimate the effects that initial costs, life-cycle savings and solar esthetics will have on residential demand. An attempt is made to relate individual socioeconomic and attitudinal characteristics to likelihood of purchasing solar.

II. Methodology

300 active homeseekers and 30 president/top marketing executives of large mass market residential home development firms were personally interviewed. Each responded to a questionnaire designed from previous focus group interviews. A general low level of solar awareness required that literature about solar be distributed to respondents several days before their interviews. These interviews measured attitudes toward solar and conventional energy sources and probabilities of purchasing solar under a variety of solar home characteristics. In addition, homeseekers rated the home characteristics they considered most important in choosing a home.

The survey format involved showing each respondent a series of 20 drawings of a standard home*, some with solar and others with extra insulation on their windows. The following information accompanied each drawing:

1. first cost (also expressed in terms of monthly mortgage)
2. estimated monthly fuel savings
3. location of collector: front vs. back of house

Conjoint analysis was used to estimate tradeoffs between these attributes, and the valuation of the home based on these attributes. Home developers did not participate in this phase of the study. Both husband and wife performed this task separately and then jointly to determine if one was more influential in the joint decision making process. This entire procedure was then repeated except that the non-solar energy conserving home was dropped and among homeseekers, only the husband - wife pair rated the home descriptions. This time, however, the husband - wife team indicated their probability of purchase. A demand curve was estimated from the aggregate answers. Home developers also rated the descriptions. The residential home developers were asked to estimate market penetration instead of probability of purchase and did so for both model homes.

* Two model homes were used. The Bainbridge model was shown to middle income respondents, while the more expensive Amherst model was shown to higher income homeseekers.

III. Major Findings

1. The principle factors homeowners consider when choosing a home are location, size, style and affordability. The type of home heating system is not an important factor.
2. High first costs severely reduce a homeseeker's probability of purchasing a solar home. Initially, only innovators will buy, and will buy for reasons other than price or fuel savings. The study estimates that probability of purchasing increases at about .8% per dollar of anticipated monthly fuel savings in the \$5000 first cost range.
3. Home buyers are generally unwilling to pay an extra dollar in mortgage in return for a dollar savings in fuel costs/month. The average consumer wants \$1.40 savings in monthly fuel costs to justify a \$1.00 increase in the monthly mortgage payment. This behavior is probably related to the uncertain future prices of fuel.
4. Home size, layout, number of rooms, and other style amenities are very important to home buyers and they appear very reluctant to trade down in these features to buy an expensive heating system.
5. Most home buyers believe solar systems should return the initial investment in less than eight years. Few consider payback periods longer than ten years to be acceptable. The professional builders agree.
6. Many homeseekers expressed a dislike of the solar collector appearance. Results suggest that homeseekers value a collector more on the rear of a home as opposed to on the front by as much as \$2000. Women tended to react more negatively than men.
7. Mass market builders and developers are very concerned about system reliability and possible unknown problems.
8. Homeowners and builders absolutely require a proven successful solar track record. Demonstration solar homes are not sufficient to induce solar purchases.
9. Performance guarantees from reputable firms and appropriate governmental agencies are considered essential by most home buyers and builders as protection from the performance and financial risks they perceive.

10. Home buyers stressed fuel cost savings, independence from utility companies, ecological improvement, clean heat, and independence from foreign oil producing nations as factors which would encourage them to buy a solar home.
11. High income families looking for more expensive homes find solar more acceptable than middle or low income families. Builders believe that middle income families would have difficulty obtaining a mortgage of a home if solar added six to eight thousand dollars to the purchase price.
12. Home buyers more likely to buy a solar home have more formal education and higher incomes, tend to be younger, have smaller families, perceive less risk (performance, social, or financial), are less dogmatic, and believe that they can personally do something about energy problems.

IV. Study Limitations

This study's reliance on conjoint analysis to determine attribute preferences and demand estimates severely limits its usefulness. Conjoint analysis, because it is a factorial design, only allows the researcher to use a few selected attributes to describe the solar system. Thus, many important attributes are left out in order to keep the questionnaire's length within reason. This will not be a satisfactory method for a comprehensive study; hence, it is recommended that conjoint not be used in the current study.

Results of this study were based on small samples from two geographic areas:

1. Wilmington, Delaware and
2. Denver, Colorado.

Clearly, these results cannot be generalized to the country as a whole. A larger sample gathered in many areas of the country is certainly necessary to assure that market estimates for solar are truly representative of the population.

V. Study Advantages

A variety of solar system attributes were rated by respondents (e.g. payback period, appearance), producing a number of tangible results which are summarized in the main findings section of this review. This indicates that an attributes rating section should be incorporated in the new study. The Scott study, however, does not relate a respondent's attribute ratings to his probability of purchase. The new study should be designed to do this.

VI. Recommendations

Results of this study indicate several areas where further exploration will be useful.

1. Most homeowners expressed a need to see solar homes working in their communities before they would be willing to buy. This suggests that a band-wagon effect exists in the solar market. Thus, respondents should be asked how likely they would be to buy if 50,000 homeowners have solar, 100,000 homeowners, 250,000 homeowners, etc.
2. Respondents in this study were especially anxious for big-name manufacturers to make solar equipment. Apparently, they do not trust the quality of small-name firms. Therefore, questions should be posed to respondents assuming alternatively that solar equipment is provided by a big-name manufacturer, (e.g. General Electric) and then a small-name company.
3. A government agency's stamp of approval on solar seems to be an important requirement of many homeowners. This issue should be addressed in the new study to determine differences in solar attitudes and purchase intentions when solar does and does not have government approval.
4. More in depth study needs to be done on government incentives to solar. The Scott study only briefly covered this important area. This might best be done by asking purchase intent questions at different solar prices without referring to government. Nevertheless, it is important to determine whether government's involvement in the solar program is a plus or a minus in regard to purchase intent.

Solar Water Heating Economic Feasibility, Captors Potential, and Incentives

Jerome Scott

February 1977

Prepared for National Science Foundation, Washington D.C.

I. Introduction

This report assesses the economic feasibility of solar hot water heaters in the residential sector and then estimates market potential with and without government incentives. A questionnaire was used to measure homeowner attitudes and purchase incentives toward solar.

II. Methodology

300 personal interviews with heads-of-households owning single family residences were completed. Open-ended interviews were also conducted with a small sample of builder-developers.

Prior to survey administration, descriptive materials about solar water heating systems were distributed to respondents. They were asked to review the materials and decide if they would consider buying a solar water heater. The educational package included detailed descriptions of system operation, approximate range of cost, appearance of completed installation, and information such as connection of back-up systems.

Two representative sampling areas were chosen - Denver, Colorado and Wilmington, Delaware. The two metropolitan areas were intended to represent a cross-section of areas exhibiting different characteristics in solar insolation, ambient temperatures, fuel costs, housing construction, and socioeconomic background.

III. Key Findings

- Only 15% of the respondents considered themselves well-educated in terms of making solar purchase decisions. The respondents mentioned performance and reliability as the factors about which they need more information before making a purchase decision. The second most frequently mentioned factor was initial cost.
- Acceptability of solar hot water heaters decreases markedly as system price increases. Solar water heaters are more acceptable in new construction than in retrofit existing homes.

- A large majority of homeowners believe the federal government should change the tax laws and/or provide some type of incentive to the homeowner. Twice as many respondents preferred a tax credit incentive to a tax deduction incentive.
- Homeowners were most concerned with solar water heater reliability, expected life of the system, future breakdowns and maintenance, amount of fuel earnings, and warranty coverage.
- Fuel cost savings was mentioned most frequently as the reason why the respondents would buy solar water heaters. Energy conservation, quality of the systems, and security of fuel supply: were the next most important reasons for buying a system.
- The socioeconomic background of the most susceptible solar purchaser is best described as a home seeker with higher education, perhaps younger, upscale in income with a small family. Members of these households may be more aware of the extent and consequences of the energy shortage and have sufficient financial flexibility to handle the elevated first cost.
- Research indicated that most homeowners prefer to compare monthly payment outlays against anticipated savings in evaluating a solar purchase. Residents of high value homes desire \$1.48/month in fuel savings to each dollar/month increase in mortgage payment.
- Homeowners indicated they would require a maximum payback period of less than 7 years.

The study advantages and limitations and final recommendations of the other Jerome Scott study reviewed are applicable to this report as well.

ABSTRACTS

System Definition Study:
Solar Heating and Cooling Commercial Project

Arthur D. Little, Inc., Cambridge, MA

February 1979

The Electric Power Research Institute (EPRI), has funded a three-phase study of solar and load-managed heating and cooling systems for commercial and light industrial applications. The first of its three phases is now complete. The first phase effort, a system definition study, was conducted by Arthur D. Little, Inc.. Its intent was to identify potential commercial applications of solar and load management systems, and then select several projects for continuation into a detailed design phase and ultimately into construction. Candidate projects were proposed by electric utilities which selected building and system concepts and which also assembled project teams. Evaluation of the proposals was based upon criteria which were developed especially for this EPRI project, and which were based in part on a survey of the potential commercial solar market. The applications definition effort of this study determined market size and characteristics for a variety of commercial buildings and for the process industries. Energy-use patterns and temperature requirements for these applications were also considered in identifying promising areas for solar augmentation of the energy supply. The seven projects ultimately selected for continuation into a second phase and detailed design included a delicatessen, schools, and office buildings.

Solar Heating and Cooling of Buildings
(SHACOB) Commercialization Report.
Part B: Analysis of Market Development.
Volume II: Technical Report, September 1977

Arthur D. Little Inc.

May 1978

The SHACOB commercialization model is designed to gauge the impacts of selected federal incentive programs to encourage the development of solar energy equipment for hot water heating, space heating, and space cooling in residential and commercial buildings. The model is designed to run with 10 different categories of market/building types; for the 10 FEA regions, and for the 14-year period of 1977 to 1990. At the heart of the model is the cell penetration module, within which the market penetrations for solar energy devices are calculated for each particular year, market and building type and region. The origin of the major economic and technical data base elements used in the model are discussed, and trends of these elements are projected over the time frame of this study -- the status of the solar industry is reviewed briefly. The results of the SHACOB model analysis are discussed in the following areas: a comparison of the four major incentive scenarios, the sensitivity of the SHACOB model to key data assumptions, the impact of single incentives (versus incentive packages), a comparative view of the National Energy Plan (NEP) projections versus the COMP/NEP approach, and finally, a brief investigation of possible phased incentive programs designed to avoid the disruptive effects resulting from the sudden termination of major incentives.

Development and Evaluation of Thermic Diode Solar Panels
for Building Heating and Cooling.

Final Report: November 1, 1975 -- October 31, 1977.

S. Buckley

July 1978

This report covers research completed between November 1975 through October 1977 regarding various aspects of the thermic diode solar panel. Three specific aspects of the research are: market analysis, cost -- volume study, and heat transfer analysis. The thermic diode solar panel is a passive solar energy system for space heating or domestic hot water heating. The thermic panel is also modular, has no moving parts and is easily installed. Each panel contains all the necessary ingredients of a complete solar energy system: collectors, controls, storage, heat exchangers and ducting. In the market analysis, questionnaires were returned from about 80 building contractors throughout the country. Six barriers were identified which must be met for a solar heating system to be accepted by the marketplace (in order of importance): initial investment cost, operating cost, warranty period, number of successful installations, expected life, and payback period. The cost -- volume study found the manufacturing costs of the panel at various production volumes. At the highest rate, 10,000 units/year, the factory price as delivered to the site was about \$6.00/ft. Heat transfer analyses, verified by experimental data taken on a scale model panel, showed how stratification of water in the panel's storage tank alters the flow rate.

Projecting the Market Penetration of Solar Energy:
A Methodological Review

S. Shiffel, D. Costello, D. Posner

1978

Market penetration models have been used to supply both government and industry decision makers with insights into the potential of solar energy. A number of models have been developed recently which project the future market penetration of solar energy technologies. Significant solar market penetration efforts are described, and it is illustrated that each model contains the same basic six components or phases. The market penetration phase is considered the critical element of these markets. Research on historical patterns of innovation diffusion and reasoning by analogy lay the theoretical foundation for most existing solar penetration models. Application of diffusion research presents a key methodological problem. Potential methodological improvements to identify and quantify important decision variables through market research on the decision making process are discussed.

Barriers and Incentives to the Commercialization
of Solar Heating and Cooling of Buildings

D.R. Costello, D.M. Posner

1977

Potential barriers to the widespread use of solar heating and cooling systems in residential and commercial buildings are reviewed. Although solar systems have been technologically proven and are used to a limited extent today, economic, institutional, and legal barriers may slow future commercialization. Consideration of incentives that might reduce these barriers raises the question of how to evaluate alternative policy -- question options.

Application of Innovation Attribute Dimensions to a New Solar
Energy Product: Implications for Advertising and Public Relations

J.D. Keeler

1976

This exploratory investigation was primarily an attempt to deal with the pragmatic problem of market introduction involving a specific solar energy product -- solar water heating systems for the home. Recent government and industry feasibility studies have viewed solar water heating systems and related solar energy applications as innovations which could result in substantial savings of non-renewable, conventional fossil fuels, if they are widely accepted and used by the public in the immediate future. Advertising, public relations, and other attitude change specialists are expected to assume much of the responsibility for securing this widespread adoption of solar devices. However, these communication specialists are confronted by the problem of determining what with regard to solar devices should be emphasized within the informational and persuasive efforts designed to secure acceptance and use of these innovations. Three methods of analysis (descriptive analysis, hierarchical grouping analysis, factor analysis) were used in handling the data, and a number of useful findings for developing advertising and public relations strategies and activities regarding solar devices were discovered. The study contains a practical discussion of diffusion of the solar water heating system, a review of the gist of diffusion of innovations theory and research, with special concentration on perceived attributes of innovations research, description of the methodology used in the study, analysis of the findings and their implications, and a summary in which further research needs are discussed and relevant theoretical questions are proposed and examined within the context of the study.

Banking Industry Issues

J.R. Kondos

1977

The banking industry's perceptions of and attitudes toward solar energy are explored. A random sample of banks in New England and New York State chosen from the bank headquarters in these states were surveyed. The survey questions were divided into four categories to determine awareness, acceptance, perception of obstacles, and the banking industry's potential contributions to solar utilization.

Constraints and Incentives of the Widespread Use of Solar Heating and Cooling Systems

C. Masterson

1976

This study briefly discusses barriers to the utilization of solar heating and cooling systems for buildings and evaluates alternative incentives that will promote their widespread use. Economics, legal and regulatory problems, and project organization and management are seen as the three main constraints. If left to the forces of the market place, solar heating and cooling systems will not become competitive with existing technologies until the year 2,000. The author further notes that the attitude of the consumer is also important for solar systems development.

Sector-Specific Output and Employment Impacts of a Solar Space and Water Heating Industry

H.C. Petersen

December 1977

This study identifies those sectors of the economy which would be most affected by increased solar utilization and estimates the magnitude of the chances. The basic methodology involves augmenting an existing input/output table to include sectors reflecting solar technology. Data required to augment the matrix were obtained from questionnaires returned by existing firms involved in collector manufacture or solar space and water heating system sales. The augmented I/O matrix was inverted to generate a direct and indirect requirements matrix. The elements of this matrix which estimate the changes in sales and employment were derived for 131 sectors of the U.S. economy. It was determined that the sectors most affected by solar development will be those involved in electricity generation and the mining, refining, and fabrication of metals, especially copper. The proportionate changes in industry sales and employment are not expected to be very great. Only copper rolling and drawing is changed by as much as 2 percent.

Public Acceptance of Solar Energy

F. Perry

1977

Ways of combatting adverse publicity and public apathy are discussed. The establishment of standards, warranties, marketing, and installing are covered.

Barriers and Incentives to the Commercialization of Solar Energy for Residential Domestic Hot Water and Space Heating: An In-Depth Assessment by Solar Consumers

S.W. Sawyer, S.L. Feldman

1978

A sample survey of 177 owners of active solar domestic water, space and combined water and space heating systems was conducted. The objective of the survey was to determine the experiences, attitudes, and assessments of the present end users of these technologies. All the consumers were non-subsidized, owners throughout the adoption process (purchase, installation, operation), owned single family homes, and purchased their systems during or since 1973. The systems were located in New England and the southwest. The preliminary results of these individuals, assessment of the barriers and incentives is discussed. Of eighteen potential barriers, high cost, lack of information, and technical problems were ranked, in that order, as the most significant encountered. The incentives assessed by these individuals as being the most helpful were, by order of importance, income tax credits, sales tax exceptions, availability of information, and continued research.

Barriers to the Commercialization of Solar Technology

R.W. Shaw

1976

The commercialization problem is discussed generally and then the specific barriers to commercialization identified in market research are described.

Citizens' Solar Program:
State Reports on Barriers and Strategies
to Renewable Energy Development

Solar Action, Inc., Washington, DC

October 1978

Solar action, the national Sun Day organization, in an effort to focus the energy generated by Sun Day, May 3, 1978, conducted serious forum where citizens and solar activists could systematically develop their analysis as to the status of solar at home and in the nation. The reports from each state grew out of this process. The 51 state solar reports in this publication provide an overview of the current status of solar power in the United States as seen through the eyes of the most ardent promoters of this emerging energy source. Financial impediments, tax complexities, hidden fuel subsidies, licensing intricacies, educational deficiencies, governmental barriers at all levels, capital shortages, and cultural biases are a few of the subject areas discussed. The 51 state solar working groups identified and discussed are educational, financial, marketing, legal, utility, regulatory, technological, policy and social barriers, and barriers due to problems within the solar industry or among solar groups.

Developing a Marketing Strategy for Solar Energy Systems

D.R. Thomas

1977

The need for identifying and classifying the population into potential market segments prior to the commercial introduction of particular solar energy systems is outlined. Then, the variables of product, price, place (distribution), and promotion and how they may be organized to best meet the needs of target consumers while, at the same time, allowing the marketer to achieve a satisfactory return on his investment are discussed.

Consumer's Four Questions

J.F. Vittek Jr.

1977

The four questions a consumer may be expected to ask about solar systems are discussed. These questions are: what will solar energy do for me; how much will it cost; is it safe; how do I get one.

Implications of Public Attitudes for Solar Energy Policy

P. Weis

1978

Public attitude surveys are examined regarding support for government action on solar energy in general and for information dissemination and economic incentive programs in particular. Twenty-nine public attitude surveys with data relevant to solar energy policy were collected. Their findings were separated and recorded under major subject categories for analysis. There is significant support expressed in surveys for government action on solar energy, but nearly half of the respondents do not feel it should replace private effort. Over 70% of respondents say they like solar, but these positive attitudes do not translate directly into willingness to purchase. Information programs and economic incentives elicit approval from well over half of respondents. General knowledge of the existence of solar energy is high, yet about 40% of sampled respondents still have not seen a solar collector. Over 80% do not know details necessary to a purchase decision. Perception of cost seems to be related to purchase intent. Information programs and economic incentives can operate to affect that perception.

Solar Energy Update

J.I. Yellott

January 1979

A progress report on solar energy examines both technical progress and non-technical developments in the form of policies, standards, and economics. Federal policies to allow tax credits for purchases of solar equipment will stimulate the market, while steps to establish performance standards and rating procedures will encourage consumer confidence. Federal demonstrations of solar energy use have been situated for high visibility. DOE research and demonstration of cost-effective passive systems for heating and cooling has attracted widespread interest among homeowners. Advances in solar technology have brought improvements to equipment, retrofit techniques, glazing materials, and heliostats in the solar radiation field. Energy conversion research has focused on silicon photovoltaic cells, wind turbine design, ocean thermal energy, and biomass.

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A MARKET ASSESSMENT FOR ACTIVE SOLAR
HEATING AND COOLING PRODUCTS

CATEGORY B: A SURVEY OF DECISION MAKERS
IN THE HVAC MARKET PLACE

DATA DOCUMENTATION
AND USER'S GUIDE

September, 1980

Prepared for

Active Building Systems Branch
Office of Solar Applications for Buildings
U.S. Department of Energy

By:

OR/MS Dialogue, Inc.
Cambridge, Massachusetts

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DOCUMENTATION FOR

RESIDENTIAL DATA

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RESIDENTIAL DATA

There are eight residential files:

PRELIMINARY	{	1.	Screeners			
		2.	Mains			
		3.	Miscellaneous			
FINAL	{	Existing Home	{	4.	Screeners	
				5.	Mains	
	{	New Home		6.	Screeners.	
				7.	Mains	
				8.	Descriptive File	

The number to the left of the contents indicates the file number of the data on the DOE database tape.

Preliminary Screener (File 1)

No notes: exactly as shown on questionnaire. Two cards/case.

Preliminary Main (File 2)

Three cards/case, but card 2 has no useful information. Ignore card 2 entirely. Everything else as indicated, but Q 7a-7e coded as follows:

99 in 100	=	99
9 in 10	=	09
8 in 10	=	08
7 in 10	=	07
6 in 10	=	06
5 in 10	=	05
4 in 10	=	04
3 in 10	=	03
2 in 10	=	02
1 in 10	=	01
0 in 10	=	00

Preliminary Miscellaneous (File 3)

This file contains information needed to identify the locations of the respondent and to match the screeners and mains with the information

in file 8.

Coding: [one card/case]

cc 1-3	ID [matches screeners and mains]
5	questionnaire type: 1 = short deterministic 2 = short undeterministic 3 = long deterministic
7	lottery: 1 = yes 2 = no
9-14	out-date of main mailout
16-21	back-date of main mailout
23-24	two digit state code
28	Identifier for NY questionnaires (state code 32): 1 = NY City 2 = corresponding to Boston, MA
30	Identifier for IL questionnaires (state code 13): 1 = corresponding to Madison, WI 2 = corresponding to Columbia

[Ignore remaining two items in cc 32 and 34]

Final Existing Homes Screener (File 4)

Two cards/case. Coded exactly as shown with following additions:

Card 1:

cc 16-17	contains INDEX for matching with data in File 8 [See appropriate documentation]
18-19	contains two-digit state code
20	region indicator: 1 = North East 2 = South 3 = North Central 4 = West

Card 2:

cc 69-73	Screener weight (F5.3) format
74-78	Main weight (F5.3) format

Final Existing-homes Main (File 5)

Two cards/case. First card indicated by "3" in cc 80; second card by "4". Coded exactly as shown, except as follows:

Probability questions 7a-7e:

99 in 100	=	99
9 in 10	=	90
8 in 10	=	80
7 in 10	=	70
6 in 10	=	60
5 in 10	=	50
4 in 10	=	40
3 in 10	=	30
2 in 10	=	20
1 in 10	=	10
0 in 10	=	01

Variables added:

type, loc, out-date and back-date -- see questionnaire.
"loc" is described below.

Question 5 has two parts:

First, a one-digit (1 to 5) indicator for which letter was circled; second, the actual circled price.

Card columns 8-9 of card 1 contain the region ("loc") -- a number from 1 - 54, interpreted as in the regional index for the supplementary file. To match with the supplementary file, this region indicator should be modified if the version is 6:

For version 6, the index becomes:

7	=	55
19	=	56
21	=	57
29	=	58
39	=	59
45	=	60

Final New-homes Screener (File 6)

Identical to Final Existing-homes Screener (but without additional variables punched -- see description of file 4)

Final New-homes Main (File 7)

Three cards/case. Treatment exactly parallels Existing-homes Main, with the exception of absence of "type" variable.

PRELIMINARY SCREENER

RESIDENTIAL DATA

THIS PAGE
WAS INTENTIONALLY
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INTERVIEWER'S NAME: _____

DATE: _____ TIME: _____

TELEPHONE # CALLED: () _____

Active Solar Products

1 _____ 1-4 SID

Market Survey
(Screener)

1 _____ 5-

(ASK TO SPEAK TO MALE/FEMALE HEAD OF HOUSEHOLD)

Hello, I'm _____ from Dialogue, an independent market research firm. We are conducting a national survey about solar energy.

I'd like to ask you a few brief questions.

1. Do you currently own a home?

Yes _____ -1

No _____ -2 (SKIP TO Q.5)

7- PS1

2. Are you currently using a solar energy system in your home?

Yes _____ -1 (GO DIRECTLY TO YELLOW QUESTIONNAIRE)

No _____ -2

8- PS2

3. How long have you owned your home? Is it: (READ LIST)

Less than two years or _____ -1

Over two years _____ -2

9- PS3

Keypunch: If "2" in cc 8,
skip to yellow portion

4. When you moved in, was your home newly built, or was it owned by someone else?

Newly built _____ -1

Owned by someone else _____ -2

10- PS4

5. Are you currently planning to build a new home or to buy a newly constructed home?

Yes _____ -1

No _____ -2

11- PS5

(IF "NO" TO Q.1 AND "NO" TO Q.5, TERMINATE)

(IF "YES" TO Q.1 AND/OR Q.5, GO TO Q.6)

6. Are you the person in your household who does most of the decision making about things like the heating and air conditioning?

(IF NOT: ASK TO SPEAK TO THE PERSON WHO IS AND REPEAT "HELLO, I'M _____ FROM DIALOGUE, AN INDEPENDENT MARKET RESEARCH COMPANY.")

We're conducting a study about solar energy and I'd like to ask you to participate. Its results will be used in the development of energy policy.

Let me tell you how the survey works. First, I'll ask you a few questions over the telephone. That will take about five minutes. When we're done, I'll mail you some information about solar energy systems. This material will also include a questionnaire. We ask you to read through the material that is sent and to discuss it with your family. Then, we'd like you to complete the questionnaire and return it in a prepaid return envelope.

I'll call you back again, in about a week, to answer any questions you may have about the questionnaire.

Our study is based on only 1500 respondent nationwide, and it's very important that we get a representative sample of households. In addition, most people who have already completed the survey have found it to be both interesting and informative. For these reasons I'd really like you to agree to take part. (One other thing: if you participate in the study, your name will be entered in a lottery. There will be six cash prizes, with the top prize being \$200. The drawing for the lottery will be held at the end of the survey.) Are there any questions that you might have about the study? Will you participate?

Yes _____

No _____ (TERMINATE & TALLY)

Terrific! Let me first get your name and address so that I can mail out the package of information tomorrow.

NAME: _____
(14-32)

(PRINT CLEARLY!
SOMEONE HAS TO
COPY THIS OVER!)

ADDRESS: _____
(34-53)

CITY: _____ STATE: _____ ZIP: _____
(55-68) (70-71) (73-77)

TELEPHONE NUMBER: () _____

(IF NECESSARY): Of course, any information you will provide will be combined with all the other responses and will be used for statistical analysis only. Your participation will be completely confidential and your name will never be associated with this survey in any way.

Now, Mr./Ms. _____, let me ask you the first set of questions.
To start with,

Introductory Telephone Survey

1. Prior to this survey, had you seen or heard anything about the use of solar energy equipment for home or water heating?

yes _____-1

no _____-2 (SKIP TO Q.16)

6-

S1

2. In your area, can you currently buy solar energy systems for: (READ LIST)

	<u>yes</u>	<u>no</u>	<u>not sure</u>		
heating your home	_____ -1	_____ -2	_____ -3	7-	S2A
providing electricity for your home	_____ -1	_____ -2	_____ -3	8-	B
heating water	_____ -1	_____ -2	_____ -3	9-	C
air conditioning your home	_____ -1	_____ -2	_____ -3	10-	D

- 3a. Have you heard of any kinds of government sponsored financial incentives to homeowners who install solar energy equipment?

yes _____-1

no _____-2

(SKIP TO Q.4)

uncertain _____-3

(SKIP TO Q.4)

11-

S3A

- 3b. What kinds of incentives are you aware of? What others? (DO NOT READ LIST)

- tax rebate - is that	federal, or	<u>1</u> 13-1	→	what percent of the total cost of a solar energy system would that rebate pay?	<u>2</u> 14-15
	state	<u>3</u> 16-1	→	what percent of the total cost of a solar energy system would that rebate pay?	<u>4</u> 17-18
	Don't Know	_____			
- low-interest loan - is that	federal, or	<u>5</u> 19-1	→	what interest rate?	<u>6</u> 20-21
	state	<u>7</u> 22-1	→	what interest rate?	<u>8</u> 23-24
	Don't Know	_____			

- lump sum payment or grant (outside of tax system) - is that	federal, or	<u>9</u> 25-1	→ what percent of the total cost of a solar energy system would that payment cover?	<u>10</u> 26-27
	state	<u>11</u> 28-1	→ what percent of the total cost of a solar energy system would that payment cover?	<u>12</u> 29-30
	Don't Know	_____		
- decreased fuel prices		<u>13</u> 31-1		
- other (PLEASE SPECIFY):		<u>14</u>		32-1
- none mentioned		<u>15</u> 33-1		

. Other than in a picture, have you ever seen a home equipped with solar collectors or solar panels?

yes _____-1 no _____-2 not sure _____-3 35- S4

. Do you know anyone who is now using solar energy for home or water heating?

yes _____-1 no _____-2 not sure _____-3 36- S5

. Have you actually gone looking for information about solar home or water heating equipment from a solar equipment manufacturer or dealer, a builder or an architect?

yes _____-1 no _____-2 (SKIP TO Q.8) 37- S6

. For what kinds of solar energy systems have you looked for information?

water heating _____ 38-1 S7A

space and water heating _____ 39-1 S7B

heat pump _____ 40-1 S7C

Other (SPECIFY) _____ 41-1 S7D

8. Are you likely to have a solar energy system installed in your home within the next year? (IF NECESSARY): Is that very likely/unlikely or somewhat likely/unlikely?

very likely	_____ -1
somewhat likely	_____ -2
unsure	_____ -3
somewhat unlikely	_____ -4
very unlikely	_____ -5

42- S8

9. If you were to consider installing a solar energy system would you be interested or not interested in information about _____? Would you be not at all interested, slightly interested, moderately interested, or very interested? (REPEAT FOR EACH TOPIC LISTED)

	<u>Not</u> <u>Interested</u>	<u>Slightly</u> <u>Interested</u>	<u>Moderately</u> <u>Interested</u>	<u>Very</u> <u>Interested</u>		
cost and savings	_____ -1	_____ -2	_____ -3	_____ -4	43-	S9A
how system works	_____ -1	_____ -2	_____ -3	_____ -4	44-	S9E
names of manufacturers	_____ -1	_____ -2	_____ -3	_____ -4	45-	S9C

10. Would you agree or disagree with the statement "I know a lot about the financial aspects of solar energy systems". (IF NECESSARY): Would that be strongly agree or disagree or moderately agree/disagree?

strongly agree	_____ -1
moderately agree	_____ -2
unsure	_____ -3
moderately disagree	_____ -4
strongly disagree	_____ -5

47- S10

11. And would you agree or disagree with the statement "I know a lot about how solar energy systems work." (IF NECESSARY): Would that be strongly agree/disagree or moderately agree/disagree?

strongly agree	_____ -1
moderately agree	_____ -2
(DO NOT READ) unsure	_____ -3
moderately disagree	_____ -4
strongly disagree	_____ -5

48- S11

12. Do you believe that you can or cannot currently obtain reliable and dependable solar energy equipment for home use? (IF NECESSARY): Is that definitely can/cannot or probably can/cannot?

definitely can _____ -1

probably can _____ -2

(DO NOT READ) unsure _____ -3

49- S12

probably can not _____ -4

definitely can not _____ -5

13. Do you believe that you can or cannot currently obtain solar energy equipment that makes economic sense for home use? (IF NECESSARY): Is that can/cannot or probably can/cannot?

definitely can _____ -1

probably can _____ -2

(DO NOT READ) unsure _____ -3

50- S13

probably can not _____ -4

definitely can not _____ -5

14. Do you believe that solar energy equipment will or will not be widely used by homeowners in your area within the next five years? (IF NECESSARY): Is that definitely will/will not or probably will/will not?

definitely will _____ -1

probably will _____ -2

(DO NOT READ) unsure _____ -3

51- S14

probably will not _____ -4

definitely will not _____ -5

15a. If the cost of a solar device were acceptable to you, would you be likely to be the first in your neighborhood to buy one?

yes _____ -1 (SKIP TO Q.16) no _____ -2

52 S15 A

- 15b. Would you agree or disagree with the statement "If several of my neighbors installed solar equipment, I would think much more seriously about installing it myself"? (IF NECESSARY): Would that be strongly agree or disagree or moderately agree/disagree?

strongly agree	_____	-1	
moderately agree	_____	-2	
(DO NOT READ) unsure	_____	-3	53- S15B
moderately disagree	_____	-4	
strongly disagree	_____	-5	

Demographics

16. Finally, I would like to get a little more information about you and your household for classification purposes. Please tell me into which of the following age groups you fall? (READ LIST)

under 25	_____	-1	
25 - 34	_____	-2	
35 - 44	_____	-3	55- S16
45 - 54	_____	-4	
over 55	_____	-5	
(DO NOT READ) refused	_____	(TERMINATE)	

17. What was the highest level of schooling completed by the head of your household? Was it: (READ LIST)

Grammar school,	_____	-1	
High school,	_____	-2	
College or	_____	-3	56- S17
Post-graduate work or degree	_____	-4	
(DO NOT READ) Refused	_____	(TERMINATE)	

18. Including yourself, how many people live in your home?

_____ 58-59 S18

19. How many are: (READ)

Adults 18 or over _____

60-61 S19A

Children under 18 _____

62-63 S19B

20. How many members of your household, including yourself, work outside the home for 30 hours or more per week?

64-65 S20

21. Finally, it would help us a great deal in our statistical analysis if we could get some idea about your income level. Was your total household income for last year, before taxes, under or over \$25,000?

(DO NOT READ) Refused (TERMINATE)

22. (RECORD SEX): Male _____ -1 Female _____ -2

68- S22

You will be receiving the information about solar energy equipment in a few days. We'd like you to read the material, and to discuss it with your family if you think that would be appropriate. Enclosed with the literature will be some questions about the information presented. We would like you to complete the questionnaire and return it to us in the postage paid return envelope that will accompany it. I will be calling you back in a few days to answer specific questions you might have about the survey. If you don't have any questions, and can complete the survey before I call again, please do so.

When would be a good time for me to phone you next week?

DAY: _____ TIME: _____

Once again, thank you for agreeing to participate in this study. I'll get the material in the mail tomorrow and you should have it within a few days. I'll talk to you again on (TIME AGREED UPON).

(GIVE RESPONDENT AT LEAST A WEEK TO 14 WEEKS)

(STAPLE TO SCREENER QUESTIONNAIRE)

PRELIMINARY MAIN

RESIDENTIAL DATA

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Dear Study Participant:

In this booklet you will find information about solar water heating systems. The description of the system is followed by a series of questions which relate to that particular description. The final section contains questions of a more general nature. Some of the questions here ask for information about your household energy usage. If you can, please use your records to answer these questions as accurately as possible. If you are unable to determine these answers exactly, please make an estimate. Other questions call for you to guess about the future, or ask for your opinions. On these kinds of questions there are no right or wrong answers, so just try to respond in a way that reflects your beliefs as accurately as possible.

We will be calling you back in a few days to answer specific questions you might have about the survey. The time agreed upon is _____. If, in the meantime, you have any questions about any of this material, please call us collect at Dialogue (617-661-9797) and we will try to help. If you don't have any questions, and can complete the survey before we call again, please do so.

After answering all of the questions, please return the questionnaire in the enclosed, postage-paid return envelope. A prompt reply will be appreciated. And please do not forget to fill out the enclosed card and return it with the questionnaire so that you will be entered in our lottery. You will be eligible to win one of the six cash prizes only if you return to us both the completed questionnaire and the card with your name, address, and telephone number.

Thank you very much for your help!

Sincerely,

Paul E. Johnston
Vice President

SOLAR DOMESTIC WATER HEATING SYSTEM FOR GEORGIA HOMES

A typical solar domestic water heating system is composed of a collector, a hot water storage tank, and the piping that connects them. The radiation of the sun heats the water as it passes through the collector. From the collector the warm water flows directly into a storage tank. The tank would be in the basement, or underground; it would be a standard size (about 80-90 gallons), of a type readily available. Controls keep the water circulating through the collector as long as the sun raises the temperature of the water. In general, this means that as long as the sun is out, the water will continue to circulate. At night, or when the weather is cold or cloudy, the water remains in the tank.

A solar system cannot, by itself, provide enough energy to meet all the hot water needs of an average family of four. In Georgia, system manufacturers and dealers say that the system will supply between 60^{NEEDLB} and 80^{NEEDLP} percent of those needs. Any additional water heating that is required is provided automatically by a conventional backup system using oil, gas, or electricity.

Most families would need four^{NCOLLECT} solar collectors to trap the sun's heat. These collectors are a little bigger than an average door. They are made of a piece of metal painted black, covered with glass and mounted in a wooden or metal frame. Collectors may be mounted on your roof if you have a roof that faces south, or installed in your yard.

A solar domestic water heating system comes with a 5-year manufacturer's warranty. The system has an expected life of 15 years, which is comparable to the expected life of a roof for your house.

A diagram of a typical system is on the next page.

A TYPICAL SOLAR DOMESTIC WATER HEATING SYSTEM

Financial Information

PRICE: The gross price of a solar domestic water heating system would be about \$2600 for a family of four with average hot water needs. These numbers include materials and installation. However, the federal government offers a refund, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be much lower than the gross price.

	Gross Price	\$2600 GROSS ³
(minus)	<u>Tax Rebate*</u>	<u>720 REBATE³</u>
	Actual Price	\$1880 ACTUAL ³

SAVINGS: The solar domestic water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see Appendix 1). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. (See graph shown in Appendix 2.) The most likely scenario would have the rate of increase over the next years be about the same as over the last 10 years, that is 12%. Under this assumption, the number of years it will take for your total savings to add up to more than the original cost of the system, (payback) has been calculated and is shown in Appendix 1.

* see Appendix 3 for calculation of Tax Credit

PAYING FOR A SYSTEM: You could pay for a solar system in cash -- in that case you would forego the interest that you could earn on the \$1880 that you use to purchase the solar system. If instead of buying a solar system, you can put that money in a 10% account you would earn the first year, but of course you would have to pay income tax on that amount so your real interest earnings would be less -- how much less would depend on your tax bracket.

You could also borrow money to pay for the system -- several banks are now giving "energy improvement" loans for 12 - 13½ percent interest. If you were to borrow \$1880 for 10 years at, say, 13%, the payments would add up to \$336 per year. In this situation, of course, the interest portion of your loan payment would be deductible for federal tax purposes, so your real annual expense would be less -- how much less would depend on your tax bracket.

Appendix 1 presents a comparison of interest earnings, loan payments, and most likely savings from a solar domestic water heater.

INCENTIVES AND REBATES: The federal government has tax rebates that you can take advantage of if you buy a solar domestic water heating system. See Appendix 3 for further information on federal tax rebates.

Appendix 1

Georgia

**Comparisons of Solar Water Heating Savings
with Interest Earnings and Loan Payments**

Year	<u>Savings</u>			<u>Annual Interest Earnings(1)</u>	<u>Annual Loan Payment(2)</u>
	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>		
1	Y1SVO 124	Y1SVE 163	Y1SVG 42	ITEARN 188	LOANP 336
2	144	180	49	206	336
3	168	198	56	227	336
4	195	219	64	250	336
5	Y5SVO 227	Y5SVE 242	Y5SVG 73	275	336
6	264	267	84	302	336
7	307	295	96	333	336
8	356	326	109	366	336
9	412	360	124	402	336
10	478	397	141	443	336
11	553	438	161		
12	640	483	183		
13	740	533	207		
14	856	588	235		
15	989	649	266		
Totals:	TSVO 6461	TSVE 5344	TSVG 1897	TINTEARN 2996	3360
Years to Payback:	8½ PAYVO	8 PAYVE	15 PAYVG		

The figures shown take into account: a) energy used to run the solar water heater's pumps, and
b) annual maintenance and upkeep expenses, estimated at \$25/year.

(1) assumes \$1880 plus all accumulated interest, left in 10% account for 10 years. (You would have to pay income tax on these earnings, so your actual interest income would be lower than these numbers indicate; how much lower would depend on your income tax bracket.)

(2) assumes \$1880 loan for 10 years at 13%. (You would get to deduct the interest portion of these payments from your income before figuring your taxes, so your out-of-pocket expense would actually be lower than these numbers suggest; how much lower would depend on your income tax bracket.)

Appendix 2

Individual Fuel Cost Rates of Increase

	<u>Overall</u>	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
Past 10 years	12%	15%	10%	12%
Projected	12%	15%	10%	12%

Data from Consumer Price Index,
U.S. Department of Labor

Appendix 3

Federal Income Tax Rebate

30% of the first \$2,000 of gross price (including installation)

20% of the amount over \$2,000

Total rebate not to exceed \$2,200

Thus on a \$2,600 system, the rebate is

30% of \$2,000 = \$600

20% of \$600 = 120

Total \$720

Questions About Solar Water Heating Systems

1. Please place a check next to the primary fuel that you plan to use for heating water in your home. Check only one:

natural gas _____-1 oil _____-3 M1 12-
electricity _____-2 other (please specify) _____-4

2. If the water heater you are now using were to break, how much would you expect to have to pay, to replace it with a 40-50 gallon tank? (including installation?) Check one:

under \$200 _____-1 \$500 - 600 _____-5
\$200 - 300 _____-2 \$600 - 700 _____-6
\$300 - 400 _____-3 \$700 - 800 _____-7 M2 13-
\$400 - 500 _____-4 over \$800 _____-8

3. Have you ever seriously considered an alternative system for heating your water?

yes _____-1 no _____-2 M3 14-

4. Using the fuel indicated in Question 1, approximately how much do you expect to pay for water heating in the next year? If you do not know approximately, please guess.

\$ _____ M4 15-19

5. The average price, including installation, of a solar water heating system, as described here, would be about \$ 2600. This figure is for an average family of four with average hot water needs. Your family's needs may be more or less than the average, so you might need a larger or smaller system. Taking into consideration your family's hot water needs and what you know about both solar energy system prices and government incentives, how much would you expect such a system would cost you, if you were to buy one? Circle the letter over the column that is closest to this figure.

	A	B	C	D	E	
	Gross Price	\$ 1900	\$ 2300	\$ 2600	\$ 2900	\$ 3300
(minus)	Tax Rebate	570	660	720	780	860
	Actual Price	\$ 1330	\$ 1640	\$ 1880	\$ 2120	\$ 2440

M5 19-

6. If you were to install a solar water heating system in your home, how much would you expect to save on your hot water bill this year, compared to what you would pay using another system?

under \$ 50 _____-1 \$201 - 250 _____-5
\$ 51 - 100 _____-2 \$251 - 300 _____-6
\$101 - 150 _____-3 \$301 - 350 _____-7
\$151 - 200 _____-4 over \$350 _____-8 M6 20-

- 7a. Look back at your "Actual Price" in Question 5. Call that figure your "Base Price" and your answer to Question 6, "Base Savings". Thinking about your base figures, how likely you would be to buy a solar water heating system for your home in the next year? Please check the appropriate space in Column A.
- 7b. Prices for solar water heating systems may go down. Keeping your base savings (Question 6) in mind, suppose you could buy a system for 25% less than your base price. (The new price of the system would then be 3/4 of your base price.) How likely would you be to buy a system in the next year? Please check the appropriate space in Column B.
- 7c. Again using your base savings (Question 6), now suppose that you could buy a system for half of your base price. How likely would you be to buy a system in the next year? Please check the appropriate space in Column C.
- 7d. Fuel prices may rise faster than we now expect. Go back to your base price (Question 5) but now suppose that your savings are 50% more than your estimated base savings (Question 6). How likely would you be to buy a system in the next year, if you could get these increased savings? Please check the appropriate space in Column D.
- 7e. Finally, go back to your base price and savings (Questions 5 and 6). The description of a solar water heater says that a system usually comes with a 5-year warranty. Suppose now that the warranty is increased to cover the system for 15 years? How likely would you be to buy a system in the next year, if you could get this longer warranty? Please check the appropriate space in Column E.

7a-7e. Answer Section

How likely would you be to install a solar water heating system in your home in the next year in each of the situations described above? (Check one space in each column):

	A	B	C	D	E
Certain, practically certain (99 in 100)	_____	_____	_____	_____	_____
Almost sure (9 in 10)	_____	_____	_____	_____	_____
Very Probable (8 in 10)	_____	_____	_____	_____	_____
Probable (7 in 10)	_____	_____	_____	_____	_____
Good possibility (6 in 10)	_____	_____	_____	_____	_____
Fairly good possibility (5 in 10)	_____	_____	_____	_____	_____
Fair possibility (4 in 10)	_____	_____	_____	_____	_____
Some possibility (3 in 10)	_____	_____	_____	_____	_____
Slight possibility (2 in 10)	_____	_____	_____	_____	_____
Very slight possibility (1 in 10)	_____	_____	_____	_____	_____
No chance, almost no chance (0 in 10)	_____	_____	_____	_____	_____
	M7A	M7B	M7C	M7D	M7E

cc. 22-23 24-25 26-27 28-29 30-31

8. If you were to purchase a solar water heating system, how would you be most likely to pay for it? (Check one space)

Personal savings _____ -1
 Bank loan _____ -2
 Other (please specify) _____ -3

M8 32-

9. If you were to purchase a solar water heating system, which of the following would you prefer to purchase it from? (Check only one)

A specialized solar
 system distributor/installer _____ -1
 Your plumber _____ -2
 The builder _____ -3
 The electric or gas company _____ -4
 The oil dealer _____ -5
 A large retail department
 store (for example, Sears) _____ -6
 Other (please specify) _____ -7

M9 33-

Keypunch	
<u>03</u>	79-80
Next card	
Duplicate 1-10	
<u>04</u>	79-80

General Questions

Please answer the following questions concerning the use of solar energy equipment in general

1. Do you believe that you can currently obtain reliable and dependable solar energy equipment for home use?

Definitely can	___	-1
Probably can	___	-2
Unsure	___	-3
Probably can not	___	-4
Definitely can not	___	-5

G1 12-

2. Do you believe that you can currently obtain solar energy equipment that makes economic sense for home use?

Definitely can	___	-1
Probably can	___	-2
Unsure	___	-3
Probably can not	___	-4
Definitely can not	___	-5

G2 13-

3. Do you believe that solar energy equipment will be widely used by homeowners in your area within the next five years?

Definitely will	___	-1
Probably will	___	-2
Unsure	___	-3
Probably will not	___	-4
Definitely will not	___	-5

G3 14-

4. Please indicate, by circling a number on the scale, how strongly you agree or disagree with each of the following statements:

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	
a. I would admire a neighbor who installed solar equipment.	1	2	3	4	5	15-
b. If several of my neighbors installed solar equipment, I would think more seriously about installing it myself.	1	2	3	4	5	16-
c. Solar energy systems can provide a lot of protection from future energy shortages.	1	2	3	4	5	17-

4. (continued)

	<u>Strongly agree</u>	<u>Agree</u>	<u>Neither agree nor disagree</u>	<u>Disagree</u>	<u>Strongly disagree</u>	
d. A solar water heating system would greatly increase the resale value of my home.	1	2	3	4	5	18-
e. If a solar energy system that I installed failed and needed major repairs or replacement, it could mean a financial disaster for my family.	1	2	3	4	5	19-
f. Solar collectors would be very unattractive on my house.	1	2	3	4	5	20-
g. It would be very easy to obtain financing for a solar energy system.	1	2	3	4	5	21-
h. If a solar energy system that I installed gave less savings than I had expected, it could mean a financial disaster for my family.	1	2	3	4	5	22-
i. Solar equipment would protect me from increasing energy costs.	1	2	3	4	5	23-
j. I would vote for zoning restrictions to ban solar collectors from the front of houses in my neighborhood.	1	2	3	4	5	24-
k. Manufacturers of solar systems are mostly little companies that are here today and will probably be gone tomorrow.	1	2	3	4	5	25-
l. Solar energy equipment will produce maintenance nightmares for me.	1	2	3	4	5	26-
m. I know a lot about the financial aspects of solar energy systems.	1	2	3	4	5	27-
n. I know a lot about how solar energy systems work.	1	2	3	4	5	28-
o. Technological advances will soon make currently available solar equipment outdated.	1	2	3	4	5	29-

5. If you stay with your current fuel, how much do you think you will have to pay per year to heat water for your home five years from now (in 1985?)

\$ _____

G5 31-34

6. Please check the one space in each row that best indicates how interested you would be in more information about each of the items listed.

	<u>Not</u> <u>Interested</u>	<u>Slightly</u> <u>Interested</u>	<u>Moderately</u> <u>Interested</u>	<u>Very</u> <u>Interested</u>		
cost and savings	_____ -1	_____ -2	_____ -3	_____ -4	G6A	35-
how system works	_____ -1	_____ -2	_____ -3	_____ -4	G6B	36-
names of manufacturers	_____ -1	_____ -2	_____ -3	_____ -4	G6C	37-

- 7a. Do you intend to look for additional information about solar energy systems within the next two or three months?

Yes _____ -1

No _____ -2 (Please skip to Question 8)

G7A 38-

- 7b. About what kinds of solar energy systems will you look for information?

solar water heating _____ -1 -49
solar-assisted heat pump _____ -2 -50
solar home heating _____ -3 -51
other (please specify) _____ -4 -52

G7B

- 8a. Do you think you will purchase any kind of solar energy system in the next five years?

Yes _____ -1

No _____ -2 (Please skip to Question 9)

G8A 40

- 8b. What kind of energy system will you buy?

solar water heater _____ -1 -53
solar home heating _____ -2 -54
solar-assisted heat pump _____ -3 -55
other (please specify) _____ -4 -56

G8B

9. Which of the following categories best describes your family's composition?

No children living at home _____ -1

Children living at home {

youngest under age 6 _____ -2

youngest age 6 - 12 _____ -3

youngest age 13 or over _____ -4

G9

10. Approximately how much does a gallon of unleaded, regular gasoline cost in your area?

under \$.95	_____1
\$1.00	_____2
\$1.05	_____3
\$1.10	_____4
\$1.15	_____5
over \$1.15	_____6

G1043-

11. How much do you think a gallon of unleaded, regular gasoline will cost five years from now (in 1985)?

\$ _____

G11 44-48

Thank you very much for your help! Please place your completed questionnaire in the postage paid return envelope and mail it back to us at your earliest convenience.

If you would be interested in the results of this study, just write your name and address in the space below and we will be happy to send them to you when they are available.

Name _____

Street _____

City _____ State _____ ZIP _____

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FINAL VERSION

EXISTING & NEW HOME SCREENER

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Active Solar Products

Market Survey

STATE: Screener

1-4

1 5-

Hello, I'm _____ from Dialogue an independent market research firm. We are conducting a national survey about solar energy.

I'd like to ask you a few brief questions.

1. Do you currently own a home?

yes _____ -1

no _____ -2 (SKIP TO Q.6)

6-

2a. Does your home have a water heater, to supply hot water for baths, showers, dishwashing and so on?

yes _____ -1

no _____ -2 (TERMINATE AND TALLY)

7-

2b. (IF YES TO Q.2a)

And what fuel does that water heater use?

Gas _____ -1

Electric _____ -2

Oil _____ -3

Solar _____ -4

Other: (SPECIFY) _____

-5

8-

2c. If your water heater broke down and had to be replaced, would you replace it your self, or have someone do the work for you?

9-

Replace by self _____ -1

Have someone do work _____ -2

And where would you buy the necessary parts? (DO NOT READ)

Plumbing supply house _____ -1

Large merchandiser (Sears, etc.) _____ -2

Hardware store, other small store _____ -3

Other (specify) _____ -4

10-

And who would you be most likely to call to replace the broken water heater? ((DO NOT READ)

Plumber _____ -1

Solar dealer _____ -5

Electric Co. _____ -2

Friend, relative _____ -6

Gas Co. _____ -3

Other (specify) _____ -7

Oil dealer _____ -4

11-

3. Are you currently using a solar energy system in your home?

yes _____ -1 (GO DIRECTLY TO YELLOW QUESTIONNAIRE)

no _____ -2

12-

4. How long have you owned your home? (READ LIST)

Keypunch: If "1" in cc 12 skip to yellow portion

less than 2 years _____ -1

over 2 years _____ -2

13-

5. When you moved in, was your home newly built, or was it owned by someone else?

newly built _____ -1

owned by someone else _____ -2 (TERMINATE IF Q.6 IS NOT "YES") 14-

6. Are you currently planning to build a new home or to buy a newly constructed home?

yes _____ -1

no _____ -2 (TERMINATE IF Q.5 IS NOT "NEWLY BUILT") 15-

(IF "LESS THAN 2 YEARS" IN Q.4 AND "NEWLY BUILT" IN Q.5, CONTINUE, OR IF "YES" TO Q.6, CONTINUE, OTHERWISE, TERMINATE)

7. Are you the person in your household who does most of the decision making about things like the heating and air conditioning?

INDEX
16-17

STATE
18-19

REGION
20

1=North East
2=South
3=North Central
4=West

*These are
variables
added to
screener.*

(IF NOT: ASK TO SPEAK TO THE PERSON WHO IS AND REPEAT "HELLO, I'M _____ FROM _____, AN INDEPENDENT MARKET RESEARCH COMPANY.")

We're conducting a study about solar energy and I'd like to ask you to participate. Its results will be used in the development of energy policy.

Let me tell you how the survey works. First, I'll ask you a few questions over the telephone. That will take about five minutes. When we're done, I'll mail you some information about solar energy systems. This material will also include a questionnaire. We ask you to read through the material that is sent and to discuss it with your family. Then, we'd like you to complete the questionnaire and return it in a prepaid return envelope.

I'll call you back again, in about a week, to answer any questions you may have about the questionnaire.

Our study is based on only 1500 respondents nationwide, and it's very important that we get a representative sample of households. In addition, most people who have already completed the survey have found it to be both interesting and informative. For these reasons I'd really like you to agree to take part. Are there any questions that you might have about the study? Will you participate?

yes _____

no _____ (GO TO DEMOGRAPHICS AND TERMINATE)

Terrific! Let me first get your name and address so that I can mail out the package of information.

RESPONDENT #: _____

Name _____

(PRINT CLEARLY!
SOMEONE HAS TO
COPY THIS OVER!)

Address _____

City _____ State _____ Zip _____

Telephone number () _____

You will be receiving the information about solar energy equipment in a week or so. We'd like you to read the material, and to discuss it with your family if you think that would be appropriate. Enclosed with the literature will be some questions about the information presented. We would like you to complete the questionnaire and return it to us in the postage paid return envelope that will accompany it. I will be calling you back in a few days to answer specific questions you might have about the survey. If you don't have any questions, and can complete and mail the survey before I call again, please do so.

When would be a good time to call you next week?

OUR _____ AM
TIME: _____ PM

DATE: _____

(THEIR TIME: _____ AM. PM)

INTERVIEWER NAME: _____

DATE OF INTERVIEW: _____ TIME START: _____ TIME END: _____

(IF NECESSARY:) Of course, any information you will provide will be combined with all the other responses and will be used for statistical analysis only. Your participation will be completely confidential and your name will never be associated with this survey in any way.

Now, Mr./Ms. _____, let me ask you the first set of questions. To start with,

(STAPLE TO COMPLETED SURVEY FORM)

01 79-80

Introductory Telephone Survey

Duplicate 1-4

1. Prior to this survey, had you seen or heard anything about the use of solar energy equipment for home or water heating?

yes _____-1

no _____-2 (SKIP TO Q.15)

6-

2. In your area, can you currently buy solar energy systems for: (READ LIST)

	<u>yes</u>	<u>no</u>	<u>not sure</u>	
heating your home	_____ -1	_____ -2	_____ -3	7-
providing electricity for your home	_____ -1	_____ -2	_____ -3	8-
heating water	_____ -1	_____ -2	_____ -3	9-
air conditioning your home	_____ -1	_____ -2	_____ -3	10-

- 3a. Have you heard of any kinds of government sponsored financial incentives to home owners who install solar energy equipment?

yes _____-1 no _____-2 (SKIP TO Q.4) uncertain _____-3 (SKIP TO Q.4) 11-

- 3b. Do you know what kinds of forms any of these incentives take?

(DO NOT READ LIST)

(DON'T KNOW -
WRITE IN "9")

(DON'T KNOW -
WRITE IN "99")

-tax rebate - is that

- federal, or _____13-1
 - what percent of the total cost of a solar energy system would that rebate pay? _____14-15
- state _____16-1
 - what percent of the total cost of a solar energy system would that rebate pay? _____17-18

-low-interest loan - is that

- federal, or _____19-1
 - what interest rate? _____20-21
- state _____22-1
 - what interest rate? _____23-24

- lump sum payment or grant (outside of tax system) - is that

federal, or 25-1 → what percent of the total cost of a solar energy system would that payment cover? 26-27
 state 28-1 → what percent of the total cost of a solar energy system would that payment cover? 29-30

- decreased fuel prices

31-1

- other (please specify) _____

32-1

- none mentioned

33-1

4. Other than in a picture, have you ever seen a home equipped with solar collectors or solar panels?

yes -1 no -2 not sure -3

34-

5. Do you know anyone who is now using solar energy for home or water heating?

yes -1 no -2 not sure -3

35-

6. Have you actually gone looking for information about solar home or water heating equipment from a solar equipment manufacturer or dealer, a builder or an architect?

yes -1 no -2 (SKIP TO Q.8)

36-

7. For what kinds of solar energy systems have you looked for information?

water heating 37-1

space and water heating 38-1

heat pump 39-1

other (SPECIFY) 40-1

8. Are you likely or unlikely to have a solar home or water heating system installed in your home in the next year? (AS NECESSARY): Is that very likely/unlikely or somewhat likely/unlikely? And how about within the next 5 years? (AS NECESSARY): Is that very likely/unlikely or somewhat likely/unlikely?

	<u>next year</u>	<u>next 5 years</u>
very likely	____-1	____-1
somewhat likely	____-2	____-2
unsure	____-3	____-3
somewhat unlikely	____-4	____-4
very unlikely	____-5	____-5
	-41-	-42-

9. If you were to consider installing a solar energy system would you be interested or not interested in receiving information about _____?
(READ TOPICS FROM BELOW, ONE AT A TIME) Would you be not at all interested, slightly interested, moderately interested, very interested?

(READ FOR EACH TOPIC LISTED)

	<u>Not Interested</u>	<u>Slightly Interested</u>	<u>Moderately Interested</u>	<u>Very Interested</u>	
cost and savings	____-1	____-2	____-3	____-4	43-
how system works	____-1	____-2	____-3	____-4	44-
names of manufacturers	____-1	____-2	____-3	____-4	45-

10. Would you agree or disagree with the statement "I understand the financial merits of solar energy systems". (AS NECESSARY): Would that be strongly agree or disagree or moderately agree/disagree?

strongly agree	____-1	
moderately agree	____-2	
unsure	____-3	47-
moderately disagree	____-4	
strongly disagree	____-5	

11. And would you agree or disagree with the statement "I understand how solar energy systems work." (AS NECESSARY) Would that be strongly agree/disagree or moderately agree/disagree?

strongly agree	____-1	
moderately agree	____-2	
unsure	____-3	48-
moderately disagree	____-4	
strongly disagree	____-5	

12. Do you believe that you can or cannot currently obtain reliable and dependable solar energy equipment for home use? (AS NECESSARY): Is that definitely can/cannot or probably can/cannot?

definitely can	_____ -1
probably can	_____ -2
unsure	_____ -3
probably can not	_____ -4
definitely can not	_____ -5

49-

13. Do you believe that you can or cannot currently obtain solar energy equipment that makes economic sense for home use? (AS NECESSARY): Is that definitely can/cannot or probably can/cannot?

definitely can	_____ -1
probably can	_____ -2
unsure	_____ -3
probably can not	_____ -4
definitely can not	_____ -5

50-

14. Do you believe that solar energy equipment will or will not be widely used by homeowners in your area within the next five years? (AS NECESSARY): Is that definitely will/will not or probably will/will not?

definitely will	_____ -1
probably will	_____ -2
unsure	_____ -3
probably will not	_____ -4
definitely will not	_____ -5

51-

(READ FOR RESPONDENTS WHO WILL NOT PARTICIPATE):

In order to be certain that we are interviewing a cross section of people, I would like to ask you a few statistical questions before we terminate.

52- 53 SP

(RESPONDENTS WHO REFUSE TO PARTICIPATE DO NOT COUNT TOWARD QUOTA)

Demographics

15. Finally, I would like to get a little more information about you and your household for classification purposes. Please tell me into which of the following age groups you fall? (READ LIST)

under 25	_____	-1
25 - 34	_____	-2
35 - 44	_____	-3
45 - 54	_____	-4
over 55	_____	-5
(DO NOT READ) refused	_____	-8

55-

16. What was the highest level of schooling completed by the head of your household? Was it: (READ LIST)

Grammar school,	_____	-1
High school,	_____	-2
College or	_____	-3
Post-graduate work or degree	_____	-4
(DO NOT READ) Refused	_____	-8

56-

17. Including yourself, how many people live in your home?

58-59

18. How many are: (READ)

Adults 18 or over	_____
Children under 18	_____

60-61

62-63

19. How many members of your household, including yourself, work outside the home for 30 hours or more per week?

64-65

20. Finally, it would help us a great deal in our statistical analysis if we could get some idea about your income level. Was your total household income for last year, before taxes, under or over \$25,000?

21. (RECORD SEX:) Male ___ -1 Female ___ -2

68-

Once again, thank you for agreeing to participate in this study. I'll get the material in the mail today and you should have it soon. I'll talk to you again on (TIME AGREED UPON).

weight for screener

69 70 71 72 73

weight for main

(STAPLE TO SCREENER QUESTIONNAIRE)

74 75 76 77 78

02 79-80

(IF REFUSED TO ANSWER QUESTIONS 15, 16, or 20,
DO NOT COUNT TOWARD QUOTA)

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WHI

TYPE _____ -7

Questions About Solar Water Heating Systems

1=SD

2=SU

3=LD

6=N.E. Special
=Conc. Collec

1. Please place a check next to the primary fuel that you use for heating water (for baths, showers, dishwashing, etc.) in your home. Check only one:

LOC _____ 8-9

(see appro. document)

natural gas _____ -1 oil _____ -2
electricity _____ -3 other _____ -4
(please specify) _____ -10

2. If the water heater you are now using were to break, how much would you expect to have to pay to replace it with a 40-50 gallon tank? (including installation) Check only one:

under \$200 _____ -1 \$500 - 600 _____ -5
\$200 - 300 _____ -2 \$600 - 700 _____ -6
\$300 - 400 _____ -3 \$700 - 800 _____ -7
\$400 - 500 _____ -4 over \$800 _____ -8 -11

3. Have you ever seriously considered an alternative system for heating your water?

yes _____ -1 no _____ -2 -12

4. Using the fuel indicated in Question 1, approximately how much did you spend for water heating last year? If you do not know approximately, please guess. How much do you expect to pay for water heating next year? How much do you think you will have to pay five years from now (in 1985)?

last year \$ _____ next year \$ _____ in 1985 \$ _____
13-18 (guess) 19-24 (guess) 25-30

5. The average price, including installation, of a solar water heating system, as described here, would be about \$2300. This figure is for an average family of four with average hot water needs. Your family's needs may be more or less than the average, so you might need a larger or smaller system. Taking into consideration your family's hot water needs and what you know about both solar energy system prices and government incentives, how much would you expect such a system would cost you, if you were to buy one? Circle the letter over the column that is closest to this figure.

cc 31 is a:
1 if A circle
2 B
3 C
4 D
5 E

cc 32-36
contain
actual price
circled

	A	B	C	D	E
Gross Price	\$1600	\$1900	\$2300	\$2600	\$2900
(Minus) Tax Rebate	880	1045	1265	1430	1595
Actual Price	\$ 720	\$ 855	\$1035	\$1170	\$1305

6. If you were to install a solar water heating system in your home now, how much less would you spend on hot water this year than you would spend using another system?

under \$50 _____ -1 \$201 - 250 _____ -5
\$ 51 - 100 _____ -2 \$251 - 300 _____ -6
\$101 - 150 _____ -3 \$301 - 350 _____ -7
\$151 - 200 _____ -4 over \$350 _____ -8 -37

Please copy your "Actual Price" from Question 5 here:
This is your BASE PRICE

\$ _____ BASE PRICE
38-43

Please copy your savings estimate from Question 6 here:
This is your BASE SAVINGS

\$ _____ BASE SAVINGS
44-49 50-55

7a. Please look at your BASE PRICE and BASE SAVINGS, above. Thinking about your base figures, how likely would you be to buy a solar water heating system for your home in the next year? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____
56-57

7b. The description of a solar water heater says that a system usually comes with a 5-year warranty. Suppose now that the warranty is increased to cover the system for 15 years (with the same BASE PRICE and SAVINGS). How likely would you be to buy a system in the next year, if you could get this longer warranty? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____
58-59

7c. Prices for solar water heating systems may go down. Keeping your BASE SAVINGS (from above) in mind, suppose you could buy a system for 25% less than your BASE PRICE. (The new price of the system would then be 3/4 of your BASE PRICE.) How likely would you be to buy a system in the next year? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____
60-61

7d. Again using your BASE SAVINGS from above, suppose that you could buy a system for half of your BASE PRICE. How likely would you be to buy a system in the next year? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____
62-63

7e. Fuel prices may rise faster than we now expect. Go back to your BASE PRICE from above, but now suppose that your savings are 50% more than your estimated BASE SAVINGS. How likely would you be to buy a system in the next year, if you could get these increased savings? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____
64-65

8. If you were to purchase a solar water heating system, how would you be most likely to pay for it? (Check one space)

Personal savings	_____	-1	
Bank loan	_____	-2	
Other (please specify)	_____	-3	-66

9. If you were to purchase a solar water heating system, which of the following would you prefer to purchase it from? (Check only one)

A specialized solar system distributor/installer	_____	-1	
Your plumber	_____	-2	
Your builder	_____	-3	
Your electric or gas company	_____	-4	
Your oil dealer	_____	-5	
A large retail department store (for example, Sears)	_____	-6	
Other (please specify)	_____	-7	-67

10. What fuel, if any, do you use to heat the living space in your home? (If more than one, please check the one that is your primary source of energy.)

electricity	_____	-1	other (please specify)	_____	-5	
natural gas	_____	-2				
oil	_____	-3				
wood	_____	-4	none	_____	-6	-68

General Questions

Please answer the following questions concerning the use of solar energy equipment in general.

1. Do you believe that you can currently obtain reliable and dependable solar energy equipment for home use?

Definitely can _____ -1
 Probably can _____ -2
 Unsure _____ -3
 Probably can not _____ -4
 Definitely can not _____ -5

-69

2. Do you believe that you can currently obtain solar energy equipment that makes economic sense for home use?

Definitely can _____ -1
 Probably can _____ -2
 Unsure _____ -3
 Probably can not _____ -4
 Definitely can not _____ -5

-70

3. Do you believe that solar energy equipment will be widely used by homeowners in your area within the next five years?

Definitely will _____ -1
 Probably will _____ -2
 Unsure _____ -3
 Probably will not _____ -4
 Definitely will not _____ -5

-71

cc 80 = 3
 dup 1-4

4. Please indicate, by circling a number on the scale, how strongly you agree or disagree with each of the following statements:

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	
a. I understand the financial merits of solar energy systems.	1	2	3	4	5	-10
b. I understand how solar energy systems work.	1	2	3	4	5	-11
c. Solar energy systems can provide a lot of protection from future energy shortages.	1	2	3	4	5	-12

4. (continued)

	<u>Strongly</u> <u>agree</u>	<u>Agree</u>	<u>Neither</u> <u>agree nor</u> <u>disagree</u>	<u>Disagree</u>	<u>Strongly</u> <u>disagree</u>	
d. A solar water heating system would greatly increase the resale value of my home.	1	2	3	4	5	-13
e. If a solar energy system that I installed failed and needed major repairs or replacement, it could mean a financial disaster for my family.	1	2	3	4	5	-14
f. Solar collectors would be very unattractive on my house.	1	2	3	4	5	-15
g. It would be very easy to obtain financing for a solar energy system.	1	2	3	4	5	-16
h. If a solar energy system that I installed gave less savings than I had expected, it could mean a financial disaster for my family.	1	2	3	4	5	-17
i. Solar equipment would protect me from increasing energy costs.	1	2	3	4	5	-18
j. I would vote for zoning restrictions to ban solar collectors from the front of houses in my neighborhood.	1	2	3	4	5	-19
k. Manufacturers of solar systems are mostly little companies that are here today and will probably be gone tomorrow.	1	2	3	4	5	-20
l. Solar energy equipment will produce maintenance nightmares for me.	1	2	3	4	5	-21
m. I would admire a neighbor who installed solar equipment.	1	2	3	4	5	-22
n. A political candidate who supports solar is progressive.	1	2	3	4	5	-23
o. Technological advances will soon make currently available solar equipment outdated.	1	2	3	4	5	-24
p. A solar water heating system might save me money in the long run, but the initial cost is just too high for me to consider buying one.	1	2	3	4	5	-25
q. If more people were aware of the information shown in this questionnaire, more of them would buy solar energy systems.	1	2	3	4	5	-26

5. Please check the one space in each row that best indicates how interested you would be in more information about each of the items listed.

	<u>Not</u> <u>Interested</u>	<u>Slightly</u> <u>Interested</u>	<u>Moderately</u> <u>Interested</u>	<u>Very</u> <u>Interested</u>	
cost and savings	_____ -1	_____ -2	_____ -3	_____ -4	-27
how system works	_____ -1	_____ -2	_____ -3	_____ -4	-28
names of manufacturers	_____ -1	_____ -2	_____ -3	_____ -4	-29

6. Do you intend to look for additional information about solar energy systems within the next two or three months?

Yes _____ -1 No _____ -2 (If "NO", please -30
skip to 0.8)

7. About what kinds of solar energy systems will you look for information?

solar water heating	_____	-1	-31
solar-assisted heat pump	_____	-2	-32
solar home heating	_____	-3	-33
other (please specify)	_____	-4	-34

8. How likely are you to have a solar home or water heating system installed in your home within the next year? Within the next 5 years?

	within the next year	within the next 5 years
Very likely	_____ -1	_____ -1
Somewhat likely	_____ -2	_____ -2
Unsure	_____ -3	_____ -3
Somewhat unlikely	_____ -4	_____ -4
Very unlikely	_____ -5	_____ -5
	-35	-36

9. Which of the following categories best describes your family's composition? (PLEASE CHECK ONLY ONE SPACE)

No (zero) children living at home	_____	-1
Children living at home {	youngest under age 6	_____ -2
	youngest age 6 - 12	_____ -3
	youngest age 13 or over	_____ -4

-37

10. Approximately how much does a gallon of unleaded, regular gasoline cost in your area?

\$1.10 or less	_____ -1	\$1.25	_____ -4
\$1.15	_____ -2	\$1.30	_____ -5
\$1.20	_____ -3	\$1.35 or more	_____ -6

-38

11. How much do you think a gallon of unleaded, regular gasoline will cost five years from now (in 1985)?

\$ _____

39-44

12. Which of the following products have you bought for your own or your family's use?

microwave oven	-1 _____ -45	waterbed	-1 _____ -50
shower massage	-1 _____ -46	quartz room heater	-1 _____ -51
home table-top computer	-1 _____ -47	water pik	-1 _____ -52
videotape player/recorder	-1 _____ -48	digital watch	-1 _____ -53
food processor	-1 _____ -49	whirlpool bath, spa or hot tub	-1 _____ -54
		none of the above	-1 _____ -55

Thank you very much for your help! Please place your completed questionnaire in the postage paid return envelope and mail it back to us at your earliest convenience.

If you would be interested in the results of this study, just write your name and address in the space below and we will be happy to send them to you when they are available.

Name _____

Street _____

City _____ State _____ Zip _____

out date 56-58

return date 59-61

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FINAL VERSION

NEW HOMES MAIN

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To begin with, are you now living in your new home, are you looking for a new home or building one? ID 1-4 Loc 6-7

- Now living in new home 1 (Please answer the rest of this questionnaire in terms of this home.)
- Now looking 2 (Please answer the rest of this questionnaire in terms of the house you would like to buy.)
- Now building 3 (Please answer the rest of the questionnaire in terms of the house you are building.) -8

Questions About Solar Water Heating Systems

1. Please place a check next to the primary fuel that you use or expect to use for heating water (for baths, showers, dishwashing, etc.) in your home. Check only one:

natural gas 1 oil 3
 electricity 2 other 4
 (please specify) 5 -9

2. Using the fuel indicated in Question 1, approximately how much did you spend for water heating last year? If you do not know approximately, please guess. How much do you expect to pay for water heating next year? How much do you think you will have to pay five years from now (in 1985)?

last year \$ 10-15 next year \$ 16-21 in 1985 \$ 22-27
 (answer only if you (guess) (guess)
 are now living in
 the new home)

3. The average cost, including installation, of a solar water heating system, as described here, would be about \$2300. This figure is for an average family of four with average hot water needs. Your family's needs may be more or less than the average, so you might need a larger or smaller system. Taking into consideration your family's hot water needs and what you know about both solar energy system prices and government incentives, by how much would you expect the cost of your new home to increase if it were to be equipped with a solar water heater? Circle the letter over the column that is closest to this figure.
- cc 28 is:
 1 if A circle
 2 B
 3 C
 4 D
 5 E
- cc 29-34 is
 actual price
 circled.

	A	B	C	D	E
Gross Cost	\$1600	\$1900	\$2300	\$2600	\$2900
(Minus) Tax Rebate	<u>880</u>	<u>1045</u>	<u>1265</u>	<u>1430</u>	<u>1595</u>
Actual Cost	\$ 720	\$ 855	\$1035	\$1170	\$1305

4. If your new home had a solar water heating system, how much less do you think you would spend on hot water next year than you would spend using another system?

under \$50 1 \$201 - 250 5
 \$ 51 - 100 2 \$251 - 300 6
 \$101 - 150 3 \$301 - 350 7
 \$151 - 200 4 over \$350 8

-35

Please copy your "Actual Cost" from Question 3 on previous page here: (This is your BASE COST)

\$ _____ BASE COST
36-41

Please copy your savings estimate from Question 4 on previous page here: (This is your BASE SAVINGS)

\$ _____ BASE SAVINGS
42-47

5a. Please look at your BASE COST and BASE SAVINGS, above. Thinking about your base figures, how likely are you to try to get a solar water heating system installed in your new home?

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____
48-49

5b. The description of a solar water heater says that a system usually comes with a 5-year warranty. Suppose now that the warranty is increased to cover the system for 15 years (with the same BASE COST and SAVINGS). How likely would you be to try to get a system installed in your new home, if you could get this longer warranty? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____
50-51

5c. Prices for solar water heating systems may go down. Keeping your BASE SAVINGS (from above) in mind, suppose you could have a system installed in your new home for 25% less than your BASE COST. (The new price of the system would then be 3/4 of your BASE COST.) How likely would you be to try to get a system installed? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____
52-53

5d. Again using your BASE SAVINGS from above, suppose that you could have a system installed in your new home for half of your BASE COST. How likely would you be to try to get a system installed? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____
54-55

5e. Fuel prices may rise faster than we now expect. Go back to your BASE COST from above, but now suppose that your savings are 50% more than your estimated BASE SAVINGS. How likely would you be to try to get a system installed in your new home, if you could get these increased savings? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____
56-57

Questions About Solar Space and Water Heating Systems

1. What fuel, if any, do you use or plan to use to heat the living space in your home? (If more than one, please check the one that is your primary source of energy.)

electricity	_____	-1	other (please specify)	_____	-5
natural gas	_____	-2			
oil	_____	-3			
wood	_____	-4	none	_____	-6 -58

2. Using the fuel indicated in Question 1, approximately how much did you spend for heating your home last year? If you do not know approximately, please guess. How much do you expect to pay for heating your home next year? How much do you think you will have to pay five years from now (in 1985)?

last year \$ 59-64 next year \$ 65-70 in 1985 \$ 71-76 cc 80=1
 (answer only if you (guess) (guess) dup 1-4.
 are now living in
 the new home)

3. The average cost, including installation, of a solar space and water heating system, as described here, would be about \$6200. This figure is for an average family of four with average heat and hot water needs. Your family's needs may be more or less than the average, so you might need a larger or smaller system. Taking into consideration your family's needs and what you know about both solar energy system prices and government incentives, by how much would you expect the cost of your new home to increase if it were to be equipped with a solar space and water heating system? Circle the letter over the column that is closest to this figure.

cc 5 is:
 1 if A circle B
 2 B
 3 C
 4 D
 5 E
 cc 6-11 is
 actual price
 circled

	A	B	C	D	E
Gross Cost	\$4500	\$5300	\$6200	\$7200	\$9200
(Minus) Tax Rebate	<u>2475</u>	<u>2915</u>	<u>3000</u>	<u>3000</u>	<u>3000</u>
Actual Cost	\$2025	\$2385	\$3200	\$4200	\$6200

4. If your new home had a solar space and water heating system, how much less do you think you would spend on heating your home next year than you would spend using another system?

under \$100	_____	-1	\$400 - 500	_____	-5
\$100 - 200	_____	-2	\$500 - 750	_____	-6
\$200 - 300	_____	-3	\$750 - 1000	_____	-7
\$300 - 400	_____	-4	over \$1000	_____	-8

-12

Please copy your Actual Cost from Question 3 on previous page here: (This is your BASE COST)

13-18

Please copy your savings estimate from Question 4 on previous page here: (This is your BASE SAVINGS)

\$ _____ BASE SAVING
19-24

- 5a Please look at your BASE COST and BASE SAVINGS, above. Thinking about your base figures, how likely are you to try to get a solar space and water heating system installed in your new home? Please place a check in the appropriate space.

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

25-26

- 5b The description of a solar space and water heating system says that a system usually comes with a 5-year warranty. Suppose now that the warranty is increased to cover the system for 15 years (with the same BASE COST and SAVINGS). How likely would you be to try to get a system installed in your new home, if you could get this longer warranty? Please place a check in the appropriate space.

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

27-28

- 5c Prices for solar space and water heating systems may go down. Keeping your BASE SAVINGS (from above) in mind, suppose you could have a system installed in your new home for 25% less than your BASE COST. (The new price of the system would then be 3/4 of your BASE COST.) How likely would you be to try to get a system installed? Again, please check the appropriate space.

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

29-30

- 5d Again using your BASE SAVINGS from above, suppose that you could have a system installed in your new home for half of your BASE COST. How likely would you be to try to get a system installed? Please check the appropriate space.

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

31-32

- 5e Fuel prices may rise faster than we now expect. Go back to your BASE COST from above, but now suppose that your savings are 50% more than your estimated BASE SAVINGS. How likely would you be to try to get a system installed in your new home, if you could get these increased savings? Please check the appropriate space.

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

33-34

General Questions

Please answer the following questions concerning the use of solar energy equipment in general.

1. Do you believe that you can currently obtain reliable and dependable solar energy equipment for home use?

Definitely can	-1	
Probably can	-2	
Unsure	-3	
Probably can not	-4	
Definitely can not	-5	-35

2. Do you believe that you can currently obtain solar energy equipment that makes economic sense for home use?

Definitely can	-1	
Probably can	-2	
Unsure	-3	
Probably can not	-4	
Definitely can not	-5	-36

3. Do you believe that solar energy equipment will be widely used by homeowners in your area within the next five years?

Definitely will	-1	
Probably will	-2	
Unsure	-3	
Probably will not	-4	
Definitely will not	-5	

4. Please indicate, by circling a number on the scale, how strongly you agree or disagree with each of the following statements:

	<u>Strongly</u> <u>agree</u>	<u>Agree</u>	<u>Neither</u> <u>agree nor</u> <u>disagree</u>	<u>Disagree</u>	<u>Strongly</u> <u>disagree</u>	
a. I understand the financial merits of solar energy systems.	1	2	3	4	5	-38
b. I understand how solar energy systems work.	1	2	3	4	5	-39
c. Solar energy systems can provide a lot of protection from future energy shortages.	1	2	3	4	5	-40

4. (continued)

	<u>Strongly agree</u>	<u>Agree</u>	<u>Neither agree nor disagree</u>	<u>Disagree</u>	<u>Strongly disagree</u>	
d. A solar water heating system would greatly increase the resale value of my home.	1	2	3	4	5	-41
e. If a solar energy system that I installed failed and needed major repairs or replacement, it could mean a financial disaster for my family.	1	2	3	4	5	-42
f. Solar collectors would be very unattractive on my house.	1	2	3	4	5	-43
g. It would be very easy to obtain financing for a solar energy system.	1	2	3	4	5	-44
h. If a solar energy system that I installed gave less savings than I had expected, it could mean a financial disaster for my family.	1	2	3	4	5	-45
i. Solar equipment would protect me from increasing energy costs.	1	2	3	4	5	-46
j. I would vote for zoning restrictions to ban solar collectors from the front of houses in my neighborhood.	1	2	3	4	5	-47
k. Manufacturers of solar systems are mostly little companies that are here today and will probably be gone tomorrow.	1	2	3	4	5	-48
l. Solar energy equipment will produce maintenance nightmares for me.	1	2	3	4	5	-49
m. I would admire a neighbor who installed solar equipment.	1	2	3	4	5	-50
n. A political candidate who supports solar is progressive.	1	2	3	4	5	-51
o. Technological advances will soon make currently available solar equipment outdated.	1	2	3	4	5	-52
p. A solar water heating system might save me money in the long run, but the initial cost is just too high for me to consider buying one.	1	2	3	4	5	-53
q. If more people were aware of the information shown in this questionnaire, more of them would buy solar energy systems.	1	2	3	4	5	-54

5. Please check the one space in each row that best indicates how interested you would be in more information about each of the items listed.

	<u>Not</u> <u>Interested</u>	<u>Slightly</u> <u>Interested</u>	<u>Moderately</u> <u>Interested</u>	<u>Very</u> <u>Interested</u>	
cost and savings	____-1	____-2	____-3	____-4	-55
how system works	____-1	____-2	____-3	____-4	-56
names of manufacturers	____-1	____-2	____-3	____-4	-57

6. Do you intend to look for additional information about solar energy systems within the next two or three months?

Yes _____-1 No _____-2 (If "NO". please skip to 0.8) -58

7. About what kinds of solar energy systems will you look for information?

solar water heating	____-1	-59
solar-assisted heat pump	____-1	-60
solar home heating	____-1	-61
other (please specify)	____-1	-62

8. How likely are you to have a solar home or water heating system installed in your home within the next year? Within the next 5 years?

	<u>within</u> <u>the next year</u>	<u>within</u> <u>the next 5 years</u>
Very likely	____-1	____-1
Somewhat likely	____-2	____-2
Unsure	____-3	____-3
Somewhat unlikely	____-4	____-4
Very unlikely	____-5	____-5
	63	64

9. Which of the following categories best describes your family's composition? (PLEASE CHECK ONLY ONE SPACE)

No (zero) children living at home	____-1	
Children living at home {	youngest under age 6	____-2
	youngest age 6 - 12	____-3
	youngest age 13 or over	____-4

-65

10. Approximately how much does a gallon of unleaded, regular gasoline cost in your area?

\$1.10 or less	_____ -1	\$1.25	_____ -4	
\$1.15	_____ -2	\$1.30	_____ -5	
\$1.20	_____ -3	\$1.35 or more	_____ -6	-61

11. How much do you think a gallon of unleaded, regular gasoline will cost five years from now (in 1985)?

\$ _____

67-71

cc 80=2

dup 1-4

12. Which of the following products have you bought for your own or your family's use?

microwave oven	_____ -1	_____ -5	waterbed	_____ -1	_____ -10
shower massage	_____ -1	_____ -6	quartz room heater	_____ -1	_____ -11
home table-top computer	_____ -1	_____ -7	water pik	_____ -1	_____ -12
videotape player/recorder	_____ -1	_____ -8	digital watch	_____ -1	_____ -13
food processor	_____ -1	_____ -9	whirlpool bath, spa or hot tub	_____ -1	_____ -14
			none of the above	_____ -1	_____ -15

13. If you were to purchase a solar water heating system, how would you be most likely to pay for it? How would you be most likely to pay for a solar space and water heating system?

Solar Water Heating System

Personal savings	_____ -1
Included in mortgage	_____ -2
Separate bank loan	_____ -3
Other (please specify)	_____ -4
	_____ -16

Solar Space and Water Heating System

Personal savings	_____ -1
Included in mortgage	_____ -2
Separate bank loan	_____ -3
Other (please specify)	_____ -4
	_____ -17

14. If you are now building, or planning to build, your new home, who is or will be the general contractors?

Self	_____ -1	Builder	_____ -2	Other	_____ -3	-18
------	----------	---------	----------	-------	----------	-----

Who is or will be constructing your new home?

Self	_____ -1	Builder/ Building Contractors	_____ -2	Other	_____ -3	-19
------	----------	-------------------------------------	----------	-------	----------	-----

out date = 20-22
return date = 23-25

Thank you very much for your help! Please place your completed questionnaire in the postage paid return envelope and mail it back to us at your earliest convenience.

If you would be interested in the results of this study, just write your name and address in the space below and we will be happy to send them to you when they are available.

Name _____

Street _____

City _____ State _____ ZIP _____

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DOCUMENTATION FOR
RESIDENTIAL SUPPLEMENTARY FILE
(DOE DATABASE TAPE FILE 8)

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OVERVIEW

The solar database includes eight datasets containing information concerning potential residential purchasers. Six of these datasets contain responses to telephone interviews or mail surveys. These datasets are:

- Preliminary Residential Screeners -- telephone interviews conducted as a preliminary investigation and a test of questionnaire design
- Preliminary Residential Mains -- mailed interviews conducted as a preliminary investigation and a test of questionnaire design
- Final Residential Screeners - Existing-homes -- telephone interviews conducted after questionnaires were modified in light of the results from the preliminary interviews: survey of retrofit market
- Final Residential Mains - Existing-homes -- retrofit market
- Final Residential Screeners - New-homes
- Final Residential Mains - New-homes

In addition to these six files, there are two files containing other information regarding the questionnaires; neither of these two files contains actual responses:

- Residential Supplementary File -- This file contains the information regarding solar space and water heating systems that was viewed by respondents in the mailed questionnaire. This information was not keypunched in the files above, which contain only responses.
- Residential Miscellaneous File -- contains various data concerning preliminary residential datasets.

This document is a description of the contents of the Residential Supplementary File, DOE Database File 8.

Recipients of either preliminary or final main questionnaires saw exactly one of six different presentations:

1. Short Deterministic
2. Short Undeterministic
3. Long Deterministic
4. New Homes (Short Deterministic)
5. New England Special (Short Undeterministic)
6. Concentrating Collector (Special California and Florida)

These presentations vary in the amount of data (short versus long); in the type of system considered (all but the New-homes deal only with water heating systems; the New-homes deals with both water heating systems and space and water heating combination systems); and whether or not different inflation projections are considered (deterministic presentations give results for expected rates on inflation only; undeterministic presentations include results for other possible inflation projections).

Further, though the format of presentation (with the exception of the Special New England and Concentrating Collector presentations) did not vary according to the geographic location of the respondent, the actual numbers (purchase price, state tax credits, savings) did vary according to location. In all, 52 regions were defined: 44 of the regions correspond to a unique state; the remaining eight regions correspond to half of one of the following four states: Illinois, New York, Oregon and Washington.

The Residential Supplementary File contains all information for all presentations for all regions with the exception of information that did not vary by region. The file is organized as an array, 129 entries by 58 regions. (These 58 regions include the 52 regions mentioned below plus six special New England regions.) The 129 entries for each region contain all the information used in any of the presentations shown in that region.

The file consists of 522 records, each of length 120 characters. Conceptually, it is 58 groups of 129 numbers. Each of the 58 groups is nine records long: the first record of each group contains regional information and the remaining eight records contain the 129 numbers.

The 129 numbers comprise all the information that varies by region on any of the various presentations. Each number is written in a F7.1 format: seven records are 17F7.1; the last is 10F7.1.

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APPENDIX I

QUESTIONNAIRE PRESENTATIONS

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SHORT DETERMINISTIC

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SOLAR DOMESTIC WATER HEATING SYSTEM FOR CALIFORNIA HOMES

A typical solar domestic water heating system is composed of a collector, a hot water storage tank, and the piping that connects them. The radiation of the sun heats the water as it passes through the collector. From the collector the warm water flows directly into a storage tank. The tank would be in the basement, or underground; it would be a standard size (about 80-90 gallons), of a type readily available. Controls keep the water circulating through the collector as long as the sun raises the temperature of the water. In general, this means that as long as the sun is out, the water will continue to circulate. At night, or when the weather is cold or cloudy, the water remains in the tank.

A solar system cannot, by itself, provide enough energy to meet all the hot water needs of an average family of four. In California, system manufacturers and dealers say that the system will supply between 60 and 80 percent of those needs. Any additional water heating that is ^{WNEEDLB} required is provided automatically by a conventional backup system using oil, gas, or electricity.

Most families would need three solar collectors to trap the sun's ^{WNCOLLECT} heat. These collectors are a little bigger than an average door. They are made of a piece of metal painted black, covered with glass and mounted in a wooden or metal frame. Collectors may be mounted on your roof if you have a roof that faces south, or installed in your yard.

A solar domestic water heating system comes with a 5-year manufacturer's warranty. The system has an expected life of 15 years, which is comparable to the expected life of the roof of your home.

A diagram of a typical system is on the next page.

A TYPICAL SOLAR DOMESTIC WATER HEATING SYSTEM

PRICE: The ~~gross~~ price of a solar water heating system would be about \$2300 for a family of four with average hot water needs. These numbers include materials and installation. However, both the federal government and the state of California offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be lower than the gross price.

	Gross Price	\$2300	WGR3
(minus)	<u>Tax Rebate</u>	<u>1265</u>	WRE3
	Actual Price	\$1035	WAC3

SAVINGS: The solar water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see below). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. The most likely projections would have the rates of increase over the next years be about the same as over the last 10 years, as shown in the accompanying table. Under this assumption, the number of years it will take for total savings to add up to more than the original cost of the system (payback) has been calculated and is also shown in the table.

Solar Water Heating Savings by Fuel Currently Used

	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
<u>Rate of Fuel Price Increase</u>			
Past 10 years	15%	10%	12% <i>fixed</i>
Projected	15%	10%	12%
<u>Estimated Savings</u>			
First year	\$131 WY1SV0	\$202 WY1SVE	\$ 28 WY1SVG
Fifth year	\$240 WY5SVO	\$300 WY5SVE	\$ 51 WY5SVG
<u>Years to Payback</u>			
	5 1/2 WPAYVO	4 1/4 WPAYVE	13 1/4 WPAYVG

The figures shown take into account:

- 1) energy used to run the solar water heater's pumps, and
- 2) annual maintenance and upkeep expenses, estimated at \$25/year.

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SOLAR DOMESTIC WATER HEATING SYSTEM FOR
CALIFORNIA HOMES

A typical solar domestic water heating system is composed of a collector, a hot water storage tank, and the piping that connects them. The radiation of the sun heats the water as it passes through the collector. From the collector the warm water flows directly into a storage tank. The tank would be in the basement, or underground; it would be a standard size (about 80-90 gallons), of a type readily available. Controls keep the water circulating through the collector as long as the sun raises the temperature of the water. In general, this means that as long as the sun is out, the water will continue to circulate. At night, or when the weather is cold or cloudy, the water remains in the tank.

A solar system cannot, by itself, provide enough energy to meet all the hot water needs of an average family of four. In California, system manufacturers and dealers say that the system will supply between 60 and 80 percent of those needs. Any additional water heating that is ^{WNEEDLB} required is provided automatically by a conventional backup system using ^{WNEEDUP} oil, gas, or electricity.

Most families would need three solar collectors to trap the sun's ^{WNCOLLECT} heat. These collectors are a little bigger than an average door. They are made of a piece of metal painted black, covered with glass and mounted in a wooden or metal frame. Collectors may be mounted on your roof if you have a roof that faces south, or installed in your yard.

A solar domestic water heating system comes with a 5-year manufacturer's warranty. The system has an expected life of 15 years, which is comparable to the expected life of the roof of your home.

A diagram of a typical system is on the next page.

A TYPICAL SOLAR DOMESTIC WATER HEATING SYSTEM

Financial Information

PRICE: The gross price of a solar domestic water heating system would be between \$1600 and \$2900, or about \$2300 for a family of four with average hot water needs. These numbers include materials and installation. However, both the federal government and the state of California offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be much lower than the gross price. For an average system the figures would be:

	<u>Low Estimate</u>	<u>Average Estimate</u>	<u>High Estimate</u>
Gross Price	\$1600 <i>WGR1</i>	\$2300 <i>WGR3</i>	\$2900 <i>WGR5</i>
(minus) <u>Tax Rebate</u>	<u>880</u> <i>WRE1</i>	<u>1265</u> <i>WRE3</i>	<u>1595</u> <i>WRE5</i>
Actual Price	\$ 720 <i>WAC1</i>	\$1035 <i>WAC3</i>	\$1305 <i>WAC5</i>

SAVINGS: The solar domestic water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see table). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. The "most likely" projections would have the rate of increase over the next years be about the same over the last 10 years, as shown in the accompanying tables. However, forecasting future energy costs is no easy business. Energy costs could increase at a lower or higher rate than in the past. As a result, the tables show savings calculated using low and high rate increase assumptions as well as the most likely assumption. Under each assumption, the number of years it will take for your total savings to add up to more than the original cost of the system (pay-back) has been calculated, and is also shown in the tables.

California

Solar Water Heating Savings by Fuel Currently Used*

<u>Oil</u>				
	<u>Low</u>	<u>Most likely</u>	<u>High</u>	
<u>Rate of fuel price increase</u>				
Past 10 years - 15%				
Projected	10%	15%	20%	<i>inflation rates fixed</i>
<u>Estimated savings(\$)</u>				
First year	131	131 WY1SV0	131	
Fifth year	196 WOLS5	240 WY5SV0	291 WOHS5	
<u>Years to payback</u>	6 WOLP	5 1/2 WPAYVO	5 WOHP	
<u>Electricity</u>				
	<u>Low</u>	<u>Most likely</u>	<u>High</u>	
<u>Rate of fuel price increase</u>				
Past 10 years - 10%				
Projected	7%	10%	15%	
<u>Estimated savings(\$)</u>				
First year	202	202 WY1SVE	202	
Fifth year	265 WELS5	300 WY5SVE	364 WEHS5	
<u>Years to payback</u>	5 WELP	4 1/4 WTAYVE	4 WEHP	
<u>Gas</u>				
	<u>Low</u>	<u>Most likely</u>	<u>High</u>	
<u>Rate of fuel price increase</u>				
Past 10 years - 12%				
Projected	8%	12%	17%	
<u>Estimated savings(\$)</u>				
First year	28	28 WY1SVG	28	
Fifth year	39 WGLS5	51 WY5SVG	67 WGH55	
<u>Years to payback</u>	17 1/4 WGLP	13 1/4	11 WGHF	

*The figures shown take into account

- 1) energy used to run the solar water heater's pumps, and
- 2) annual maintenance and upkeep expenses.

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SOLAR DOMESTIC WATER HEATING SYSTEM FOR
CALIFORNIA HOMES

A typical solar domestic water heating system is composed of a collector, a hot water storage tank, and the piping that connects them. The radiation of the sun heats the water as it passes through the collector. From the collector the warm water flows directly into a storage tank. The tank would be in the basement, or underground; it would be a standard size (about 80-90 gallons), of a type readily available. Controls keep the water circulating through the collector as long as the sun raises the temperature of the water. In general, this means that as long as the sun is out, the water will continue to circulate. At night, or when the weather is cold or cloudy, the water remains in the tank.

A solar system cannot, by itself, provide enough energy to meet all the hot water needs of an average family of four. In California, system manufacturers and dealers say that the system will supply between 60 and ^{WNEEDLB} 80 percent of those needs. Any additional water heating that is ^{WNEEDUP} required is provided automatically by a conventional backup system using oil, gas, or electricity.

Most families would need three solar collectors to trap the sun's ^{WNCOLLECT} heat. These collectors are a little bigger than an average door. They are made of a piece of metal painted black, covered with glass and mounted in a wooden or metal frame. Collectors may be mounted on your roof if you have a roof that faces south, or installed in your yard.

A solar domestic water heating system comes with a 5-year manufacturer's warranty. The system has an expected life of 15 years, which is comparable to the expected life of the roof of your home.

A diagram of a typical system is on the next page.

A TYPICAL SOLAR DOMESTIC WATER HEATING SYSTEM

Financial Information

PRICE: The gross price of a solar domestic water heating system would be about \$2300 for a family of four with average hot water needs. These numbers include materials and installation. However, both the federal government and the state of California offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be much lower than the gross price.

	Gross Price	\$2300 WCR3
(minus)	<u>Tax Rebate</u>	<u>1265*</u> WCE3
	Actual Price	\$1035 WAC3

SAVINGS: The solar domestic water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see Appendix 1). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. (See graph shown in Appendix 2.) The most likely scenario would have the rate of increase over the next years be about the same as over the last 10 years, that is, 12%. Under this assumption, the number of years it will take for your total savings to add up to more than the original cost of the system (payback) has been calculated and is shown in Appendix 1.

* see Appendix 3 for calculation of Tax Credit

PAYING FOR A SYSTEM: You could pay for a solar system in cash -- in that case you would forego the interest that you could earn on the \$1035 that you use to purchase the solar system. Instead of buying a solar system, you could put the money in a 10% savings account, but of course you would have to pay income tax on the interest earnings -- how much tax would depend on your tax bracket.

You could also borrow money to pay for the system -- several banks are now giving "energy improvement" loans for 12 - 13 1/2 percent interest. If you were to borrow \$1035 for 10 years at, say, 13%, the payments would add up to \$185^{WAC3} per year. In this situation, of course, the interest portion of your^{WLOANP} loan payment would be deductible for federal tax purposes, so your real annual expense would be less -- how much less would depend on your tax bracket.

Appendix 1 presents a comparison of interest earnings, loan payments, and most likely savings from a solar domestic water heater.

INCENTIVES AND REBATES: Both the federal government and the state of California have tax rebates that you can take advantage of if you buy a solar domestic water heating system. See Appendix 3 for further information on federal and state tax rebates.

Appendix 1

California

**Comparisons of Solar Domestic Water Heater Savings
with Interest Earnings and Loan Payments**

<u>Year</u>	<u>Savings</u>			Annual Interest Earnings(1)	Annual L Payment(2)
	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>		
1	\$ 131 WY1SVO	\$ 202 WY1SVE	\$ 28 WY1SVG	\$ 104 WINTERN1	\$ 185 WLOANP
2	153 2	223 2	33 2	114 2	185
3	178 3	246 3	38 3	125 3	185
4	207 4	272 4	44 4	138 4	185
5	240 WY5SVO	300 WY5SVE	51 WY5SVG	132 5	185
6	279 6	331 6	58 6	167 6	185
7	323 7	365 7	67 7	183 7	185
8	375 8	402 8	77 8	202 8	185
9	434 9	442 8	88 9	222 9	185
10	503 10	489 9	101 10	244 WINTERN10	185
11	582 11	540 10	115 11		
12	673 12	595 11	132 12		
13	778 13	656 12	150 13		
14	900 14	723 13	171 14		
15	1035 WY15SVO	798 WY15SVE	195 WY15SVG		
Totals:	\$ 6794 WTSVO	\$ 6584 WTSVE	\$ 1348 WTSVG	\$ 1650 WINTERN	\$ 1850
Years to Payback	5 1/2 WPAYVO	4 1/4 WPAYVE	13 1/4 WPAYVG		

The figures shown take into account: a) energy used to run the solar water heater's pumps, and
b) annual maintenance and upkeep expenses estimated at \$25/year.

- (1) assumes \$ 1035, plus all accumulated interest, left in a 10% account for 10 years. (You would have to pay income tax on these earnings, so your actual interest income would be lower than these numbers indicate; how much lower would depend on your income tax bracket.)
- (2) assumes \$ 1035 loan for 10 years at 13%. (You would get to deduct the interest portion of these payments from your income before figuring your taxes, so your out-of-pocket expense would actually be lower than these numbers suggest; how much lower would depend on your income tax bracket.)

Appendix 2

Individual Fuel Cost Rates of Increase*

	<u>Overall</u>	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
Past 10 years	12%	15%	10%	12%
Projected	12%	15%	10%	12%

Energy Price Index for 12 years*

* Data from Consumer Price Index, U.S. Department of Labor

Appendix 3

Federal and State Income Tax Rebates

Federal Income Tax Rebate

30% of the first \$2,000 of gross price (including installation)

20% of the amount over \$2,000

Total rebate not to exceed \$2,200

California State Income Tax Rebate

55% of system price, retail plus installation, up to a maximum rebate of \$3,000, minus the federal rebate

Thus, on a \$2,300 system, rebates are calculated as:

Federal

30% of \$2,000 = \$ 600

20% of \$ 300 = 60

Total Rebate = \$ 660

California

55% of \$2,300 = \$1,265

minus federal rebate= 660

\$ 605

Total

Federal = \$ 660

California = 605

\$1,265

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SOLAR DOMESTIC WATER HEATING SYSTEM FOR
CALIFORNIA HOMES

A typical solar domestic water heating system is composed of a collector, a hot water storage tank, and the piping that connects them. The radiation of the sun heats the water as it passes through the collector. From the collector the warm water flows directly into a storage tank. The tank would be in the basement, or underground; it would be a standard size (about 80-90 gallons), of a type readily available. Controls keep the water circulating through the collector as long as the sun raises the temperature of the water. In general, this means that as long as the sun is out, the water will continue to circulate. At night, or when the weather is cold or cloudy, the water remains in the tank.

A solar system cannot, by itself, provide enough energy to meet all the hot water needs of an average family of four. In California, system manufacturers and dealers say that the system will supply between 60 and 80 percent of those needs. Any additional water heating that is ^{WNEEDLB} required is provided automatically by a conventional backup system using ^{WNEEDUP} oil, gas, or electricity.

Most families would need three solar collectors to trap the sun's ^{WNCOLLECT} heat. These collectors are a little bigger than an average door. They are made of a piece of metal painted black, covered with glass and mounted in a wooden or metal frame. Collectors may be mounted on your roof if you have a roof that faces south, or installed in your yard.

A solar domestic water heating system comes with a 5-year manufacturer's warranty. The system has an expected life of 15 years, which is comparable to the expected life of the roof of your home.

A diagram of a typical system is on the next page.

Financial Information

PRICE: The gross cost of a solar water heating system would be about \$2300 for a family of four with average hot water needs. These numbers include materials and installation. However, both the federal government and the state of California offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you (or increase in the cost of your home) would thus be lower than the gross price.

	Gross Cost	\$2300 WGR3
(minus)	<u>Tax Rebate</u>	<u>1265 WRE3</u>
	Actual Cost	\$1035 WAC3

PAYING FOR A SYSTEM: You could pay for a system with cash. Alternatively you could finance the system through your mortgage. The following figures are typical of payments if the system is included in a home mortgage: (25 years, current interest rates)

Additional down payment at time of purchase:	\$ 210 WDOWNP
Increase in <u>monthly</u> mortgage payment:	\$ 10 W10RT

SAVINGS: The solar water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating the home with solar energy varies depending on the alternative fuel that is used (see below). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. The most likely projections would have the rates of increase over the next years be about the same as over the last 10 years, as shown in the accompanying table. Under this assumption, the number of years it will take for total savings to add up to more than the original cost of the system (payback) has been calculated and is also shown in the table.

Solar Water Heating Savings by Alternative Fuels

<u>Rate of Fuel Price Increase</u>	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
Past 10 years	15%	10%	12%
Projected	15%	10%	12%
<u>Estimated Savings</u>			
First year	\$131 WY1SVO	\$202 WY1SVE	\$ 28 WY1SVG
Fifth year	\$240 WY5SVO	\$300 WY5SVE	\$ 51 WY5SVG
<u>Years to Payback</u>	5 1/2 WPA1VO	4 1/4 WPA1VE	13 1/4 WPA1VG

The figures shown take into account:

- 1) energy used to run the solar water heater's pumps, and
- 2) annual maintenance and upkeep expenses, estimated at \$25/year.

SOLAR HOME AND WATER HEATING SYSTEM FOR CALIFORNIA HOMES

A typical residential solar home heating system is composed of a collector, a storage tank and the piping that connects them. The radiation of the sun heats water (or, in some systems, air) as it passes through the collector. The heat is then distributed through the house through its normal set of air ducts, radiators or baseboard units. If the heat is not needed immediately, it is placed in a storage system. Controls keep the circulation going as long as the sun is providing additional heat to either the house or to the storage system. At night, or when the weather is cold or cloudy, the collector circulation shuts down and the distribution system works to draw heat from storage, and to distribute that heat to the living space in the house.

Part of the system would also provide hot water for domestic use.

A solar energy system cannot, by itself, provide enough energy to meet all the heating and hot water needs of most families. In California, a typical system will supply between 70 and 90 percent of those needs. Any additional heat that is required is provided automatically by a conventional back-up system, using gas, electricity or oil.

Most families in this area would need 10 collectors to trap the sun's heat. These collectors are a little bigger than an average door. They are made of a piece of metal panel, covered with glass and mounted in a wooden or metal frame. Collectors are usually mounted on the roof of your home, although they can also be installed in your yard. The storage system consists of a large water tank (about 1000-2000 gallons of water) or a bin of small rocks or pebbles. Storage systems are usually installed in the basement or buried immediately outside if no basement or crawl space is available.

A solar home and water heating system comes with a 5-year manufacturer's warranty. The collectors have an expected life of 15 years, which is comparable to the expected life of your roof.

A diagram of a typical system is shown on the next page.

A TYPICAL SOLAR HOME AND WATER HEATING SYSTEM

Financial Information

PRICE: The gross cost of a solar space and water heating system would be about \$6200 for a family of four with average heat and hot water needs. These numbers include materials and installation. However, both the federal government and the state of California offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you (or increase in the cost of your home) would thus be lower than the gross price.

	Gross Cost	\$6200
(minus)	<u>Tax Rebate</u>	<u>3000</u>
	Actual Cost	\$3200

PAYING FOR A SYSTEM: You could pay for a system with cash. Alternatively you could finance the system through your mortgage. The following figures are typical of payments if the system is included in a home mortgage: (25 years, current interest rates)

Additional down payment at time of purchase: \$ 640 *SDOWNP*
Increase in monthly mortgage payment: \$ 32 *SMORT*

SAVINGS: The solar space and water heating system will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating the home with solar energy varies depending on the alternative fuel that is used (see below). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. The most likely projections would have the rates of increase over the next years be about the same as over the last 10 years, as shown in the accompanying table. Under this assumption, the number of years it will take for total savings to add up to more than the original cost of the system (payback) has been calculated and is also shown in the table.

Solar Space and Water Heating Savings by Alternative Fuels

<u>Rate of Fuel Price Increase</u>	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
Past 10 years	15%	10%	12%
Projected	15%	10%	12%
<u>Estimated Savings</u>			
First year	\$280	\$469	\$ 84
Fifth year	\$512	\$694	\$145
<u>Years to Payback</u>	7	5 1/2	14

The figures shown take into account:

- 1) energy used to run the system's pumps, and
- 2) annual maintenance and upkeep expenses, estimated at \$50/year.

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SOLAR DOMESTIC WATER HEATING SYSTEM FOR
MASSACHUSETTS HOMES

A typical solar domestic water heating system is composed of a collector, a hot water storage tank, and the piping that connects them. The radiation of the sun heats the water as it passes through the collector. From the collector the warm water flows directly into a storage tank. The tank would be in the basement, or underground; it would be a standard size (about 80-90 gallons), of a type readily available. Controls keep the water circulating through the collector as long as the sun raises the temperature of the water. In general, this means that as long as the sun is out, the water will continue to circulate. At night, or when the weather is cold or cloudy, the water remains in the tank.

A solar system cannot, by itself, provide enough energy to meet all the hot water needs of an average family of four. In Massachusetts, system manufacturers and dealers say that the system will supply between 45 and 65 percent of those needs. Any additional water heating that is required is provided automatically by a conventional backup system using oil, gas, or electricity.

Most families would need four solar collectors to trap the sun's heat. These collectors are a little bigger than an average door. They are made of a piece of metal painted black, covered with glass and mounted in a wooden or metal frame. Collectors may be mounted on your roof if you have a roof that faces south, or installed in your yard.

A solar domestic water heating system comes with a 5-year manufacturer's warranty. The system has an expected life of 15 years, which is comparable to the expected life of the roof of your home.

A diagram of a typical system is on the next page.

A TYPICAL SOLAR DOMESTIC WATER HEATING SYSTEM

Financial Information

PRICE: The gross price of a solar domestic water heating system would be between \$2600 and \$4100, or about \$3300 for a family of four with average hot water needs. These numbers include materials and installation. However, both the federal government and the state of Massachusetts offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be much lower than the gross price. For an average system the figures would be:

	<u>Low Estimate</u>	<u>Average Estimate</u>	<u>High Estimate</u>
Gross Price	\$2600	\$3300	\$4100
(minus) <u>Tax Rebate</u>	<u>1378</u>	<u>1714</u>	<u>2020</u>
Actual Price	\$1222	\$1586	\$2080

SAVINGS: The solar domestic water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see table). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. However, over the most recent past, some forms of energy have increased at a 40% rate. Forecasting future energy costs, and thus the amount of money a solar water heating system would save, is no easy business. Perhaps the "most likely" event would be for the future rate of increase in energy costs to be the same as it has been over the past 10 years. However, the tables on the following page display savings under "high" and "low" energy cost increases as well. For each of these three possibilities (low, most likely, and high energy cost increases), the number of years it will take for your total savings to add up to more than the original cost of the system has been calculated. This length of time is called "payback".

Massachusetts

Solar Water Heating Savings by Fuel Currently Used*

<u>Oil</u>			
	<u>Low</u>	<u>Most likely</u>	<u>High</u>
<u>Rate of fuel price increase</u>			
Past 10 years - 15%			
Projected	10%	15%	40% for 5 years 20% thereafter
<u>Estimated savings (\$)</u>			
First year	103	103	103
Fifth year	155	191	459
<u>Years to payback</u>	10	8 1/4	6

<u>Electricity</u>			
	<u>Low</u>	<u>Most likely</u>	<u>High</u>
<u>Rate of fuel price increase</u>			
Past 10 years - 10%			
Projected	7%	10%	35% for 5 years 17% thereafter
<u>Estimated savings (\$)</u>			
First year	231	231	231
Fifth year	303	342	818
<u>Years to payback</u>	6	5 1/2	4

<u>Gas</u>			
	<u>Low</u>	<u>Most likely</u>	<u>High</u>
<u>Rate of fuel price increase</u>			
Past 10 years - 12%			
Projected	8%	12%	30% for 5 years 15% thereafter
<u>Estimated savings (\$)</u>			
First year	66	66	66
Fifth year	91	110	227
<u>Years to payback</u>	14	11 1/2	8

*The figures shown take into account

- 1) energy used to run the solar water heater's pumps, and
- 2) annual maintenance and upkeep expenses.

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CONCENTRATING COLLECTORS

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SOLAR DOMESTIC WATER HEATING SYSTEM FOR
CALIFORNIA HOMES

A typical solar domestic water heating system is composed of a collector, a hot water storage tank, and the piping that connects them. The radiation of the sun heats the water as it passes through the collector. From the collector the warm water flows directly into a storage tank. The tank would be in the basement, or underground; it would be a standard size (about 80-90 gallons), of a type readily available. Controls keep the water circulating through the collector as long as the sun raises the temperature of the water. In general, this means that as long as the sun is out, the water will continue to circulate. At night, or when the weather is cold or cloudy, the water remains in the tank.

A solar system cannot, by itself, provide enough energy to meet all the hot water needs of an average family of four. In California, system manufacturers and dealers say that the system will supply between 60 and 80 percent of those needs. Any additional water heating that is required is provided automatically by a conventional backup system using oil, gas, or electricity.

Most families would need three solar collectors to trap the sun's heat. These collectors are a little bigger than an average door. They are made of a piece of metal painted black, covered with glass and mounted in a wooden or metal frame. Collectors may be mounted on your roof if you have a roof that faces south, or installed in your yard.

A solar domestic water heating system comes with a 5-year manufacturer's warranty. The system has an expected life of 15 years, which is comparable to the expected life of the roof of your home.

A diagram of a typical system is on the next page.

A TYPICAL SOLAR DOMESTIC WATER HEATING SYSTEM WITH CONCENTRATING COLLECTOR

PRICE: The ~~gross~~ price of a solar water heating system would be about \$2300 for a family of four with average hot water needs. These numbers include materials and installation. However, both the federal government and the state of California offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be lower than the gross price.

	Gross Price	\$2300
(minus)	<u>Tax Rebate</u>	<u>1265</u>
	Actual Price	\$1035

SAVINGS: The solar water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see below). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. The most likely projections would have the rates of increase over the next years be about the same as over the last 10 years, as shown in the accompanying table. Under this assumption, the number of years it will take for total savings to add up to more than the original cost of the system (payback) has been calculated and is also shown in the table.

Solar Water Heating Savings by Fuel Currently Used

	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
<u>Rate of Fuel Price Increase</u>			
Past 10 years	15%	10%	12%
Projected	15%	10%	12%
<u>Estimated Savings</u>			
First year	\$131	\$202	\$ 28
Fifth year	\$240	\$300	\$ 51
<u>Years to Payback</u>	5 1/2	4 1/4	13 1/4

The figures shown take into account:

- 1) energy used to run the solar water heater's pumps, and
- 2) annual maintenance and upkeep expenses, estimated at \$25/year.

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APPENDIX II

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EXHIBIT 1

The Thirteen Cities

1. Atlanta, GA
2. Bismarck, ND
3. Boston, MA
4. Charleston, SC
5. Columbia, MO
6. Dallas, TX
7. Grand Junction, CO
8. Los Angeles, CA
9. Madison, WI
10. Miami, FL
11. New York City, NY
12. Seattle, WA
13. Washington, D.C.

EXHIBIT 2

Correspondence of States with Cities

1.	Alabama	AL	1	26.	Montana	MT	2
2.	Alaska	AK	-	27.	Nebraska	NE	2
3.	Arizona	AZ	8	28.	Nevada	NV	7
4.	Arkansas	AR	6	29.	New Hampshire	NH	3
5.	California	CA	8	30.	New Jersey	NJ	3
6.	Colorado	CO	7	31.	New Mexico	NM	8
7.	Connecticut	CT	3	32.	New York	NY	3,11
8.	Delaware	DE	13	33.	North Carolina	NC	4
9.	Florida	FL	10	34.	North Dakota	ND	2
10.	Georgia	GA	1	35.	Ohio	OH	9
11.	Hawaii	HI	-	36.	Oklahoma	OK	6
12.	Idaho	ID	7	37.	Oregon	OR	7,12
13.	Illinois	IL	5,9	38.	Pennsylvania	PA	13
14.	Indiana	IN	5,9	39.	Rhode Island	RI	3
15.	Iowa	IA	5	40.	South Carolina	SC	4
16.	Kansas	KS	5	41.	South Dakota	SD	2
17.	Kentucky	KY	5	42.	Tennessee	TN	1
18.	Louisiana	LA	6	43.	Texas	TX	6
19.	Maine	ME	3	44.	Utah	UT	7
20.	Maryland	MD	13	45.	Vermont	VT	3
21.	Massachusetts	MA	3	46.	Virginia	VA	13
22.	Michigan	MI	9	47.	Washington	WA	7,12
23.	Minnesota	MN	9	48.	West Virginia	WV	13
24.	Mississippi	MS	1	49.	Wisconsin	WI	9
25.	Missouri	MO	5	50.	Wyoming	WY	2

EXHIBIT 3

Information for Cities

Hot Water System

		<u>Gross Price</u>	<u>Collectors</u>	<u>Savings%</u>		<u>Year 1 Savings (\$)</u>		
				<u>Lower</u>	<u>Upper</u>	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
1.	Atlanta	2600	4	60	80	149	188	51
2.	Bismarck	2900	3	45	65	129	171	25
3.	Boston	3300	4	45	65	128	256	91
4.	Charleston	2600	4	65	85	159	226	46
5.	Columbia	2900	3	45	65	121	180	30
6.	Dallas	2600	4	65	85	146	226	66
7.	Grand Junction	3300	4	70	90	179	251	53
8.	Los Angeles	2300	3	60	80	156	227	53
9.	Madison	2900	3	40	60	112	162	26
10.	Miami	2600	4	70	90	179	283	56
11.	New York City	3300	4	45	65	134	299	127
12.	Seattle	3300	4	40	60	112	27	73
13.	Washington, D.C.	3300	4	50	70	132	226	27

EXHIBIT 3 (continued)

Information for Cities

Space Heating and Hot Water System

	<u>Gross Price</u>	<u>Collectors</u>	<u>Savings(%)</u>		<u>Year 1 Savings (\$)</u>		
			<u>Lower</u>	<u>Upper</u>	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
1. Atlanta	6200	10	50	70	337	384	143
2. Bismark	7200	10	25	45	417	498	129
3. Boston	11200	20	35	55	447	805	160
4. Charleston	6200	10	55	75	317	407	112
5. Columbia	7200	10	25	45	281	379	93
6. Dallas	6200	10	55	75	282	396	154
7. Grand Junction	7200	10	40	60	457	578	161
8. Los Angeles	6200	10	70	90	330	519	134
9. Madison	7200	10	15	35	307	398	110
10. Miami	5300	10	90	100	238	340	90
11. New York City	9200	30	30	50	371	746	353
12. Seattle	7200	10	15	35	214	102	140
13. Washington, D.C.	7200	10	30	50	295	453	97

EXHIBIT 4

Price Ranges for Solar Heating Systems

	<u>Hot Water Range</u>			
	<u>Lowest</u>	<u>Second</u>	<u>Third</u>	<u>Highest</u>
Upper Bound	2900	3300	3700	4100
Above	2600	2900	3300	3700
Estimate	2300	2600	2900	3300
Below	1900	2300	2600	2900
Lower Bound	1600	1900	2300	2600

	<u>Space Heating and Hot Water Range</u>				
	<u>Lowest</u>	<u>Second</u>	<u>Third</u>	<u>Fourth</u>	<u>Highest</u>
Upper Bound	7200	9200	11200	13200	15200
Above	6200	7200	9200	11200	13200
Estimate	5300	6200	7200	9200	11200
Below	4500	5300	6200	7200	9200
Lower Bound	3900	4500	5300	6200	7200

EXHIBIT 5

Federal Tax Credit for Solar Heating and Hot Water Systems

Federal Tax Credit =

30% of first \$2000 of system price
+ 20% of balance of price over \$2000

up to a maximum rebate of \$2200

EXHIBIT 6

State Tax Credits for Solar Energy Systems

1. Alabama	AL	NONE	26. Montana	MT	OTHER
2. Alaska	AK	-	27. Nebraska	NE	NONE
3. Arizona	AZ	(35%, \$1000)	28. Nevada	NV	NONE
4. Arkansas	AR	OTHER	29. New Hampshire	NH	NONE
5. California	CA	OTHER	30. New Jersey	NJ	NONE
6. Colorado	CO	OTHER	31. New Mexico	NM	(25%, \$1000)
7. Connecticut	CT	NONE	32. New York	NY	NONE
8. Delaware	DE	OTHER	33. North Carolina	NC	(25%, \$1000)
9. Florida	FL	NONE	34. North Dakota	ND	(10%, no max)
10. Georgia	GA	NONE	35. Ohio	OH	(10%, \$1000)
11. Hawaii	HI	-	36. Oklahoma	OK	(25%, \$2000)
12. Idaho	ID	OTHER	37. Oregon	OR	(25%, \$1000)
13. Illinois	IL	NONE	38. Pennsylvania	PA	NONE
14. Indiana	IN	NONE	39. Rhode Island	RI	OTHER
15. Iowa	IA	NONE	40. South Carolina	SC	NONE
16. Kansas	KS	(25%, \$1000)	41. South Dakota	SD	NONE
17. Kentucky	KY	NONE	42. Tennessee	TN	NONE
18. Louisiana	LA	NONE	43. Texas	TX	NONE
19. Maine	ME	(25%, \$1000)	44. Utah	UT	(10%, \$1000)
20. Maryland	MD	NONE	45. Vermont	VT	(25%, \$1000)
21. Massachusetts	MA	OTHER	46. Virginia	VA	NONE
22. Michigan	MI	OTHER	47. Washington	WA	NONE
23. Minnesota	MN	(20%, \$2000)	48. West Virginia	WV	NONE
24. Mississippi	MS	NONE	49. Wisconsin	WI	(10%, \$1000)
25. Missouri	MO	NONE	50. Wyoming	WY	NONE

States with no tax credit = NONE

States with percentage P tax credit up to a maximum of M = (P%, SM)

States with tax credit calculated differently = OTHER

EXHIBIT 7

State Tax Credits for States using
Method other than Fixed Percentage to a Maximum

3. Arkansas - Tax Deduction -- We used a 6% tax rate.
5. California -- Rebate = 55% of the gross price up to a maximum rebate of \$3000. However, the federal tax rebate is then deducted from this amount.
6. Colorado - Tax Deduction -- We used a 8% tax rate (Colorado has a graduated state income tax.)
8. Delaware -- Rebate = \$200 fixed tax credit.
12. Idaho - Tax Deduction -- We used a 7.5% tax rate.
21. Massachusetts - Rebates 35% of the gross price after the federal rebate is subtracted. Maximum rebate is \$1000.
22. Michigan -- 25% of the first \$2000, 15% of the next \$8000.
26. Montana -- 5% of the first \$1000, 2.5% of the next \$3000.
39. Rhode Island - Rebates 19% of the federal rebate.

EXHIBIT 8

Assumed Inflation Rates and Repair Costs

Repair Costs, First Year

Hot Water	\$25
Space Heating and Hot Water	\$50

Inflation: Expected

Gas	12%
Oil	15%
Electricity	10%

: Lower Inflation

Gas	8%
Oil	10%
Electricity	7%

: Higher Inflation

Gas	17%
Oil	20%
Electricity	15%

: Overall Inflation Rate (applies to repair costs) 7%

: Special Inflation Rates:- first five years

Gas	30%
Oil	40%
Electricity	35%

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APPENDIX III

LISTING OF RESIDENTIAL SUPPLEMENTARY FILE

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1 1 Alabama Atlanta, GA
60.0 80.0 4.0 124.0 163.0 43.0 145.0 180.0 49.0 168.0 199.0 56.0 196.0 220.0 65.0 228.0 242.0
74.0 265.0 268.0 84.0 307.0 296.0 96.0 356.0 326.0 110.0 413.0 360.0 125.0 478.0 397.0 142.0 554.0
438.0 161.0 641.0 484.0 183.0 741.0 534.0 208.0 857.0 589.0 235.0 990.0 649.0 267.0 6461.0 5345.0 1897.0
8.2 8.0 15.0 188.0 207.0 227.0 250.0 275.0 303.0 333.0 366.0 403.0 443.0 2996.0 337.0 59.0 19.0
94.0 12.3 185.0 9.5 276.0 7.3 214.0 8.7 296.0 7.0 1900.0 2300.0 2600.0 2900.0 3300.0 570.0 660.0
720.0 780.0 860.0 1330.0 1640.0 1880.0 2120.0 2440.0 50.0 70.0 10.0 287.0 334.0 112.0 524.0 497.0 189.0
14778.010944.0 4777.0 8.7 9.2 15.0 4500.0 5300.0 6200.0 7200.0 9200.0 1100.0 1260.0 1440.0 1640.0 2040.0 3400.0
4040.0 4760.0 5560.0 7160.0 380.0 19.0 950.0 47.0 1.0 1.0
3 8 Arizona Los Angeles, CA
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51.0 279.0 331.0 58.0 323.0 365.0 67.0 375.0 402.0 77.0 434.0 444.0 88.0 503.0 489.0 101.0 582.0
540.0 115.0 673.0 595.0 132.0 778.0 656.0 150.0 900.0 723.0 171.0 1039.0 798.0 195.0 6794.0 6584.0 1348.0
4.7 3.6 12.0 84.0 92.0 101.0 111.0 122.0 134.0 148.0 163.0 179.0 197.0 1331.0 150.0 39.0 15.2
67.0 10.0 196.0 5.1 291.0 4.4 265.0 3.7 364.0 3.4 1600.0 1900.0 2300.0 2600.0 2900.0 1040.0 1235.0
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4 6 Arkansas Dallas/Fort Worth, TX
65.0 85.0 4.0 121.0 201.0 41.0 141.0 222.0 47.0 164.0 245.0 54.0 191.0 270.0 62.0 223.0 298.0
71.0 259.0 329.0 81.0 300.0 363.0 93.0 348.0 400.0 106.0 404.0 441.0 120.0 468.0 487.0 137.0 541.0
537.0 156.0 627.0 592.0 177.0 725.0 653.0 201.0 838.0 720.0 228.0 969.0 794.0 258.0 6318.0 6552.0 1832.0
7.9 6.4 14.6 172.0 190.0 209.0 229.0 252.0 278.0 305.0 336.0 370.0 407.0 2748.0 309.0 57.0 18.6
91.0 12.0 181.0 9.1 270.0 7.1 263.0 6.9 363.0 5.8 1900.0 2300.0 2600.0 2900.0 3300.0 684.0 798.0
876.0 954.0 1058.0 1216.0 1502.0 1724.0 1946.0 2242.0 55.0 75.0 10.0 232.0 346.0 104.0 428.0 514.0 177.0
12161.011325.0 4485.0 9.3 8.5 14.8 4500.0 5300.0 6200.0 7200.0 9200.0 1370.0 1578.0 1812.0 2072.0 2592.0 3130.0
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5 8 California Los Angeles, CA
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6 7 Colorado Grand Junction, MO
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86.0 325.0 369.0 98.0 377.0 407.0 112.0 436.0 449.0 127.0 505.0 495.0 144.0 584.0 546.0 164.0 675.0
602.0 186.0 780.0 664.0 211.0 901.0 731.0 239.0 1041.0 806.0 270.0 1202.0 889.0 305.0 7889.0 7347.0 2193.0
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109.0 12.3 229.0 9.1 338.0 7.1 296.0 7.6 426.0 6.3 2600.0 2900.0 3300.0 3700.0 4100.0 928.0 1012.0
1124.0 1236.0 1348.0 1672.0 1888.0 2176.0 2464.0 2752.0 40.0 60.0 10.0 407.0 528.0 118.0 734.0 781.0 199.0
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7 3 Connecticut Boston, MA
45.0 65.0 4.0 103.0 231.0 66.0 120.0 255.0 75.0 141.0 281.0 86.0 164.0 310.0 97.0 191.0 342.0
110.0 222.0 377.0 125.0 259.0 416.0 142.0 300.0 459.0 161.0 349.0 506.0 182.0 404.0 558.0 206.0 469.0
615.0 233.0 543.0 678.0 264.0 629.0 747.0 298.0 727.0 824.0 337.0 841.0 908.0 380.0 5462.0 7506.0 2764.0
10.4 7.5 14.1 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 91.0 17.5
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8 13 Delaware Washington, D. C.

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 537.0 191.0 561.0 592.0 217.0 650.0 653.0 245.0 752.0 720.0 277.0 870.0 794.0 314.0 5652.0 6552.0 2257.0
 9.8 7.8 15.0 224.0 246.0 271.0 298.0 328.0 361.0 397.0 437.0 480.0 528.0 3570.0 401.0 73.0 18.9
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 9 10 Florida Miami, FL
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 94.0 12.3 229.0 8.3 338.0 6.6 338.0 6.1 462.0 5.2 1900.0 2300.0 2600.0 2900.0 3300.0 570.0 660.0
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 10 1 Georgia Atlanta, GA
 60.0 80.0 4.0 124.0 163.0 43.0 145.0 180.0 49.0 168.0 199.0 56.0 196.0 220.0 65.0 228.0 242.0
 74.0 265.0 268.0 84.0 307.0 296.0 96.0 356.0 326.0 110.0 413.0 360.0 125.0 478.0 397.0 142.0 554.0
 438.0 161.0 641.0 484.0 183.0 741.0 534.0 208.0 857.0 589.0 235.0 990.0 649.0 267.0 6461.0 5345.0 1897.0
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 94.0 12.3 185.0 9.5 276.0 7.3 214.0 8.7 296.0 7.0 1900.0 2300.0 2600.0 2900.0 3300.0 570.0 660.0
 720.0 780.0 860.0 1330.0 1640.0 1880.0 2120.0 2440.0 50.0 70.0 10.0 287.0 334.0 112.0 524.0 497.0 189.0
 14778.0 10944.0 4777.0 8.7 9.2 15.0 4500.0 5300.0 6200.0 7200.0 9200.0 1100.0 1260.0 1440.0 1640.0 2040.0 3400.0
 4040.0 4760.0 5560.0 7160.0 380.0 19.0 950.0 47.0 10.0 1.0
 12 7 Idaho Grand Junction, MO
 70.0 90.0 4.0 154.0 226.0 51.0 179.0 249.0 59.0 208.0 275.0 67.0 242.0 303.0 76.0 280.0 335.0
 87.0 325.0 369.0 99.0 377.0 407.0 113.0 436.0 449.0 128.0 505.0 495.0 146.0 584.0 546.0 165.0 675.0
 602.0 187.0 780.0 664.0 212.0 901.0 731.0 240.0 1041.0 806.0 272.0 1202.0 889.0 308.0 7889.0 7347.0 2210.0
 8.0 7.1 15.0 219.0 241.0 265.0 292.0 321.0 353.0 388.0 427.0 470.0 517.0 3494.0 393.0 71.0 18.9
 110.0 12.3 229.0 9.2 338.0 7.2 296.0 7.7 406.0 6.3 2600.0 2900.0 3300.0 3700.0 4100.0 915.0 997.5
 1107.5 1217.5 1327.5 1685.0 1902.5 2192.5 2482.5 2772.5 40.0 60.0 10.0 407.0 528.0 119.0 734.0 781.0 200.0
 20488.0 17108.0 5037.0 7.3 7.0 15.0 5300.0 6200.0 7200.0 9200.0 11200.0 1657.5 1905.0 2180.0 2730.0 3040.0 3642.5
 4295.0 5020.0 6470.0 8160.0 440.0 22.0 1000.0 50.0 12.0 7.0
 13 5 Illinois Columbia, MO
 45.0 65.0 3.0 96.0 155.0 49.0 112.0 171.0 56.0 131.0 189.0 64.0 153.0 209.0 74.0 179.0 231.0
 84.0 208.0 255.0 96.0 242.0 281.0 109.0 282.0 311.0 124.0 327.0 343.0 141.0 380.0 378.0 160.0 440.0
 418.0 181.0 510.0 461.0 205.0 591.0 509.0 233.0 684.0 561.0 263.0 792.0 619.0 298.0 5129.0 5091.0 2137.0
 10.0 8.9 15.0 212.0 233.0 257.0 282.0 310.0 341.0 376.0 413.0 454.0 500.0 3379.0 380.0 68.0 18.9
 106.0 12.3 144.0 11.9 218.0 8.8 203.0 9.9 282.0 7.8 2300.0 2600.0 2900.0 3300.0 3700.0 660.0 720.0
 780.0 860.0 940.0 1640.0 1880.0 2120.0 2440.0 2760.0 25.0 45.0 10.0 231.0 329.0 133.0 426.0 489.0 223.0
 12114.0 10785.0 5577.0 10.5 10.2 15.0 5300.0 6200.0 7200.0 9200.0 11200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
 4760.0 5560.0 7160.0 9000.0 420.0 21.0 1110.0 55.0 13.0 5.0
 14 5 Indiana Columbia, MO
 45.0 65.0 3.0 96.0 155.0 49.0 112.0 171.0 56.0 131.0 189.0 64.0 153.0 209.0 74.0 179.0 231.0
 84.0 208.0 255.0 96.0 242.0 281.0 109.0 282.0 311.0 124.0 327.0 343.0 141.0 380.0 378.0 160.0 440.0
 418.0 181.0 510.0 461.0 205.0 591.0 509.0 233.0 684.0 561.0 263.0 792.0 619.0 298.0 5129.0 5091.0 2137.0
 10.0 8.9 15.0 212.0 233.0 257.0 282.0 310.0 341.0 376.0 413.0 454.0 500.0 3379.0 380.0 68.0 18.9
 106.0 12.3 144.0 11.9 218.0 8.8 203.0 9.9 282.0 7.8 2300.0 2600.0 2900.0 3300.0 3700.0 660.0 720.0
 780.0 860.0 940.0 1640.0 1880.0 2120.0 2440.0 2760.0 25.0 45.0 10.0 231.0 329.0 133.0 426.0 489.0 223.0
 12114.0 10785.0 5577.0 10.5 10.2 15.0 5300.0 6200.0 7200.0 9200.0 11200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
 4760.0 5560.0 7160.0 9000.0 420.0 21.0 1110.0 55.0 14.0 5.0
 15 5 Iowa Columbia, MO
 45.0 65.0 3.0 96.0 155.0 49.0 112.0 171.0 56.0 131.0 189.0 64.0 153.0 209.0 74.0 179.0 231.0

84.0 208.0 255.0 96.0 242.0 281.0 109.0 282.0 311.0 124.0 327.0 343.0 141.0 380.0 378.0 160.0 440.0
 418.0 181.0 510.0 461.0 205.0 591.0 509.0 233.0 684.0 561.0 263.0 792.0 619.0 298.0 5129.0 5091.0 2137.0
 10.0 8.9 15.0 212.0 233.0 257.0 282.0 310.0 341.0 376.0 413.0 454.0 500.0 3379.0 380.0 68.0 18.9
 106.0 12.3 144.0 11.9 218.0 8.8 203.0 9.9 282.0 7.8 2300.0 2600.0 2900.0 3300.0 3700.0 660.0 720.0
 780.0 860.0 940.0 1640.0 1880.0 2120.0 2440.0 2760.0 25.0 45.0 10.0 231.0 329.0 133.0 426.0 489.0 223.0
 12114.010785.0 5577.0 10.5 10.2 15.0 5300.0 6200.0 7200.0 9200.011200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
 4760.0 5560.0 7160.0 9000.0 420.0 21.0 1110.0 55.0 15.0 5.0
 16 5 Kansas Columbia, MO
 45.0 65.0 3.0 96.0 155.0 30.0 112.0 171.0 35.0 131.0 189.0 40.0 153.0 209.0 46.0 179.0 231.0
 53.0 208.0 255.0 61.0 242.0 281.0 71.0 282.0 311.0 81.0 327.0 343.0 93.0 380.0 378.0 106.0 440.0
 418.0 121.0 510.0 461.0 138.0 591.0 509.0 157.0 684.0 561.0 179.0 792.0 619.0 203.0 5129.0 5091.0 1412.0
 8.0 6.7 15.0 140.0 153.0 169.0 186.0 204.0 225.0 247.0 272.0 299.0 329.0 2223.0 250.0 42.0 19.4
 70.0 12.2 144.0 9.2 218.0 7.1 203.0 7.2 282.0 6.0 2300.0 2600.0 2900.0 3300.0 3700.0 1235.0 1370.0
 1505.0 1685.0 1865.0 1065.0 1230.0 1395.0 1615.0 1835.0 25.0 45.0 10.0 231.0 329.0 106.0 426.0 489.0 181.0
 12114.010785.0 4577.0 9.5 9.0 15.0 5300.0 6200.0 7200.0 9200.011200.0 2260.0 2440.0 2640.0 3040.0 3200.0 3040.0
 3760.0 4560.0 6160.0 8000.0 280.0 14.0 910.0 45.0 16.0 5.0
 17 5 Kentucky Columbia, MO
 45.0 65.0 3.0 96.0 155.0 49.0 112.0 171.0 56.0 131.0 189.0 64.0 153.0 209.0 74.0 179.0 231.0
 84.0 208.0 255.0 96.0 242.0 281.0 109.0 282.0 311.0 124.0 327.0 343.0 141.0 380.0 378.0 160.0 440.0
 418.0 181.0 510.0 461.0 205.0 591.0 509.0 233.0 684.0 561.0 263.0 792.0 619.0 298.0 5129.0 5091.0 2137.0
 10.0 8.9 15.0 212.0 233.0 257.0 282.0 310.0 341.0 376.0 413.0 454.0 500.0 3379.0 380.0 68.0 18.9
 106.0 12.3 144.0 11.9 218.0 8.8 203.0 9.9 282.0 7.8 2300.0 2600.0 2900.0 3300.0 3700.0 660.0 720.0
 780.0 860.0 940.0 1640.0 1880.0 2120.0 2440.0 2760.0 25.0 45.0 10.0 231.0 329.0 133.0 426.0 489.0 223.0
 12114.010785.0 5577.0 10.5 10.2 15.0 5300.0 6200.0 7200.0 9200.011200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
 4760.0 5560.0 7160.0 9000.0 420.0 21.0 1110.0 55.0 17.0 5.0
 18 6 Louisiana Dallas/Fort Worth, TX
 65.0 85.0 4.0 121.0 201.0 43.0 1 222.0 49.0 164.0 245.0 56.0 191.0 270.0 65.0 223.0 298.0
 74.0 259.0 329.0 84.0 300.0 363.0 348.0 400.0 110.0 404.0 441.0 125.0 468.0 487.0 142.0 541.0
 537.0 161.0 627.0 592.0 183.0 725.0 6 208.0 838.0 720.0 235.0 969.0 794.0 267.0 6318.0 6552.0 1897.0
 8.3 6.9 15.0 188.0 207.0 227.0 250.0 275.0 303.0 333.0 366.0 403.0 443.0 2996.0 337.0 59.0 19.0
 94.0 12.3 181.0 9.7 270.0 7.4 263.0 7.4 363.0 6.2 1900.0 2300.0 2600.0 2900.0 3300.0 570.0 660.0
 720.0 780.0 860.0 1330.0 1640.0 1880.0 2120.0 2440.0 55.0 75.0 10.0 232.0 346.0 112.0 428.0 514.0 189.0
 12161.011325.0 4777.0 9.7 9.0 15.0 4500.0 5300.0 6200.0 7200.0 9200.0 1100.0 1260.0 1440.0 1640.0 2040.0 3400.0
 4040.0 4760.0 5560.0 7160.0 380.0 19.0 950.0 47.0 18.0 6.0
 19 3 Maine Boston, MA
 45.0 65.0 4.0 103.0 231.0 66.0 120.0 255.0 75.0 141.0 281.0 86.0 164.0 310.0 97.0 191.0 342.0
 110.0 222.0 377.0 125.0 259.0 416.0 142.0 300.0 459.0 161.0 349.0 506.0 182.0 404.0 558.0 206.0 469.0
 615.0 233.0 543.0 678.0 264.0 629.0 747.0 298.0 727.0 824.0 337.0 841.0 908.0 380.0 5462.0 7506.0 2764.0
 10.2 7.3 13.9 234.0 257.0 283.0 311.0 343.0 377.0 415.0 456.0 502.0 552.0 3729.0 419.0 91.0 17.2
 138.0 11.6 155.0 12.1 233.0 9.0 303.0 7.9 415.0 6.5 2600.0 2900.0 3300.0 3700.0 4100.0 820.0 880.0
 960.0 1040.0 1120.0 1780.0 2020.0 2340.0 2660.0 2980.0 35.0 55.0 20.0 397.0 755.0 223.0 716.0 1113.0 364.0
 20012.024320.0 8917.0 10.3 8.1 15.0 7200.0 9200.011200.013200.015200.0 1740.0 2140.0 2300.0 2300.0 2300.0 5460.0
 7060.0 8900.010900.012900.0 470.0 23.0 1780.0 88.0 19.0 3.0
 20 13 Maryland Washington, D. C.
 50.0 70.0 4.0 107.0 201.0 58.0 125.0 222.0 56.0 146.0 245.0 75.0 170.0 270.0 86.0 198.0 298.0
 97.0 230.0 329.0 111.0 268.0 363.0 126.0 311.0 400.0 143.0 361.0 441.0 162.0 418.0 487.0 184.0 485.0
 537.0 208.0 561.0 592.0 235.0 650.0 653.0 266.0 752.0 720.0 301.0 870.0 794.0 340.0 5652.0 6552.0 2457.0
 10.2 8.3 15.0 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 80.0 18.8
 122.0 12.3 160.0 12.2 241.0 9.0 263.0 9.1 363.0 7.3 2600.0 2900.0 3300.0 3700.0 4100.0 720.0 780.0
 860.0 940.0 1020.0 1880.0 2120.0 2440.0 2760.0 3080.0 30.0 50.0 10.0 245.0 403.0 133.0 450.0 598.0 223.0
 12780.013136.0 5577.0 10.2 9.0 15.0 5300.0 6200.0 7200.0 9200.011200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
 4760.0 5560.0 7160.0 9000.0 490.0 24.0 1110.0 55.0 20.0 13.0
 21 3 Massachusetts Boston, MA
 45.0 65.0 4.0 103.0 231.0 66.0 120.0 255.0 75.0 141.0 281.0 86.0 164.0 310.0 97.0 191.0 342.0
 110.0 222.0 377.0 125.0 259.0 416.0 142.0 300.0 459.0 161.0 349.0 506.0 182.0 404.0 558.0 206.0 469.0

615.0	233.0	543.0	678.0	264.0	629.0	747.0	298.0	727.0	824.0	337.0	841.0	908.0	380.0	5462.0	7506.0	2764.0
8.2	5.4	11.4	159.0	174.0	192.0	211.0	232.0	255.0	281.0	309.0	340.0	374.0	2528.0	284.0	91.0	13.7
138.0	9.7	155.0	9.6	233.0	7.4	303.0	5.8	415.0	5.0	2600.0	2900.0	3300.0	3700.0	4100.0	1378.0	1522.0
1714.0	1906.0	2020.0	1222.0	1378.0	1586.0	1794.0	2080.0	35.0	55.0	20.0	397.0	755.0	199.0	716.0	1113.0	326.0
20012.0	24320.0	8017.0	9.7	7.5	15.0	7200.0	9200.0	11200.0	13200.0	15200.0	2640.0	3040.0	3200.0	3200.0	3200.0	4560.0
6160.0	8000.0	10000.0	12000.0	320.0	16.0	1600.0	79.0	21.0	3.0							
22	9	Michigan	Madison, WI													
40.0	60.0	3.0	87.0	137.0	32.0	102.0	151.0	37.0	119.0	167.0	43.0	140.0	185.0	50.0	163.0	204.0
57.0	190.0	226.0	66.0	222.0	249.0	75.0	258.0	276.0	86.0	300.0	304.0	99.0	348.0	336.0	112.0	404.0
371.0	128.0	468.0	410.0	146.0	543.0	452.0	166.0	629.0	499.0	189.0	728.0	551.0	215.0	4701.0	4519.0	1502.0
8.7	7.6	15.0	149.0	163.0	180.0	198.0	217.0	239.0	263.0	289.0	318.0	350.0	2367.0	266.0	45.0	19.3
74.0	12.2	131.0	10.2	199.0	7.7	180.0	8.3	251.0	6.7	2300.0	2600.0	2900.0	3300.0	3700.0	1205.0	1310.0
1415.0	1555.0	1695.0	1095.0	1290.0	1485.0	1745.0	2005.0	15.0	35.0	10.0	257.0	348.0	99.0	471.0	517.0	169.0
13351.0	11389.0	4297.0	8.7	8.3	15.0	5300.0	6200.0	7200.0	9200.0	11200.0	2255.0	2570.0	2920.0	3440.0	3600.0	3045.0
3630.0	4280.0	5760.0	7600.0	300.0	15.0	860.0	42.0	22.0	9.0							
23	9	Minnesota	Madison, WI													
40.0	60.0	3.0	87.0	137.0	34.0	102.0	151.0	39.0	119.0	167.0	45.0	140.0	185.0	52.0	163.0	204.0
59.0	190.0	226.0	68.0	222.0	249.0	78.0	258.0	276.0	89.0	300.0	304.0	102.0	348.0	336.0	117.0	404.0
371.0	133.0	468.0	410.0	151.0	543.0	452.0	172.0	629.0	499.0	196.0	728.0	551.0	222.0	4701.0	4519.0	1557.0
8.9	7.8	15.0	154.0	169.0	186.0	205.0	225.0	248.0	273.0	300.0	330.0	363.0	2454.0	276.0	47.0	19.3
77.0	12.2	131.0	10.4	199.0	7.9	180.0	8.6	251.0	6.9	2300.0	2600.0	2900.0	3300.0	3700.0	1120.0	1240.0
1360.0	1520.0	1680.0	1180.0	1360.0	1540.0	1780.0	2020.0	15.0	35.0	10.0	257.0	348.0	95.0	471.0	517.0	162.0
13351.0	11389.0	4137.0	8.5	8.1	15.0	5300.0	6200.0	7200.0	9200.0	11200.0	2320.0	2680.0	3080.0	3880.0	4200.0	2980.0
3520.0	4120.0	5320.0	7000.0	310.0	15.0	820.0	41.0	23.0	9.0							
24	1	Mississippi	Atlanta, GA													
60.0	80.0	4.0	124.0	163.0	43.0	145.0	180.0	49.0	168.0	199.0	56.0	196.0	220.0	65.0	228.0	242.0
74.0	265.0	268.0	84.0	307.0	296.0	96.0	356.0	326.0	110.0	413.0	360.0	125.0	478.0	397.0	142.0	554.0
438.0	161.0	641.0	484.0	183.0	741.0	534.0	208.0	857.0	509.0	235.0	990.0	649.0	267.0	6461.0	5345.0	1897.0
8.2	8.0	15.0	188.0	207.0	227.0	250.0	275.0	303.0	333.0	366.0	403.0	443.0	2996.0	337.0	59.0	19.0
94.0	12.3	185.0	9.5	276.0	7.3	214.0	8.7	296.0	7.0	1900.0	2300.0	2600.0	2900.0	3300.0	570.0	660.0
720.0	780.0	860.0	1330.0	1640.0	1880.0	2120.0	2440.0	50.0	70.0	10.0	287.0	334.0	112.0	524.0	497.0	189.0
14778.0	10944.0	4777.0	8.7	9.2	15.0	4500.0	5300.0	6200.0	7200.0	9200.0	1100.0	1260.0	1440.0	1640.0	2040.0	3400.0
4040.0	4760.0	5560.0	7160.0	380.0	19.0	950.0	47.0	24.0	1.0							
25	5	Missouri	Columbia, MO													
45.0	65.0	3.0	96.0	155.0	49.0	112.0	171.0	56.0	131.0	189.0	64.0	153.0	209.0	74.0	179.0	231.0
84.0	208.0	255.0	96.0	242.0	281.0	109.0	282.0	311.0	124.0	327.0	343.0	141.0	380.0	378.0	160.0	440.0
418.0	181.0	510.0	461.0	205.0	591.0	509.0	233.0	684.0	561.0	263.0	792.0	619.0	298.0	5129.0	5091.0	2137.0
10.0	8.9	15.0	212.0	233.0	257.0	282.0	310.0	341.0	376.0	413.0	454.0	500.0	3379.0	380.0	68.0	18.9
106.0	12.3	144.0	11.9	218.0	8.8	203.0	9.9	282.0	7.8	2300.0	2600.0	2900.0	3300.0	3700.0	660.0	720.0
780.0	860.0	940.0	1640.0	1880.0	2120.0	2440.0	2760.0	25.0	45.0	10.0	231.0	329.0	133.0	426.0	489.0	223.0
12114.0	10785.0	5577.0	10.5	10.2	15.0	5300.0	6200.0	7200.0	9200.0	11200.0	1260.0	1440.0	1640.0	2040.0	2200.0	4040.0
4760.0	5560.0	7160.0	9000.0	420.0	21.0	1110.0	55.0	25.0	5.0							
26	2	Montana	Bismarck, ND													
45.0	65.0	3.0	104.0	146.0	47.0	122.0	161.0	53.0	142.0	178.0	61.0	166.0	197.0	70.0	193.0	218.0
80.0	224.0	240.0	91.0	261.0	265.0	104.0	303.0	293.0	118.0	352.0	324.0	134.0	408.0	357.0	152.0	473.0
394.0	173.0	548.0	435.0	196.0	634.0	480.0	222.0	733.0	530.0	252.0	848.0	585.0	285.0	5510.0	4805.0	2040.0
9.4	9.0	15.0	202.0	222.0	245.0	269.0	296.0	326.0	358.0	394.0	434.0	477.0	3223.0	362.0	65.0	19.0
101.0	12.3	156.0	11.1	235.0	8.3	191.0	10.0	266.0	7.8	2300.0	2600.0	2900.0	3300.0	3700.0	742.5	810.0
877.5	967.5	1057.5	1557.5	1790.0	2022.5	2332.5	2642.5	25.0	45.0	10.0	367.0	448.0	130.0	664.0	664.0	218.0
18584.0	14566.0	5452.0	8.2	8.3	15.0	5300.0	6200.0	7200.0	9200.0	11200.0	1385.0	1565.0	1765.0	2165.0	2325.0	3915.0
4635.0	5435.0	7035.0	8875.0	400.0	20.0	1090.0	54.0	26.0	2.0							
27	2	Nebraska	Bismarck, ND													
45.0	65.0	3.0	104.0	146.0	49.0	122.0	161.0	56.0	142.0	178.0	64.0	166.0	197.0	74.0	193.0	218.0
84.0	224.0	240.0	96.0	261.0	265.0	109.0	303.0	293.0	124.0	352.0	324.0	141.0	408.0	357.0	160.0	473.0
394.0	181.0	548.0	435.0	205.0	634.0	480.0	233.0	733.0	530.0	263.0	848.0	585.0	298.0	5510.0	4805.0	2137.0

9.6 9.3 15.0 212.0 233.0 257.0 282.0 310.0 341.0 376.0 413.0 454.0 500.0 3379.0 380.0 68.0 18.9
 106.0 12.3 156.0 11.4 235.0 8.5 191.0 10.4 266.0 8.1 2300.0 2600.0 2900.0 3300.0 3700.0 660.0 720.0
 780.0 860.0 940.0 1640.0 1880.0 2120.0 2440.0 2760.0 25.0 45.0 10.0 367.0 448.0 133.0 664.0 664.0 223.0
 18584.014566.0 5577.0 8.3 8.4 15.0 5300.0 6200.0 7200.0 9200.011200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
 4760.0 5560.0 7160.0 9000.0 420.0 21.0 1110.0 55.0 27.0 2.0
 28 7 Nevada Grand Junction, MO
 70.0 90.0 4.0 154.0 226.0 58.0 179.0 249.0 66.0 208.0 275.0 75.0 242.0 303.0 86.0 280.0 335.0
 97.0 325.0 369.0 111.0 377.0 407.0 126.0 436.0 449.0 143.0 505.0 495.0 162.0 584.0 546.0 184.0 675.0
 602.0 208.0 780.0 664.0 235.0 901.0 731.0 266.0 1041.0 806.0 301.0 1202.0 889.0 340.0 7889.0 7347.0 2457.0
 8.5 7.6 15.0 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 80.0 18.8
 122.0 12.3 229.0 9.8 338.0 7.6 296.0 8.3 406.0 6.8 2600.0 2900.0 3300.0 3700.0 4100.0 720.0 780.0
 860.0 940.0 1020.0 1880.0 2120.0 2440.0 2760.0 3080.0 40.0 60.0 10.0 407.0 528.0 133.0 734.0 781.0 223.0
 20488.017108.0 5577.0 7.8 7.5 15.0 5300.0 6200.0 7200.0 9200.011200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
 4760.0 5560.0 7160.0 9000.0 490.0 24.0 1110.0 55.0 28.0 7.0
 29 3 New Hampshire Boston, MA
 45.0 65.0 4.0 103.0 231.0 66.0 120.0 255.0 75.0 141.0 281.0 86.0 164.0 310.0 97.0 191.0 342.0
 110.0 222.0 377.0 125.0 259.0 416.0 142.0 300.0 459.0 161.0 349.0 506.0 182.0 404.0 558.0 206.0 469.0
 615.0 233.0 543.0 678.0 264.0 629.0 747.0 298.0 727.0 824.0 337.0 841.0 908.0 380.0 5462.0 7506.0 2764.0
 10.4 7.5 14.1 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 91.0 17.5
 138.0 11.8 155.0 12.4 233.0 9.1 303.0 8.2 415.0 6.7 2600.0 2900.0 3300.0 3700.0 4100.0 720.0 780.0
 860.0 940.0 1020.0 1880.0 2120.0 2440.0 2760.0 3080.0 35.0 55.0 20.0 397.0 755.0 226.0 716.0 1113.0 368.0
 20012.024320.0 9017.0 10.4 8.2 15.0 7200.0 9200.011200.013200.015200.0 1640.0 2040.0 2200.0 2200.0 2200.0 5560.0
 7160.0 9000.011000.013000.0 490.0 24.0 1800.0 89.0 29.0 3.0
 30 3 New Jersey Boston, MA
 45.0 65.0 4.0 103.0 231.0 66.0 120.0 255.0 75.0 141.0 281.0 86.0 164.0 310.0 97.0 191.0 342.0
 110.0 222.0 377.0 125.0 259.0 416.0 142.0 300.0 459.0 161.0 349.0 506.0 182.0 404.0 558.0 206.0 469.0
 615.0 233.0 543.0 678.0 264.0 629.0 747.0 298.0 727.0 824.0 337.0 841.0 908.0 380.0 5462.0 7506.0 2764.0
 10.4 7.5 14.1 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 91.0 17.5
 138.0 11.8 155.0 12.4 233.0 9.1 303.0 8.2 415.0 6.7 2600.0 2900.0 3300.0 3700.0 4100.0 720.0 780.0
 860.0 940.0 1020.0 1880.0 2120.0 2440.0 2760.0 3080.0 35.0 55.0 20.0 397.0 755.0 226.0 716.0 1113.0 368.0
 20012.024320.0 9017.0 10.4 8.2 15.0 7200.0 9200.011200.013200.015200.0 1640.0 2040.0 2200.0 2200.0 2200.0 5560.0
 7160.0 9000.011000.013000.0 490.0 24.0 1800.0 89.0 30.0 3.0
 31 8 New Mexico Los Angeles, CA
 60.0 80.0 3.0 131.0 202.0 28.0 153.0 223.0 33.0 178.0 246.0 38.0 207.0 272.0 44.0 240.0 300.0
 51.0 279.0 331.0 58.0 323.0 365.0 67.0 375.0 402.0 77.0 434.0 444.0 88.0 503.0 489.0 101.0 582.0
 540.0 115.0 673.0 595.0 132.0 778.0 656.0 150.0 900.0 723.0 171.0 1039.0 798.0 195.0 6794.0 6584.0 1348.0
 5.6 4.4 13.5 107.0 117.0 129.0 142.0 156.0 172.0 189.0 208.0 228.0 251.0 1697.0 191.0 39.0 17.4
 67.0 11.1 196.0 6.2 291.0 5.1 265.0 4.6 364.0 4.1 1600.0 1900.0 2300.0 2600.0 2900.0 880.0 1045.0
 1235.0 1370.0 1505.0 720.0 855.0 1065.0 1230.0 1395.0 70.0 90.0 10.0 280.0 469.0 85.0 512.0 694.0 147.0
 14445.015233.0 3777.0 7.7 6.1 15.0 4500.0 5300.0 6200.0 7200.0 9200.0 2100.0 2260.0 2440.0 2640.0 3040.0 2400.0
 7040.0 3760.0 4560.0 6160.0 210.0 11.0 750.0 37.0 31.0 8.0
 32 3 New York Boston, MA
 45.0 65.0 4.0 103.0 231.0 66.0 120.0 255.0 75.0 141.0 281.0 86.0 164.0 310.0 97.0 191.0 342.0
 110.0 222.0 377.0 125.0 259.0 416.0 142.0 300.0 459.0 161.0 349.0 506.0 182.0 404.0 558.0 206.0 469.0
 615.0 233.0 543.0 678.0 264.0 629.0 747.0 298.0 727.0 824.0 337.0 841.0 908.0 380.0 5462.0 7506.0 2764.0
 10.4 7.5 14.1 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 91.0 17.5
 138.0 11.8 155.0 12.4 233.0 9.1 303.0 8.2 415.0 6.7 2600.0 2900.0 3300.0 3700.0 4100.0 720.0 780.0
 860.0 940.0 1020.0 1880.0 2120.0 2440.0 2760.0 3080.0 35.0 55.0 20.0 397.0 755.0 226.0 716.0 1113.0 368.0
 20012.024320.0 9017.0 10.4 8.2 15.0 7200.0 9200.011200.013200.015200.0 1640.0 2040.0 2200.0 2200.0 2200.0 5560.0
 7160.0 9000.011000.013000.0 490.0 24.0 1800.0 89.0 32.0 3.0
 33 4 North Carolina Charleston, SC
 65.0 85.0 4.0 134.0 201.0 25.0 156.0 222.0 30.0 182.0 245.0 34.0 211.0 270.0 40.0 245.0 298.0
 46.0 285.0 329.0 54.0 330.0 363.0 62.0 383.0 430.0 71.0 443.0 441.0 82.0 513.0 487.0 94.0 594.0
 537.0 107.0 687.0 592.0 122.0 794.0 653.0 140.0 918.0 720.0 159.0 1061.0 794.0 181.0 6937.0 6552.0 1247.0
 6.1 5.0 15.0 123.0 135.0 149.0 164.0 180.0 198.0 218.0 240.0 264.0 290.0 1960.0 220.0 36.0 19.6

61.0 12.1 200.0 6.7 297.0 5.5 263.0 5.3 363.0 4.6 1900.0 2300.0 2600.0 2900.0 3300.0 1045.0 1235.0
 1370.0 1505.0 1685.0 855.0 1065.0 1230.0 1395.0 1615.0 55.0 75.0 10.0 267.0 357.0 85.0 489.0 530.0 147.0
 13826.0 11675.0 3777.0 7.9 7.5 15.0 4500.0 5300.0 6200.0 7200.0 9200.0 2100.0 2260.0 2440.0 2640.0 3040.0 2400.0
 3040.0 3760.0 4560.0 6160.0 250.0 12.0 750.0 37.0 33.0 4.0
 34 2 North Dakota Bismarck, ND
 45.0 65.0 3.0 104.0 146.0 41.0 122.0 161.0 48.0 142.0 178.0 55.0 166.0 197.0 63.0 193.0 218.0
 72.0 224.0 240.0 82.0 261.0 265.0 94.0 303.0 293.0 107.0 352.0 324.0 121.0 408.0 357.0 138.0 473.0
 394.0 157.0 548.0 435.0 178.0 634.0 480.0 202.0 733.0 530.0 229.0 848.0 585.0 260.0 5510.0 4805.0 1847.0
 8.9 8.4 15.0 183.0 201.0 221.0 244.0 268.0 295.0 324.0 357.0 392.0 432.0 2917.0 328.0 58.0 19.1
 92.0 12.3 156.0 10.4 235.0 7.9 191.0 9.3 266.0 7.4 2300.0 2600.0 2900.0 3300.0 3700.0 890.0 980.0
 1070.0 1190.0 1310.0 1410.0 1620.0 1830.0 2110.0 2390.0 25.0 45.0 10.0 367.0 448.0 114.0 664.0 664.0 193.0
 18584.0 14566.0 4857.0 7.6 7.6 15.0 5300.0 6200.0 7200.0 9200.0 11200.0 1790.0 2060.0 2360.0 2960.0 3320.0 3510.0
 4140.0 4840.0 6240.0 7880.0 370.0 18.0 970.0 48.0 34.0 2.0
 35 9 Ohio Madison, WI
 40.0 60.0 3.0 87.0 137.0 41.0 102.0 151.0 48.0 119.0 167.0 55.0 140.0 185.0 63.0 163.0 204.0
 72.0 190.0 226.0 82.0 222.0 249.0 94.0 258.0 276.0 107.0 300.0 304.0 121.0 348.0 336.0 138.0 404.0
 371.0 157.0 468.0 410.0 178.0 543.0 452.0 202.0 629.0 499.0 229.0 728.0 551.0 260.0 4701.0 4519.0 1847.0
 9.7 8.8 15.0 183.0 201.0 221.0 244.0 268.0 295.0 324.0 357.0 392.0 432.0 2917.0 328.0 58.0 19.1
 92.0 12.3 131.0 11.6 199.0 8.5 180.0 9.8 251.0 7.6 2300.0 2600.0 2900.0 3300.0 3700.0 890.0 980.0
 1070.0 1190.0 1310.0 1410.0 1620.0 1830.0 2110.0 2390.0 15.0 35.0 10.0 257.0 348.0 114.0 471.0 517.0 193.0
 13351.0 11389.0 4857.0 9.3 9.0 15.0 5300.0 6200.0 7200.0 9200.0 11200.0 1790.0 2060.0 2360.0 2960.0 3200.0 3510.0
 1140.0 4840.0 6240.0 8000.0 370.0 18.0 970.0 48.0 35.0 9.0
 36 6 Oklahoma Dallas/Fort Worth, TX
 65.0 85.0 4.0 121.0 201.0 41.0 141.0 222.0 47.0 164.0 245.0 54.0 191.0 270.0 62.0 223.0 298.0
 71.0 259.0 329.0 81.0 300.0 363.0 93.0 348.0 400.0 106.0 404.0 441.0 120.0 468.0 487.0 137.0 541.0
 537.0 156.0 627.0 592.0 177.0 725.0 653.0 201.0 838.0 720.0 228.0 969.0 794.0 258.0 6318.0 6552.0 1832.0
 6.4 5.0 12.4 123.0 135.0 149.0 164.0 180.0 198.0 218.0 240.0 264.0 290.0 1960.0 220.0 57.0 15.5
 91.0 10.4 181.0 7.3 270.0 5.9 263.0 5.3 363.0 4.6 1900.0 2300.0 2600.0 2900.0 3300.0 1045.0 1235.0
 1370.0 1505.0 1685.0 855.0 1065.0 1230.0 1395.0 1615.0 55.0 75.0 10.0 232.0 346.0 104.0 428.0 514.0 177.0
 12161.0 11325.0 4485.0 7.8 6.8 12.8 4500.0 5300.0 6200.0 7200.0 9200.0 2225.0 2585.0 2990.0 3440.0 4040.0 2275.0
 2715.0 3210.0 3760.0 5160.0 250.0 12.0 640.0 32.0 36.0 6.0
 37 7 Oregon Grand Junction, MO
 70.0 90.0 4.0 154.0 226.0 36.0 179.0 249.0 41.0 208.0 275.0 47.0 242.0 303.0 55.0 280.0 335.0
 63.0 325.0 369.0 72.0 377.0 407.0 82.0 436.0 449.0 94.0 505.0 495.0 107.0 584.0 546.0 122.0 675.0
 602.0 139.0 780.0 664.0 158.0 901.0 731.0 180.0 1041.0 806.0 204.0 1202.0 889.0 232.0 7889.0 7347.0 1632.0
 6.6 5.6 15.0 162.0 178.0 195.0 215.0 236.0 260.0 286.0 315.0 346.0 381.0 2574.0 289.0 50.0 19.2
 81.0 12.2 229.0 7.4 338.0 6.0 296.0 6.0 406.0 5.1 2600.0 2900.0 3300.0 3700.0 4100.0 1370.0 1505.0
 1685.0 1865.0 2020.0 1230.0 1395.0 1615.0 1835.0 2080.0 40.0 60.0 10.0 407.0 528.0 111.0 734.0 781.0 188.0
 20488.0 17108.0 4746.0 6.9 6.5 14.7 5300.0 6200.0 7200.0 9200.0 11200.0 2260.0 2440.0 2640.0 3040.0 3200.0 3040.0
 3760.0 4560.0 6160.0 8000.0 320.0 16.0 910.0 45.0 37.0 7.0
 38 13 Pennsylvania Washington, D. C.
 50.0 70.0 4.0 107.0 201.0 58.0 125.0 222.0 66.0 146.0 245.0 75.0 170.0 270.0 86.0 198.0 298.0
 97.0 230.0 329.0 111.0 268.0 363.0 126.0 311.0 400.0 143.0 361.0 441.0 162.0 418.0 487.0 184.0 485.0
 537.0 208.0 561.0 592.0 235.0 650.0 653.0 266.0 752.0 720.0 301.0 870.0 794.0 340.0 5652.0 6552.0 2457.0
 10.2 8.3 15.0 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 80.0 18.8
 122.0 12.3 160.0 12.2 241.0 9.0 263.0 9.1 363.0 7.3 2600.0 2900.0 3300.0 3700.0 4100.0 720.0 780.0
 860.0 940.0 1020.0 1880.0 2120.0 2440.0 2760.0 3080.0 30.0 50.0 10.0 245.0 403.0 133.0 450.0 598.0 223.0
 12780.0 13136.0 5577.0 10.2 9.0 15.0 5300.0 6200.0 7200.0 9200.0 11200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
 4760.0 5560.0 7160.0 9000.0 490.0 24.0 1110.0 55.0 38.0 13.0
 39 3 Rhode Island Boston, MA
 45.0 65.0 4.0 103.0 231.0 66.0 120.0 255.0 75.0 141.0 281.0 86.0 164.0 310.0 97.0 191.0 342.0
 110.0 222.0 377.0 125.0 259.0 416.0 142.0 300.0 459.0 161.0 349.0 506.0 182.0 404.0 558.0 206.0 469.0
 615.0 233.0 543.0 678.0 264.0 629.0 747.0 298.0 727.0 824.0 337.0 841.0 380.0 5462.0 7506.0 2764.0
 10.0 7.1 13.7 228.0 250.0 275.0 303.0 333.0 367.0 403.0 444.0 488.0 537.0 3628.0 408.0 91.0 16.9
 138.0 11.4 155.0 12.0 233.0 8.8 303.0 7.7 415.0 6.4 2600.0 2900.0 3300.0 3700.0 4100.0 856.8 928.2

1023.4 1118.6 1213.8 1743.2 1971.8 2276.6 2581.4 2886.2 35.0 55.0 20.0 397.0 755.0 214.0 716.0 1113.0 350.0
20012.024320.0 8599.0 10.1 7.9 15.0 7200.0 9200.0 11200.0 13200.0 15200.0 1951.6 2427.6 2618.0 2618.0 2618.0 5248.4
6772.4 8582.0 10582.0 12582.0 460.0 23.0 1720.0 85.0 39.0 3.0
40 4 South Carolina Charleston, SC
65.0 85.0 4.0 134.0 201.0 43.0 156.0 222.0 49.0 182.0 245.0 56.0 211.0 270.0 65.0 245.0 298.0
74.0 285.0 329.0 84.0 330.0 363.0 96.0 383.0 400.0 110.0 443.0 441.0 125.0 513.0 487.0 142.0 594.0
537.0 161.0 687.0 592.0 183.0 794.0 653.0 208.0 918.0 720.0 235.0 1061.0 794.0 267.0 6937.0 6552.0 1897.0
7.9 6.9 15.0 188.0 207.0 227.0 250.0 275.0 303.0 333.0 366.0 403.0 443.0 2996.0 337.0 59.0 19.0
94.0 12.3 200.0 9.1 297.0 7.1 263.0 7.4 363.0 6.2 1900.0 2300.0 2600.0 2900.0 3300.0 570.0 660.0
720.0 780.0 860.0 1330.0 1640.0 1880.0 2120.0 2440.0 55.0 75.0 10.0 267.0 357.0 112.0 489.0 530.0 189.0
13826.0 11675.0 4777.0 9.0 8.8 15.0 4500.0 5300.0 6200.0 7200.0 9200.0 1100.0 1260.0 1440.0 1640.0 2040.0 3400.0
4040.0 4760.0 5560.0 7160.0 380.0 19.0 950.0 47.0 40.0 4.0
41 2 South Dakota Bismarck, ND
45.0 65.0 3.0 104.0 146.0 49.0 122.0 161.0 56.0 142.0 178.0 64.0 166.0 197.0 74.0 193.0 218.0
84.0 224.0 240.0 96.0 261.0 265.0 109.0 303.0 293.0 124.0 352.0 324.0 141.0 408.0 357.0 160.0 473.0
394.0 181.0 548.0 435.0 205.0 634.0 480.0 233.0 733.0 530.0 263.0 848.0 585.0 298.0 5510.0 4805.0 2137.0
9.6 9.3 15.0 212.0 233.0 257.0 282.0 310.0 341.0 376.0 413.0 454.0 500.0 3379.0 380.0 68.0 18.9
106.0 12.3 156.0 11.4 235.0 8.5 191.0 10.4 266.0 8.1 2300.0 2600.0 2900.0 3300.0 3700.0 660.0 720.0
780.0 860.0 940.0 1640.0 1880.0 2120.0 2440.0 2760.0 25.0 45.0 10.0 367.0 448.0 133.0 664.0 664.0 223.0
18584.0 14566.0 5577.0 8.3 8.4 15.0 5300.0 6200.0 7200.0 9200.0 11200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
4760.0 5560.0 7160.0 9000.0 420.0 21.0 1110.0 55.0 41.0 2.0
42 1 Tennessee Atlanta, GA
60.0 80.0 4.0 124.0 163.0 43.0 145.0 180.0 49.0 168.0 199.0 56.0 196.0 220.0 65.0 228.0 242.0
74.0 265.0 268.0 84.0 307.0 296.0 96.0 356.0 326.0 110.0 413.0 360.0 125.0 478.0 397.0 142.0 554.0
438.0 161.0 641.0 484.0 183.0 741.0 534.0 208.0 857.0 589.0 235.0 990.0 649.0 267.0 6461.0 5345.0 1897.0
8.2 8.0 15.0 188.0 207.0 227.0 250.0 275.0 303.0 333.0 366.0 403.0 443.0 2996.0 337.0 59.0 19.0
94.0 12.3 185.0 9.5 276.0 7.3 214.0 8.7 296.0 7.0 1900.0 2300.0 2600.0 2900.0 3300.0 570.0 660.0
720.0 780.0 860.0 1330.0 1640.0 1880.0 2120.0 2440.0 50.0 70.0 10.0 287.0 334.0 112.0 524.0 497.0 189.0
14778.0 10944.0 4777.0 8.7 9.2 15.0 4500.0 5300.0 6200.0 7200.0 9200.0 1100.0 1260.0 1440.0 1640.0 2040.0 3400.0
4040.0 4760.0 5560.0 7160.0 380.0 19.0 950.0 47.0 42.0 1.0
43 6 Texas Dallas/Fort Worth, TX
65.0 85.0 4.0 121.0 201.0 43.0 141.0 222.0 49.0 164.0 245.0 56.0 191.0 270.0 65.0 223.0 298.0
74.0 259.0 329.0 84.0 300.0 363.0 96.0 348.0 400.0 110.0 404.0 441.0 125.0 468.0 487.0 142.0 541.0
537.0 161.0 627.0 592.0 183.0 725.0 653.0 208.0 838.0 720.0 235.0 969.0 794.0 267.0 6318.0 6552.0 1897.0
8.3 6.9 15.0 188.0 207.0 227.0 250.0 275.0 303.0 333.0 366.0 403.0 443.0 2996.0 337.0 59.0 19.0
94.0 12.3 181.0 9.7 270.0 7.4 263.0 7.4 363.0 6.2 1900.0 2300.0 2600.0 2900.0 3300.0 570.0 660.0
720.0 780.0 860.0 1330.0 1640.0 1880.0 2120.0 2440.0 55.0 75.0 10.0 232.0 346.0 112.0 428.0 514.0 189.0
12161.0 11325.0 4777.0 9.7 9.0 15.0 4500.0 5300.0 6200.0 7200.0 9200.0 1100.0 1260.0 1440.0 1640.0 2040.0 3400.0
4040.0 4760.0 5560.0 7160.0 380.0 19.0 950.0 47.0 43.0 6.0
44 7 Utah Grand Junction, MO
70.0 90.0 4.0 154.0 226.0 49.0 179.0 249.0 56.0 208.0 275.0 64.0 242.0 303.0 73.0 280.0 335.0
84.0 325.0 369.0 95.0 377.0 407.0 108.0 436.0 449.0 123.0 505.0 495.0 140.0 584.0 546.0 159.0 675.0
602.0 180.0 780.0 664.0 204.0 901.0 731.0 232.0 1041.0 806.0 262.0 1202.0 889.0 297.0 7889.0 7347.0 2127.0
7.8 6.9 15.0 211.0 232.0 255.0 281.0 309.0 340.0 374.0 411.0 452.0 498.0 3363.0 378.0 68.0 18.9
106.0 12.3 229.0 8.9 338.0 7.0 296.0 7.4 406.0 6.2 2600.0 2900.0 3300.0 3700.0 4100.0 980.0 1070.0
1190.0 1310.0 1430.0 1620.0 1830.0 2110.0 2390.0 2670.0 40.0 60.0 10.0 407.0 528.0 114.0 734.0 781.0 193.0
20488.0 17108.0 4857.0 7.2 6.8 15.0 5300.0 6200.0 7200.0 9200.0 11200.0 1790.0 2060.0 2360.0 2960.0 3200.0 3510.0
4140.0 4840.0 6240.0 8000.0 420.0 21.0 970.0 48.0 44.0 7.0
45 3 Vermont Boston, MA
45.0 65.0 4.0 103.0 231.0 66.0 120.0 255.0 75.0 141.0 281.0 86.0 164.0 310.0 97.0 191.0 342.0
110.0 222.0 377.0 125.0 259.0 416.0 142.0 300.0 459.0 161.0 349.0 506.0 182.0 404.0 558.0 206.0 469.0
615.0 233.0 543.0 678.0 264.0 629.0 747.0 298.0 727.0 824.0 337.0 841.0 908.0 380.0 5462.0 7506.0 2764.0
8.3 5.5 11.5 162.0 178.0 195.0 215.0 236.0 260.0 286.0 315.0 346.0 381.0 2574.0 289.0 91.0 13.9
138.0 9.8 155.0 9.7 233.0 7.4 303.0 5.9 415.0 5.1 2600.0 2900.0 3300.0 3700.0 4100.0 1370.0 1505.0
1685.0 1865.0 2045.0 1230.0 1395.0 1615.0 1835.0 2055.0 35.0 55.0 20.0 397.0 755.0 150.0 716.0 1113.0 250.0

20012.024320.0 6217.0 8.5 6.3 15.0 7200.0 9200.011200.013200.015200.0 3440.0 4340.0 5000.0 5500.0 6000.0 3760.0
 4860.0 6200.0 7700.0 9200.0 320.0 16.0 1240.0 62.0 45.0 3.0
 46 13 Virginia Washington D. C.
 50.0 70.0 4.0 107.0 201.0 58.0 125.0 222.0 66.0 146.0 245.0 75.0 170.0 270.0 86.0 198.0 298.0
 97.0 230.0 329.0 111.0 268.0 363.0 126.0 311.0 400.0 143.0 361.0 441.0 162.0 418.0 487.0 184.0 485.0
 537.0 208.0 561.0 592.0 235.0 650.0 553.0 266.0 752.0 720.0 301.0 870.0 794.0 340.0 5652.0 6552.0 2457.0
 10.2 8.3 15.0 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 80.0 18.8
 122.0 12.3 160.0 12.2 241.0 9.0 263.0 9.1 363.0 7.3 2600.0 2900.0 3300.0 3700.0 4100.0 720.0 780.0
 860.0 940.0 1020.0 1880.0 2120.0 2440.0 2760.0 3080.0 30.0 50.0 10.0 245.0 403.0 133.0 450.0 598.0 223.0
 12780.013136.0 5577.0 10.2 9.0 15.0 5300.0 6200.0 7200.0 9200.011200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
 4760.0 5560.0 7160.0 9000.0 490.0 24.0 1110.0 55.0 46.0 13.0
 47 7 Washington Grand Junction, MO
 70.0 90.0 4.0 154.0 226.0 58.0 179.0 249.0 66.0 208.0 275.0 75.0 242.0 303.0 86.0 280.0 335.0
 97.0 325.0 369.0 111.0 377.0 407.0 126.0 436.0 449.0 143.0 505.0 495.0 162.0 584.0 546.0 184.0 675.0
 602.0 208.0 780.0 664.0 235.0 901.0 731.0 266.0 1041.0 806.0 301.0 1202.0 889.0 340.0 7889.0 7347.0 2457.0
 8.5 7.6 15.0 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 80.0 18.8
 122.0 12.3 229.0 9.8 338.0 7.6 296.0 8.3 406.0 6.8 2600.0 2900.0 3300.0 3700.0 4100.0 720.0 780.0
 860.0 940.0 1020.0 1880.0 2120.0 2440.0 2760.0 3080.0 40.0 60.0 10.0 407.0 528.0 133.0 734.0 781.0 223.0
 20488.017108.0 5577.0 7.8 7.5 15.0 5300.0 6200.0 7200.0 9200.011200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
 4760.0 5560.0 7160.0 9000.0 490.0 24.0 1110.0 55.0 47.0 7.0
 48 13 West Virginia Washington, D. C.
 50.0 70.0 4.0 107.0 201.0 58.0 125.0 222.0 66.0 146.0 245.0 75.0 170.0 270.0 86.0 198.0 298.0
 97.0 230.0 329.0 111.0 268.0 363.0 126.0 311.0 400.0 143.0 361.0 441.0 162.0 418.0 487.0 184.0 485.0
 537.0 208.0 561.0 592.0 235.0 650.0 553.0 266.0 752.0 720.0 301.0 870.0 794.0 340.0 5652.0 6552.0 2457.0
 10.2 8.3 15.0 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 80.0 18.8
 122.0 12.3 160.0 12.2 241.0 9.0 263.0 9.1 363.0 7.3 2600.0 2900.0 3300.0 3700.0 4100.0 720.0 780.0
 860.0 940.0 1020.0 1880.0 2120.0 2440.0 2760.0 3080.0 30.0 50.0 10.0 245.0 403.0 133.0 450.0 598.0 223.0
 12780.013136.0 5577.0 10.2 9.0 15.0 5300.0 6200.0 7200.0 9200.011200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
 4760.0 5560.0 7160.0 9000.0 490.0 24.0 1110.0 55.0 48.0 13.0
 49 9 Wisconsin Madison, WI
 40.0 60.0 3.0 87.0 137.0 37.0 102.0 151.0 42.0 119.0 167.0 49.0 140.0 185.0 56.0 163.0 204.0
 64.0 190.0 226.0 74.0 222.0 249.0 84.0 258.0 276.0 96.0 300.0 304.0 110.0 348.0 336.0 125.0 404.0
 371.0 143.0 468.0 410.0 162.0 543.0 452.0 184.0 629.0 499.0 209.0 728.0 551.0 237.0 4701.0 4519.0 1673.0
 9.2 8.2 15.0 166.0 182.0 200.0 220.0 242.0 267.0 293.0 323.0 355.0 390.0 2639.0 297.0 51.0 19.2
 83.0 12.2 131.0 10.9 199.0 8.1 180.0 9.1 251.0 7.2 2300.0 2600.0 2900.0 3300.0 3700.0 1028.0 1136.0
 1244.0 1388.0 1532.0 1272.0 1464.0 1656.0 1912.0 2168.0 15.0 35.0 10.0 257.0 348.0 102.0 471.0 517.0 174.0
 13351.011389.0 4425.0 8.8 8.5 15.0 5300.0 6200.0 7200.0 9200.011200.0 2108.0 2432.0 2792.0 3512.0 3992.0 3192.0
 3768.0 4408.0 5688.0 7208.0 330.0 16.0 880.0 44.0 49.0 9.0
 50 2 Wyoming Bismarck, ND
 45.0 65.0 3.0 104.0 146.0 49.0 122.0 161.0 56.0 142.0 178.0 64.0 166.0 197.0 74.0 193.0 218.0
 84.0 224.0 240.0 96.0 261.0 265.0 109.0 303.0 293.0 124.0 352.0 324.0 141.0 408.0 357.0 160.0 473.0
 394.0 181.0 548.0 435.0 205.0 634.0 480.0 233.0 733.0 530.0 263.0 848.0 585.0 298.0 5510.0 4805.0 2137.0
 9.6 9.3 15.0 212.0 233.0 257.0 282.0 310.0 341.0 376.0 413.0 454.0 500.0 3379.0 380.0 68.0 18.9
 106.0 12.3 156.0 11.4 235.0 8.5 191.0 10.4 266.0 8.1 2300.0 2600.0 2900.0 3300.0 3700.0 660.0 720.0
 780.0 860.0 940.0 1640.0 1880.0 2120.0 2440.0 2760.0 25.0 45.0 10.0 367.0 448.0 133.0 664.0 664.0 223.0
 18584.014566.0 5577.0 8.3 8.4 15.0 5300.0 6200.0 7200.0 9200.011200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
 4760.0 5560.0 7160.0 9000.0 420.0 21.0 1110.0 55.0 50.0 2.0
 13 9 Illinois Madison, WI
 40.0 60.0 3.0 87.0 137.0 49.0 102.0 151.0 56.0 119.0 167.0 64.0 140.0 185.0 74.0 163.0 204.0
 84.0 190.0 226.0 96.0 222.0 249.0 109.0 258.0 276.0 124.0 300.0 304.0 141.0 348.0 336.0 160.0 404.0
 371.0 181.0 468.0 410.0 205.0 543.0 452.0 233.0 629.0 499.0 263.0 728.0 551.0 298.0 4701.0 4519.0 2137.0
 10.5 9.7 15.0 212.0 233.0 257.0 282.0 310.0 341.0 376.0 413.0 454.0 500.0 3379.0 380.0 68.0 18.9
 106.0 12.3 131.0 12.6 199.0 9.2 180.0 10.8 251.0 8.3 2300.0 2600.0 2900.0 3300.0 3700.0 660.0 720.0
 780.0 860.0 940.0 1640.0 1880.0 2120.0 2440.0 2760.0 15.0 35.0 10.0 257.0 348.0 133.0 471.0 517.0 223.0
 13351.011389.0 5577.0 10.0 9.9 15.0 5300.0 6200.0 7200.0 9200.011200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0

4760.0 5560.0 7160.0 9000.0 420.0 21.0 1110.0 55.0 13.0 9.0
32 11 New York New York City, NY
45.0 65.0 4.0 109.0 274.0 102.0 127.0 302.0 115.0 149.0 333.0 131.0 173.0 367.0 148.0 202.0 405.0
167.0 234.0 446.0 189.0 272.0 492.0 213.0 316.0 543.0 211.0 367.0 598.0 271.0 425.0 659.0 306.0 493.0
726.0 345.0 571.0 800.0 389.0 661.0 882.0 438.0 764.0 972.0 494.0 884.0 1071.0 556.0 5748.0 8872.0 4106.0
10.1 6.6 11.5 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 140.0 13.7
205.0 9.9 163.0 12.1 245.0 8.9 359.0 7.2 490.0 6.0 2600.0 2900.0 3300.0 3700.0 4100.0 720.0 780.0
860.0 940.0 1020.0 1880.0 2120.0 2440.0 2760.0 3080.0 30.0 50.0 15.0 321.0 696.0 303.0 583.0 1027.0 490.0
16396.022446.011903.0 10.2 7.4 11.6 6200.0 7200.0 9200.011200.013200.0 1440.0 1640.0 2040.0 2200.0 2200.0 4760.0
5560.0 7160.0 9000.011000.0 490.0 24.0 1430.0 71.0 32.0 11.0
37 12 Oregon Seattle, WA
40.0 60.0 4.0 87.0 46.0 48.0 102.0 52.0 55.0 119.0 57.0 63.0 140.0 64.0 72.0 163.0 71.0
82.0 190.0 80.0 94.0 222.0 89.0 107.0 258.0 98.0 121.0 300.0 110.0 138.0 348.0 122.0 156.0 404.0
135.0 178.0 468.0 150.0 201.0 543.0 167.0 228.0 629.0 185.0 258.0 728.0 206.0 292.0 4701.0 1632.0 2093.0
9.1 15.0 13.3 162.0 178.0 195.0 215.0 236.0 260.0 286.0 315.0 346.0 381.0 2574.0 289.0 67.0 16.6
104.0 11.1 131.0 10.7 199.0 8.1 60.0 18.3 92.0 12.0 2600.0 2900.0 3300.0 3700.0 4100.0 1370.0 1505.0
1685.0 1865.0 2020.0 1230.0 1395.0 1615.0 1835.0 2080.0 15.0 35.0 10.0 164.0 134.0 106.0 309.0 203.0 181.0
8926.0 4577.0 4577.0 11.2 15.0 15.0 5300.0 6200.0 7200.0 9200.011200.0 2260.0 2440.0 2640.0 3040.0 3200.0 3040.0
3760.0 4560.0 6160.0 8000.0 320.0 16.0 910.0 45.0 37.0 12.0
47 12 Washington Seattle, WA
40.0 60.0 4.0 87.0 72.0 58.0 102.0 80.0 66.0 119.0 89.0 75.0 140.0 99.0 86.0 163.0 109.0
97.0 190.0 121.0 111.0 222.0 135.0 126.0 258.0 149.0 143.0 300.0 165.0 162.0 348.0 183.0 184.0 404.0
203.0 208.0 468.0 224.0 235.0 543.0 248.0 266.0 629.0 275.0 301.0 728.0 304.0 340.0 4701.0 2457.0 2457.0
11.2 15.0 15.0 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 80.0 18.8
122.0 12.3 131.0 13.6 199.0 9.8 95.0 17.9 137.0 12.2 2600.0 2900.0 3300.0 3700.0 4100.0 720.0 780.0
860.0 940.0 1020.0 1880.0 2120.0 2440.0 2760.0 3080.0 15.0 35.0 10.0 164.0 165.0 133.0 309.0 249.0 223.0
8926.0 5577.0 5577.0 12.2 15.0 15.0 5300.0 6200.0 7200.0 9200.011200.0 1260.0 1440.0 1640.0 2040.0 2200.0 4040.0
4760.0 5560.0 7160.0 9000.0 490.0 24.0 1110.0 55.0 47.0 12.0
7 3 Connecticut Boston, MA
45.0 65.0 4.0 103.0 231.0 66.0 120.0 255.0 75.0 141.0 281.0 86.0 164.0 310.0 97.0 191.0 342.0
110.0 222.0 377.0 125.0 259.0 416.0 142.0 300.0 459.0 161.0 349.0 506.0 182.0 404.0 558.0 206.0 469.0
615.0 233.0 543.0 678.0 264.0 629.0 747.0 298.0 727.0 824.0 337.0 841.0 908.0 380.0 5462.0 7506.0 2764.0
10.4 7.5 14.1 244.0 268.0 295.0 325.0 357.0 393.0 432.0 475.0 523.0 575.0 3889.0 437.0 91.0 17.5
227.0 9.9 155.0 12.4 459.0 6.9 303.0 8.2 818.0 5.0 2600.0 2900.0 3300.0 3700.0 4100.0 720.0 780.0
860.0 940.0 1020.0 1880.0 2120.0 2440.0 2760.0 3080.0 35.0 55.0 20.0 397.0 755.0 226.0 716.0 1113.0 368.0
20012.024320.0 9017.0 10.4 8.2 15.0 7200.0 9200.011200.013200.015200.0 1640.0 2040.0 2200.0 2200.0 2200.0 5560.0
7160.0 9000.011000.013000.0 490.0 24.0 1800.0 89.0 7.0 3.0
19 3 Maine Boston, MA
45.0 65.0 4.0 103.0 231.0 66.0 120.0 255.0 75.0 141.0 281.0 86.0 164.0 310.0 97.0 191.0 342.0
110.0 222.0 377.0 125.0 259.0 416.0 142.0 300.0 459.0 161.0 349.0 506.0 182.0 404.0 558.0 206.0 469.0
615.0 233.0 543.0 678.0 264.0 629.0 747.0 298.0 727.0 824.0 337.0 841.0 908.0 380.0 5462.0 7506.0 2764.0
10.2 7.3 13.9 234.0 257.0 283.0 311.0 343.0 377.0 415.0 456.0 502.0 552.0 3729.0 419.0 91.0 17.2
227.0 9.7 155.0 12.1 459.0 6.8 303.0 7.9 818.0 4.9 2600.0 2900.0 3300.0 3700.0 4100.0 820.0 880.0
960.0 1040.0 1120.0 1780.0 2020.0 2340.0 2660.0 2980.0 35.0 55.0 20.0 397.0 755.0 223.0 716.0 1113.0 364.0
20012.024320.0 8917.0 10.3 8.1 15.0 7200.0 9200.011200.013200.015200.0 1740.0 2140.0 2300.0 2300.0 2300.0 5460.0
7060.0 8900.010900.012900.0 470.0 23.0 1780.0 88.0 19.0 3.0
21 3 Massachusetts Boston, MA
45.0 65.0 4.0 103.0 231.0 66.0 120.0 255.0 75.0 141.0 281.0 86.0 164.0 310.0 97.0 191.0 342.0
110.0 222.0 377.0 125.0 259.0 416.0 142.0 300.0 459.0 161.0 349.0 506.0 182.0 404.0 558.0 206.0 469.0
615.0 233.0 543.0 678.0 264.0 629.0 747.0 298.0 727.0 824.0 337.0 841.0 908.0 380.0 5462.0 7506.0 2764.0
8.2 5.4 11.4 159.0 174.0 192.0 211.0 232.0 255.0 281.0 309.0 340.0 374.0 2528.0 284.0 91.0 13.7
227.0 7.9 155.0 9.6 459.0 5.6 303.0 5.8 818.0 4.0 2600.0 2900.0 3300.0 3700.0 4100.0 1378.0 1522.0
1714.0 1906.0 2020.0 1222.0 1378.0 1586.0 1794.0 2080.0 35.0 55.0 20.0 397.0 755.0 199.0 716.0 1113.0 326.0
20012.024320.0 8017.0 9.7 7.5 15.0 7200.0 9200.011200.013200.015200.0 2640.0 3040.0 3200.0 3200.0 3200.0 4560.0
6160.0 8000.010000.012000.0 320.0 16.0 1600.0 79.0 21.0 3.0

29	3	New Hampshire	Boston, MA																
45.0	65.0	4.0	103.0	231.0	66.0	120.0	255.0	75.0	141.0	281.0	86.0	164.0	310.0	97.0	191.0	342.0			
110.0	222.0	377.0	125.0	259.0	416.0	142.0	300.0	459.0	161.0	349.0	506.0	182.0	404.0	558.0	206.0	469.0			
615.0	233.0	543.0	678.0	264.0	629.0	747.0	298.0	727.0	824.0	337.0	841.0	908.0	380.0	5462.0	7506.0	2764.0			
10.4	7.5	14.1	244.0	268.0	295.0	325.0	357.0	393.0	432.0	475.0	523.0	575.0	3889.0	437.0	91.0	17.5			
227.0	9.9	155.0	12.4	459.0	6.9	303.0	8.2	818.0	5.0	2600.0	2900.0	3300.0	3700.0	4100.0	720.0	780.0			
860.0	940.0	1020.0	1880.0	2120.0	2440.0	2750.0	3080.0	35.0	5.0	20.0	397.0	755.0	226.0	716.0	1113.0	368.0			
20012.024320.0	9017.0	10.4		8.2	13.0	7200.0	9200.0	11200.0	13200.0	15200.0	1640.0	2040.0	2200.0	2200.0	2200.0	2200.0	5560.0		
7160.0	9000.0	11000.0	13000.0	490.0	24.0	1200.0	89.0	29.0	3.0										
39	3	Rhode Island	Boston, MA																
45.0	65.0	4.0	103.0	231.0	66.0	120.0	255.0	75.0	141.0	281.0	86.0	164.0	310.0	97.0	191.0	342.0			
110.0	222.0	377.0	125.0	259.0	416.0	142.0	300.0	459.0	161.0	349.0	506.0	182.0	404.0	558.0	206.0	469.0			
615.0	233.0	543.0	678.0	264.0	629.0	747.0	298.0	727.0	824.0	337.0	841.0	908.0	380.0	5462.0	7506.0	2764.0			
10.0	7.1	13.7	228.0	250.0	275.0	303.0	333.0	367.0	403.0	444.0	488.0	537.0	3628.0	408.0	91.0	16.9			
227.0	9.5	155.0	12.0	459.0	6.7	303.0	7.7	818.0	4.8	2600.0	2900.0	3300.0	3700.0	4100.0	856.8	928.2			
1023.4	1118.6	1213.8	1743.2	1971.8	2276.6	2581.4	2886.2	35.0	5.0	20.0	397.0	755.0	214.0	716.0	1113.0	350.0			
20012.024320.0	8599.0	10.1		7.9	15.0	7200.0	9200.0	11200.0	13200.0	15200.0	1951.6	2427.6	2618.0	2618.0	2618.0	5248.4			
6772.4	8582.0	10582.0	12582.0	460.0	23.0	1720.0	85.0	39.0	3.0										
45	3	Vermont	Boston, MA																
45.0	65.0	4.0	103.0	231.0	66.0	120.0	255.0	75.0	141.0	281.0	86.0	164.0	310.0	97.0	191.0	342.0			
110.0	222.0	377.0	125.0	259.0	416.0	142.0	300.0	459.0	161.0	349.0	506.0	182.0	404.0	558.0	206.0	469.0			
615.0	233.0	543.0	678.0	264.0	629.0	747.0	298.0	727.0	824.0	337.0	841.0	908.0	380.0	5462.0	7506.0	2764.0			
8.3	5.5	11.5	162.0	178.0	195.0	215.0	236.0	260.0	286.0	315.0	346.0	381.0	2574.0	289.0	91.0	13.9			
227.0	8.0	155.0	9.7	459.0	5.6	303.0	5.9	818.0	4.0	2600.0	2900.0	3300.0	3700.0	4100.0	1370.0	1505.0			
1695.0	1865.0	2045.0	1230.0	1395.0	1615.0	1835.0	2055.0	35.0	55.0	20.0	397.0	755.0	150.0	716.0	1113.0	250.0			
20012.024320.0	6217.0	8.5		6.3	15.0	7200.0	9200.0	11200.0	13200.0	15200.0	3440.0	4340.0	5000.0	5500.0	6000.0	3760.0			
4860.0	6200.0	7700.0	9200.0	320.0	16.0	1240.0	62.0	45.0	3.0										

EXHIBIT 9

Regional Index

1. Alabama	1	31. New Mexico	8
2. Alaska, not used		32. New York	3
3. Arizona	8	33. North Carolina	4
4. Arkansas	6	34. North Dakota	2
5. California	8	35. Ohio	9
6. Colorado	7	36. Oklahoma	6
7. Connecticut	3	37. Oregon	7
8. Delaware	13	38. Pennsylvania	13
9. Florida	10	39. Rhode Island	3
10. Georgia	1	40. South Carolina	4
11. Hawaii, not used		41. South Dakota	2
12. Idaho	7	42. Tennessee	1
13. Illinois	5	43. Texas	6
14. Indiana	5	44. Utah	7
15. Iowa	5	45. Vermont	3
16. Kansas	5	46. Virginia	13
17. Kentucky	5	47. Washington	7
18. Louisiana	6	48. West Virginia	13
19. Maine	3	49. Wisconsin	9
20. Maryland	13	50. Wyoming	2
21. Massachusetts	3	51. Illinois	9
22. Michigan	9	52. New York	11
23. Minnesota	9	53. Oregon	12
24. Mississippi	1	54. Washington	12
25. Missouri	5	55. Connecticut	
26. Montana	2	56. Maine	
27. Nebraska	2	57. Massachusetts	
28. Nevada	7	58. New Hampshire	
29. New Hampshire	3	59. Rhode Island	
30. New Jersey	3	60. Vermont	

second city
for states
with two
corresponding
cities

special
New England

EXHIBIT 10

Usage (by Presentation) of Variables
Residential Supplementary File

1.	WNEEDLB		44.	WY14SVE		87.	WREBAT4	
2.	WNEEDUP		45.	14	long	88.	5	
3.	WNCOLLECT	all	46.	15	deterministic	89.	WACTUL1	
4.	WY1SVO		47.	15	only	90.	WACTUL2	
5.	WY1SVE		48.	15		91.	3	all
6.	WY1SVG		49.	WTSVO		92.	4	
7.	WY2SVO		50.	WTSVE		93.	5	
8.	WY2SVE		51.	WTSVG		94.	SNEEDLB	
9.	WY2SVG		52.	WPAYVO		95.	SNEEDUP	
10.	3		53.	WPAYVE	all	96.	SNCOLLECT	all
11.	3	long	54.	WPAYVG		97.	SY1SVO	new
12.	3	deterministic	55.	WINTERN1		98.	SY1SVE	homes
13.	4	only	56.	WINTERN2		99.	SY1SVG	
14.	4		57.	3		100.	SY5SVO	
15.	4		58.	4		101.	SY5SVE	
16.	5		59.	5		102.	SY5SVG	
17.	5	all	60.	6	long	103.	STVO	
18.	5		61.	7	deter-	104.	STVE	unused
19.	6		62.	8	ministic	105.	STVG	
20.	6		63.	9	only	106.	SPAYVO	
21.	6		64.	10		107.	SPAYVE	
22.	7		65.	WTINTERN		108.	SPAYVG	
23.	7		66.	WLOANP		109.	SGROSS1	
24.	7		67.	WOLS5		110.	2	
25.	8		68.	WOLP		111.	3	
26.	8		69.	WOHS5		112.	4	
27.	8		70.	WOHP	short	113.	5	
28.	9		71.	WFHLS5	undeter-	114.	SREBAT1	
29.	9		72.	WELP	ministic	115.	?	all
30.	9		73.	WEHS5	only	116.	3	new
31.	10	long	74.	WEHP		117.	4	homes
32.	10	deterministic	75.	WGLS5		118.	5	
33.	10	only	76.	WGLP		119.	SACTUL1	
34.	11		77.	WGHS5		120.	2	
35.	11		78.	WGHP		121.	3	
36.	11		79.	WGROSS1		122.	4	
37.	12		80.	WGROSS2		123.	5	
38.	12		81.	3		124.	WDOWNP	
39.	12		82.	4	all	125.	WMORT	
40.	13		83.	5		126.	SDOWNP	
41.	13		84.	WREBAT1		127.	SMORT	
42.	13		85.	WREBAT2		128.	STATE	all
43.	14		86.	3		129.	CITY	

EXHIBIT 11

Variables on Residential Supplementary File

1. WNEEDLB Lower bound on water heating needs (percentage times 100) supplied by average solar water heating system.
2. WNEEDUP Upper bound on water heating needs.
3. WNCOLLECT Number of 20 sq. ft. solar collectors needed for solar water heater.
- 4-6. WY1SVO
WY1SVE
WY1SVG Expected first year savings (in \$) for a solar water heater versus oil, electric, or gas water heaters.
These numbers come directly from Exhibit 3 except when the payback period for a system turned out to be greater than 15 years. (See below.) In that case, a fictitious first year savings was determined and used so that the savings in 15 years would equal system price plus estimated repair costs plus \$17 (so that the calculation would not be exact).
- 7-48. Savings (in \$) for a solar water heater as compared with oil, electric and gas hot water systems in the second through 15th year.
Derived from 4, 5, and 6 (above) using the expected annual inflation rates in Exhibit 8 and assuming a maintenance/repair expense of \$25 in the first year, annually inflated by 7%.
- 49-51. Total savings (in \$) over 15 years obtained by appropriate summation of entries in 7-48.
- 52-54. WPAYVO
WPAYVE
WPAYVG Payback period (in years) for solar water heater against oil, electric, and gas heaters. Assumptions are as above, using an expected actual system purchase price of WACTUL3 (entry 91).
- 55-64. WINTERN1 - 10 Annual interest earnings for each of 10 years, assuming 10% rate, compounded monthly on WACTUL3 (dollars) plus accumulated interest.
65. WTINTERN Sum of 55-64.
66. WLOANP Amount of an annual loan payment on WACTUL3 (dollars) with a 10 year period and interest rate of 13% compounded monthly.
67. WOLS5 Savings (dollars) in the fifth year for a solar water heater versus oil with same assumptions as before expect using the lower inflation rate for oil in Exhibit 8.

EXHIBIT 11 (Continued)

68.	WOLP	Payback period (dollars) for solar water heater versus oil using assumptions of 67 above.
69.	WOHSS	Same as 67, only using the <u>higher</u> inflation rate for oil in Exhibit 8. Also, for the special New England questionnaires, this entry uses the alternate assumptions in Exhibit 8.
70.	WOHP	Payback period (dollars) for solar water heater versus oil using assumptions of 69 above.
71-78.		Same as 67-70, but in comparison with electric and gas water heaters.
79-83.	WGROSS1 - 5	WGROSS is the expected gross price of a solar water heater (dollars) from Exhibit 3. Using this as an estimate, WGROSS1 is a lower bound, WGROSS5 is an upper bound, and the three remaining are intermediate prices. These numbers can be obtained from Exhibit 4.
84-88.	SREBAT1 - 5	Using the process in 79-83 for a solar water heater, 84-88 give the total rebates available using the federal deductions in Exhibit 5 and the state tax credits in Exhibits 6 and 7.
89-93.	WACTUL1 - 5	Obtained by subtracting 84-88 appropriately from 79-83, these entries are the expected actual purchase prices (dollars) of a solar water heater. WACTUL3 is the estimated purchase price used to base payback period, interest earnings and loan payments.
94-96.	SNEEDLB SNEEDUP SNCOLLECT	Same as 1-3, but for solar <u>space heating and hot water system</u> combination, not just a water heating system.
97-99.	SY1SVO SY1SVE SY1SVG	Same as 4-6, but for space and water heating system.
100-102.	SY5SVO SY5SVE SY5SVG	Same as 16-18, but for space and water heating system.
103-105.	STVO STVE STVG	Same as 49-51, but for space and water heating system. (These numbers, however, do not appear on any questionnaires.)
106-108.	SPAYVO SPAYVE SPAYVG	Same as 52-54, but for space and water heating system.
109-123.	SGROSS1 : SACTUL5	Same as 79-93, but for space and water heating system.

EXHIBIT 11 (Continued)

124. WDOWNP Additional down payment (dollars) on a new home due to solar water heater installation at time of building -- calculated as one-fifth of WACTUL3 (purchase price of system) rounded to nearest \$10.
125. WMORT Increase in monthly mortgage payment (dollars) due to installation of solar water heater at time of building. Uses amount of WDOWNP, period of 25 years and an interest rate of 14.5% compounded monthly.
- 126-127. SDOWNP
SMORT Same as 124-125, but for solar space and water heating system.
128. STATE State code, 1-50 (states in alphabetical order, Exhibit 2).
129. CITY City code (1 - 13) from Exhibit 1.

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BUILDERS' DATA

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BUILDER DATA

The Builder Data is file nine of the DOE database tape.

There are 4 cards/case, and 256 cases.

NOTES:

- Q2 Recorded in thousands of dollars.
- Q35 Interpretation is provided in Open-End and
Revised Coding (see Exhibit 12 and 13 in
Industrial section).

Builder's Questionnaire

Hello, I'm _____ from Dialogue, a marketing consulting firm. We're conducting a study for the Department of Energy about marketing active solar energy products. The survey is being done among several different groups, one of which is home builders, and I'd like to ask you to participate. Does your firm build single family residential houses on speculation, that is, build first and find a buyer as the house gets finished?

YES _____ NO _____ (TERMINATE)

And does your firm build only mobile homes?

YES _____ (TERMINATE) NO _____

I'd like to ask you to participate in our study. The interview will take only a short while.

(IF INDIVIDUAL AGREES): Thank you very much. (SEAT RESPONDENT WITH RESPONSE CARD.) In the study we are trying to find out what home builders think about active solar energy systems and also to get their views of home buyers' attitudes about solar energy. This survey will only take a short while. We will be glad to send you the results of the study when it is complete if you stamp this form. (HAND FORM TO RESPONDENT.)

- 1a. To begin with, how many single family residential units, both spec and custom, and excluding mobile homes, did your company build in 1979?

_____ units

5- 9 Q1A

- 1b. And about what percentage of your detached, single-family residential construction is spec built? What percentage is custom built?

spec built _____ %

10-12 Q1Bx1

custom built _____ %

13-15 Q1Bx2

(MUST ADD TO 100%) 100 %

2. Approximately what was the residential construction volume for your company in 1979, in thousands of dollars?

_____ ~~K~~ dollars

16-21 Q2

3. (HAND MAP TO RESPONDENT) What percentage of the single-family residential homes that your firm built in 1979 fall into each of these regions? (SHOW MAP, READ LIST)

Northeast _____ %

22-24 Q3x1

Southeast _____ %

25-27 x2

Northwest _____ %

28-30 x3

Southwest _____ %

31-33 x4

(MUST ADD TO 100%) 100 %

4a. Approximately what percentage of the homes that you build are: (READ LIST)

entry level houses	_____ %	Q4Ax1	34-36
middle price houses	_____ %	x2	37-39
luxury houses	_____ %	x3	40-42
(MUST ADD TO 100%)	100 %		

4b. Consider a typical house you build on speculation. Looking at Scale A on your response card, which of the ranges most closely reflects the selling price of that house?

\$30-50	_____ -1	110-130	_____ -5		
50-70	_____ -2	130-150	_____ -6	Q4B	43-
70-90	_____ -3	150 & up	_____ -7		
90-110	_____ -4				

5. Next, I'd like to get some information about the kinds of heating, cooling and hot water systems you install when you build a home. First let's talk about the primary fuel used for home heating.

a) What percentage of spec homes that you build use gas as the primary heating fuel? (REPEAT FOR EACH OF THE FOLLOWING):

gas	_____ %	Q5Ax1	44-46
electricity	_____ %	x2	47-49
oil	_____ %	x3	50-52
solar	_____ %	x4	53-55
other	_____ %	x5	56-58
no heating system	_____ %	x6	59-61

(COLUMNS MUST ADD TO 100%: TOTAL = 100%)

b) What percentage of spec homes that you build use gas as the primary fuel to heat water? (REPEAT FOR EACH OF THE FOLLOWING):

gas	_____ %	Q5Bx1	62-64
electricity	_____ %	x2	65-67
oil	_____ %	x3	68-70
solar	_____ %	x4	71-73
other	_____ %	x5	74-76

(COLUMNS MUST ADD TO 100%: TOTAL = 100%)

c) In about what percentage of the homes that you build do you install a central air conditioning system?

80- 1
Card 2 Dup 1-4

_____ % Q5C 5- 7

d) Have you ever installed a heat pump in a home?

_____ YES -1

_____ NO -2

Q5D 8-

6. Active solar energy systems are systems with a collector that use a fluid, or air, to move the trapped heat from the collector to where it will be used. Have you included any kinds of active solar devices in any of the homes you've built?

____ YES -1

____ NO -2 (SKIP TO Q. 15)

Q6 9-

In all of the following questions when we are talking about solar energy systems, we are only talking about active solar energy systems.

7. What kinds of active solar energy systems have you installed? (READ LIST)
(PROBE FOR OTHER KINDS OF SYSTEMS) (IF "YES" ASK FOLLOW-UP QUESTION):
In how many houses have you installed this kind of system? (RECORD)

	yes	no	Number of houses		
water heating	____ -1	____ -2	-10 Q7x1	____	Q7x1 11-13
pool heating	____ -1	____ -2	-14 x2	____	x2 15-17
home heating (and water)	____ -1	____ -2	-18 x3	____	x3 19-21
solar-assisted heat pump	____ -1	____ -2	-22 x4	____	x4 23-24
other _____				____	x5 25-26

8. Who manufactured the systems that you installed? (PROBE) (ASK FOR EACH SYSTEM MARKED "YES" IN Q.7)

water heater names:

_____ } -1

Q8x1 27-

don't remember _____ -2

site built _____ -3

pool heater names:

_____ } -1

x2 28-

don't remember _____ -2

site built _____ -3

home heating
(and water)

-1

x3 29-

don't remember _____ -2

site built _____ -3

solar-assisted
heat pump

-1

x4 30-

don't remember _____ -2

site built _____ -3

other type manufacturer x5

31-1

9. Looking at Scale B (HAND SCALE CARD TO RESPONDENT), please tell me the number that best shows how satisfied you are with the _____
(READ EACH SYSTEM TYPE INSTALLED FROM Q. 7), you have installed?

neither
satisfied

very moderately nor moderately very
satisfied satisfied dissatisfied dissatisfied dissatisfied

solar water heaters	1	2	3	4	5	33-Q9x1
solar home heating systems	1	2	3	4	5	34- x2
solar assisted heat pumps	1	2	3	4	5	35- x3
other: _____	1	2	3	4	5	36- x4
_____	1	2	3	4	5	37- x5

10. Were there any specific solar related problems that developed either during or after your installation of any system? What were they?

NO _____ -1

Q10 38-

-2

11. Do you plan to install any kinds of active solar energy systems in the future?

____ YES -1

____ NO -2

Q11 39-

12. Have you used any federal or state incentives to reduce your own cost of installing active solar energy equipment?

____ YES -1

____ NO -2(SKIP TO Q.13a)

Q12 40-

What incentives did you use?

13a. Did the homebuyer(s) use any federal or state incentives to reduce the cost of purchasing the solar systems that you installed?

____ YES -1

____ NO -2

____ DON'T KNOW -3

(IF "NO" OR "DON'T KNOW", SKIP TO Q.14)

Q13A 41-

13b. How important were the incentives in getting the purchaser to buy the house? Where they: (READ LIST)

Very important _____ -1

Moderately important _____ -2

Unimportant _____ -3

Don't know _____ -4

Q13B 42-

Custom designed house _____ -5

14a. Using your most recent spec solar home as an example, did you perform any analysis of fuel savings, compared to the cost of the solar energy system?

____ YES -1

____ NO -2 (SKIP TO Q18)

____ NO SPEC SOLAR -3 43-
(SKIP TO Q.18) Q14A

14b. In what form was the analysis done? (READ LIST) (CHECK ALL MENTIONED)

was it: fuel savings per year _____ 44-1 Q14Bx1

payback analysis or
years to payback _____ 45-1 x2

cash flow analysis _____ 46-1 x3

other (please specify) _____ 47-1 x4

(SKIP TO Q 18)

15a. Have you ever considered installing a solar energy system in one of your spec houses?

YES _____ -1

NO _____ -2 (SKIP TO Q. 16) 48-Q15A

15b. What prompted you to consider installing solar? (CHECK ALL MENTIONED)

demonstration	_____	49-1	Q15Bx1
manufacturer/vendor	_____	50-1	x2
another builder	_____	51-1	x3
just went out looking	_____	52-1	x4
other (please specify)	_____	53-1	x5

16a. What kinds of active solar energy systems for home use are available in your area?

solar water heating	_____55-1	Q16Ax1
solar home and water heating	_____56-1	x2
solar-assisted heat pump	_____57-1	x3
other (please specify)	_____58-1 _____	x4
none mentioned	_____59-1 (SKIP TO Q. 17)	x5

16b. (FOR EACH "YES" IN Q. 16a, ASK:) Please look at Scale C.
Which number on the scale best describes how much you agree or disagree with the statement: "I know a lot about how a _____ system works."

	Strongly agree		Neither		Strongly Disagree	
solar water heating	1	2	3	4	5	Q16Bx1 60-
solar home and water heating	1	2	3	4	5	x2 61-
solar-assisted heat pump	1	2	3	4	5	x3 62-
other (please specify)	1	2	3	4	5	x4 63-

What manufacturers of active solar energy systems do you know of?
What others?

_____ } 64-1 Q17

18. Looking at Scale D, which number best describes how likely you are to install a solar energy system in a spec home during 1980?

Certain, practically certain (99 in 100)	_____	-10	
Almost sure (9 in 10)	_____	-09	
Very Probable (8 in 10)	_____	-08	
Probable (7 in 10)	_____	-07	
Good possibility (6 in 10)	_____	-06	
Fairly good possibility (5 in 10)	_____	-05	Q18 66-67
Fair possibility (4 in 10)	_____	-04	
Some possibility (3 in 10)	_____	-03	
Slight possibility (2 in 10)	_____	-02	
Very slight possibility (1 in 10)	_____	-01	
No chance, almost no chance (0 in 10)	_____	-88	

19. Using Scale E, do you believe that a manufacturer or supplier can or cannot currently provide reliable and dependable solar energy equipment for home use?

Definitely can	_____	-1	
Probably can	_____	-2	
Unsure	_____	-3	Q19 68-
Probably can not	_____	-4	
Definitely can not	_____	-5	

20. Again, using Scale E, do you believe that a manufacturer or supplier can or cannot provide solar energy that makes economic sense for home use?

Definitely can	_____	-1	
Probably can	_____	-2	
Unsure	_____	-3	Q20 69-
Probably can not	_____	-4	
Definitely can not	_____	-5	

21. Now look back at Scale C. Please tell me the number on the scale that best describes how much you agree or disagree with the statement "It is easy to obtain financing for a solar energy system".

Strongly agree	_____	-1	
Moderately agree	_____	-2	
Neither agree nor disagree	_____	-3	Q21 70-
Moderately disagree	_____	-4	
Strongly disagree	_____	-5	

22. What number on Scale C best describes how much you agree or disagree with the statement: "Manufacturers of solar systems are mostly little companies that are here today and will probably be gone tomorrow"?

Strongly agree _____ -1
 Moderately agree _____ -2
 Neither agree nor disagree _____ -3
 Moderately disagree _____ -4
 Strongly disagree _____ -5

Q22 71-

23. What number on Scale C best describes how much you agree or disagree that solar energy equipment will be widely used by homeowners within the next five years?

Strongly agree _____ -1
 Moderately agree _____ -2
 Neither agree nor disagree _____ -3
 Moderately disagree _____ -4
 Strongly disagree _____ -5

Q23 72-

24. Now I'd like to ask you some questions about home buyers in your area. Using Scale P, would you tell me how much demand there is among home buyers for solar energy heating systems?
 (REPEAT QUESTION FOR SOLAR WATER HEATING SYSTEMS.)

	<u>strong</u> <u>demand</u>	<u>moderate</u> <u>demand</u>	<u>slight</u> <u>demand</u>	<u>no</u> <u>demand</u>	
solar heating systems	_____ -1	_____ -2	_____ -3	_____ -4	Q24x1 73-
solar water heating systems	_____ -1	_____ -2	_____ -3	_____ -4	x2 74-

Next, I'm going to give you three lists of criteria that people use to evaluate solar energy systems. (HAND FORMS TO RESPONDENT.) With the first list, I'll ask you to tell me the importance of each criterion as it affects you, in your own business. Then, with the second list, I'll ask you to tell me about your customers. Finally, I'll ask you how a solar manufacturer should evaluate the criteria.

25. On the first list, the criteria are ones that you might consider when thinking about using a solar energy system on a spec house. I'd like you to circle the number in the column indicating how much priority you'd assign to each criterion. Please try to place about three circles in each column.

(ALLOW SUFFICIENT TIME FOR RESPONDENT TO COMPLETE THIS QUESTION.)

26a. If you'll now turn the page, you'll see a list of criteria that are often mentioned as ways in which general consumers evaluate solar equipment. Please look at this page and circle the number in the column that indicates how much priority one of your customers would give to each of the criteria in deciding to adopt a solar energy system in a new home. Once again, please try to place three circles in each column.

(ALLOW SUFFICIENT TIME FOR RESPONDENT TO COMPLETE THIS QUESTION.)

26b. What other high priority criteria do you think your customers use?

Q26B75-1

27a. Please turn to the next page. Now, I'd like you to place yourself in the position of a solar product manufacturer. You want to increase sales of your products. Unfortunately, you also have a fixed budget, so you can't do everything that you might like to. Keeping both these goals in mind, I'd like you to look at the list of marketing actions and circle the numbers in the columns to indicate how you'd place your marketing priorities in order to increase your business. This time, please try to place about four circles in each column.

(ALLOW SUFFICIENT TIME FOR RESPONDENT TO COMPLETE THIS QUESTION.)

27b. What other actions would you take if you were a solar manufacturer or vendor?

Q27B 77-1

28. Please turn to the final page. This question is about the various job responsibilities you have. During a typical week, what fraction of your job responsibilities are associated with each of the categories listed on the page? Please place the appropriate percentages in the spaces provided, and note that the total must add to 100%.

(ALLOW SUFFICIENT TIME FOR RESPONDENT TO COMPLETE THIS QUESTION.)

80- 2

Card 3 Dup 1-4

29. Who designs the spec single-family houses that you build? (CHECK ALL MENTIONED)

me	_____	5-1	Q29x1
staff architect/design	_____	6-1	x2
outside architect/design	_____	7-1	x3
other (please specify) _____	_____	8-1	x4

30. Who chooses the energy system that you install? (CHECK ALL MENTIONED)

me	_____	9-1	Q30x1
staff engineer	_____	10-1	x2
outside engineer	_____	11-1	x3
HVAC contractor	_____	12-1	x4
other (please specify) _____	_____	13-1	x5

31. Who else would be involved in making decisions about which kinds of energy systems to install in the houses you build? Who else is involved? (DO NOT READ LIST) (CHECK ALL MENTIONED)

no one	Q31x1	14-1	firm's owner/officers	Q31x6	19-1
staff architect	x2	15-1	legal/financial staff	x7	20-1
outside architect	x3	16-1	contractors	x8	21-1
staff engineer	x4	17-1	other (please specify)	x9	22-1
outside engineer	x5	18-1	_____		

32. Suppose that after installing solar water heating equipment you had to increase the price of a typical house by \$3500 to cover costs and profit. Using Scale G, please tell me how the marketability of that house would be affected.

no demand -
unable to sell

demand
unaffected

large demand -
sell immediately

1	2	3	4	5	6	7	Q32	23-
				don't know	_____	-8		

33. Suppose that after installing solar home heating equipment you had to increase the price of a typical house by \$8500 to cover costs and profit. Using Scale G, please tell me how the marketability of that house would be affected.

no demand - unable to sell		demand unaffected			large demand - sell immediately		
1	2	3	4	5	6	7	Q33 24-

don't know _____ -8

34. In your business, would it be worth your while to keep abreast of research developments in solar assisted heat pump technology? Please look at Scale H and tell me the number that best describes how worthwhile this information would be to you: (REPEAT FOR SOLAR COOLING TECHNOLOGY.)

	would definitely be <u>worthwhile</u>	would be moderately <u>worthwhile</u>	would be slightly <u>worthwhile</u>	would not be <u>worthwhile</u>
solar assisted heat pump technology	1	2	3	4 Q34x125-
solar cooling technology	1	2	3	4 x226-

35. What two or three technical or trade publications do you read most regularly? (IF OTHER THAN ONES LISTED, LIST IN BLANKS)

Professional Builder	<u>Q35x1</u>	27-1	_____	
Commercial Building	<u>x2</u>	28-1	_____	
Home Building	<u>x3</u>	29-1	_____	<u>Q35x1</u> 31-32
Housing	<u>x4</u>	30-1	_____	

36. Company Name: _____

Another portion of this study will involve our interviewing people who are either looking to buy a newly-built spec house or who are building custom - designed homes, or have recently bought a newly-built spec home or custom-built home. In order to do this, we need lists of such people. Would your company be willing to provide us with names of people who have contacted you about buying a newly-built home or who have recently bought a newly-built home?

(IF YES SAY:)

Thank you very much. We will be contacting you in a week or so to get the list of names (MAKE SURE COMPANY NAME, ADDRESS, AND PHONE # ARE RECORDED.) We really appreciate your help.

Name _____

Company Name _____

Address _____

Phone # _____

36	37	38	39	40	41	42	43	44

45	46	47	48	49	50	51	52	53

80-3

SCALE A

\$30 - 50	50 - 70	70 - 90	90 - 110
110 - 130	130 - 150	Over 150	

SCALE B

<u>VERY</u> <u>SATISFIED</u>	<u>MODERATELY</u> <u>SATISFIED</u>	<u>NEITHER</u> <u>SATISFIED</u> <u>NOR</u> <u>DISSATISFIED</u>	<u>MODERATELY</u> <u>DISSATISFIED</u>	<u>VERY</u> <u>DISSATISFIED</u>
1	2	3	4	5

SCALE C

<u>STRONGLY</u> <u>AGREE</u>	<u>MODERATELY</u> <u>AGREE</u>	<u>NEITHER</u> <u>AGREE</u> <u>NOR</u> <u>DISAGREE</u>	<u>MODERATELY</u> <u>DISAGREE</u>	<u>STRONGLY</u> <u>DISAGREE</u>
1	2	3	4	5

SCALE D

Certain, practically certain (99 in 100)
Almost sure (9 in 10)
Very probably (8 in 10)
Probable (7 in 10)
Good Possibility (6 in 10)
Fairly good possibility (5 in 10)
Fair possibility (4 in 10)
Some possibility (3 in 10)
Slight possibility (2 in 10)
Very slight possibility (1 in 10)
No chance, almost no chance (0 in 10)

SCALE E

<u>DEFINITELY</u> <u>CAN</u>	<u>PROBABLY</u> <u>CAN</u>	<u>UNSURE</u>	<u>PROBABLY</u> <u>CAN NOT</u>	<u>DEFINITELY</u> <u>CAN NOT</u>
1	2	3	4	5

SCALE F

STRONG
DEMAND

1

MODERATE
DEMAND

2

SLIGHT
DEMAND

3

NO
DEMAND

4

SCALE G

No demand --
Unable to sell

1

2

3

Demand
unaffected

4

5

6

Large demand --
Sell immediately

7

SCALE H

WOULD
DEFINITELY BE
WORTHWHILE

1

WOULD BE
MODERATELY
WORTHWHILE

2

WOULD BE
SLIGHTLY
WORTHWHILE

3

WOULD
NOT BE
WORTHWHILE

4

Builder's Criteria

	<u>top</u> <u>priority</u>	<u>high</u> <u>priority</u>	<u>medium</u> <u>priority</u>	<u>low</u> <u>priority</u>	
1. Profit margin on solar equipment	1	2	3	4	-5 BC1
2. Performance reliability of solar equipment	1	2	3	4	-6
3. Ease of installation	1	2	3	4	-7
4. Amount of change from usual building schedules	1	2	3	4	-8
5. Likely customer demand for solar equipped houses	1	2	3	4	-9
6. Installation of solar equipment by other builders in the area	1	2	3	4	-10
7. Building regulations	1	2	3	4	-11
8. Availability of solar equipment	1	2	3	4	-12
9. Willingness of subcontractors to participate in solar installation	1	2	3	4	-13
10. Reliability of suppliers	1	2	3	4	-14
11. Availability of fully integrated solar equipment	1	2	3	4	-15
12. Government certification of solar equipment	1	2	3	4	-16

Customers' Criteria

	<u>top</u> <u>priority</u>	<u>high</u> <u>priority</u>	<u>medium</u> <u>priority</u>	<u>low</u> <u>priority</u>	
1. System's expected life	1	2	3	4	-17 CC
2. Initial cost	1	2	3	4	-18
3. Warranty period	1	2	3	4	-19
4. Operating and maintenance cost	1	2	3	4	-20
5. Number of successful installations	1	2	3	4	-21
6. Payback period	1	2	3	4	-22
7. Effect on home appearance	1	2	3	4	-23
8. Yearly savings on energy costs	1	2	3	4	-24
9. Effect on the environment	1	2	3	4	-25
10. Good citizenship	1	2	3	4	-26
11. Protection from fuel shortages	1	2	3	4	-27

Solar Product Manufacturer

	<u>would</u> <u>definitely</u> <u>do</u>	<u>would</u> <u>probably</u> <u>do</u>	<u>might or</u> <u>might</u> <u>not do</u>	<u>would</u> <u>not do</u>	
1. Install demonstration units	1	2	3	4 -28	SPM1
2. Advertise non-financial benefits (energy independence, etc.)	1	2	3	4 -29	
3. Sell components only	1	2	3	4 -30	
4. Advertise financial benefits	1	2	3	4 -31	
5. Reduce price	1	2	3	4 -32	
6. Lengthen warranty	1	2	3	4 -33	
7. Sell integrated systems	1	2	3	4 -34	
8. Provide how-to workshops for installers	1	2	3	4 -35	
9. Sell directly to the builder or end-user	1	2	3	4 -36	
10. Build sturdier collectors	1	2	3	4 -37	
11. Improve system performance	1	2	3	4 -38	
12. Sell through local distributors	1	2	3	4 -39	
13. Advertise in trade publications	1	2	3	4 -40	
14. Have my product certified by the appropriate agencies	1	2	3	4 -41	
15. Advertise to the general public	1	2	3	4 -42	

Job Responsibilities

	<i>median</i>		
Construction management	<u>20.4</u>	% 43-45	JR1
Sales/Marketing management	<u>9.8</u>	% 46-48	2
Technical management/engineering	<u>5.5</u>	% 49-51	3
Financial responsibilities	<u></u>	% 52-54	4
Procurement or purchasing	<u></u>	% 55-57	5
General management	<u></u>	% 59-61	6
Other	<u></u>	% 61-63	7
	<u></u>	% 64-66	8

(Total must equal = 100 %)

80-4

DOCUMENTATION FOR

HVAC DATA

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HVAC DATA

The HVAC data resides on file 10 of the DOE database tape. There are three cards/case. Data was collected in two separate installments and some slight questionnaire changes were made for the second installment. The installment is indicated by card column 5 of card 1: 1 = old, 2 = new.

The discrepancies between the versions are as follows:

Q6 (card 2 column 1)	On the old installment, "definitely will" was not divided into two parts: there a "definitely will" response on the old version has been recoded to a value of 7.
Q7 (card 2 columns 12 and 13)	Missing on old version.
Insert between Q7 and Q8 (card 2 column 14)	Missing on new version: same as Q7 but for period of 6 months. Also,
	very likely 1
	somewhat likely 2
	neither likely
	nor unlikely 3
	somewhat unlikely 4
	very unlikely 5

NOTES:

Q4, Q20 and Q21 are open-ended questions with interpretations provided in the Open-Ended and Revised Coding section.

Q14 (card 3 column 7-10) uses only cc 9-10 and is a two-digit state code which is the number of the state in the alphabetical listing of all states.

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HVAC QUESTIONNAIRE

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HVAC Questionnaire
April, 1980

1-4

Installment -5

Hello, I'm _____ from Dialogue, an independent market research firm. We are conducting a study about solar energy. (IF RELEVANT: we got your name from _____.) It is very important for us to get attitudes of individuals such as you who influence purchase decisions for heating and air conditioning equipment. Do you, personally, work directly with clients in the selection or evaluation of heating or air conditioning equipment?

1=old

2=new

yes _____ -1

no _____ -2 (IF NO, GO TO (A))

-7

I'd like to ask you to agree to take part in the study. Our questions will only take a few minutes of your time. Of course, any information you provide will be combined with all other responses and will be used for statistical analyses only. Your participation will be completely confidential and your name will never be associated with this survey in any way. In addition, we will make available to you results of the study.

I'd like to ask you to agree to take part. Are there any questions you might have about the study? Will you participate?

yes _____ -1 Great! no _____ -2 (GO TO (A)) [Not Now (GO TO B)]
(GO TO Q.1)

-8

B. When would be a good time to call you back? _____ Day _____ Time.

(A) Who in your organization would be an appropriate individual for us to contact?

Name _____

Telephone _____

Who Else? (PROBE)

Name _____

Telephone _____

Name _____

Telephone _____

(TRY TO GET ONE INDIVIDUAL FROM AN ORGANIZATION)

1a. Are you aware of how solar energy systems work?

yes _____ -1 no _____ -2

-9

1b. Has your firm actively sought information about solar energy from a solar equipment manufacturer or dealer?

yes _____ -1 no _____ -2 (IF NO, GO TO Q. 2a)

-10

(IF YES, ASK:)

1c. For what kinds of solar energy systems have you looked for information?

domestic water heating	_____ -1	-11
process water heating	_____ -2	-12
space heating	_____ -3	-13
space cooling	_____ -4	-14

2a. Has your firm considered the use of solar energy equipment for: (READ LIST)

2b. Has your firm specified the use of solar energy for: (ASK ONLY THOSE ITEMS CONSIDERED AND ENTER IN Col. Q.2b) (IF THERE IS A SYSTEM CONSIDERED BUT NOT SPECIFIED, ASK 2c. OTHERWISE, GO TO 2d.)

	(Q.2a) Considered	(Q.2b) Specified
any domestic water heating application?	_____ -1-15	_____ -1-19
any process water heating application?	_____ -1-16	_____ -1-20
any space heating application?	_____ -1-17	_____ -1-21
any space cooling application?	_____ -1-18	_____ -1-22

(IF NOT CONSIDERED ALL OF THE ABOVE, GO TO 3)

(ASK FOR TYPE NOT SPECIFIED IN Q.2b)

2c. What are the reasons for not specifying solar when it was considered? (DO NOT READ LIST: CHECK ANY BOXES THAT APPLY. NOTE: USE "GENERAL" BOX HERE AND IN Q.2e. WHEN RESPONDENT DOES NOT SPECIFY ANY DIFFERENCE BY SYSTEM-TYPE.)

	<u>General</u>	<u>Water Heating</u>	<u>Process Heating</u>	<u>Space Heating</u>	<u>Space Cooling</u>
cost	_____ -1-23	_____ -1-24	_____ -1-25	_____ -1-26	_____ -1-27
reliability	_____ -1-28	_____ -1-29	_____ -1-30	_____ -1-31	_____ -1-32
manufacturer reputation	_____ -1-33	_____ -1-34	_____ -1-35	_____ -1-36	_____ -1-37
client decided against	_____ -1-38	_____ -1-39	_____ -1-40	_____ -1-41	_____ -1-42
other (specify)	_____ -1-43	_____ -1-44	_____ -1-45	_____ -1-46	_____ -1-47

- 2d. (IF ANY TYPE OF EQUIPMENT SPECIFIED IN Q.2b, ASK Q.2d; IF NONE, GO TO Q.3)
How much of your company's business is solar related?

_____ -1 less than 5%
_____ -2 5% - 25%
_____ -3 over 25%

-50

- 2e. Would you say your clients have been satisfied or dissatisfied with their solar energy experience? (IF NECESSARY:) Would that be moderately satisfied/dissatisfied or very satisfied/dissatisfied?

	<u>General</u>	<u>Water Heating</u>	<u>Process Heating</u>	<u>Space Heating</u>	<u>Space Cooling</u>
Very satisfied	_____ -1	_____ -1	_____ -1	_____ -1	_____ -1
Moderately satisfied	_____ -2	_____ -2	_____ -2	_____ -2	_____ -2
Unsure	_____ -3	_____ -3	_____ -3	_____ -3	_____ -3
Moderately dissatisfied	_____ -4	_____ -4	_____ -4	_____ -4	_____ -4
Very Dissatisfied	_____ -5	_____ -5	_____ -5	_____ -5	_____ -5
	_____	_____	_____	_____	_____
	51	52	53	54	55

3. What types of solar collectors do you know about? What others?
(DO NOT READ LIST)

flat plate	_____ -1	-56
concentrator	_____ -1	-57
evacuated tubes	_____ -1	-58
trickle collectors	_____ -1	-59
air collectors	_____ -1	-60
selective	_____ -1	-61
non-selective	_____ -1	-62
other (specify)	_____ -1	-63
none	_____ -1	-64

4. Are you aware of suppliers or manufacturers of any solar systems?
(IF NO, GO TO Q.6) If so, what names come to mind? Others?
(PROBE AND RECORD BELOW.)
- 5a. Taking these manufacturers and suppliers one at a time, would you
say (READ FROM LIST) makes a reliable or unreliable product? (RECORD BELOW
ON RELIABILITY SCALE.) (REPEAT FOR EACH MANUFACTURER/SUPPLIER LISTED.)
- 5b. Again, taking these manufacturers and suppliers one at a time,
would you say (READ FROM LIST) makes economical or uneconomical
products? (RECORD BELOW ON ECONOMICAL SCALE. REPEAT FOR EACH
MANUFACTURER/SUPPLIER LISTED.)

4. manufacturers/ suppliers	5a.			5b.		
	reliable	unreliable		economical	uneconomical	
_____ -65-66	1	2	-67	1	2	-68
_____ -69-70	1	2	-71	1	2	-72
_____ -73-74	1	2	-75	1	2	-76
_____ -77-78	1	2	-05	1	2	-06
_____ -07-08	1	2	-09	1	2	-10

cc 80-1
dup 1-4

Not Aware of Suppliers ☐ SKIP TO Q.6

(ASK EVERYONE):

6. Do you believe that solar energy equipment will or will not be
widely used within the next five years? (AS NECESSARY, ASK:)
Is that definitely will/will not, or probably will/will not?
(IF DEFINITELY WILL, ASK:) Do you feel fairly certain about
that, or are you just pretty sure?

Definitely will _____

Fairly certain _____ -1

Pretty sure _____ -2

Probably will _____ -3

Unsure _____ -4

Probably will not _____ -5

Definitely will not _____ -6

Definitely will _____ -7 (old installment)

-11

7a. Is it likely or unlikely that your firm will specify solar heating or cooling equipment for some application in the next year? (AS NECESSARY, ASK:) Is that very likely/unlikely, or somewhat likely/unlikely? (IF VERY LIKELY, ASK:) Are you 100% certain or just pretty sure?

How about in the next five years?

Next Year		Five Years	
Very Likely	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">100% certain _____ -1</div> <div style="display: inline-block; vertical-align: middle;">pretty sure _____ -2</div> </div>	Very Likely	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">100% certain _____ -1</div> <div style="display: inline-block; vertical-align: middle;">pretty sure _____ -2</div> </div>
Somewhat Likely _____ -3		Somewhat Likely _____ -3	
Unsure _____ -4		Unsure _____ -4	
Somewhat Unlikely _____ -5		Somewhat Unlikely _____ -5	
Very Unlikely _____ -6	-12	Very Unlikely _____ -6	-13

(IF EITHER 1 YEAR OR 5 YEAR, OR BOTH, ARE "VERY LIKELY", THEN ASK Q. 8, 9a AND 9b. IF NEITHER ARE "VERY LIKELY", THEN SKIP TO Q. 10.)

Old version only: same as Q7 but for a period of 6 months --

1=very likely; 2=somewhat likely; 3=neither likely nor unlikely; 4=somewhat unlikely; 5=very unlikely.

(IF "VERY LIKELY"):

What application/technology do you expect to specify solar heating or cooling equipment for: (IF NECESSARY, READ LIST)

Solar domestic water heating	_____ -1	-15
Solar space heating	_____ -1	-16
Solar absorption cooling	_____ -1	-17
Solar assisted heat pumps and cooling systems	_____ -1	-18

9a. Would this be for:

Residential use	_____ -1	-19
Industrial use	_____ -1	-20
Commercial use	_____ -1	-21
Municipal/government buildings	_____ -1	-22
Hospitals	_____ -1	-23
Other (please specify)	_____ -1	-24

9b. Are these likely to be new or retrofit installations?

new	_____ -1	-25
retrofit	_____ -1	-26

(ASK EVERYONE):

10. Now I'm going to read a few statements to you. After each statement, please tell me on a scale of 1 to 5 if you agree, or disagree with the statement. An answer of 1 would mean you strongly agree, 5 would mean you strongly disagree, 3 would mean neither agree nor disagree.

ROTATE			Neither				
			Strongly agree	Moderately agree	agree nor disagree	Moderately disagree	Strongly disagree
()	a.	HVAC manufacturers can currently produce cost effective solar energy systems.	1	2	3	4	5 -27
()	b.	HVAC manufacturers can currently produce reliable and dependable solar energy systems.	1	2	3	4	5 -28
()	c.	If my firm recommended a solar HVAC system that proved less <u>economical</u> than we expected, it could harm our reputation.	1	2	3	4	5 -29
()	d.	If I, personally, recommended a solar HVAC system that proved less <u>economical</u> than projected, it could ruin my career.	1	2	3	4	5 -30
()	e.	If my firm recommended a solar HVAC that proved less <u>reliable</u> and <u>dependable</u> than projected, it could harm our reputation.	1	2	3	4	5 -31
()	f.	If I, personally, recommended a solar HVAC that proved less reliable and dependable than projected, it could ruin my career.	1	2	3	4	5 -32

10. (continued)		Strongly <u>agree</u>	Moderately <u>agree</u>	Neither agree nor <u>disagree</u>	Moderately <u>disagree</u>	Strongly <u>disagree</u>	
g.	I find it interesting and exciting to be the first one in my area to try a new product.	1	2	3	4	5	-33
h.	My firm is known in the industry as one that only specifies or recommends systems that are "tried and true".	1	2	3	4	5	-34
i.	The federal government should finance the development of markets for solar energy.	1	2	3	4	5	-35
j.	Day in and day out, solar energy systems can provide a significant fraction of a building's HVAC needs.	1	2	3	4	5	-36
k.	Solar HVAC systems are too complex.	1	2	3	4	5	-37
l.	Specifications of solar HVAC systems will lead to construction delays.	1	2	3	4	5	-38
m.	The widespread adoption of solar energy systems would be the best way for the nation to achieve energy independence.	1	2	3	4	5	-39
n.	A solar HVAC system user conveys a modern, innovative image.	1	2	3	4	5	-40
o.	Solar HVAC systems incorporate too many concepts that have not been fully tested.	1	2	3	4	5	-41
p.	I like the concept of using solar energy for HVAC applications.	1	2	3	4	5	-42
q.	Solar HVAC systems protect against fuel rationing.	1	2	3	4	5	-43
r.	Solar HVAC systems are difficult to service.	1	2	3	4	5	-44

11. Now I'd like to review with you the criteria you use in evaluating HVAC systems in general for recommendation to your clients.

First, when you perform an economic evaluation of alternative HVAC systems, which one of the following criteria do you emphasize most:

(READ LIST, CHECK ONLY ONE: THE MOST EMPHASIZED)

(1)	Payback period, balancing differences in investment cost with differences in operating and maintenance costs.	_____ -1	-45
(2)	Net present value of the investment and future operating and maintenance costs.	_____ -2	
(3)	Initial investment cost only	_____ -3	
	or some other criterion (please specify):	_____ -4	

- 12a. Suppose you were retained to recommend an HVAC system for a client. There may be criteria that you use to screen out alternatives that you wouldn't consider recommending. Is there a minimum overall economic life, less than which you wouldn't consider a system?

_____ -1 YES _____ -2 NO -46

(IF YES): How many years? _____ years

-47-48

- 12b. Is there a minimum factory warranty on HVAC equipment that you require?

_____ -1 YES _____ -2 NO -49

(IF YES): How many months? _____ months

-50-51

- 12c. Is there a certain minimum number of prior successful installations for a system that you require before you will recommend a system?

_____ -1 YES _____ -2 NO -52

(IF YES): How many prior installations? _____

-53-54

- 12d. Will you consider recommending a system if you or your firm have had no previous experience with the system's vendor or manufacturer?

_____ -1 YES _____ -2 NO -55

- 12e. For a heating system, is there a minimum % energy conversion efficiency that you require?

_____ -1 YES _____ -2 NO -56

(IF YES): What %? _____ %

-57-58

12f. For a cooling system, is there a minimum coefficient of performance that you require?

_____ -1 YES _____ -2 NO -59
(IF YES): What coefficient of performance? _____ --60-62

12g. Is there a minimum profit margin, or fee for your firm that you require?

_____ -1 YES _____ -2 NO -63
(DO NOT READ): Refused _____ -3
(IF YES): What % of the system's price to the client would that be?
_____ % -64-66

13. When your firm evaluates new HVAC systems introduced to the market, how important is _____ (READ EACH ITEM FROM LIST BELOW. IS IT OF HIGHEST IMPORTANCE, MODERATELY IMPORTANT, OR NOT IMPORTANT?)

ROTATE		<u>Of highest importance</u>	<u>Moderately important</u>	<u>Not important</u>	
()	a. the system's expected life?	1	2	3	-67
()	b. the reputation of the system's producers?	1	2	3	-68
()	c. previous experience with the system's producers?	1	2	3	-69
()	d. ease of installation?	1	2	3	-70
()	f. the system's ease of maintenance?	1	2	3	-71
()	g. the modularity of the system's components?	1	2	3	-72
()	h. the initial investment cost?	1	2	3	-73
()	i. the warranty period?	1	2	3	-74
()	j. the system's maintenance costs?	1	2	3	-75
()	k. client's availability of primary fuel?	1	2	3	-76
()	l. future costs of client's primary fuel?	1	2	3	-77

cc 80-2
dup 1-4

Next, I'd like to get some information about your firm.

14. In what city is the principal office of your firm located?

7-10

15. What is your firm's main activity? Is it: (READ LIST)

architecture or design	_____	-1
contracting	_____	-2
HVAC consulting	_____	-3
both HVAC consulting and contracting	_____	-4
other	_____	-5

-1

16. About how many architects or engineering professionals does your firm employ?

_____ -12-14

17. About how many separate HVAC installation recommendations was your firm involved in last year?

_____ -15-19

18. About what percentage of these installations were for: (READ LIST)

municipal or government buildings	_____	-20-22
hospitals	_____	-23-25
industrial buildings	_____	-26-28
commercial buildings	_____	-29-31
multiple family residences	_____	-32-34
single family residences	_____	-35-37
other (Please specify)	_____	-38-40

(CHECK TO SEE THAT TOTAL IS EQUAL TO 100%)

19. About what percent of your firm's dollar business is located in the:

Northeast	_____	% -41-43
Southeast	_____	% -44-46
Southwest	_____	% -47-49
Northwest	_____	% -50-52

20. Does your firm represent a manufacturer of HVAC equipment?

_____ -1 YES

_____ -2 NO

-53

(IF YES): Which manufacturer? _____

-54-5

(IF MORE THAN ONE MENTIONED, ASK: "Which is the primary manufacturer?")

21. What was your firm's average growth rate in total revenue during the last five years?

_____ -56-58

Finally, I would like to get a little information about you for classification purposes:

22. What is your job title?

_____ -59-60

23. Which of the following categories most closely corresponds to your current job responsibility?

architecture	_____ -1	-61
system specification and engineering	_____ -2	
sales and customer contact	_____ -3	
customer service and maintenance	_____ -4	
company management	_____ -5	
other (specify)	_____ -6	

24. About how many people report to you in your company, directly or indirectly?

0	_____ -1	-62
1 - 3	_____ -2	
4 - 10	_____ -3	
11 - 30	_____ -4	
over 30	_____ -5	

25. In your highest degree, which of the following best describes the area of study you concentrated in?

Architecture	_____ -1	-63
Math/Science	_____ -2	
Engineering	_____ -3	
Business	_____ -4	
Liberal Arts	_____ -5	

What was the highest level of schooling you completed?

less than college	_____	-1
college	_____	-2
post-graduate	_____	-3
(DO NOT READ) refused	_____	-4

-64

Into which of the following age groups do you fall?

Under 25	_____	-1
25 - 34	_____	-2
35 - 44	_____	-3
45 - 54	_____	-4
Over 55	_____	-5
(DO NOT READ) refused	_____	-6

-65

If you would like a copy of the results of this study, please give me your full name and address:

NAME _____

ADDRESS _____

PHONE #: _____

Thank you very much for your time and cooperation!

INTERVIEWER'S NAME: _____ DATE: _____

DOCUMENTATION FOR
PRELIMINARY INDUSTRIAL DATA

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INDUSTRIAL DATA

There are two datasets containing preliminary industrial data:
tape file 11 containing preliminary screeners and tape file 16 containing preliminary mains.

Screeners

One card/case. Exactly as indicated on questionnaire, with following additions:

cc 75-76 contain a two-digit SIC code

cc 77 contains a size of company indicator:
1=large,
2=small.

NOTE:

The file contains an additional two records at the beginning calling attention to the above additions. Question 7 involves manufacturers: codes are described in the Open-Ended and Revised Coding section.

Mains

There are nine cards/case. Notes:

- COP questions (11,21): multiply COP by 10
- Q15 units are thousands of sq.ft.
- Q15, Q19 coded with decimal points

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PRELIMINARY QUESTIONNAIRE

INDUSTRIAL SCREENER

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Industrial Screener Questionnaire

Hello, I'm _____ from Dialogue, an independent market research firm. We are running a study about attitudes toward solar energy in the industrial sector. (IF RELEVANT: WE GOT YOUR NAME FROM WHO SAID YOU WERE AN APPROPRIATE PERSON TO ANSWER OUR QUESTIONS.)

It is very important for us to get opinions of relevant decision-makers such as yourself in a representative sample of firms. The individuals we need to speak to are those who usually participate in the decision process for the selection and purchase of heating and air conditioning equipment. These individuals should be familiar with the space heating and cooling needs of your organization.

Are you an appropriate individual to work with us on this study?

yes _____ no _____ (IF NO, GO TO A)

Let me explain how the study works. First I'll ask you a few questions over the phone about your firm's energy systems. That will take 5-10 minutes. When we're done, I'll mail you some information about solar energy systems. The material will also contain a questionnaire. We'd like you to read through the material and discuss it, if you wish, with any relevant members of your organization. Then we'd like you to complete the questionnaire and return it in a prepaid return envelope.

I'll call back in a week or so to answer any questions you may have about the questionnaire.

We know your time is valuable and we can't pay you directly to participate. Our material will, however, include a card for you to fill out that will enter your name in a project contest. There are half a dozen cash prizes, following a random drawing, with a top prize of \$200. As our study is small, your chances of winning are quite reasonable if you participate.

Since our results will be based on a small sample, it is very important that we get your response. In addition, most organizations that have completed the survey have found it interesting and informative.

I'd like to ask you to agree to take part. Are there any questions you might have about the study? Will you participate?

yes _____ no _____ (GO TO A)

Great! Let me first get your name so I can mail out the package of material.

Name _____

Job Title _____

Firm Name _____

Firm Address _____

And when would be a good time to call you back to complete the survey,
say within 10 days to 2 weeks? Time: _____ Day: _____

(IF NECESSARY): Of course any information you provide will be combined with
all other responses and will be used for statistical analyses only. Your
participation will be completely confidential and your name will never be
associated with this survey in any way.

Before I go on:

(A) Who (besides yourself) in your organization would be appropriate for us
to contact?

Name _____

Telephone _____

Who else? (PROBE)

Name _____

Telephone _____

Name _____

Telephone _____

Name _____

Telephone _____

Name _____

Telephone _____

(TRY TO GET FIVE NAMES. TERMINATE IF THE RESPONDENT HAS NOT AGREED TO
PARTICIPATE.)

Industrial Questionnaire

SCREENER

COMPANY ID# _____ 1-

INDIVIDUAL ID# _____ 5-

1. Prior to this study, have you seen or heard anything about the use of solar energy equipment for heating hot water or for space heating or cooling for industrial use?

yes _____ no _____ (IF NO, SKIP TO Q. 1) 10

- 2a. (IF YES TO Q. 1): Would this be for:

	yes	no	
domestic water heating	_____ -1	_____ -2	11
space heating	_____ -1	_____ -2	12
space cooling	_____ -1	_____ -2	13

- 2b. To the best of your knowledge is your company using solar energy for:

	yes	no	
domestic water heating	_____ -1	_____ -2	14
process water heating	_____ -1	_____ -2	15
space heating	_____ -1	_____ -2	16
space cooling	_____ -1	_____ -2	17

(IF YES TO ANY OF THE ABOVE, PROCEED WITH 2C; IF NO TO ALL OF THE ABOVE, GO TO 2E)

- 2c. Would you say your company's experience with (SYSTEM FROM 2B) is extensive -- that is, more than 20% of the heating and cooling load in the application area? (REPEAT FOR EACH "YES" IN Q. 2b)

	yes	no	
domestic water heating	_____ -1	_____ -2	18
process water heating	_____ -1	_____ -2	19
space heating	_____ -1	_____ -2	20
space cooling	_____ -1	_____ -2	21

- 2d. Would you say your firm is satisfied or dissatisfied with its solar energy experience? (Would that be moderately satisfied/dissatisfied or very satisfied/dissatisfied?)

very satisfied	_____ -1
moderately satisfied	_____ -2
neither satisfied nor dissatisfied	_____ -3
moderately dissatisfied	_____ -4
very dissatisfied	_____ -5

2e. Has your firm actively sought information about solar energy from a solar equipment manufacturer or dealer?

yes _____ -1 no _____ -2 (IF NO, GO TO Q. 3)

23-

(IF YES): For what kinds of solar energy systems have you looked for information?

domestic water heating	_____ -1	25-
process water heating	_____ -1	26-
space heating	_____ -1	27-
space cooling	_____ -1	28-

3. Are you personally aware of how solar energy systems work?

yes _____ -1 no _____ -2 (SKIP TO Q.5)

29-

4. What different kinds of collectors do you know about? (DO NOT READ LIST)

flat plate	_____ -1	30-
concentrator	_____ -1	31-
evacuated tube	_____ -1	32-
trickle collectors	_____ -1	33-
air collectors	_____ -1	34-
selective	_____ -1	35-
non-selective	_____ -1	36-
other (specify) _____	_____ -1	37-

5. Do you believe that a manufacturer or supplier can or cannot currently provide solar energy equipment for use in your company that is reliable and dependable? (Is that definitely can/cannot or probably can/cannot?)

Definitely can	_____ -1
Probably can	_____ -2
Unsure	_____ -3
Probably cannot	_____ -4
Definitely cannot	_____ -5

38-

6. Do you believe that a manufacturer or supplier can or cannot currently provide solar energy equipment for use in your company that makes economic sense?
(Is that definitely can/cannot or probably can/cannot?)

Definitely can	_____	-1
Probably can	_____	-2
Unsure	_____	-3
Probably cannot	_____	-4
Definitely cannot	_____	-5

39

- 7a. Do you know the names of any suppliers or manufacturers of solar systems? (IF NO, GO TO Q8) What names come to mind? What others?
(PROBE, RECORD BELOW)

- 7b. Taking these manufacturers and suppliers one at a time, would you say
(READ FROM LIST) _____ makes a reliable, or unreliable product?

(RECORD BELOW ON RELIABILITY SCALE.) (REPEAT FOR EACH MANUFACTURER/SUPPLIER LISTED.)

- 7c. Again, taking these manufacturers and suppliers one at a time, would you say (READ FROM LIST) _____ makes an economical, or uneconomical product? (RECORD BELOW ON ECONOMICAL SCALE, REPEAT FOR EACH MANUFACTURER/SUPPLIER LISTED.)

7a. manufacturers/ suppliers	7b.		7c.	
	reliable	unreliable	economical	uneconomical
40-41	1	2 42-	1	2 43-
44-45	1	2 46-	1	2 47-
48-49	1	2 50-	1	2 51-
52-53	1	2 54-	1	2 55-
56-57	1	2 58-	1	2 59-

8. Do you believe that solar energy equipment will or will not be widely used in your industry within the next five years? (AS NECESSARY): Is that definitely will/will not, or probably will/will not?

Definitely will	_____	-1
Probably will	_____	-2
Unsure	_____	-3
Probably will not	_____	-4
Definitely will not	_____	-5

60-

9. Is it likely or unlikely that your company will buy solar heating or cooling equipment for some application in the next six months? Is that somewhat likely/unlikely or very likely/unlikely?

Very likely	_____	-1
Somewhat likely	_____	-2
Unsure	_____	-3
Somewhat unlikely	_____	-4
Very unlikely	_____	-5

61-

- 10a. If new government incentives or a comparable change in the market place occurred, for which system-type would you most want to get information?
(READ LIST)

	1st choice	2nd choice	
Solar domestic water heating	_____ -1	_____ -2	63-
Solar space heating	_____ -1	_____ -2	64-
Solar absorption cooling systems	_____ -1	_____ -2	65-
Solar assisted heat pump/ cooling systems	_____ -1	_____ -2	66-

- 10b. What system-type would be your second choice for more information?
(RECORD UNDER Q. 10a., 2ND CHOICE COLUMN)

Finally, I would like to get a little more information about you for classification purposes:

11. What category corresponds most closely to your job responsibilities?

(READ LIST)

production engineer	_____	-1
plant or maintenance engineer	_____	-2
Design engineer	_____	-3
Plant or factory manager	_____	-4
Financial controller/
accountant	_____	-5
Procurement or
purchasing officer	_____	-6
General manager	_____	-7

67

12. About how many people report to you in your company, directly or indirectly? (READ LIST)

0	_____	-1
1 - 3	_____	-2
4 - 10	_____	-3
11 - 30	_____	-4
over 30	_____	-5

68

13. In your highest degree, which of the following best describes the area of study you concentrated in? (READ LIST)

Math/science	_____	-1
Engineering	_____	-2
Business	_____	-3
Liberal Arts	_____	-4

69

14. What was the highest level of schooling you completed? (READ LIST)

high school	_____	-1
college	_____	-2
post-graduate	_____	-3
(DO NOT READ:) refused	_____	-4

70

15. Into which of the following age groups do you fall? (READ LIST)

Under 25 _____ -1

71-

25 - 34 _____ -2

35 - 44 _____ -3

45 - 54 _____ -4

Over 55 _____ -5

(DO NOT READ:) Refused _____ -6

cc75-76 SIC code

cc 77 company
size --
1=large
2=small

(CONFIRM CALLBACK TIME/DATE)

Thank you very much for your time!

80-1

PRELIMINARY QUESTIONNAIRE

INDUSTRIAL MAIN

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QUESTIONNAIRE:

1-4

THE SOLAR ENERGY EQUIPMENT PURCHASING PROCESS

In the following questionnaire, we ask you for information about your company and the process you use to purchase HVAC equipment.

Some of the information requested may not be immediately available to you. Please use any sources (people, reports) within your company that you need to complete the questions. Note also that we would prefer to get your best guess about any of the questions than to have the answer left blank.

Section I: HVAC Investment Information

The questions below concern the characteristics an industrial HVAC system must have to represent an acceptable alternative for your company.

1. Suppose your company has decided to install a HVAC system in a new plant and has identified several different systems for consideration. Please fill in the level of the criteria below for those you use; if you don't use the criterion, check the right hand column. In screening these alternatives, you, personally, will not consider any system:

Please check here
if you do not use
this criterion.

a.	If its expected life is less than _____ years.	_____ 7-1
	5-6	
b.	For cooling, if its initial investment cost is more than _____ \$/ton.	_____ 13-1
	8-12	
c.	For heating, if its initial investment cost is more than _____ \$/thousand BTU's per hour.	_____ 19-1
	14-18	
d.	If it is covered by a complete warranty of less than _____ months.	_____ 23-1
	20-22	
e.	If the manufacturer had no local presence.	
	YES _____ 1 NO _____ 2	
f.	If it is successfully operating in less than _____ other industrial installation(s).	_____ 29-1
	25-28	
g.	If its annual maintenance cost is more than _____ % of its initial investment.	_____ 33-1
	30-32	
h.	For heating, if its energy conversion efficiency is less than _____.	_____ 37-1
	34-36	
i.	For cooling, if its coefficient of performance (COP) is less than _____.	_____ 43-1
	38-42	

24-

- j. If you had no previous experience with the system vendor or manufacturer.

YES _____ -1 NO _____ -2

44-

2. Consider Question 1. again, this time for an HVAC retrofit installation or system replacement. In screening alternatives you will not consider any system:

Please check here
if you do not use
this criterion.

- a. If its expected life is less than _____ years. _____ 47-1
45-46
- b. For cooling, if its initial investment cost is more than _____ \$/ton. _____ 53-1
48-52
- c. For heating, if its initial investment cost is more than _____ \$/thousand BTU's per hour. _____ 54-1
54-58
- d. If it is covered by a complete warranty of less than _____ months. _____ 61-1
60-62
- e. If it is successfully operating in less than _____ other industrial installation(s). _____ 66-1
64-67
- f. If the manufacturer had no local presence.

YES _____ -1 NO _____ -2

69-

- g. If its annual maintenance cost is more than _____ % of its initial investment. _____ 73-1
70-72
- h. For heating, if its energy conversion efficiency is less than _____ %. _____ 75-1
74-76
- i. For cooling, if its coefficient of performance (COP) is less than _____. _____ 80-1
5-9

cc 80-
dup 1-4

- j. If you had no previous experience with the system's vendor or manufacturer.

YES _____ -1 NO _____ -2

11-

- k. If the system was not the same one that was being replaced.

YES _____ -1 NO _____ -2

12-

- l. If the energy source is not the same as the current one.

YES _____ -1 NO _____ -2

13-

3. In evaluating industrial HVAC equipment, what financial criteria does your company use?

3 a. A method that estimated the number of years required to recover the initial cash investment and selects equipment for which the recovery time is sufficiently short (payback period method).

YES _____ -1 NO _____ -2 (Go to Question 3b.) 14 -

3 b. A method that estimates yearly cash inflows (savings) and cash outflows (costs) over the life of the equipment and discounts these flows to account for the time value of money (present value method, internal rate of return method, etc.)

YES _____ -1 NO _____ -2 (Go to Question 3c.) 15 -

If YES, does your company use the

Net Present Value method _____ YES-1 _____ NO-2 16 -

If YES, what does your company currently use as its discount rate (cost of capital)? _____ %
17-19

Internal Rate of Return (discounted cash flow rate of return)

YES _____ -1 NO _____ -2 20 -

If YES, what minimum rate of return does your company require for acceptance of equipment of this type? _____ %
21-23

3 c. Initial investment cost only _____ YES-1 _____ NO-2 24 -

3 d. Other financial criteria (please specify) _____ } 1 25 -

4. Several criteria typically used to evaluate industrial equipment are listed below. Please indicate how important these criteria are in your evaluation. First for new, then retrofit installations. Circle one number for each criterion when considering such systems.

	<u>New Installations</u>						<u>Retrofit Installations</u>					
	Unimportant			Highest Importance			Unimportant			Highest Importance		
System's expected life	1	2	3	4	5	26	1	2	3	4	5	43
Reputation of system's producer	1	2	3	4	5	27	1	2	3	4	5	44
Previous experience with the system's producer	1	2	3	4	5	28	1	2	3	4	5	45
Ease of installation	1	2	3	4	5	29	1	2	3	4	5	46
System's reliability	1	2	3	4	5	30	1	2	3	4	5	47
System's ease of maintenance	1	2	3	4	5	31	1	2	3	4	5	48
Modularity of system's components	1	2	3	4	5	32	1	2	3	4	5	49
Initial investment cost	1	2	3	4	5	33	1	2	3	4	5	50
Number of successful installations	1	2	3	4	5	34	1	2	3	4	5	51
Warranty period	1	2	3	4	5	35	1	2	3	4	5	52
Operating cost	1	2	3	4	5	36	1	2	3	4	5	53
Maintenance cost	1	2	3	4	5	37	1	2	3	4	5	54
Availability of primary fuel	1	2	3	4	5	38	1	2	3	4	5	55
Future cost of primary fuel (relative to alternatives)	1	2	3	4	5	39	1	2	3	4	5	56
Local service	1	2	3	4	5	40	1	2	3	4	5	57
Payback period	1	2	3	4	5	41	1	2	3	4	5	58
A measure based on discounting yearly inflows and outflows over the life of the equipment (NPV, IRR, etc.)	1	2	3	4	5	42	1	2	3	4	5	59

5. Between now and 1985, what average rate of annual fuel cost increase do you expect your firm will see?

_____ % per year (average)
50 52

Section II: Attitudes Toward Alternative Systems

Now we would like to learn your reaction to two industrial solar HVAC systems.

The summary description of each system is followed by a list of statements that you will be asked to agree or disagree with.

We are interested in how you FEEL about these systems, based on their descriptions, rather than your quantitative evaluation of the systems.

There are NO RIGHT OR WRONG ANSWERS, so feel free to register your opinion about the product described.

		(Circle one number for each item)											
System A: <u>SOLAR DOMESTIC WATER HEATING</u>		Strongly Disagree		Neither Agree nor Disagree			Strongly Agree		Don't Know				
The system produces reliable output.		1	2	3	4	5	6	7		8	63		
Adoption of the system protects against power failures.		1	2	3	4	5	6	7		8	64-		
Performance of the system is sensitive to climatic conditions.		1	2	3	4	5	6	7		8	65-		
The system is made up of field proven components.		1	2	3	4	5	6	7		8	66-		
Adopting the system conveys the image of a modern, innovative company.		1	2	3	4	5	6	7		8	67-		
The system requires a major retraining effort.		1	2	3	4	5	6	7		8	68-		
The system's initial cost is acceptably low.		1	2	3	4	5	6	7		8	69-		
The system protects against fuel rationing.		1	2	3	4	5	6	7		8	70-		
In adopting this system, we would do our part in reducing pollution.		1	2	3	4	5	6	7		8	71-		
System components produced by several manufacturers can be substituted for one another.		1	2	3	4	5	6	7		8	72-		
The system can easily be extended to meet increased HVAC needs.		1	2	3	4	5	6	7		8	73-		
The system is easily installed.		1	2	3	4	5	6	7		8	74-		
The system has too many concepts that have not been fully tested.		1	2	3	4	5	6	7		8	75-		
System components are easily accessible for maintenance and repair.		1	2	3	4	5	6	7		8	76-		
The system leads to considerable energy savings.		1	2	3	4	5	6	7		8	77-		
The system is easily integrated into an industrial building.		1	2	3	4	5	6	7		8	78-		
The system is too complex.		1	2	3	4	5	6	7		8	79-	cc 80-21 dup 1-	
The system's operating cost is acceptably low.		1	2	3	4	5	6	7		8	80-	5-	
The system offers a state-of-the-art solution to HVAC needs.		1	2	3	4	5	6	7		8	81-		
The system increases the noise level in the plant.		1	2	3	4	5	6	7		8	82-		
The system makes use of currently unproductive areas in industrial buildings.		1	2	3	4	5	6	7		8	83-		
Adoption of this system will increase construction delays.		1	2	3	4	5	6	7		8	84-		
The system is modular.		1	2	3	4	5	6	7		8	85-		
Service for the system will be quick and easy.		1	2	3	4	5	6	7		8	86-		

System B: <u>SOLAR SPACE HEATING</u>	(Circle one number for each item)									
	Strongly Disagree		Neither Agree nor Disagree			Strongly Agree		Don't Know		
The system produces reliable output.	1	2	3	4	5	6	7	8		13-
Adoption of the system protects against power failures.	1	2	3	4	5	6	7	8		14-
Performance of the system is sensitive to climatic conditions.	1	2	3	4	5	6	7	8		15-
The system is made up of field proven components.	1	2	3	4	5	6	7	8		16-
Adopting the system conveys the image of a modern, innovative company.	1	2	3	4	5	6	7	8		17-
The system requires a major retraining effort.	1	2	3	4	5	6	7	8		18-
The system's initial cost is acceptabl low.	1	2	3	4	5	6	7	8		19-
The system protects against fuel rationing.	1	2	3	4	5	6	7	8		20-
In adopting this system, we would do our part in reducing pollution.	1	2	3	4	5	6	7			21-
System components produced by several manufacturers can be substituted for one another.	1	2	3	4	5	6	7	8		22-
The system can easily be extended to meet increased HVAC needs.	1	2	3	4	5	6	7	8		23-
The system is easily installed.	1	2	3	4	5	6	7	8		24-
The system has too many concepts that have not been fully tested.	1	2	3	4	5	6	7	8		25-
System components are easily accessible for maintenance and repair.	1	2	3	4	5	6	7	8		26-
The system leads to considerable energy savings.	1	2	3	4	5	6	7	8		27-
The system is easily integrated into an industrial building.	1	2	3	4	5	6	7	8		28-
The system is too complex.	1	2	3	4	5	6	7	8		29-
The system's operating cost is acceptably low.	1	2	3	4	5	6	7	8		30-
The system offers a state-of-the-art solution to HVAC needs.	1	2	3	4	5	6	7	8		31-
The system increases the noise level in the plant.	1	2	3	4	5	6	7	8		32-
The system makes use of currently unproductive areas in industrial buildings.	1	2	3	4	5	6	7	8		33-
Adoption of this system will increase construction delays.	1	2	3	4	5	6	7	8		34-
The system is modular.	1	2	3	4	5	6	7	8		35-
Service for the system will be quick and easy.	1	2	3	4	5	6	7	8		36-

Section III: Preference Analysis

In the questions below, remember that System A is a Hot Water System and System B is a Space Heating System.

5. Assuming that each system met all of the operating and financial requirements that you specified in Section 1, what is the likelihood that you would recommend for purchase: (Check one line in each column, that is check one line in column a, b, c, and d.)

	System A		System B	
	(a) for new installation	(b) for retrofit installation	(c) for new installation	(d) for retrofit installation
Certain, practically certain (99 in 100)	_____ -99	_____ -99	_____ -99	_____ -99
Almost sure (9 in 10)	_____ -90	_____ -90	_____ -90	_____ -90
Very Probable (8 in 10)	_____ -80	_____ -80	_____ -80	_____ -80
Probable (7 in 10)	_____ -70	_____ -70	_____ -70	_____ -70
Good possibility (6 in 10)	_____ -60	_____ -60	_____ -60	_____ -60
Fairly good possibility (5 in 10)	_____ -50	_____ -50	_____ -50	_____ -50
Fair possibility (4 in 10)	_____ -40	_____ -40	_____ -40	_____ -40
Some possibility (3 in 10)	_____ -30	_____ -30	_____ -30	_____ -30
Slight possibility (2 in 10)	_____ -20	_____ -20	_____ -20	_____ -20
Very slight possibility (1 in 10)	_____ -10	_____ -10	_____ -10	_____ -10
No chance, almost no chance (0 in 10)	_____ -00	_____ -00	_____ -00	_____ -00
	37-38	39-40	41-42	43-44

6. In financial analysis, many companies use the payback period method for evaluating HVAC equipment. It determines the number of years required to recover an initial cash investment.

Now, considering your evaluation about fuel escalation, how long would you require that an investment in each HVAC system payback to:

	System A	System B
(a) Be 100% certain to recommend it over a conventional alternative (please answer to the nearest tenth of a year.)	_____, years 51-54	_____, years 63-66
(b) Be indifferent between it and a conventional alternative. (a 50-50% chance of recommending it)	_____, years 55-58	_____, years 67-70
(c) Be just willing to consider it for recommendation (a 10-20% chance of recommending it.)	_____, years 59-62	_____, years 71-74

7. How likely do you feel it is that an HVAC equipment manufacturer can currently produce:

	Very Unlikely		Moderately Likely			Very Likely		
a) a cost-effective system A?	1	2	3	4	5	6	7	75-
b) a reliable and dependable system A?	1	2	3	4	5	6	7	76-
c) a cost-effective system B?	1	2	3	4	5	6	7	77-
d) a reliable and dependable system B?	1	2	3	4	5	6	7	78-

cc 80-3
dup 1-4

8. Suppose your company chose an HVAC system which did not fully meet its expectations. How significant would it be for your organization if the system proved:

	Of little consequence to the organization				potentially catastrophic to the organization			
a) less economical than projected?	1	2	3	4	5	6	7	8-
b) less reliable and dependable than projected?	1	2	3	4	5	6	7	8-

9. Suppose you actively supported adoption of an HVAC system which did not fully meet expectations. How significant would it be for you personally if the system proved:

	Would not affect my position and credibility				Would highly endanger my position and credibility			
a) less economical than projected?	1	2	3	4	5	6	7	7 -
b) less reliable and dependable than projected?	1	2	3	4	5	6	7	8 -

Section IV: Decision Process Information

10. The purchase of an industrial HVAC system typically involves several participants. In this question, we would like to know more about who would be involved in the important phases of the decision-making process -- both company personnel and people external to the firm.

For each of the "decision phases" in the chart below, please indicate approximately what percentage of the task-responsibilities is that of each category of participants. For instance, Phase 1 may be the responsibility of the architect (25%), the HVAC consulting firm (25%), and top management (50%).

Of course, a given decision-making phase might be the responsibility of only one category of participants, in which case, you should write 100% in the appropriate box and leave all of the other boxes in that column blank.

	Decision Phases Decision Participants	Identification of HVAC alternatives		Financial and Technical evaluation*		Final Equipment and Source Selection**	
		New	Retrofit	New	Retrofit	New	Retrofit
INTERNAL COMPANY PERSONNEL	Production engineer	9 11 %	42 44 %	5 7 %	38 40 %	71 73 %	32 34 %
	Plant or maintenance engineer	12 14 %	45 47 %	8 10 %	41 43 %	74 76 %	35 37 %
	Design engineer	15 17 %	48 50 %	11 13 %	44 46 %	cc80-5 dup 1-4 5 7	38 40 %
	Plant or factory manager	18 20 %	51 53 %	14 16 %	47 49 %	8 10 %	41 43 %
	Financial controller or accountant	21 23 %	54 56 %	17 19 %	50 52 %	11 13 %	44 46 %
	Procurement or purchasing officer	24 26 %	57 59 %	20 22 %	53 55 %	14 16 %	47 49 %
	General Management	27 29 %	60 62 %	23 25 %	56 58 %	17 19 %	50 52 %
	Other (specify)	30 32 %	63 65 %	26 28 %	59 61 %	20 22 %	53 55 %
EXTERNAL PERSONNEL	HVAC/Engineering firm	33 35 %	66 68 %	29 31 %	62 64 %	23 25 %	56 58 %
	Architects	36 38 %	69 71 %	32 34 %	65 67 %	26 28 %	59 61 %
	HVAC equipment manufacturers/vendors	39 41 %	72 74 %	35 37 %	68 70 %	29 31 %	62 64 %
	COLUMN TOTAL	100%	cc80-4 dup 1-4 100%	100%	100%	100%	100%

*Decision phase 2 generally involves evaluation of all alternative HVAC systems that meet your company's needs while

** Decision phase 3 involves only the alternatives (generally 2-3) used for final selection.

Section V: Company Information

11. At what level in your organization are final HVAC decisions typically made: (CHECK ONE)

corporate level _____ 1
divisional level _____ 2
individual plant level _____ 3

66

Call the level noted above, the HVAC "decision unit", and answer the following questions in terms of that decision unit.

12. What were the sales for your decision unit last year (+ 10%)?

\$ _____ million
67 71

13. a. Where is the headquarters of your decision unit located?

ZIP _____
72 76

- b. Where is the plant you are associated with located?

ZIP _____
5 9

cc 80 6
dup 1-4

14. About how many separate plants does your decision unit have?

_____ 10 13

15. a. About how many total sq. ft. of plant area does your decision unit have?

_____ sq. ft.
14 19

- b. About what percent of this space is owned by the decision unit (not rented or leased)?

_____ %
20 22

- c. Of the area in (a), how is it distributed geographically? (See map)

Northeast _____ % 23 25
Northwest _____ % 26 28
Southeast _____ % 29 31
Southwest _____ % 32 34

100%

16. About how many employees does your decision unit have?

35 39

17. What is your expected growth rate in new plant area as a percent of your current plant floor area (do not subtract plant area currently being vacated)

40 42 % annual growth rate

18. Which of the following SIC codes represents the primary and secondary (if relevant) classifications for your decision unit:

20. Food and kindred products	30. Rubber and plastics
21. Tobacco manufacturers	31. Leather and leather products
22. Textile mill products	32. Stone, clay, glass and concrete
23. Apparel and other finished products made from fabrics	33. Primary metal industries
24. Lumber and wood products (except furniture)	34. Fabricated metal products (except machinery and transportation)
25. Furniture and fixtures	35. Machinery (except electrical)
26. Paper and allied products	36. Electrical and electronic machinery and equipment
27. Printing and Publishing	37. Transportation equipment
28. Chemicals	38. Measuring, analyzing and controlling instruments; photographic, medical, and optical goods; watches and clocks.
29. Petroleum and allied industries	Other: (specify) _____

Primary Classification 43 44

Secondary Classification 45 46

19. Estimate the annual HVAC energy usage for your decision unit (and your per unit energy cost):

a.

Primary Energy Source

Application	Oil	Gas	Elec.	Coal	Wood	Other - Specify
	5	4	5	5	5	
Space Heating	\$ 47 51	\$52 55	\$56 60	\$61 65	\$66 70	50 54 5
Space Cooling	\$71 75	\$ 5 9	\$10 14	\$15 19	\$20 24	55 59 5
Water Heating	\$ 18 80-21 dup 1-4	\$30 34	\$35 39	\$40 44	\$45 49	60 66 7
	25 29	5	5	5	5	

b.

	67 71	72 76	cc 80-8 dup 1-4	10 14	15 19	20 24
Cost per unit of energy	\$/gallon	\$/M cubic ft.	\$/KWH	\$/ton	\$/cord	

20. c. In the next 2-3 years, do you expect your firm will shift its fuel usage pattern?

1 NO

25

2 YES, we'll probably use less A and use more B .

Please check all that apply:

A. use less				B. use more			
Oil	<u> </u>	1	26	Oil	<u> </u>	1	32
Gas	<u> </u>	1	27	Gas	<u> </u>	1	33
Electricity	<u> </u>	1	28	Electricity	<u> </u>	1	34
Coal	<u> </u>	1	29	Coal	<u> </u>	1	35
Wood	<u> </u>	1	30	Wood	<u> </u>	1	36
Other (please specify)	<u> </u>	1	31	Other (please specify)	<u> </u>	1	37
<u> </u>				<u> </u>			
<u> </u>				<u> </u>			

21. About what percent of existing HVAC equipment do you expect your company will replace within the next five years?

 38 40 % of space heating
 41 43 % of space cooling
 44 46 % of water heating

22. Which statement best reflects your company's attitude toward new products and technologies (CHECK ONE):

- 1 We like to be at the frontier of technology and to be the first to experiment with new products and processes.
- 2 We carefully monitor test-installations in our industry and, if they work well, we are quick to adopt.
- 3 We take a wait-and-see attitude toward new products and processes.

47

ction VI: Personal Information

How many years have you been working for your present company?

48 49 _____ years

During a typical week, what percent of your job responsibilities are associated with the following job categories?

Plant or maintenance engineering	_____ %	50 52
Design engineering	_____ %	53 55
Plant management	_____ %	56 58
Procurement	_____ %	59 61
Financial analysis	_____ %	62 64
General management/planning	_____ %	65 67
Other _____	_____ %	68 70
_____	_____ %	71 73
_____	_____ %	74 76
_____	_____ %	
TOTAL	=	100 %

In making purchases for your own home, which statement best reflects your approach: (CHECK ONE):

- 1 _____ I find it interesting and exciting to be the first one in my area to try a new product.
- 2 _____ I'm interested in new products, but I like to have one or two of my friends try the product first to see if it has "bugs".
- 3 _____ If a product is really good, I'll buy it eventually, but not until it has proven itself for a few years.

77

cc 79-80 10

If you would like a copy of the results, please give us your name and address:

Name _____

Company _____

Address _____

Thank you very much for your cooperation!

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DOCUMENTATION FOR
FINAL INDUSTRIAL DATA

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Description of the Industrial Data

Content This document describes two data sets:

1. Industrial final screener survey.
2. Industrial final mailer survey.

Each section describes the data base, and has the questionnaire attached to it.

Data Location The data sets are in a tape, with labels on the tape describing its content.

Industrial Final Screener Data

1. General The data set for the industrial screener contains 655 observations. They are organized in a card format, 80 characters per line, 4 lines per observations. The ID that identifies the observation are the 5 numbers in column 2-6 of the first card of each observation, i.e. every four cards. The last three digits are the SIC code, and the first within each SIC code. These five numbers should be matched with the corresponding ID for the mailer questionnaire for the purpose of merging the data sets.
All blanks are missing or non available.
2. Data Description This part describes the coding of the data, references are included in the attached questionnaire.

CARD 1

<u>Col 1</u>	has always o, not meaningful
2-6	ID number
2-4	serial number
5-6	SIC code
7	question 1, verification of SIC code, should have 1=yes, 2=no
8	Q2, 1=yes, 2=no
9-12	Q3A1 - Q3A4, 1=yes, 2=no
13-18	Q3B1 - Q3B6
19-23	Q3C1 - Q3C5
skip	
27-31	Q4A - Q4E
32-40	Q5A - Q5I
41-60	Q6 manufacturer's codes are attached at the end of this description, Exhibit 12
61-62	Q7
skip	
64-75	Q8A - Q8B
skip	
80	card # 1

CARD 2

1-4	duplication of 1-4 of first card
5-72	Q8M
73-76	Q9A, Q9B, Q9C1-Q9C2
skip	
80	card # 2

CARD 3

Col

5-18 Q10, note that 18 corresponds to initial investment
cost only

19-29,
21-22 other financial criteria codes are enclosed at the end,
at Exhibit 13 (up to two criteria)

skip

23-28 Q11

29-31 Q12

32-33 Q13

34-35 Q14

36 Q15

37-43 Q16, other coding attached

46-54 Q17A-C, 3 columns for each

56-57 Q18A-B

58-78 Q19A - Q19G, 3 each

skip

80 card # 3

CARD 4

skip

Col

5-7 Q19H

8 Q20

9-11 Q21

12 Q22

13 Q23

14 Q24

skip

80 card # 4

EXHIBIT 12

Manufacturers Coding for Question 6

01	Sunworks
02	Grummond
03	Rheam
05	Century
06	Raypack
07	Pittsburgh Plate Glass (21)
08	Solaron
09	Lennox
11	Northrup
12	Westinghouse
13	Revere
18	Owens-Corning
20	Solartron
21	(enter 7)
24	American-Helio-Thermal
30	GE
35	Solar Dynamics, Inc. (111)
36	Solar Energy Products & Sales (44, 99)
41	Carrier
44	(enter 36)
55	Honeywell
65	Sol-Air (90)
89	A. O. Smith
99	(all others)

EXHIBIT 13

Financial Codes for Questions 10

01	Cost of Operation
02	Cost of Maintenance
03	Depreciation
04	Cost of Financing
05	Energy Costs
06	Installation Costs
07	Initial Control
08	Profitability Index
09	Percentage Service Contract
10	Initial Investment
11	Life Cycle
12	Long Term Return on Assets
13	Interest
14	Saving in Fuel
15	Purchase Rather Than Lease
16	Cost Over Performance
17	Compare Total Cost to Energy Cost
18	Estimated Service Dollars
19	Capital Appropriation
20	Investment Tax Credit-Government Grants
21	Quantity Discounts
22	Method of Financing
23	Any Additional Inventory Required

FINAL QUESTIONNAIRE

INDUSTRIAL SCREENER

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ID # _____

TIME START _____

(1-4)

TIME END _____

INDUSTRIAL SCREENER QUESTIONNAIRE

Hello, I'm _____ from Dialogue, an independent market research firm. We are conducting a study about attitudes toward solar energy in the industrial sector. (IF RELEVANT: WE GOT YOUR NAME FROM _____ WHO SAID YOU WERE AN APPROPRIATE PERSON TO ANSWER OUR QUESTIONS.)

It is very important for us to get opinions of relevant decision-makers such as yourself in a representative sample of firms. The individuals we need to speak to are those who usually participate in the decision process for the selection and purchase of heating and air conditioning equipment. These individuals should be familiar with the space heating and cooling needs of your organization.

Are you an appropriate individual to work with us on this study?

Yes _____ No _____ (IF NO, GO TO Q.A)

Let me explain how the study works. First I'll ask you a few questions over the phone about your firm's energy systems. That will take 20-25 minutes. When we're done, I'll mail you some information about solar energy systems. The material will also contain a questionnaire. We'd like you to read through the material and discuss it, if you wish, with any relevant members of your organization. Then we'd like you to complete the questionnaire and return it in a prepaid return envelope.

I'll call back in 10 days to 2 weeks to answer any questions you may have about the questionnaire.

Since our results will be based on a small sample, it is very important that we get your response. In addition, most organizations that have completed the survey have found it interesting and informative.

I'd like to ask you to agree to take part. Are there any questions you might have about the study? Will you participate?

Yes _____ No _____ (GO TO Q.A)

Great! Let me first get your name so I can mail out the package of material.

NAME: _____ TITLE: _____

FIRM NAME: _____

ADDRESS: _____ CITY: _____ STATE: _____ ZIP: _____

PHONE #: _____ INTERVIEWER'S NAME: _____

And when would be a good time to call you back, say within 10 days to 2 weeks?

TIME: _____ DAY: _____

(IF NECESSARY): Of course any information you provide will be combined with all other responses and will be used for statistical analyses only. Your participation will be completely confidential and your name will never be associated with this survey in any way.

Before I go on:

A... Who (besides yourself) in your organization would be appropriate for us to contact? (TRY TO GET FIVE NAMES - RECORD ON CALL RECORD SHEET)

- SIC #20 - Food & kindred products
 22 - Textile Mill products
 26 - Paper & allied products
 27 - Printing & publishing
 28 - Chemicals
 35 - Machinery except electric
 36 - Electrical & electronic
 machinery & equipment
 38 - Measuring, analyzing and
 controlling instruments
 *(ie. Photo, medical &
 optical equip. Also includ
 watches and clocks)
 * not necessary to read this

INDUSTRIAL QUESTIONNAIRE

1. According to our information your company's SIC code (standard industrial
 classification code) is _____ which means your company is principally in the
 _____ industry. Is that correct? RECORD S
(5-6)

GSIC

Yes ----- (SKIP TO Q.2) ----- 1
 No ----- 2

(IF NO):

Could you please describe in a few words the industry your organization is in:

- TERMINATE -

2. Prior to this study, have you seen or heard anything about the use of active solar
 energy equipment for heating water or for space heating or cooling for industrial
 use?

Yes ----- 8-
 No ----- (SKIP TO Q.8) ----- 1

(IF YES):

- 3a. Would this be for: (READ LIST AND CIRCLE ALL THAT APPLY)

	<u>YES</u>	<u>NO</u>
domestic water heating -----	9- 1	2
process water heating -----	10- 1	2
space heating -----	11- 1	2
space cooling -----	12- 1	2

- 3b. To the best of your knowledge, is your company now using any solar energy systems?

Yes ----- 13-
 No ----- (SKIP TO Q.3c) ----- 1

(IF YES, ASK): Is the system active or passive?

Active ----- 14-
 Passive ----- (SKIP TO Q.3c) ----- 1

(IF ACTIVE, ASK): For what purpose does your firm use active solar energy? Is it
 used for: (READ LIST AND CIRCLE ALL THAT APPLY)

domestic water heating -----	15- 1	} SKIP TO Q.4
process water heating -----	16- 1	
space heating -----	17- 1	
space cooling -----	18- 1	

3c. Has your firm actively sought information about an active solar energy system from a solar equipment manufacturer or dealer?

Yes _____ 19- 1
No _____ (GO TO Q.4) _____ 2

(IF YES):

For what kinds of active solar energy systems have you looked for information?
(READ LIST AND CIRCLE AS MANY AS APPLICABLE)

domestic water heating _____ 20- 1
process water heating _____ 21- 1
space heating _____ 22- 1
space cooling _____ 23- 1

24-
25-
26-

4. Now I'm going to read a few statements to you. After each statement, please tell me on a scale of 1 to 5 if you agree, or disagree with the statement. An answer of 1 would mean you strongly agree, 5 would mean you strongly disagree, 3 would mean you neither agree nor disagree.

	<u>Strongly agree</u>	<u>Moderately agree</u>	<u>Neither agree nor disagree</u>	<u>Moderately disagree</u>	<u>Strongly disagree</u>	
4a. We can currently obtain <u>reliable</u> and <u>dependable</u> solar energy equipment for use in our company.	1	2	3	4	5	27-
4b. We can currently obtain <u>reliable</u> and <u>dependable</u> solar energy equipment that makes economic sense for use in our company.	1	2	3	4	5	28-
4c. Solar energy equipment will be widely used in our industry within the next five years.	1	2	3	4	5	29-
4d. I understand the financial merits of solar energy systems.	1	2	3	4	5	30-
4e. I understand how solar energy systems work.	1	2	3	4	5	31-

(IF 4 OR 5 CIRCLED IN Q.4e, SKIP TO Q.6)

5. What different kinds of collectors do you know about? What others? (DO NOT READ LIST)

flat plate ----- 32- 1
 concentrator ----- 33- 1
 evacuated tube ----- 34- 1
 trickle collectors ----- 35- 1
 air collectors ----- 36- 1
 selective ----- 37- 1
 non-selective ----- 38- 1
 other (please specify)
 ----- 39- 1
 none ----- 40- (1)

Do you know the names of any suppliers or manufacturers of solar systems? (IF NO, GO TO Q.7) What names come to mind? What others? (PROBE, RECORD BELOW)

(ASK FOR EACH MANUFACTURER MENTIONED IN Q.6a)

Taking these manufacturers and suppliers one at a time, would you say (READ FROM LIST) makes a reliable, or unreliable product? (RECORD BELOW ON RELIABILITY SCALE) (REPEAT FOR EACH MANUFACTURER/SUPPLIER LISTED)

Again, taking these manufacturers and suppliers one at a time, would you say (READ FROM LIST) makes an economical, or uneconomical product? (RECORD BELOW ON ECONOMICAL SCALE, REPEAT FOR EACH MANUFACTURER/SUPPLIER LISTED)

Q.6a manufacturers/ suppliers	Q.6b			Q.6c		
	reliable	unreliable	DK	economical	uneconomical	DK
41-42	1	2	3 -43	1	2	3 4
45-46	1	2	3 -47	1	2	3 -48
49-50	1	2	3 -51	1	2	3 52
53-54	1	2	3 -55	1	2	3 6
57-58	1	2	3 -59	1	2	3 -60

Is it likely or unlikely that your company will buy solar heating or cooling equipment for some application in the next (READ LIST)? Is that very or somewhat (likely/unlikely)?

	Very Likely	Somewhat Likely	Unsure	Somewhat Unlikely	Very Unlikely	
six months	1	2	3	4	5	61-
two years	1	2	3	4	5	62-

8. Now suppose that your firm has decided to install a new HVAC system, and has identified several different systems for consideration. I'd like to ask you about the criteria you use to screen out some of these alternatives. For each criteria I mention, I'd first like to know if you use it or not. The first is (READ UNDERLINED WORDS PREFACED BY "DO YOU USE...", IF "NO", CHECK RIGHT HAND COLUMN. READ ENTIRE LIST THEN FOR EACH "YES" GO BACK AND ASK FULL QUESTION AND FILL IN RESPONSE IN APPROPRIATE BLANK SPACE. NOT USED

Do you use (READ UNDERLINED WORDING)?

o What is the minimum expected life you would consider? years -67
64-66

o For cooling equipment, what is the maximum initial investment cost in dollars per ton that you would consider? \$/ton -75
68-74

o For heating, what is the maximum initial investment cost in dollars per thousand BTU's per hour you would consider? \$/KBTU/hr -12
5-11
(80) 1
DUP 1-4

o What is the minimum warranty period that you would consider? months -17
13-16

o What is the minimum number of other successful industrial installations you would consider? -25
13-24

o What is the maximum annual maintenance cost as a percentage of initial investment that you would consider? % -29
26-28

o For heating, what is the minimum energy conversion efficiency you would consider? -33
30-32

o For cooling, what is the minimum coefficient of performance, or COP you would consider? -38
34-37

(NOTE: COP IS A NUMBER, NOT A PERCENTAGE, BETWEEN 0 AND 15. IF RESPONDENT ANSWERS OVER 15, OR X "PERCENT", ASK: Can you tell me how you are defining COP?)

NOT USED

- o What is the minimum energy efficiency ratio, or EER, that you would consider? 39-45 -46
- o What is the minimum seasonal energy efficiency ratio or SEER? 47-53 -54
- o For cooling, what is the maximum cost of a service contract, in dollars per year per ton of cooling, that you would consider? \$/yr/ton -62
55-61
- o What is the minimum coefficient of performance or COP you would consider for heat pumps in the heating mode? 63-66 -67
- o What is the minimum seasonal COP in heating for heat pumps? 68-71 -72
- 9a. Would you consider an HVAC system if the manufacturer did not have a local presence? yes-1 no-2 -73
- 9b. Would you consider an HVAC system if you had no previous experience with the system vendor or the manufacturer? yes-1 no-2 -74
- 9c. Now assuming you were considering a retrofit installation, in screening alternatives would you consider the system (READ FOR EACH STATEMENT FOLLOWING)
- If it was not the same type as the one that was being replaced? 75-
Yes ----- 1
No ----- 2
- If the energy source is not the same as the one you are currently using? 76-
Yes ----- 1
No -----
- 10a. In evaluating industrial HVAC equipment, which of the following financial criteria does your company use? Do you use (READ LIST) (80) 2
(READ ALL METHODS FIRST THEN GO BACK & ASK QUESTION FOR EACH YES) DUP 1
- Payback method - which is a method that estimates the number of years required to recover the initial cash investment and selects equipment for which the recovery time is sufficiently short? 5-
Yes ----- 1
No ----- 2
- (IF YES, ASK:) What is the length of the payback period you required? years 6-
7-
8-

A Cash Flow Discounting Method - which is a method that estimates yearly cash inflows or savings and cash outflows or costs over the life of the equipment and discounts these flows to account for the time value of money.

9-
Yes ----- 1
No ----- 2

(IF YES, ASK:)
Does your company use the Net Present Value Method?

10-
Yes ----- 1
No ----- 2

(IF YES, ASK:) What does your company currently use as its discount rate (cost of capital)?

11-
12-
13-

Does your company use the Internal Rate of Return (that is, the discounted cash flow of return)?

14-
Yes ----- 1
No ----- 2

(IF YES, ASK:) What does your company use as its internal rate of return?

15-
16-
17-
18-

Initial investment cost only, or

Yes ----- 1
No ----- 2

Some other financial criteria (SPECIFY)

19-

11. Now I am going to read you a list of six criteria that are often used in evaluating HVAC equipment for new installation. After I read the list, I would like you to tell me which criterion you consider to be the most important in your evaluation of HVAC equipment. (READ LIST. MAKING SURE TO READ X'D CRITERION FIRST, CONTINUING UNTIL ALL CRITERIA ARE READ. RECORD A "1" NEXT TO MOST IMPORTANT.) Which one do you consider the most important in your evaluation of HVAC equipment?

20-
21-
22-

Now, of all the remaining criteria (READ LIST, OMITTING "MOST IMPORTANT CRITERION", AGAIN STARTING WITH X'D FEATURE) which would you consider to be the second most important criterion in evaluating HVAC equipment? (RECORD A "2" NEXT TO SECOND MOST IMPORTANT. REPEAT QUESTION UNTIL ALL SIX CRITERIA HAVE BEEN RANK ORDERED. BE SURE TO READ LIST OF REMAINING CRITERIA EACH TIME AND RECORD RANK ORDER IN THE SPACE NEXT TO THE CRITERIA.)

<u>Criteria</u>	<u>Rank Order</u>
() Initial cost	23- _____
() Supplier reputation and service	24- _____
() Cost of operating and maintenance	25- _____
() System reliability	26- _____
() Convenience of installation and operation	27- _____
() Life cycle cost	28- _____

12. Between now and 1985, what average annual rate of fuel cost increase do you expect your firm will see?

29-
30-
31-

_____ % per year (average)

13. Suppose your company chose an HVAC system which did not fully meet its expectations. On a five point scale, where 1 is of little consequence to your company and 5 is potentially catastrophic to your company, how significant would it be for your organization if the system proved: (READ LIST)

	Of little consequence to the organization			Potentially catastrophic to the organization			
a) less economical than projected?	1	2	3	4	5		-32
b) less reliable and dependable than projected?	1	2	3	4	5		-33

14. Suppose you actively supported adoption of an HVAC system which did not fully meet expectations. On a five point scale, where 1 would not affect your position and credibility and 5 would highly endanger your position and credibility, how significant would it be for you personally if the system proved: (READ LIST)

	Would not affect my position and credibility			Would highly endanger my position and credibility			
a) less economical than projected?	1	2	3	4	5		-34
b) less reliable and dependable than projected?	1	2	3	4	5		-35

15. At what level in your organization are final HVAC decisions typically made:
(READ LIST)

	36-
Corporate level -----	1
Divisional level -----	2
Individual plant level -----	3

16. In the next 2-3 years, do you expect your firm will shift its fuel usage pattern?

Yes ----- 37- 1
 No --- (SKIP TO Q.17) ----- 2

(IF YES, ASK:)

What fuels do you expect to use less of? What fuels do you expect to use more of? (READ LIST)

		A. use less	B. use more
Oil -----	38-	1	2
Gas -----	39-	1	2
Electricity -----	40-	1	2
Coal -----	41-	1	2
Wood -----	42-	1	2
Other (SPECIFY) -----	43-	1	2

17. About what percent of existing HVAC equipment in the following three areas do you expect your company will replace within the next five years? (READ LIST)

Space heating	_____ %	46- 47- 48- 49- 50- 51- 52- 53- 54-
Space cooling	_____ %	
Water heating	_____ %	

18a. Which of the following three statements best reflects your company's attitude toward new products and technologies: (READ LIST)

- a) We like to be at the frontier of technology and to be the first to experiment with new products and processes. 56- 1
- or
- b) We carefully monitor test-installation in our industry and, if they work well, we are quick to adopt. 2
- or
- c) We take a wait-and-see attitude toward new products and processes. 3

18b. In making purchases for your own home, which of the following three statements best reflects your approach: (READ LIST)

- a) I find it interesting and exciting to be the first one in my area to try a new product. 57- 1
- or
- b) I'm interested in new products, but I like to have one or two of my friends try the product first to see if it has "bugs". 2
- or
- c) If a product is really good, I'll buy it eventually, but not until it has proven itself for a few years. 3

Finally, I would like to get a little more information about you for classification purposes:

19. Which of the following categories correspond most closely to your job responsibilities or if you feel that you are responsible for more than one area what % of time is spent in each category? (READ LIST) (INDICATE %)

Production engineer	_____ %	58-
		59-
		60-
Plant or maintenance engineer	_____ %	61-
		62-
		63-
Design engineer	_____ %	64-
		65-
		66-
Plant or factory manager	_____ %	67-
		68-
		69-
Financial controller/ accountant	_____ %	70-
		71-
		72-
Procurement or purchasing officer	_____ %	73-
		74-
		75-
General manager	_____ %	76-
		77-
		78-
Other (SPECIFY)		80-3
		DUP 1-4
_____ %		5-
		6-
		7-
TOTAL	100%	

20. About how many people report to you in your company, directly or indirectly?
(READ LIST)

0	_____	8-
1 - 3	_____	1
4 - 10	_____	2
11 - 30	_____	3
over 30	_____	4
		5

1. How many years have you been working for your present company? 9-
 10-
 _____ years 11-

22. In your highest degree, which of the following best describes the area of study you concentrated in? (READ LIST)

Math/science -----	12-1
Engineering -----	2
Business -----	3
Liberal arts -----	4

23. What was the highest level of schooling you completed? (READ LIST)

High school -----	13-1
College -----	2
Post-graduate -----	3
(DO NOT READ) Refused -----	4

24. Into which of the following age groups do you fall? (READ LIST)

Under 25 -----	14-1
25 - 34 -----	2
35 - 44 -----	3
45 - 54 -----	4
Over 55 -----	5
(DO NOT READ) Refused -----	6

80-4

(CONFIRM CALLBACK TIME/DATE AND RECORD ON SCREENER)

THANK YOU VERY MUCH FOR YOUR TIME!

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FINAL QUESTIONNAIRE

INDUSTRIAL MAIN

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Industrial Mailer Questionnaire

1. General The data set for the industrial mail questionnaire contains 209 observations. They are organized in a card format, 80 characters per line, 5 lines, or cards per observation. The ID that identifies the observation is the five first digit or the first card of each observation. First there is SIC code, and the other two are serial numbers. The five digits are to be used for matching with the screener.

All blanks are missing values. 999 means the number is larger than 999.
2. Data Description This part describes the coding of the data, references are included in the attached questionnaire.

CARD 1

1-5 ID number

1-3 serial number

4-5 SIC code

6 questionnaire type, there are seven different questionnaire types, where system A & B are different, a description of which are systems A & B for each questionnaire type is attached at the end

7-30 SYS1 - SYS24 for system A

31-54 SYS1 - SYS24 for system B

55-56 Q1 for system A

57-58 Q1 for system B

codes are described in the attached questionnaire

53-62 Q2A1 for system A

63-66 Q2B1 for system B

skip

80 card # 1

CARD 2

Col

7-10 Q2A2 for system A

11-14 Q2B2 for system B

15-18 Q2A3 for system A

19-22 Q2B3 for system B

23-29 Q3A - Q3g

30-69

skip

Question 4. Description in the attached questionnaire

CARD 3

7-54

CARD 3 (continued)

55 Q5
56-58 Q6
59-63 Q7a
64-66 Q7b
70 card # 3

CARD 4

Col

7-18 Q7C1 - Q7C4, 3 digits each
19-28 Q8A - Q8B
29-31 Q9
32-35 Q10
36-39 Q11

40-70

CARD 5

7-29
30-32 Q12b.

Q12a. description in the attached
questionnaire

Industrial Questionnaire - Main
Questionnaire Type vs. Systems

<u>Version #</u>	<u>System A</u>	<u>System B</u>
1	water heating	space heating
2*	space cooling	space heating
3	water heating	space cooling
4	water heating	heat pump
5	space heating	heat pump
6	space cooling	space heating
7	space cooling	heat pump

* Version #2 had concentrating collector description, all others had flat plate.

QUESTIONNAIRE:THE SOLAR ENERGY EQUIPMENT PURCHASING PROCESS

In the following questionnaire, we ask you for information about your company and the process you use to purchase heating, ventilating and air conditioning (HVAC) equipment.

Some of the information requested may not be immediately available to you. Please use any sources (people, reports) within your company that you need to complete the questions. Note also that we would prefer to get your best guess about any of the questions than to have the answer left blank.

Section I: Attitudes Toward Alternative Systems

We would like to learn your reaction to two industrial solar HVAC systems. The summary description of each system is followed by a list of statements that you will be asked to agree or disagree with.

We are interested in how you FEEL about these systems, based on their descriptions, rather than your quantitative evaluation of the systems. There are NO RIGHT OR WRONG ANSWERS, so feel free to register your opinion about the product described.

SYSTEM A

SOLAR ABSORPTION COOLING

A solar absorption cooling system contains three major components: a solar collector array, storage tanks, and an absorption chiller unit. (See Diagram.)

The flat plate collector array consists of a modular set of panels (collectors) installed in a location with maximum exposure to the sun at all times of the year. The collectors are mounted at an angle from the horizontal approximately equal to the installation latitude. Direct attachment to a roof of acceptable slope often produces an aesthetically pleasing installation. Each flat plate solar collector is an insulated box, completely glazed on one side enclosing a flat black metal plate which contains closed channels for the passage of heat transfer fluid. In January of 1980 a flat plate collector could be purchased for between \$10 and \$20 per square foot. The thermal performance of flat plate collectors depends on many factors. However, a rule of thumb is that flat plate collectors will deliver the energy equivalent of 1 to 2 gallons of fuel oil, 1 to 2 thousand cubic feet of natural gas, or 30 to 60 KWH of electricity per square foot of collector per year, at a delivered temperature of 150°F.

The insulated hot water storage tank is used as a method of retaining solar heat for use at night or on days when the sun is obscured by clouds. The storage tank is usually sized to hold two days worth of normal heating requirement. In many installations, a thermostatic mixing valve is used in the delivery line from the tank to keep delivery temperature constant.

In addition to hot water storage, chilled water can be stored for later use in cooling building air when solar energy is not available.

The actual air conditioning unit works on the

same principal as a gas refrigerator, with the gas flame being replaced by solar heat. In the refrigeration cycle, a chilled liquid (usually water) expands to cool the building supply air. This liquid is then recompressed through a process of absorbing the lower pressure liquid vapor in a concentrated salt solution. The salt solution and water vapor is produced in a generator driven by solar-heated hot water. During sunless days or at night the system uses hot water storage tanks for driving heat, or draws on stored chilled water. One positive element of solar cooling is the strong correlation between available solar energy and cooling requirements.

As can be seen in the system diagram, the process starts in the generator which is filled with the absorber liquid (lithium bromide solution) and is heated by energy from the solar collector. The absorber boils, producing refrigerant vapor and concentrated absorbent. Heat is rejected from the refrigerant vapor by the cooling water, condensing it to a liquid. The liquid refrigerant flows through the expansion valve separating the High and Low pressure side to the evaporator. At the evaporator the drop in pressure boils the refrigerant producing refrigeration, which is applied to the cooling load. The cycle is completed at the absorber where the concentrated lithium bromide solution absorbs the coolant (water) vapor. The heat exchanger for the absorbent serves to preheat dilute absorbent and cool the concentrated absorbent.

The entire absorption system utilizes standard gas fired refrigeration technology with the generator modified to operate on the 200°F solar-heated water.

System A: <u>SOLAR ABSORPTION COOLING</u>	(Circle one number for each item)									
	Strongly Disagree		Neither Agree nor Disagree			Strongly Agree		Don't Know		
The system produces reliable output.	1	2	3	4	5	6	7	8	-7	
Adoption of the system protects against power failures.	1	2	3	4	5	6	7	8	-8	
Performance of the system is sensitive to climatic conditions.	1	2	3	4	5	6	7	8	-9	
The system is made up of field proven components.	1	2	3	4	5	6	7	8	-10	
Adopting the system conveys the image of a modern, innovative company.	1	2	3	4	5	6	7	8	-11	
The system requires a major retraining effort.	1	2	3	4	5	6	7	8	-12	
The system's initial cost is acceptably low.	1	2	3	4	5	6	7	8	-13	
The system protects against fuel rationing.	1	2	3	4	5	6	7	8	-14	
In adopting this system, we would do our part in reducing pollution.	1	2	3	4	5	6	7	8	-15	
System components produced by several manufacturers can be substituted for one another.	1	2	3	4	5	6	7	8	-16	
The system can easily be extended to meet increased HVAC needs.	1	2	3	4	5	6	7	8	-17	
The system is easily installed.	1	2	3	4	5	6	7	8	-18	
The system has too many concepts that have not been fully tested.	1	2	3	4	5	6	7	8	-19	
System components are easily accessible for maintenance and repair.	1	2	3	4	5	6	7	8	-20	
The system leads to considerable energy savings.	1	2	3	4	5	6	7	8	-21	
The system is easily integrated into an industrial building.	1	2	3	4	5	6	7	8	-22	
The system is too complex.	1	2	3	4	5	6	7	8	-23	
The system's operating cost is acceptably low.	1	2	3	4	5	6	7	8	-24	
The system offers a state-of-the-art solution to HVAC needs.	1	2	3	4	5	6	7	8	-25	
The system increases the noise level in the plant.	1	2	3	4	5	6	7	8	-26	
The system makes use of currently unproductive areas in industrial buildings.	1	2	3	4	5	6	7	8	-27	
Adoption of this system will increase construction delays.	1	2	3	4	5	6	7	8	-28	
The system is modular.	1	2	3	4	5	6	7	8	-29	
Service for the system will be quick and easy.	1	2	3	4	5	6	7	8	-30	

SYSTEM B

SOLAR ASSISTED HEAT PUMP

The major components of a solar assisted heat pump system are the collector array, transfer fluid system, solar storage, solar controller and heat pump. (See Diagram.)

The flat plate collector array consists of a modular set of panels (collectors) installed in a location with maximum exposure to the sun at all times of the year. The collectors are mounted at an angle from the horizontal approximately equal to the installation latitude. Direct attachment to a roof of acceptable slope often produces an esthetically pleasing installation. Each flat plate solar collector is an insulated box, completely glazed on one side enclosing a flat black metal plate which contains closed channels for the passage of heat transfer fluid. In January of 1980 a flat plate collector could be purchased for between \$10 and \$20 per square foot. The thermal performance of flat plate collectors depends on many factors. However, a rule of thumb is that flat plate collectors will deliver the energy equivalent of 1 to 2 gallons of fuel oil, 1 to 2 thousand cubic feet of natural gas, or 30 to 60 KWH of electricity per square foot of collector per year, at a delivered temperature of 150°F.

The transfer fluid system consists of a pump, heat exchanger and associated piping. To avoid problems of freezing and corrosion, glycol solutions are usually used as the transfer fluid. The transfer fluid pump is activated by the solar system controller and circulates the fluid across the collectors and through a heat exchanger at the storage tank.

The system controller operates the transfer fluid pump in response to thermostat sensors. The controller measures the difference between collector and storage temperatures and starts the operation of the pump when a positive difference is measured.

The insulated hot water storage tank is used as a method of retaining solar heat for use at night or on days when the sun is obscured by clouds. The storage tank is usually sized to hold two days worth of normal heating requirements. In many installations, a

thermostatic mixing valve is used in the delivery line from the tank to keep delivery temperature constant.

A heat pump uses the same three components as an air conditioner - an evaporator, compressor, and condenser. However, the cycle is reversed. In effect, a heat pump attempts to cool the outside, and in the process "pumps" heat to the indoor air. In a normal heat pump installation the indoor air absorbs heat from the refrigerant which obtains the heat from the outside air. In a solar-assisted unit the heat is obtained from the stored solar-heated fluid. The higher the temperature of the source fluid, the more efficient the heat transfer. This efficiency is measured by the COP (coefficient of performance). A COP of 2 means that one unit of electrical energy applied to the unit will move 2 units of heat across the unit.

When the temperatures of the solar storage and collector return line are lower than that which can be efficiently used for direct building heating, the solar-assisted heat pump is an effective heating system. In the hypothetical example shown in the system diagram, the heat pump alone would have a low COP (coefficient of performance) because the ambient temperature below freezing decreases the heat source and causes freezing problems on the outdoor coil. The solar system alone, as shown in the schematic, cannot produce transfer fluid temperatures high enough to provide useful heat to the building. However, when coupled in a system as shown in the schematic, the efficiency of both systems is improved.

The heat pump operates on a fluid which has a temperature elevated well above freezing. Even if the solar storage is kept as little as 20°F above ambient, the heat pump COP is improved (as long as the storage temperature is above 35°F). The solar collector efficiency is also improved over a direct solar heating scheme. Since a lower temperature transfer fluid is in use, the collector cover losses are less, increasing efficiency. The collectors can be used during periods of otherwise marginal sunshine such as at the beginning and end of the day and on partly cloudy days, which also increases solar system efficiency.

		(Circle one number for each item)											
System B: <u>SOLAR ASSISTED HEAT PUMP</u>		Strongly Disagree		Neither Agree nor Disagree					Strongly Agree		Don't Know		
1	The system produces reliable output.	1	2	3	4	5	6	7			8	-31	
2	Adoption of the system protects against power failures.	1	2	3	4	5	6	7			8	-32	
3	Performance of the system is sensitive to climatic conditions.	1	2	3	4	5	6	7			8	-33	
4	The system is made up of field proven components.	1	2	3	4	5	6	7			8	-34	
5	Adopting the system conveys the image of a modern, innovative company.	1	2	3	4	5	6	7			8	-35	
6	The system requires a major retraining effort.	1	2	3	4	5	6	7			8	-36	
7	The system's initial cost is acceptably low.	1	2	3	4	5	6	7			8	-37	
8	The system protects against fuel rationing.	1	2	3	4	5	6	7			8	-38	
9	In adopting this system, we would do our part in reducing pollution.	1	2	3	4	5	6	7			8	-39	
10	System components produced by several manufacturers can be substituted for one another.	1	2	3	4	5	6	7			8	-40	
11	The system can easily be extended to meet increased HVAC needs.	1	2	3	4	5	6	7			8	-41	
12	The system is easily installed.	1	2	3	4	5	6	7			8	-42	
13	The system has too many concepts that have not been fully tested.	1	2	3	4	5	6	7			8	-43	
14	System components are easily accessible for maintenance and repair.	1	2	3	4	5	6	7			8	-44	
15	The system leads to considerable energy savings.	1	2	3	4	5	6	7			8	-45	
16	The system is easily integrated into an industrial building.	1	2	3	4	5	6	7			8	-46	
17	The system is too complex.	1	2	3	4	5	6	7			8	-47	
18	The system's operating cost is acceptably low.	1	2	3	4	5	6	7			8	-48	
19	The system offers a state-of-the-art solution to HVAC needs.	1	2	3	4	5	6	7			8	-49	
20	The system increases the noise level in the plant.	1	2	3	4	5	6	7			8	-50	
21	The system makes use of currently unproductive areas in industrial buildings.	1	2	3	4	5	6	7			8	-51	
22	Adoption of this system will increase construction delays.	1	2	3	4	5	6	7			8	-52	
23	The system is modular.	1	2	3	4	5	6	7			8	-53	
24	Service for the system will be quick and easy.	1	2	3	4	5	6	7			8	-54	

Next, we'd like to get your feelings about solar:

Section II: Preference Analysis

In the questions below, remember that SYSTEM A IS A SPACE COOLING SYSTEM and SYSTEM B IS A SOLAR ASSISTED HEAT PUMP SYSTEM.

1. Assuming that each system met all of the operating and financial requirements of your firm (as we discussed over the phone), what is the likelihood that you would recommend that your firm purchase each system for a new installation? (Check one line in each column.)

	<u>System A</u>	<u>System B</u>
Certain, practically certain (99 in 100)	<u>99</u>	<u> </u>
Almost sure (9 in 10)	<u>90</u>	<u> </u>
Very probable (8 in 10)	<u>80</u>	<u> </u>
Probable (7 in 10)	<u>70</u>	<u> </u>
Good possibility (6 in 10)	<u>60</u>	<u> </u>
Fairly good possibility (5 in 10)	<u>50</u>	<u> </u>
Fair possibility (4 in 10)	<u>40</u>	<u> </u>
Some possibility (3 in 10)	<u>30</u>	<u> </u>
Slight possibility (2 in 10)	<u>20</u>	<u> </u>
Very slight possibility (1 in 10)	<u>10</u>	<u> </u>
No chance, almost no chance (0 in 10)	<u>01</u>	<u> </u>
	55-56	57-58

2. In financial analysis, many companies use the payback period method for evaluating HVAC equipment. It determines the number of years required to recover an initial cash investment.

Now, considering your feeling about fuel escalation, how long would you require that an investment in each HVAC system payback to:

	<u>System A</u>	<u>System B</u>
(a) Be 100% certain to recommend it over a conventional alternative. (Please answer to the nearest tenth of a year.)	<u> </u> years 59-62	<u> </u> years 63-66
(b) Be indifferent between it and a conventional alternative (a 50% chance of recommending it).	<u> </u> years 7-10	<u> </u> years 11-14
(c) Be just willing to consider it for recommendation (a 10-20% chance of recommending it).	<u> </u> years 15-18	<u> </u> years 19-22

80-1
dup 1-1

3. Again, SYSTEM A IS A SPACE COOLING SYSTEM AND SYSTEM B IS A HEAT PUMP SYSTEM. Please circle the number which shows how much you agree or disagree with each of the following statements:

	<u>Strongly agree</u>	<u>Moderately agree</u>	<u>Neither agree nor disagree</u>	<u>Moderately disagree</u>	<u>Strongly disagree</u>	
a) We can currently obtain a System A that makes economic sense for use in our company.	1	2	3	4	5	-23
b) We can currently obtain a reliable and dependable System A for use in our company.	1	2	3	4	5	-24
c) We can currently obtain a System B that makes economic sense for use in our company.	1	2	3	4	5	-25
d) We can currently obtain a reliable and dependable System B for use in our company.	1	2	3	4	5	-26
e) Solar energy equipment will be widely used in our industry within the next five years.	1	2	3	4	5	-27
f) I understand the financial merits of solar energy systems.	1	2	3	4	5	-28
g) I understand how solar energy systems work.	1	2	3	4	5	-29

Section III: Decision Process Information

4. The purchase of an industrial HVAC system typically involves several participants. In this question, we would like to know more about who would be involved in the important phases of the decision-making process -- both company personnel and people external to the firm.

For each of the "decision phases" in the following chart, please indicate approximately what percentage of the task-responsibilities is that of each category of participants. For instance, Phase I may be the responsibility of the architect (25%), the HVAC consulting firm (25%), and top management (50%).

Of course, a given decision-making phase might be the responsibility of only one category of participants, in which case, you should write 100% in the appropriate box and leave all of the other boxes in that column blank.

	Decision Phases Decision Participants	1 Identification of HVAC alternatives		2 Financial and technical evaluation*	3 Final equipment and source selection**	
		New Installation	Retrofit Installation			
INTERNAL COMPANY PERSONNEL	Production engineer	30-31 %	32-33 %	34-35 %	36-37 %	
	Plant or maintenance engineer	38-39 %	40-41 %	42-43 %	44-45 %	
	Design engineer	46-47 %	48-49 %	50-51 %	52-53 %	
	Plant or factory manager	54-55 %	56-57 %	58-59 %	60-61 dup %	
	Financial controller or accountant	62-63 %	64-65 %	66-67 %	68-69	80-2 dup 1-6
	Procurement or purchasing officer	7-8 %	9-10 %	11-12 %	13-14 %	
	General management	15-16 %	17-18 %	19-20 %	21-22 %	
	Other (specify)	23-24 %	25-26 %	27-28 %	29-30 %	
EXTERNAL PERSONNEL	HVAC/Engineering firm	31-32 %	33-34 %	35-36 %	37-38 %	
	Architects	39-40 %	41-42 %	43-44 %	45-46 %	
	HVAC equipment manufacturers/vendors	47-48 %	49-50 %	51-52 %	53-54 %	
	COLUMN TOTAL	100%	100%	100%	100%	

*Decision phase 2 generally involves evaluation of all alternative HVAC systems that meet your company's needs, while

**Decision phase 3 involves only the alternatives (generally 2-3) retained for final selection

Section IV: Company Information

5. At what level in your organization are final HVAC decisions typically made?
(CHECK ONE)

corporate level _____ $\leftarrow$ 1
divisional level _____ $\leftarrow$ 2
individual plant level _____ $\leftarrow$ 3

-55

Call the level noted above the HVAC "decision unit", and answer the following questions in terms of that decision unit.

6. About how many separate plants does your decision unit have?

56-58

- 7a. About how many total sq. ft. of plant area does your decision unit have?

Q7SQFT _____ thousand sq. ft.
59-63

- b. About what percent of this space is owned by the decision unit (not rented or leased)?

Q7PRCNT _____ %
64-66

- c. Of the area in (a), how is it distributed geographically (see map)?

Northeast Q7C1 _____ % 7-9

Northwest Q7C2 _____ % 10-12

Southeast Q7C3 _____ % 13-15

Southwest Q7C4 _____ % 16-18

100 %

80-3

dup 1-6

8a. Where is the headquarters of your decision unit located?

ZIP _____

19-23

b. Where is the plant you are associated with located?

ZIP _____

24-28

9. What is your expected growth rate in new plant area as a percent of your current plant floor area (do not subtract plant area currently being vacated)?

_____ % annual growth rate

29-31

10. What were the sales for your decision unit last year (+ 10%)?

\$ _____ million

32-35

11. About how many employees does your decision unit have?

_____ 36-39

12a. Please estimate your decision unit's annual HVAC energy usage of each of the following fuels. What is your company's unit energy cost of each of these fuels?

	<u>Oil</u>	<u>Gas</u>	<u>Elec.</u>	<u>Coal</u>	<u>Wood</u>	<u>Other</u> (speci ')
Annual usage (thousands of dollars)						
usage 1-6	40-43	44-47	48-51	52-55	56-59	62-65 60-61
per unit energy cost						
uncost 1-6	\$/gal	\$/M	\$/KWH	\$/ton	\$/cord	
	66-70	ft ³	12-16	17-21	22-26	27-29

80-3
dup 1-6 7-11

01=Propane

02=Solar

03=Solar

(from process

b. Please check the primary fuel your company uses for each of the following HVAC applications. (Please place only one check in each row.)

	<u>Oil</u>	<u>Gas</u>	<u>Elec.</u>	<u>Coal</u>	<u>Wood</u>	<u>Other</u> (speci ')
Space heating	SH _____ -1	_____ -2	_____ -3	_____ -4	_____ -5	_____ -6 50
Space cooling	SC _____ -1	_____ -2	_____ -3	_____ -4	_____ -5	_____ -6 1
Water heating	WH _____ -1	_____ -2	_____ -3	_____ -4	_____ -5	_____ -6 2

Thank you very much for your cooperation! If you would like a copy of the results, please write your name and address below, and we will be happy to send you a copy when they are available.

Name _____

Company _____

Address _____

If you would like to comment on this questionnaire or solar products in general, please use the space below to do so.

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A MARKET ASSESSMENT FOR ACTIVE SOLAR
HEATING AND COOLING PRODUCTS

CATEGORY B: A SURVEY OF DECISION MAKERS
IN THE HVAC MARKET PLACE

SURVEY INSTRUMENTS

September, 1980

Prepared for:

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Office of Solar Applications for Buildings
U.S. Department of Energy

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RESIDENTIAL SEGMENT

TELEPHONE SCREENER QUESTIONNAIRE

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Market Survey

STATE:

Screening

1 1-4

1 5-

Hallo, I'm _____ from Dialogue an independent market research firm. We are conducting a national survey about solar energy.

I'd like to ask you a few brief questions.

1. Do you currently own a home?

yes _____ -1

no _____ -2 (SKIP TO Q.6)

6-

2a. Does your home have a water heater, to supply hot water for baths, showers, dishwashing and so on?

yes _____ -1

no _____ -2 (TERMINATE AND TALLY)

7-

2b. (IF YES TO Q.2a)

And what fuel does that water heater use?

Gas _____ -1

8-

Electric _____ -2

Oil _____ -3

Solar _____ -4

Other: (SPECIFY)

-5

2c. If your water heater broke down and had to be replaced, would you replace it your self, or have someone do the work for you?

9-

Replace by self _____ -1

Have someone do work _____ -2

And where would you buy the necessary parts? (DO NOT READ)

Plumbing supply house _____ -1

Large merchandiser (Sears, etc.) _____ -2

Hardware store, other small store _____ -3

Other (specify) _____ -4

10-

And who would you be most likely to call to replace the broken water heater? ((DO NOT READ)

Plumber _____ -1

Solar dealer _____ -5

Electric Co. _____ -2

Friend, relative _____ -6

Gas Co. _____ -3

Other (specify) _____ -7

Oil dealer _____ -4

11-

3. Are you currently using a solar energy system in your home?

yes _____ -1 (GO DIRECTLY TO YELLOW QUESTIONNAIRE) no _____ -2

12-

4. How long have you owned your home? (READ LIST)

Keypunch: If "1" in cc 12 skip to yellow portion

less than 2 years _____ -1

13-

over 2 years _____ -2

5. When you moved in, was your home newly built, or was it owned by someone else?

newly built _____-1

owned by someone else _____-2 (TERMINATE IF Q.6 IS NOT "YES") 14-

6. Are you currently planning to build a new home or to buy a newly constructed home?

yes _____-1

no _____-2 (TERMINATE IF Q.5 IS NOT "NEWLY BUILT") 13-

(IF "LESS THAN 2 YEARS" IN Q.4 AND "NEWLY BUILT" IN Q.5, CONTINUE, OR IF "YES" TO Q.6, CONTINUE, OTHERWISE, TERMINATE)

7. Are you the person in your household who does most of the decision making about things like the heating and air conditioning?

INDEX
16-17

STATE
18-19

REGION
20

1=North East
2=South
3=North Central
4=West

*These are
variables
added to
screeners.*

(IF NOT: ASK TO SPEAK TO THE PERSON WHO IS AND REPEAT "HELLO, I'M _____ FROM _____, AN INDEPENDENT MARKET RESEARCH COMPANY.")

We're conducting a study about solar energy and I'd like to ask you to participate. Its results will be used in the development of energy policy.

Let me tell you how the survey works. First, I'll ask you a few questions over the telephone. That will take about five minutes. When we're done, I'll mail you some information about solar energy systems. This material will also include a questionnaire. We ask you to read through the material that is sent and to discuss it with your family. Then, we'd like you to complete the questionnaire and return it in a prepaid return envelope.

I'll call you back again, in about a week, to answer any questions you may have about the questionnaire.

Our study is based on only 1500 respondents nationwide, and it's very important that we get a representative sample of households. In addition, most people who have already completed the survey have found it to be both interesting and informative. For these reasons I'd really like you to agree to take part. Are there any questions that you might have about the study? Will you participate?

yes _____

no _____ (GO TO DEMOGRAPHICS AND TERMINATE)

Terrific! Let me first get your name and address so that I can mail out the package of information.

RESPONDENT #: _____

Name _____

(PRINT CLEARLY!
SOMEONE HAS TO
COPY THIS OVER!)

Address _____

City _____ State _____ Zip _____

Telephone number () _____

You will be receiving the information about solar energy equipment in a week or so. We'd like you to read the material, and to discuss it with your family if you think that would be appropriate. Enclosed with the literature will be some questions about the information presented. We would like you to complete the questionnaire and return it to us in the postage paid return envelope that will accompany it. I will be calling you back in a few days to answer specific questions you might have about the survey. If you don't have any questions, and can complete and mail the survey before I call again, please do so.

When would be a good time to call you next week?

OUR _____ AM
TIME: _____ PM

DATE: _____

(THEIR TIME: _____ AM, PM)

INTERVIEWER NAME: _____

DATE OF INTERVIEW: _____ TIME START: _____ TIME END: _____

(IF NECESSARY:) Of course, any information you will provide will be combined with all the other responses and will be used for statistical analysis only. Your participation will be completely confidential and your name will never be associated with this survey in any way.

Now, Mr./Ms. _____, let me ask you the first set of questions. To start with,

(STAPLE TO COMPLETED SURVEY FORM)

01 79-80

Introductory Telephone Survey

1. Prior to this survey, had you seen or heard anything about the use of solar energy equipment for home or water heating?

yes ____ -1

no ____ -2 (SKIP TO Q.15)

6-

2. In your area, can you currently buy solar energy systems for: (READ LIST)

	<u>yes</u>	<u>no</u>	<u>not sure</u>	
heating your home	____ -1	____ -2	____ -3	7-
providing electricity for your home	____ -1	____ -2	____ -3	8-
heating water	____ -1	____ -2	____ -3	9-
air conditioning your home	____ -1	____ -2	____ -3	10-

- 3a. Have you heard of any kinds of government sponsored financial incentives to home owners who install solar energy equipment?

yes ____ -1 no ____ -2 (SKIP TO Q.4) uncertain ____ -3 (SKIP TO Q.4) 11-

- 3b. Do you know what kinds of forms any of these incentives take?

(DO NOT READ LIST)

(DON'T KNOW -
WRITE IN "9")(DON'T KNOW -
WRITE IN "99")

-tax rebate - is that

federal, or	____	what percent of the total cost of a solar energy system would that rebate pay?	____
	13-1		14-15
state	____	what percent of the total cost of a solar energy system would that rebate pay?	____
	16-1		17-18

-low-interest loan - is that

federal, or	____	what interest rate?	____
	19-1		20-21
state	____	what interest rate?	____
	22-1		23-24

- lump sum payment or grant (outside of tax system) - is that

federal, or 25-1 → what percent of the total cost of a solar energy system would that payment cover? 26-27
 state 28-1 → what percent of the total cost of a solar energy system would that payment cover? 29-30

- decreased fuel prices 31-1

- other (please specify) _____ 32-1

- none mentioned 33-1

4. Other than in a picture, have you ever seen a home equipped with solar collectors or solar panels?

yes _____-1 no _____-2 not sure _____-3 34-

5. Do you know anyone who is now using solar energy for home or water heating?

yes _____-1 no _____-2 not sure _____-3 35-

6. Have you actually gone looking for information about solar home or water heating equipment from a solar equipment manufacturer or dealer, a builder or an architect?

yes _____-1 no _____-2 (SKIP TO Q.8) 36-

7. For what kinds of solar energy systems have you looked for information?

water heating 37-1
 space and water heating 38-1
 heat pump 39-1
 other (SPECIFY) _____ 40-1

8. Are you likely or unlikely to have a solar home or water heating system installed in your home in the next year? (AS NECESSARY): Is that very likely/unlikely or somewhat likely/unlikely? And how about within the next 5 years? (AS NECESSARY): Is that very likely/unlikely or somewhat likely/unlikely?

	<u>next year</u>	<u>next 5 years</u>
very likely	____-1	____-1
somewhat likely	____-2	____-2
unsure	____-3	____-3
somewhat unlikely	____-4	____-4
very unlikely	____-5	____-5
	-41-	-42-

9. If you were to consider installing a solar energy system would you be interested or not interested in receiving information about _____?
(READ TOPICS FROM BELOW, ONE AT A TIME) Would you be not at all interested, slightly interested, moderately interested, very interested?

(READ FOR EACH TOPIC LISTED)

	<u>Not</u> <u>Interested</u>	<u>Slightly</u> <u>Interested</u>	<u>Moderately</u> <u>Interested</u>	<u>Very</u> <u>Interested</u>	
cost and savings	____-1	____-2	____-3	____-4	43-
how system works	____-1	____-2	____-3	____-4	44-
names of manufacturers	____-1	____-2	____-3	____-4	45-

10. Would you agree or disagree with the statement "I understand the financial merits of solar energy systems". (AS NECESSARY): Would that be strongly agree or disagree or moderately agree/disagree?

strongly agree	____-1
moderately agree	____-2
unsure	____-3
moderately disagree	____-4
strongly disagree	____-5

47-

11. And would you agree or disagree with the statement "I understand how solar energy systems work." (AS NECESSARY) Would that be strongly agree/disagree or moderately agree/disagree?

strongly agree	____-1
moderately agree	____-2
unsure	____-3
moderately disagree	____-4
strongly disagree	____-5

48-

12. Do you believe that you can or cannot currently obtain reliable and dependable solar energy equipment for home use? (AS NECESSARY): Is that definitely can/cannot or probably can/cannot?

definitely can	_____ -1
probably can	_____ -2
unsure	_____ -3
probably can not	_____ -4
definitely can not	_____ -5

49-

13. Do you believe that you can or cannot currently obtain solar energy equipment that makes economic sense for home use? (AS NECESSARY): Is that definitely can/cannot or probably can/cannot?

definitely can	_____ -1
probably can	_____ -2
unsure	_____ -3
probably can not	_____ -4
definitely can not	_____ -5

50-

14. Do you believe that solar energy equipment will or will not be widely used by homeowners in your area within the next five years? (AS NECESSARY): Is that definitely will/will not or probably will/will not?

definitely will	_____ -1
probably will	_____ -2
unsure	_____ -3
probably will not	_____ -4
definitely will not	_____ -5

51-

(READ FOR RESPONDENTS WHO WILL NOT PARTICIPATE):

In order to be certain that we are interviewing a cross section of people, I would like to ask you a few statistical questions before we terminate.

52- 53 SP

(RESPONDENTS WHO REFUSE TO PARTICIPATE DO NOT COUNT TOWARD QUOTA)

Demographics

15. Finally, I would like to get a little more information about you and your household for classification purposes. Please tell me into which of the following age groups you fall? (READ LIST)

under 25	_____	-1
25 - 34	_____	-2
35 - 44	_____	-3
45 - 54	_____	-4
over 55	_____	-5
(DO NOT READ) refused	_____	-8

55-

16. What was the highest level of schooling completed by the head of your household? Was it: (READ LIST)

Grammar school,	_____	-1
High school,	_____	-2
College or	_____	-3
Post-graduate work or degree	_____	-4
(DO NOT READ) Refused	_____	-8

56-

17. Including yourself, how many people live in your home?

_____ 58-59

18. How many are: (READ)

Adults 18 or over	_____
Children r 18	_____

60-61

62-63

19. How many members of your household, including yourself, work outside the home for 30 hours or more per week?

64-65

20. Finally, it would help us a great deal in our statistical analysis if we could get some idea about your income level. Was your total household income for last year, before taxes, under or over \$25,000?

67-

(DO NOT READ) Refused ___ -8

21. (RECORD SEX:) Male ___ -1 Female ___ -2

68-

Once again, thank you for agreeing to participate in this study. I'll get the material in the mail today and you should have it soon. I'll talk to you again on (TIME AGREED UPON).

weight for screener

69 70 71 72 73

weight for main

(STAPLE TO SCREENER QUESTIONNAIRE)

74 75 76 77 78

02 79-80

(IF REFUSED TO ANSWER QUESTIONS 15, 16, or 20,
DO NOT COUNT TOWARD QUOTA)

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RESIDENTIAL SEGMENT

MAIL-OUT QUESTIONNAIRES

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Existing Homes Segment

Dear Study Participant:

In this booklet you will find information about solar water heating systems. The description of the system is followed by a series of questions which relate to that particular description. The final section contains questions of a more general nature. Some of the questions here ask for information about your household energy usage. If you can, please use your records to answer these questions as accurately as possible. If you are unable to determine these answers exactly, please make an estimate. Other questions call for you to guess about the future, or ask for your opinions. On these kinds of questions there are no right or wrong answers, so just try to respond in a way that reflects your beliefs as accurately as possible.

We will be calling you back in a few days to answer specific questions you might have about the survey. The time agreed upon is _____. If, in the meantime, you have any questions about any of this material, please call us collect at Dialogue (617-661-9797) and we will try to help. If you don't have any questions, and can complete the survey before we call again, please do so.

Thank you very much for your help!

Sincerely,

Paul E. Johnston
Vice President

SOLAR DOMESTIC WATER HEATING SYSTEM FOR CALIFORNIA HOMES

A typical solar domestic water heating system is composed of a collector, a hot water storage tank, and the piping that connects them. The radiation of the sun heats the water as it passes through the collector. From the collector the warm water flows directly into a storage tank. The tank would be in the basement, or underground; it would be a standard size (about 80-90 gallons), of a type readily available. Controls keep the water circulating through the collector as long as the sun raises the temperature of the water. In general, this means that as long as the sun is out, the water will continue to circulate. At night, or when the weather is cold or cloudy, the water remains in the tank.

A solar system cannot, by itself, provide enough energy to meet all the hot water needs of an average family of four. In California, system manufacturers and dealers say that the system will supply between 60 and 80 percent of those needs. Any additional water heating that is required is provided automatically by a conventional backup system using oil, gas, or electricity.

Most families would need three solar collectors to trap the sun's heat. These collectors are a little bigger than an average door. They are made of a piece of metal painted black, covered with glass and mounted in a wooden or metal frame. Collectors may be mounted on your roof if you have a roof that faces south, or installed in your yard.

A solar domestic water heating system comes with a 5-year manufacturer's warranty. The system has an expected life of 15 years, which is comparable to the expected life of the roof of your home.

A diagram of a typical system is on the next page.

A TYPICAL SOLAR DOMESTIC WATER HEATING SYSTEM

Financial Information

PRICE: The ~~gross~~ price of a solar water heating system would be about \$2300 for a family of four with average hot water needs. These numbers include materials and installation. However, both the federal government and the state of California offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be lower than the gross price.

	Gross Price	\$2300
(minus)	<u>Tax Rebate</u>	<u>1265</u>
	Actual Price	\$1035

SAVINGS: The solar water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see below). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. The most likely projections would have the rates of increase over the next years be about the same as over the last 10 years, as shown in the accompanying table. Under this assumption, the number of years it will take for total savings to add up to more than the original cost of the system (payback) has been calculated and is also shown in the table.

Solar Water Heating Savings by Fuel Currently Used

	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
<u>Rate of Fuel Price Increase</u>			
Past 10 years	15%	10%	12%
Projected	15%	10%	12%
<u>Estimated Savings</u>			
First year	\$131	\$202	\$ 28
Fifth year	\$240	\$300	\$ 51
<u>Years to Payback</u>	5 1/2	4 1/4	13 1/4

The figures shown take into account:

- 1) energy used to run the solar water heater's pumps, and
- 2) annual maintenance and upkeep expenses, estimated at \$25/year.

Questions About Solar Water Heating Systems

1. Please place a check next to the primary fuel that you use for heating water (for baths, showers, dishwashing, etc.) in your home. Check only one:

natural gas _____ oil _____
 electricity _____ other _____
 (please specify) _____

2. If the water heater you are now using were to break, how much would you expect to have to pay to replace it with a 40-50 gallon tank? (including installation) Check only one:

under \$200 _____ \$500 - 600 _____
 \$200 - 300 _____ \$600 - 700 _____
 \$300 - 400 _____ \$700 - 800 _____
 \$400 - 500 _____ over \$800 _____

3. Have you ever seriously considered an alternative system for heating your water?

yes _____ no _____

4. Using the fuel indicated in Question 1, approximately how much did you spend for water heating last year? If you do not know approximately, please guess. How much do you expect to pay for water heating next year? How much do you think you will have to pay five years from now (in 1985)?

last year \$ _____ next year \$ _____ in 1985 \$ _____
 (guess) (guess) (guess)

5. The average price, including installation, of a solar water heating system, as described here, would be about \$2300. This figure is for an average family of four with average hot water needs. Your family's needs may be more or less than the average, so you might need a larger or smaller system. Taking into consideration your family's hot water needs and what you know about both solar energy system prices and government incentives, how much would you expect such a system would cost you, if you were to buy one? Circle the letter over the column that is closest to this figure.

	A	B	C	D	E
Gross Price	\$1600	\$1900	\$2300	\$2600	\$2900
(Minus) Tax Rebate	<u>880</u>	<u>1045</u>	<u>1265</u>	<u>1430</u>	<u>1595</u>
Actual Price	\$ 720	\$ 855	\$1035	\$1170	\$1305

6. If you were to install a solar water heating system in your home now, how much less would you spend on hot water this year than you would spend using another system?

under \$50 _____ \$201 - 250 _____
 \$ 51 - 100 _____ \$251 - 300 _____
 \$101 - 150 _____ \$301 - 350 _____
 \$151 - 200 _____ over \$350 _____

This is your BASE PRICE

\$ _____ BASE PRICE

Please copy your savings estimate from Question 6 here:

This is your BASE SAVINGS

\$ - BASE SAVINGS

- 7a. Please look at your BASE PRICE and BASE SAVINGS, above. Thinking about your base figures, how likely would you be to buy a solar water heating system for your home in the next year? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

- 7b. The description of a solar water heater says that a system usually comes with a 5-year warranty. Suppose now that the warranty is increased to cover the system for 15 years (with the same BASE PRICE and SAVINGS). How likely would you be to buy a system in the next year, if you could get this longer warranty? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

- 7c. Prices for solar water heating systems may go down. Keeping your BASE SAVINGS (from above) in mind, suppose you could buy a system for 25% less than your BASE PRICE. (The new price of the system would then be 3/4 of your BASE PRICE.) How likely would you be to buy a system in the next year? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

- 7d. Again using your BASE SAVINGS from above, suppose that you could buy a system for half of your BASE PRICE. How likely would you be to buy a system in the next year? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

- 7e. Fuel prices may rise faster than we now expect. Go back to your BASE PRICE from above, but now suppose that your savings are 50% more than your estimated BASE SAVINGS. How likely would you be to buy a system in the next year, if you could get these increased savings? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

8. If you were to purchase a solar water heating system, how would you be most likely to pay for it? (Check one space)

Personal savings _____
Bank loan _____
Other (please specify) _____

9. If you were to purchase a solar water heating system, which of the following would you prefer to purchase it from? (Check only one)

A specialized solar
system distributor/installer _____

Your plumber _____

Your builder _____

Your electric or gas company _____

Your oil dealer _____

A large retail department
store (for example, Sears) _____

Other (please specify) _____

10. What fuel, if any, do you use to heat the living space in your home?
(If more than one, please check the one that is your primary source
of energy.)

electricity _____
natural gas _____
oil _____
wood _____

other (please specify) _____

none _____

General Questions

Please answer the following questions concerning the use of solar energy equipment in general.

1. Do you believe that you can currently obtain reliable and dependable solar energy equipment for home use?

Definitely can _____
Probably can _____
Unsure _____
Probably can not _____
Definitely can not _____

2. Do you believe that you can currently obtain solar energy equipment that makes economic sense for home use?

Definitely can _____
Probably can _____
Unsure _____
Probably can not _____
Definitely can not _____

3. Do you believe that solar energy equipment will be widely used by homeowners in your area within the next five years?

Definitely will _____
Probably will _____
Unsure _____
Probably will not _____
Definitely will not _____

4. Please indicate, by circling a number on the scale, how strongly you agree or disagree with each of the following statements:

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a. I understand the financial merits of solar energy systems.	1	2	3	4	5
b. I understand how solar energy systems work.	1	2	3	4	5
c. Solar energy systems can provide a lot of protection from future energy shortages.	1	2	3	4	5

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
d. A solar water heating system would greatly increase the resale value of my home.	1	2	3	4	5
e. If a solar energy system that I installed failed and needed major repairs or replacement, it could mean a financial disaster for my family.	1	2	3	4	5
f. Solar collectors would be very unattractive on my house.	1	2	3	4	5
g. It would be very easy to obtain financing for a solar energy system.	1	2	3	4	5
h. If a solar energy system that I installed gave less savings than I had expected, it could mean a financial disaster for my family.	1	2	3	4	5
i. Solar equipment would protect me from increasing energy costs.	1	2	3	4	5
j. I would vote for zoning restrictions to ban solar collectors from the front of houses in my neighborhood.	1	2	3	4	5
k. Manufacturers of solar systems are mostly little companies that are here today and will probably be gone tomorrow.	1	2	3	4	5
l. Solar energy equipment will produce maintenance nightmares for me.	1	2	3	4	5
m. I would admire a neighbor who installed solar equipment.	1	2	3	4	5
n. A political candidate who supports solar is progressive.	1	2	3	4	5
o. Technological advances will soon make currently available solar equipment outdated.	1	2	3	4	5
p. A solar water heating system might save me money in the long run, but the initial cost is just too high for me to consider buying one.	1	2	3	4	5
q. If more people were aware of the information shown in this questionnaire, more of them would buy solar energy systems.	1	2	3	4	5

5. Please check the one space in each row that best indicates how interested you would be in more information about each of the items listed.

	<u>Not</u> <u>Interested</u>	<u>Slightly</u> <u>Interested</u>	<u>Moderately</u> <u>Interested</u>	<u>Very</u> <u>Interested</u>
cost and savings	_____	_____	_____	_____
how system works	_____	_____	_____	_____
names of manufacturers	_____	_____	_____	_____

6. Do you intend to look for additional information about solar energy systems within the next two or three months?

Yes _____ No _____ (If "NO", please skip to 0.8)

7. About what kinds of solar energy systems will you look for information?

solar water heating _____
solar-assisted heat pump _____
solar home heating _____
other (please specify) _____

8. How likely are you to have a solar home or water heating system installed in your home within the next year? Within the next 5 years?

	within the next year	within the next 5 years
Very likely	_____	_____
Somewhat likely	_____	_____
Unsure	_____	_____
Somewhat unlikely	_____	_____
Very unlikely	_____	_____

9. Which of the following categories best describes your family's composition? (PLEASE CHECK ONLY ONE SPACE)

No (zero) children living at home _____

Children living at home { youngest under age 6 _____
youngest age 6 - 12 _____
youngest age 13 or over _____

10. Approximately how much does a gallon of unleaded, regular gasoline cost in your area?

\$1.10 or less	_____	\$1.25	_____
\$1.15	_____	\$1.30	_____
\$1.20	_____	\$1.35 or more	_____

11. How much do you think a gallon of unleaded, regular gasoline will cost five years from now (in 1985)?

\$ _____

12. Which of the following products have you bought for your own or your family's use?

microwave oven	_____	waterbed	_____
shower massage	_____	quartz room heater	_____
home table-top computer	_____	water pik	_____
videotape player/recorder	_____	digital watch	_____
food processor	_____	whirlpool bath, spa or hot tub	_____
		none of the above	_____

Thank you very much for your help! Please place your completed questionnaire in the postage paid return envelope and mail it back to us at your earliest convenience.

If you would be interested in the results of this study, just write your name and address in the space below and we will be happy to send them to you when they are available.

Name _____

Street _____

City _____ State _____ Zip _____

Variable Financial Information

Short Undeterministic

Financial Information

PRICE: The gross price of a solar domestic water heating system would be between \$1600 and \$2900, or about \$2300 for a family of four with average hot water needs. These numbers include materials and installation. However, both the federal government and the state of California offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be much lower than the gross price. For an average system the figures would be:

	<u>Low Estimate</u>	<u>Average Estimate</u>	<u>High Estimate</u>
Gross Price	\$1600	\$2300	\$2900
(minus) <u>Tax Rebate</u>	<u>880</u>	<u>1265</u>	<u>1595</u>
Actual Price	\$ 720	\$1035	\$1305

SAVINGS: The solar domestic water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see table). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. The "most likely" projections would have the rate of increase over the next years be about the same over the last 10 years, as shown in the accompanying tables. However, forecasting future energy costs is no easy business. Energy costs could increase at a lower or higher rate than in the past. As a result, the tables show savings calculated using low and high rate increase assumptions as well as the most likely assumption. Under each assumption, the number of years it will take for your total savings to add up to more than the original cost of the system (pay-back) has been calculated, and is also shown in the tables.

California

Solar Water Heating Savings by Fuel Currently Used*

<u>Oil</u>			
	<u>Low</u>	<u>Most likely</u>	<u>High</u>
<u>Rate of fuel price increase</u>			
Past 10 years - 15%			
Projected	10%	15%	20%
<u>Estimated savings(\$)</u>			
First year	131	131	131
Fifth year	196	240	291
<u>Years to payback</u>	6	5 1/2	5

<u>Electricity</u>			
	<u>Low</u>	<u>Most likely</u>	<u>High</u>
<u>Rate of fuel price increase</u>			
Past 10 years - 10%			
Projected	7%	10%	15%
<u>Estimated savings(\$)</u>			
First year	202	202	202
Fifth year	265	300	364
<u>Years to payback</u>	5	4 1/4	4

<u>Gas</u>			
	<u>Low</u>	<u>Most likely</u>	<u>High</u>
<u>Rate of fuel price increase</u>			
Past 10 years - 12%			
Projected	8%	12%	17%
<u>Estimated savings(\$)</u>			
First year	28	28	28
Fifth year	39	51	67
<u>Years to payback</u>	17 1/4	13 1/4	11

*The figures shown take into account

- 1) energy used to run the solar water heater's pumps, and

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Variable Financial Information

Long Deterministic

Financial Information

PRICE: The gross price of a solar domestic water heating system would be about \$2300 for a family of four with average hot water needs. These numbers include materials and installation. However, both the federal government and the state of California offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be much lower than the gross price.

	Gross Price	\$2300
(minus)	<u>Tax Rebate</u>	<u>1265*</u>
	Actual Price	\$1035

SAVINGS: The solar domestic water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see Appendix 1). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. (See graph shown in Appendix 2.) The most likely scenario would have the rate of increase over the next years be about the same as over the last 10 years, that is, 12%. Under this assumption, the number of years it will take for your total savings to add up to more than the original cost of the system (payback) has been calculated and is shown in Appendix 1.

* see Appendix 3 for calculation of Tax Credit

PAYING FOR A SYSTEM: You could pay for a solar system in cash -- in that case you would forego the interest that you could earn on the \$1035 that you use to purchase the solar system. Instead of buying a solar system, you could put the money in a 10% savings account, but of course you would have to pay income tax on the interest earnings -- how much tax would depend on your tax bracket.

You could also borrow money to pay for the system -- several banks are now giving "energy improvement" loans for 12 - 13 1/2 percent interest. If you were to borrow \$1035 for 10 years at, say, 13%, the payments would add up to \$185 per year. In this situation, of course, the interest portion of your loan payment would be deductible for federal tax purposes, so your real annual expense would be less -- how much less would depend on your tax bracket.

Appendix 1 presents a comparison of interest earnings, loan payments, and most likely savings from a solar domestic water heater.

INCENTIVES AND REBATES: Both the federal government and the state of California have tax rebates that you can take advantage of if you buy a solar domestic water heating system. See Appendix 3 for further information on federal and state tax rebates.

Appendix 1

California

Comparisons of Solar Domestic Water Heater Savings with Interest Earnings and Loan Payments

Year	Savings			Annual Interest Earnings(1)	Annual L Payment(2)
	Oil	Electricity	Gas		
1	\$ 131	\$ 202	\$ 28	\$ 104	\$ 185
2	153	223	33	114	185
3	178	246	38	125	185
4	207	272	44	138	185
5	240	300	51	132	185
6	279	331	58	167	185
7	323	365	67	183	185
8	375	402	77	202	185
9	434	442	88	222	185
10	503	489	101	244	185
11	582	540	115		
12	673	595	132		
13	778	656	150		
14	900	723	171		
15	<u>039</u>	<u>798</u>	<u>195</u>		
Totals:	\$ 6794	\$ 6584	\$ 1348	\$ 1650	\$ 1850
Years to Payback	5 1/2	4 1/4	13 1/4		

The figures shown take into account: a) energy used to run the solar water heater's pumps, and
b) annual maintenance and upkeep expenses estimated at \$25/year.

- (1) assumes \$ 1035, plus all accumulated interest, left in a 10% account for 10 years. (You would have to pay income tax on these earnings, so your actual interest income would be lower than these numbers indicate; how much lower would depend on your income tax bracket.)
- (2) assumes \$ 1035 loan for 10 years at 13%. (You would get to deduct the interest portion of these payments from your income before figuring your taxes, so your out-of-pocket expense would actually be lower than these numbers suggest; how much lower would depend on your income tax bracket.)

Appendix 2

Individual Fuel Cost Rates of Increase*

	<u>Overall</u>	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
Past 10 years	12%	15%	10%	12%
Projected	12%	15%	10%	12%

Energy Price Index for 12 years*

* Data from Consumer Price Index, U.S. Department of Labor

Appendix 3

Federal and State Income Tax Rebates

Federal Income Tax Rebate

30% of the first \$2,000 of gross price (including installation)

20% of the amount over \$2,000

Total rebate not to exceed \$2,200

California State Income Tax Rebate

55% of system price, retail plus installation, up to a maximum rebate of \$3,000; minus the federal rebate

Thus, on a \$2,300 system, rebates are calculated as:

Federal

30% of \$2,000 = \$ 600

20% of \$ 300 = 60

Total Rebate = \$ 660

California

55% of \$2,300 = \$1,265

minus federal rebate= 660

\$ 605

Total

Federal = \$ 660

California = 605

\$1,265

Variable Financial Information

Special New England

Financial Information

PRICE: The gross price of a solar domestic water heating system would be between \$2600 and \$4100, or about \$3300 for a family of four with average hot water needs. These numbers include materials and installation. However, both the federal government and the state of Massachusetts offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you would thus be much lower than the gross price. For an average system the figures would be:

	<u>Low Estimate</u>	<u>Average Estimate</u>	<u>High Estimate</u>
Gross Price	\$2600	\$3300	\$4100
(minus) <u>Tax Rebate</u>	<u>1378</u>	<u>1714</u>	<u>2020</u>
Actual Price	\$1222	\$1586	\$2080

SAVINGS: The solar domestic water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating water with solar energy varies depending on what fuel is now being used to heat water (see table). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. However, over the most recent past, some forms of energy have increased at a 40% rate. Forecasting future energy costs, and thus the amount of money a solar water heating system would save, is no easy business. Perhaps the "most likely" event would be for the future rate of increase in energy costs to be the same as it has been over the past 10 years. However, the tables on the following page display savings under "high" and "low" energy cost increases as well. For each of these three possibilities (low, most likely, and high energy cost increases), the number of years it will take for your total savings to add up to more than the original cost of the system has been calculated. This length of time is called "payback".

Massachusetts

Solar Water Heating Savings by Fuel Currently Used*

<u>Oil</u>			
	<u>Low</u>	<u>Most likely</u>	<u>High</u>
<u>Rate of fuel price increase</u>			
Past 10 years - 15%			
Projected	10%	15%	40% for 5 years 20% thereafter
<u>Estimated savings (\$)</u>			
First year	103	103	103
Fifth year	155	191	459
<u>Years to payback</u>	10	8 1/4	6

<u>Electricity</u>			
	<u>Low</u>	<u>Most likely</u>	<u>High</u>
<u>Rate of fuel price increase</u>			
Past 10 years - 10%			
Projected	7%	10%	35% for 5 years 17% thereafter
<u>Estimated savings (\$)</u>			
First year	231	231	231
Fifth year	303	342	818
<u>Years to payback</u>	6	5 1/2	4

<u>Gas</u>			
	<u>Low</u>	<u>Most likely</u>	<u>High</u>
<u>Rate of fuel price increase</u>			
Past 10 years - 12%			
Projected	8%	12%	30% for 5 years 15% thereafter
<u>Estimated savings (\$)</u>			
First year	66	66	66
Fifth year	91	110	227
<u>Years to payback</u>	14	11 1/2	8

*The figures shown take into account

1) energy used to run the solar water heater's pumps, and

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Variable Financial Information

Special Concentrating Collector

SOLAR DOMESTIC WATER HEATING SYSTEM FOR

FLORIDA HOMES

A typical solar domestic water heating system is composed of a collector, a hot water storage tank, and the piping that connects them. The radiation of the sun heats the water as it passes through the collector. From the collector the warm water flows directly into a storage tank. The tank would be in the basement, or underground; it would be a standard size (about 80-90 gallons), of a type readily available. Controls keep the water circulating through the collector as long as the sun raises the temperature of the water. In general, this means that as long as the sun is out, the water will continue to circulate. At night, or when the weather is cold or cloudy, the water remains in the tank.

A solar system cannot, by itself, provide enough energy to meet all the hot water needs of an average family of four. In Florida, system manufacturers and dealers say that the system will supply between 70 and 90 percent of those needs. Any additional water heating that is required is provided automatically by a conventional backup system using oil, gas, or electricity.

A concentrating collector array is made of a shiny curved reflector and an "absorber" tube. The curved surface of the collector reflects sunlight onto the absorber tube, thus "concentrating" the solar energy at the tube. Water is pumped through the tube, where it absorbs the concentrated heat. The collector is mounted on a frame which moves so that the collectors remain aimed at the sun throughout the day. The collector and frame may be mounted on your roof if you have a roof that faces south, or installed in your yard.

A solar domestic water heating system comes with a 5-year manufacturer's warranty. The system has an expected life of 15 years, which is comparable to the expected life of the roof of your home.

A diagram of a typical system is on the next page.

A TYPICAL SOLAR DOMESTIC WATER HEATING SYSTEM WITH CONCENTRATING COLLECTOR

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New Homes Segment

Dear Study Participant:

This study is being conducted among people who are thinking about buying a newly constructed home, who are building one, or who have recently moved into a newly constructed home. If you are now looking for or building a new home, please answer these questions in terms of the house you would like to buy, or are building. If you now live in your new home, please try to take yourself back to the time when you were thinking about buying or building. Then answer the questions as you would have at that time. In this booklet you will find information about solar water heating and home heating systems. Each description is followed by a series of questions which relate to that particular description. The final section contains questions of a more general nature. Some of the question here ask for information about your current or planned household energy usage. If you can, please use your records to answer these questions as accurately as possible. Otherwise, please make an estimate. Other questions call for you to guess about the future, or ask for your opinions. On these kinds of questions there are no right or wrong answers, so just try to respond in a way that reflects your beliefs as accurately as possible.

We will be calling you back in a few days to answer specific questions you might have about the survey. The time agreed upon is _____. If, in the meantime, you have any questions about any of this material, please call us collect at Dialogue (617-661-9797) and we will try to help. If you don't have any questions, and can complete the survey before we call again, please do so.

Thank you very much for your help!

Sincerely,

Paul E. Johnston
Vice President

SOLAR DOMESTIC WATER HEATING SYSTEM FOR
CALIFORNIA HOMES

A typical solar domestic water heating system is composed of a collector, a hot water storage tank, and the piping that connects them. The radiation of the sun heats the water as it passes through the collector. From the collector the warm water flows directly into a storage tank. The tank would be in the basement, or underground; it would be a standard size (about 80-90 gallons), of a type readily available. Controls keep the water circulating through the collector as long as the sun raises the temperature of the water. In general, this means that as long as the sun is out, the water will continue to circulate. At night, or when the weather is cold or cloudy, the water remains in the tank.

A solar system cannot, by itself, provide enough energy to meet all the hot water needs of an average family of four. In California, system manufacturers and dealers say that the system will supply between 60 and 80 percent of those needs. Any additional water heating that is required is provided automatically by a conventional backup system using oil, gas, or electricity.

Most families would need three solar collectors to trap the sun's heat. These collectors are a little bigger than an average door. They are made of a piece of metal painted black, covered with glass and mounted in a wooden or metal frame. Collectors may be mounted on your roof if you have a roof that faces south, or installed in your yard.

A solar domestic water heating system comes with a 5-year manufacturer's warranty. The system has an expected life of 15 years, which is comparable to the expected life of the roof of your home.

A diagram of a typical system is on the next page.

A TYPICAL SOLAR DOMESTIC WATER HEATING SYSTEM

Financial Information

PRICE: The gross cost of a solar water heating system would be about \$2300 for a family of four with average hot water needs. These numbers include materials and installation. However, both the federal government and the state of California offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you (or increase in the cost of your home) would thus be lower than the gross price.

	Gross Cost	\$2300
(minus)	<u>Tax Rebate</u>	<u>1265</u>
	Actual Cost	\$1035

PAYING FOR A SYSTEM: You could pay for a system with cash. Alternatively you could finance the system through your mortgage. The following figures are typical of payments if the system is included in a home mortgage: (25 years, current interest rates)

Additional down payment at time of purchase:	\$ 210
Increase in <u>monthly</u> mortgage payment:	\$ 10

SAVINGS: The solar water heater will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating the home with solar energy varies depending on the alternative fuel that is used (see below). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. The most likely projections would have the rates of increase over the next years be about the same as over the last 10 years, as shown in the accompanying table. Under this assumption, the number of years it will take for total savings to add up to more than the original cost of the system (payback) has been calculated and is also shown in the table.

Solar Water Heating Savings by Alternative Fuels

<u>Rate of Fuel Price Increase</u>	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
Past 10 years	15%	10%	12%
Projected	15%	10%	12%
<u>Estimated Savings</u>			
First year	\$131	\$202	\$ 28
Fifth year	\$240	\$300	\$ 51
<u>Years to Payback</u>	5 1/2	4 1/4	13 1/4

The figures shown take into account:

- 1) energy used to run the solar water heater's pumps, and
- 2) annual maintenance and upkeep expenses, estimated at \$25/year.

To begin with, are you now living in your new home, are you looking for a new home or building one?

Now living in new home _____ (Please answer the rest of this questionnaire in terms of this home.)

Now looking _____ (Please answer the rest of this questionnaire in terms of the house you would like to buy.)

Now building _____ (Please answer the rest of the questionnaire in terms of the house you are building.)

Questions About Solar Water Heating Systems

1. Please place a check next to the primary fuel that you use or expect to use for heating water (for baths, showers, dishwashing, etc.) in your home. Check only one:

natural gas _____ oil _____
electricity _____ other _____
(please specify) _____

2. Using the fuel indicated in Question 1, approximately how much did you spend for water heating last year? If you do not know approximately, please guess. How much do you expect to pay for water heating next year? How much do you think you will have to pay five years from now (in 1985)?

last year \$ _____ next year \$ _____ in 1985 \$ _____
(answer only if you (guess) (guess)
are now living in
the new home)

3. The average cost, including installation, of a solar water heating system, as described here, would be about \$2300. This figure is for an average family of four with average hot water needs. Your family's needs may be more or less than the average, so you might need a larger or smaller system. Taking into consideration your family's hot water needs and what you know about both solar energy system prices and government incentives, by how much would you expect the cost of your new home to increase if it were to be equipped with a solar water heater? Circle the letter over the column that is closest to this figure.

	A	B	C	D	E
Gross Cost	\$1600	\$1900	\$2300	\$2600	\$2900
(Minus) Tax Rebate	<u>880</u>	<u>1045</u>	<u>1265</u>	<u>1430</u>	<u>1595</u>
Actual Cost	\$ 720	\$ 855	\$1035	\$1170	\$1305

4. If your new home had a solar water heating system, how much less do you think you would spend on hot water next year than you would spend using another system?

under \$50 _____ \$201 - 250 _____
\$ 51 - 100 _____ \$251 - 300 _____
\$101 - 150 _____ \$301 - 350 _____
\$151 - 200 _____ over \$350 _____

Please copy your "Actual Cost" from Question 3 on previous page here: (This is your BASE COST)

\$ _____ BASE COST

Please copy your savings estimate from Question 4 on previous page here: (This is your BASE SAVINGS)

\$ _____ BASE SAVINGS

1. Please look at your BASE COST and BASE SAVINGS, above. Thinking about your base figures, how likely are you to try to get a solar water heating system installed in your new home?

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

- 5b. The description of a solar water heater says that a system usually comes with a 5-year warranty. Suppose now that the warranty is increased to cover the system for 15 years (with the same BASE COST and SAVINGS). How likely would you be to try to get a system installed in your new home, if you could get this longer warranty? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

- 5c. Prices for solar water heating systems may go down. Keeping your BASE SAVINGS (from above) in mind, suppose you could have a system installed in your new home for 25% less than your BASE COST. (The new price of the system would then be 3/4 of your BASE COST.) How likely would you be to try to get a system installed? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

- 5d. Again using your BASE SAVINGS from above, suppose that you could have a system installed in your new home for half of your BASE COST. How likely would you be to try to get a system installed? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

- 5e. Fuel prices may rise faster than we now expect. Go back to your BASE COST from above, but now suppose that your savings are 50% more than your estimated BASE SAVINGS. How likely would you be to try to get a system installed in your new home, if you could get these increased savings? Please check the appropriate space:

Certain, practically certain (99 in 100) _____
Almost sure (9 in 10) _____
Very probable (8 in 10) _____
Probable (7 in 10) _____
Good possibility (6 in 10) _____
Fairly good possibility (5 in 10) _____
Fair possibility (4 in 10) _____
Some possibility (3 in 10) _____
Slight possibility (2 in 10) _____
Very slight possibility (1 in 10) _____
No chance, almost no chance (0 in 10) _____

SOLAR HOME AND WATER HEATING SYSTEM
FOR CALIFORNIA HOMES

A typical residential solar home heating system is composed of a collector, a storage tank and the piping that connects them. The radiation of the sun heats water (or, in some systems, air) as it passes through the collector. The heat is then distributed through the house through its normal set of air ducts, radiators or baseboard units. If the heat is not needed immediately, it is placed in a storage system. Controls keep the circulation going as long as the sun is providing additional heat to either the house or to the storage system. At night, or when the weather is cold or cloudy, the collector circulation shuts down and the distribution system works to draw heat from storage, and to distribute that heat to the living space in the house.

Part of the system would also provide hot water for domestic use.

A solar energy system cannot, by itself, provide enough energy to meet all the heating and hot water needs of most families. In California, a typical system will supply between 70 and 90 percent of those needs. Any additional heat that is required is provided automatically by a conventional back-up system, using gas, electricity or oil.

Most families in this area would need 10 collectors to trap the sun's heat. These collectors are a little bigger than an average door. They are made of a piece of metal painted black, covered with glass and mounted in a wooden or metal frame. Collectors are usually mounted on the roof of your home, although they can also be installed in your yard. The storage system consists of a large water tank (about 1000-2000 gallons of water) or a bin of small rocks or pebbles. Storage systems are usually installed in the basement or buried immediately outside if no basement or crawl space is available.

A solar home and water heating system comes with a 5-year manufacturer's warranty. The collectors have an expected life of 15 years, which is comparable to the expected life of your roof.

A diagram of a typical system is shown on the next page.

A TYPICAL SOLAR HOME AND WATER HEATING SYSTEM

Financial Information

PRICE: The gross cost of a solar space and water heating system would be about \$6200 for a family of four with average heat and hot water needs. These numbers include materials and installation. However, both the federal government and the state of California offer refunds, paid to you as a lump sum subtracted from your income taxes. The actual cost to you (or increase in the cost of your home) would thus be lower than the gross price.

	Gross Cost	\$6200
(minus)	<u>Tax Rebate</u>	<u>3000</u>
	Actual Cost	\$3200

PAYING FOR A SYSTEM: You could pay for a system with cash. Alternatively you could finance the system through your mortgage. The following figures are typical of payments if the system is included in a home mortgage: (25 years, current interest rates)

Additional down payment at time of purchase: \$ 640
Increase in monthly mortgage payment: \$ 32

SAVINGS: The solar space and water heating system will begin to save you money as soon as it is installed. However, the savings will grow because while the cost of alternative fuels will increase, the sun remains free. The amount that the average homeowner would save in lower energy costs during the first year of heating the home with solar energy varies depending on the alternative fuel that is used (see below). The figures shown account for annual system maintenance and upkeep expenses.

Over the past 10 years, overall energy costs have increased at a rate of 12% per year. Rates of increase for individual fuels varied somewhat from the overall rate of increase. The most likely projections would have the rates of increase over the next years be about the same as over the last 10 years, as shown in the accompanying table. Under this assumption, the number of years it will take for total savings to add up to more than the original cost of the system (payback) has been calculated and is also shown in the table.

Solar Space and Water Heating Savings by Alternative Fuels

<u>Rate of Fuel Price Increase</u>	<u>Oil</u>	<u>Electricity</u>	<u>Gas</u>
Past 10 years	15%	10%	12%
Projected	15%	10%	12%
<u>Estimated Savings</u>			
First year	\$280	\$469	\$ 84
Fifth year	\$512	\$694	\$145
<u>Years to Payback</u>	7	5 1/2	14

The figures shown take into account:

- 1) energy used to run the system's pumps, and
- 2) annual maintenance and upkeep expenses, estimated at \$50/year.

Questions About Solar Space and Water Heating Systems

1. What fuel, if any, do you use or plan to use to heat the living space in your home? (If more than one, please check the one that is your primary source of energy.)

electricity _____	other (please specify) _____
natural gas _____	
oil _____	
wood _____	none _____

2. Using the fuel indicated in Question 1, approximately how much did you spend for heating your home last year? If you do not know approximately, please guess. How much do you expect to pay for heating your home next year? How much do you think you will have to pay five years from now (in 1985)?

last year \$ _____	next year \$ _____	in 1985 \$ _____
(answer only if you	(guess)	(guess)
are now living in		
the new home)		

3. The average cost, including installation, of a solar space and water heating system, as described here, would be about \$6200. This figure is for an average family of four with average heat and hot water needs. Your family's needs may be more or less than the average, so you might need a larger or smaller system. Taking into consideration your family's needs and what you know about both solar energy system prices and government incentives, by how much would you expect the cost of your new home to increase if it were to be equipped with a solar space and water heating system? Circle the letter over the column that is closest to this figure.

	A	B	C	D	E
Gross Cost	\$4500	\$5300	\$6200	\$7200	\$9200
(Minus) Tax Rebate	<u>2475</u>	<u>2915</u>	<u>3000</u>	<u>3000</u>	<u>3000</u>
Actual Cost	\$2025	\$2385	\$3200	\$4200	\$6200

4. If your new home had a solar space and water heating system, how much less do you think you would spend on heating your home next year than you would spend using another system?

under \$100 _____	\$400 - 500 _____
\$100 - 200 _____	\$500 - 750 _____
\$200 - 300 _____	\$750 - 1000 _____
\$300 - 400 _____	over \$1000 _____

Please copy your "Actual Cost" from Question 3 on previous page here: (This is your BASE COST) \$ _____ BASE COST

Please copy your savings estimate from Question 4 on previous page here: (This is your BASE SAVINGS) \$ _____ BASE SAVINGS

- 5a Please look at your BASE COST and BASE SAVINGS, above. Thinking about your base figures, how likely are you to try to get a solar space and water heating system installed in your new home? Please place a check in the appropriate space.

Certain, practically certain (99 in 100)
 Almost sure (9 in 10)
 Very probable (8 in 10)
 Probable (7 in 10)
 Good possibility (6 in 10)
 Fairly good possibility (5 in 10)
 Fair possibility (4 in 10)
 Some possibility (3 in 10)
 Slight possibility (2 in 10)
 Very slight possibility (1 in 10)
 No chance, almost no chance (0 in 10)

- 5b The description of a solar space and water heating system says that a system usually comes with a 5-year warranty. Suppose now that the warranty is increased to cover the system for 15 years (with the same BASE COST and SAVINGS). How likely would you be to try to get a system installed in your new home, if you could get this longer warranty? Please place a check in the appropriate space.

Certain, practically certain (99 in 100)
 Almost sure (9 in 10)
 Very probable (8 in 10)
 Probable (7 in 10)
 Good possibility (6 in 10)
 Fairly good possibility (5 in 10)
 Fair possibility (4 in 10)
 Some possibility (3 in 10)
 Slight possibility (2 in 10)
 Very slight possibility (1 in 10)
 No chance, almost no chance (0 in 10)

- 5c Prices for solar space and water heating systems may go down. Keeping your BASE SAVINGS (from above) in mind, suppose you could have a system installed in your new home for 25% less than your BASE COST. (The new price of the system would then be 3/4 of your BASE COST.) How likely would you be to try to get a system installed? Again, please check the appropriate space.

Certain, practically certain (99 in 100)
 Almost sure (9 in 10)
 Very probable (8 in 10)
 Probable (7 in 10)
 Good possibility (6 in 10)
 Fairly good possibility (5 in 10)
 Fair possibility (4 in 10)
 Some possibility (3 in 10)
 Slight possibility (2 in 10)
 Very slight possibility (1 in 10)
 No chance, almost no chance (0 in 10)

- 5d Again using your BASE SAVINGS from above, suppose that you could have a system installed in your new home for half of your BASE COST. How likely would you be to try to get a system installed? Please check the appropriate space.

Certain, practically certain (99 in 100)
 Almost sure (9 in 10)
 Very probable (8 in 10)
 Probable (7 in 10)
 Good possibility (6 in 10)
 Fairly good possibility (5 in 10)
 Fair possibility (4 in 10)
 Some possibility (3 in 10)
 Slight possibility (2 in 10)
 Very slight possibility (1 in 10)
 No chance, almost no chance (0 in 10)

- 5e Fuel prices may rise faster than we now expect. Go back to your BASE COST from above, but now suppose that your savings are 50% more than your estimated BASE SAVINGS. How likely would you be to try to get a system installed in your new home, if you could get these increased savings? Please check the appropriate space.

Certain, practically certain (99 in 100)
 Almost sure (9 in 10)
 Very probable (8 in 10)
 Probable (7 in 10)
 Good possibility (6 in 10)
 Fairly good possibility (5 in 10)
 Fair possibility (4 in 10)
 Some possibility (3 in 10)
 Slight possibility (2 in 10)
 Very slight possibility (1 in 10)
 No chance, almost no chance (0 in 10)

General Questions

Please answer the following questions concerning the use of solar energy equipment in general.

1. Do you believe that you can currently obtain reliable and dependable solar energy equipment for home use?

Definitely can _____
Probably can _____
Unsure _____
Probably can not _____
Definitely can not _____

2. Do you believe that you can currently obtain solar energy equipment that makes economic sense for home use?

Definitely can _____
Probably can _____
Unsure _____
Probably can not _____
Definitely can not _____

3. Do you believe that solar energy equipment will be widely used by homeowners in your area within the next five years?

Definitely will _____
Probably will _____
Unsure _____
Probably will not _____
Definitely will not _____

4. Please indicate, by circling a number on the scale, how strongly you agree or disagree with each of the following statements:

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a. I understand the financial merits of solar energy systems.	1	2	3	4	5
b. I understand how solar energy systems work.	1	2	3	4	5
c. Solar energy systems can provide a lot of protection from future energy shortages.	1	2	3	4	5

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
d. A solar water heating system would greatly increase the resale value of my home.	1	2	3	4	5
e. If a solar energy system that I installed failed and needed major repairs or replacement, it could mean a financial disaster for my family.	1	2	3	4	5
f. Solar collectors would be very unattractive on my house.	1	2	3	4	5
g. It would be very easy to obtain financing for a solar energy system.	1	2	3	4	5
h. If a solar energy system that I installed gave less savings than I had expected, it could mean a financial disaster for my family.	1	2	3	4	5
i. Solar equipment would protect me from increasing energy costs.	1	2	3	4	5
j. I would vote for zoning restrictions to ban solar collectors from the front of houses in my neighborhood.	1	2	3	4	5
k. Manufacturers of solar systems are mostly little companies that are here today and will probably be gone tomorrow.	1	2	3	4	5
l. Solar energy equipment will produce maintenance nightmares for me.	1	2	3	4	5
m. I would admire a neighbor who installed solar equipment.	1	2	3	4	5
n. A political candidate who supports solar is progressive.	1	2	3	4	5
o. Technological advances will soon make currently available solar equipment outdated.	1	2	3	4	5
p. A solar water heating system might save me money in the long run, but the initial cost is just too high for me to consider buying one.	1	2	3	4	5
q. If more people were aware of the information shown in this questionnaire, more of them would buy solar energy systems.	1	2	3	4	5

5. Please check the one space in each row that best indicates how interested you would be in more information about each of the items listed.

	<u>Not</u> <u>Interested</u>	<u>Slightly</u> <u>Interested</u>	<u>Moderately</u> <u>Interested</u>	<u>Very</u> <u>Interested</u>
cost and savings	_____	_____	_____	_____
how system works	_____	_____	_____	_____
names of manufacturers	_____	_____	_____	_____

6. Do you intend to look for additional information about solar energy systems within the next two or three months?

Yes _____

No _____ (If "NO", please skip to 0.8)

7. About what kinds of solar energy systems will you look for information?

solar water heating _____

solar-assisted heat pump _____

solar home heating _____

other (please specify) _____

8. How likely are you to have a solar home or water heating system installed in your home within the next year? Within the next 5 years?

	<u>within</u> <u>the next year</u>	<u>within</u> <u>the next 5 years</u>
Very likely	_____	_____
Somewhat likely	_____	_____
Unsure	_____	_____
Somewhat unlikely	_____	_____
Very unlikely	_____	_____

9. Which of the following categories best describes your family's composition? (PLEASE CHECK ONLY ONE SPACE)

No (zero) children living at home _____

Children living at home { youngest under age 6 _____
 youngest age 6 - 12 _____
 youngest age 13 or over _____

10. Approximately how much does a gallon of unleaded, regular gasoline cost in your area?

\$1.10 or less	_____	\$1.25	_____
\$1.15	_____	\$1.30	_____
\$1.20	_____	\$1.35 or more	_____

11. How much do you think a gallon of unleaded, regular gasoline will cost five years from now (in 1985)?

\$ _____

12. Which of the following products have you bought for your own or your family's use?

microwave oven	_____	waterbed	_____
shower massage	_____	quartz room heater	_____
home table-top computer	_____	water pik	_____
videotape player/recorder	_____	digital watch	_____
food processor	_____	whirlpool bath, spa or hot tub	_____
		none of the above	_____

13. If you were to purchase a solar water heating system, how would you be most likely to pay for it? How would you be most likely to pay for a solar space and water heating system?

Solar Water Heating System

Personal savings _____
 Included in mortgage _____
 Separate bank loan _____
 Other (please specify) _____

Solar Space and Water Heating System

Personal savings _____
 Included in mortgage _____
 Separate bank loan _____
 Other (please specify) _____

14. If you are now building, or planning to build, your new home, who is or will be the general contractors?

Self _____ Builder _____ Other _____

Who is or will be constructing your new home?

Self _____ Builder/
 Building _____ Other _____
 Contractors

Thank you very much for your help! Please place your completed questionnaire in the postage paid return envelope and mail it back to us at your earliest convenience.

If you would be interested in the results of this study, just write your name and address in the space below and we will be happy to send them to you when they are available.

Name _____

Street _____

City _____ State _____ ZIP _____

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INDUSTRIAL SEGMENT

TELEPHONE SCREENER QUESTIONNAIRE

SIC _____

ID # _____

TIME START _____

(1-4)

TIME END _____

INDUSTRIAL SCREENER QUESTIONNAIRE

Hello, I'm _____ from Dialogue, an independent market research firm. We are conducting a study about attitudes toward solar energy in the industrial sector. (IF RELEVANT: WE GOT YOUR NAME FROM _____ WHO SAID YOU WERE AN APPROPRIATE PERSON TO ANSWER OUR QUESTIONS.)

It is very important for us to get opinions of relevant decision-makers such as yourself in a representative sample of firms. The individuals we need to speak to are those who usually participate in the decision process for the selection and purchase of heating and air conditioning equipment. These individuals should be familiar with the space heating and cooling needs of your organization.

Are you an appropriate individual to work with us on this study?

Yes _____ No _____ (IF NO, GO TO Q.A)

Let me explain how the study works. First I'll ask you a few questions over the phone about your firm's energy systems. That will take 20-25 minutes. When we're done, I'll mail you some information about solar energy systems. The material will also contain a questionnaire. We'd like you to read through the material and discuss it, if you wish, with any relevant members of your organization. Then we'd like you to complete the questionnaire and return it in a prepaid return envelope.

I'll call back in 10 days to 2 weeks to answer any questions you may have about the questionnaire.

Since our results will be based on a small sample, it is very important that we get your response. In addition, most organizations that have completed the survey have found it interesting and informative.

I'd like to ask you to agree to take part. Are there any questions you might have about the study? Will you participate?

Yes _____ No _____ (GO TO Q.A)

Great! Let me first get your name so I can mail out the package of material.

NAME: _____ TITLE: _____

FIRM NAME: _____

ADDRESS: _____ CITY: _____ STATE: _____ ZIP: _____

PHONE #: _____ INTERVIEWER'S NAME: _____

And when would be a good time to call you back, say within 10 days to 2 weeks?

TIME: _____ DAY: _____

(IF NECESSARY): Of course any information you provide will be combined with all other responses and will be used for statistical analyses only. Your participation will be completely confidential and your name will never be associated with this survey in any way.

Before I go on:

A. Who (besides yourself) in your organization would be appropriate for us to contact? (TRY TO GET FIVE NAMES - RECORD ON CALL RECORD SHEET)

- SIC #20 - Food & kindred products
 22 - Textile Mill products
 26 - Paper & allied products
 27 - Printing & publishing
 28 - Chemicals
 35 - Machinery except electrical
 36 - Electrical & electronic
 machinery & equipment
 38 - Measuring, analyzing and
 controlling instruments
 *(ie. Photo, medical &
 optical equip. Also includes
 watches and clocks)
 * not necessary to read this

INDUSTRIAL QUESTIONNAIRE

1. According to our information your company's SIC code (standard industrial classification code) is _____, which means your company is principally in the _____ industry. Is that correct? RECORD SIC (5-6)

7-

Yes ----- (SKIP TO Q.2) ----- 1

No ----- 2

(IF NO):

Could you please describe in a few words the industry your organization is in:

- TERMINATE -

2. Prior to this study, have you seen or heard anything about the use of active solar energy equipment for heating water or for space heating or cooling for industrial use?

8-

Yes ----- 1

No ----- (SKIP TO Q.8) ----- 2

(IF YES):

- 3a. Would this be for: (READ LIST AND CIRCLE ALL THAT APPLY)

	<u>YES</u>	<u>NO</u>
domestic water heating -----	9- 1	2
process water heating -----	10- 1	2
space heating -----	11- 1	2
space cooling -----	12- 1	2

- 3b. To the best of your knowledge, is your company now using any solar energy systems?

13-

Yes ----- 1

No ----- (SKIP TO Q.3c) ----- 2

(IF YES, ASK): Is the system active or passive?

14-

Active ----- 1

Passive ----- (SKIP TO Q.3c) ----- 2

(IF ACTIVE, ASK): For what purpose does your firm use active solar energy? Is it used for: (READ LIST AND CIRCLE ALL THAT APPLY)

domestic water heating -----	15- 1	} SKIP TO Q.4
process water heating -----	16- 1	
space heating -----	17- 1	
space cooling -----	18- 1	

Has your firm actively sought information about an active solar energy system from a solar equipment manufacturer or dealer?

Yes ----- 19- 1
No ----- (GO TO Q.4) ----- 2

(IF YES):

For what kinds of active solar energy systems have you looked for information?
(READ LIST AND CIRCLE AS MANY AS APPLICABLE)

domestic water heating ----- 20- 1
process water heating ----- 21- 1
space heating ----- 22- 1
space cooling ----- 23- 1

24-
25-
26-

Now I'm going to read a few statements to you. After each statement, please tell me on a scale of 1 to 5 if you agree, or disagree with the statement. An answer of 1 would mean you strongly agree, 5 would mean you strongly disagree, 3 would mean you neither agree nor disagree.

	<u>Strongly agree</u>	<u>Moderately agree</u>	<u>Neither agree nor disagree</u>	<u>Moderately disagree</u>	<u>Strongly disagree</u>	
4a. We can currently obtain <u>reliable</u> and <u>dependable</u> solar energy equipment for use in our company.	1	2	3	4	5	27-
4b. We can currently obtain <u>reliable</u> and <u>dependable</u> solar energy equipment that makes economic sense for use in our company.	1	2	3	4	5	28-
4c. Solar energy equipment will be widely used in our industry within the next five years.	1	2	3	4	5	29-
4d. I understand the financial merits of solar energy systems.	1	2	3	4	5	30-
4e. I understand how solar energy systems work.	1	2	3	4	5	31-

(IF 4 OR 5 CIRCLED IN Q.4e, SKIP TO Q.6)

5. What different kinds of collectors do you know about? What others? (DO NOT READ LIST)

flat plate -----	32-	1
concentrator -----	33-	1
evacuated tube -----	34-	1
trickle collectors -----	35-	1
air collectors -----	36-	1
selective -----	37-	1
non-selective -----	38-	1
other (please specify)		
_____ -----	39-	1
none -----	40-	(1)

6a. Do you know the names of any suppliers or manufacturers of solar systems? (IF NO, GO TO Q.7) What names come to mind? What others? (PROBE, RECORD BELOW)

6b. (ASK FOR EACH MANUFACTURER MENTIONED IN Q.6a)

Taking these manufacturers and suppliers one at a time, would you say (READ FROM LIST) makes a reliable, or unreliable product? (RECORD BELOW ON RELIABILITY SCALE) (REPEAT FOR EACH MANUFACTURER/SUPPLIER LISTED)

6c. Again, taking these manufacturers and suppliers one at a time, would you say (READ FROM LIST) makes an economical, or uneconomical product? (RECORD BELOW ON ECONOMICAL SCALE, REPEAT FOR EACH MANUFACTURER/SUPPLIER LISTED)

Q.6a manufacturers/ suppliers	Q.6b			Q.6c		
	reliable	unreliable	DK	economical	uneconomical	DK
41-42	1	2	3 -43	1	2	3 -44
45-46	1	2	3 -47	1	2	3 -48
49-50	1	2	3 -51	1	2	3 -52
53-54	1	2	3 -55	1	2	3 -56
57-58	1	2	3 -59	1	2	3 -60

7. Is it likely or unlikely that your company will buy solar heating or cooling equipment for some application in the next (READ LIST)? Is that very or somewhat (likely/unlikely)?

	Very Likely	Somewhat Likely	Unsure	Somewhat Unlikely	Very Unlikely	
six months	1	2	3	4	5	61-
two years	1	2	3	4	5	62-

8. Now suppose that your firm has decided to install a new HVAC system, and has identified several different systems for consideration. I'd like to ask you about the criteria you use to screen out some of these alternatives. For each criteria I mention, I'd first like to know if you use it or not. The first is (READ UNDERLINED WORDS PREFACED BY "DO YOU USE...", IF "NO", CHECK RIGHT HAND COLUMN. READ ENTIRE LIST THEN FOR EACH "YES" GO BACK AND ASK FULL QUESTION AND FILL IN RESPONSE IN APPROPRIATE BLA

Do you use (READ UNDERLINED WORDING)?

NOT USED

o What is the minimum <u>expected life</u> you would consider?	<u> </u> years	<u> </u> -67
	64-66	
o For cooling equipment, what is the maximum <u>initial investment cost</u> in dollars per ton that you would consider?	<u> </u> \$/ton	<u> </u> -75
	68-74	
o For heating, what is the maximum <u>initial investment cost</u> in dollars per thousand BTU's per hour you would consider?		(80) 1
DUP 1-4
	<u> </u> \$/KBTU/hr	<u> </u> -12
	5-11	
o What is the minimum <u>warranty period</u> that you would consider?	<u> </u> months	<u> </u> -17
	13-16	
o What is the minimum <u>number of other successful industrial installations</u> you would consider?	<u> </u>	<u> </u>
	13-24	
o What is the maximum <u>annual maintenance cost</u> as a percentage of initial investment that you would consider?	<u> </u> %	<u> </u> -29
	26-28	
o For heating, what is the minimum <u>energy conversion efficiency</u> you would consider?	<u> </u>	<u> </u> -33
	30-32	
o For cooling, what is the minimum <u>coefficient of performance, or COP</u> you would consider?	<u> </u>	<u> </u> -38
	34-37	

(NOTE: COP IS A NUMBER, NOT A PERCENTAGE, BETWEEN 0 AND 15. IF RESPONDENT ANSWERS OVER 15, OR X "PERCENT", ASK: Can you tell me how you are defining COP?)

NOT USED

- o What is the minimum energy efficiency ratio, or EER, that you would consider? -46
39-45
- o What is the minimum seasonal energy efficiency ratio or SEER? -54
47-53
- o For cooling, what is the maximum cost of a service contract, in dollars per year per ton of cooling, that you would consider? -62
\$ / yr / ton
55-61
- o What is the minimum coefficient of performance or COP you would consider for heat pumps in the heating mode? -67
63-66
- o What is the minimum seasonal COP in heating for heat pumps? -72
68-71
- 9a. Would you consider an HVAC system if the manufacturer did not have a local presence? -73
yes-1 no-2
- 9b. Would you consider an HVAC system if you had no previous experience with the system vendor or the manufacturer? -74
yes-1 no-2
- 9c. Now assuming you were considering a retrofit installation, in screening alternatives would you consider the system _____ (READ FOR EACH STATEMENT FOLLOWING)
- If it was not the same type as the one that was being replaced? 75-
Yes ----- 1
No ----- 2
- If the energy source is not the same as the one you are currently using? 76-
Yes ----- 1
No ----- 2
- 10a. In evaluating industrial HVAC equipment, which of the following financial criteria does your company use? Do you use (READ LIST) (80) 2
(READ ALL METHODS FIRST THEN GO BACK & ASK QUESTION FOR EACH YES) DUP 1-4
- Payback method - which is a method that estimates the number of years required to recover the initial cash investment and selects equipment for which the recovery time is sufficiently short? 5-
Yes ----- 1
No ----- 2
- (IF YES, ASK:) What is the length of the payback period you required? 6-
_____ years 7-
8-

A Cash Flow Discounting Method - which is a method that estimates yearly cash inflows or savings and cash outflows or costs over the life of the equipment and discounts these flows to account for the time value of money.

9-
Yes ----- 1
No ----- 2

(IF YES, ASK:) Does your company use the Net Present Value Method?

10-
Yes ----- 1
No ----- 2

(IF YES, ASK:) What does your company currently use as its discount rate (cost of capital)?

11-
12-
13-
_____ %

Does your company use the Internal Rate of Return (that is, the discounted cash flow of return)?

14-
Yes ----- 1
No ----- 2

(IF YES, ASK:) What does your company use as its internal rate of return?

15-
16-
17-
18-
_____ %

Initial investment cost only, or

Yes ----- 1
No ----- 2

Some other financial criteria (SPECIFY)

19-

20-

21-

22-

11. Now I am going to read you a list of six criteria that are often used in evaluating HVAC equipment for new installation. After I read the list, I would like you to tell me which criterion you consider to be the most important in your evaluation of HVAC equipment. (READ LIST, MAKING SURE TO READ X'D CRITERION FIRST, CONTINUING UNTIL ALL CRITERIA ARE READ. RECORD A "1" NEXT TO MOST IMPORTANT.) Which one do you consider the most important in your evaluation of HVAC equipment?

Now, of all the remaining criteria (READ LIST, OMITTING "MOST IMPORTANT CRITERION", AGAIN STARTING WITH X'D FEATURE) which would you consider to be the second most important criterion in evaluating HVAC equipment? (RECORD A "2" NEXT TO SECOND MOST IMPORTANT. REPEAT QUESTION UNTIL ALL SIX CRITERIA HAVE BEEN RANK ORDERED. BE SURE TO READ LIST OF REMAINING CRITERIA EACH TIME AND RECORD RANK ORDER IN THE SPACE NEXT TO THE CRITERIA.)

<u>Criteria</u>	<u>Rank Order</u>
() Initial cost	23- _____
() Supplier reputation and service	24- _____
() Cost of operating and maintenance	25- _____
() System reliability	26- _____
() Convenience of installation and operation	27- _____
() Life cycle cost	28- _____

12. Between now and 1985, what average annual rate of fuel cost increase do you expect your firm will see?

_____ % per year (average)

29-
30-
31-

13. Suppose your company chose an HVAC system which did not fully meet its expectations. On a five point scale, where 1 is of little consequence to your company and 5 is potentially catastrophic to your company, how significant would it be for your organization if the system proved: (READ LIST)

	Of little consequence to the organization			Potentially catastrophic to the organization			
a) less economical than projected?	1	2	3	4	5		-32
b) less reliable and dependable than projected?	1	2	3	4	5		-33

14. Suppose you actively supported adoption of an HVAC system which did not fully meet expectations. On a five point scale, where 1 would not affect your position and credibility and 5 would highly endanger your position and credibility, how significant would it be for you personally if the system proved: (READ LIST)

	Would not affect my position and credibility			Would highly endanger my position and credibility			
a) less economical than projected?	1	2	3	4	5		-34
b) less reliable and dependable than projected?	1	2	3	4	5		-35

15. At what level in your organization are final HVAC decisions typically made: (READ LIST)

	36-
Corporate level -----	1
Divisional level -----	2
Individual plant level -----	3

16. In the next 2-3 years, do you expect your firm will shift its fuel usage pattern?

Yes ----- 37-
No --- (SKIP TO Q.17) ----- 1

(IF YES, ASK:)

What fuels do you expect to use less of? What fuels do you expect to use more of? (READ LIST)

		A. <u>use less</u>	B. <u>use more</u>
Oil -----	38-	1	2
Gas -----	39-	1	2
Electricity -----	40-	1	2
Coal -----	41-	1	2
Wood -----	42-	1	2
Other (SPECIFY)			
_____	43-	1	2

17. About what percent of existing HVAC equipment in the following three areas do you expect your company will replace within the next five years? (READ LIST)

Space heating	_____ %	46- 47- 48- 49- 50- 51- 52- 53- 54-
Space cooling	_____ %	
Water heating	_____ %	

18a. Which of the following three statements best reflects your company's attitude toward new products and technologies: (READ LIST)

a) We like to be at the frontier of technology and to be the first to experiment with new products and processes.	56-
1
or	
b) We carefully monitor test-installation in our industry and, if they work well, we are quick to adopt.	2
or	
c) We take a wait-and-see attitude toward new products and processes.	3

18b. In making purchases for your own home, which of the following three statements best reflects your approach: (READ LIST)

a) I find it interesting and exciting to be the first one in my area to try a new product.	57-
1
or	
b) I'm interested in new products, but I like to have one or two of my friends try the product first to see if it has "bugs".	2
or	
c) If a product is really good, I'll buy it eventually, but not until it has proven itself for a few years.	3

Finally, I would like to get a little more information about you for classification purposes:

19. Which of the following categories correspond most closely to your job responsibilities or if you feel that you are responsible for more than one area what % of time is spent in each category? (READ LIST) (INDICATE %)

Production engineer	_____ %	58-
		59-
		60-
Plant or maintenance engineer	_____ %	61-
		62-
		63-
Design engineer	_____ %	64-
		65-
		66-
Plant or factory manager	_____ %	67-
		68-
		69-
Financial controller/ accountant	_____ %	70-
		71-
		72-
Procurement or purchasing officer	_____ %	73-
		74-
		75-
General manager	_____ %	76-
		77-
		78-
		80-3
		DUP 1-4
Other (SPECIFY)		
_____ %		5-
		6-
		7-
TOTAL	100%	

20. About how many people report to you in your company, directly or indirectly? (READ LIST)

0	-----	8-
1 - 3	-----	1
4 - 10	-----	2
11 - 30	-----	3
over 30	-----	4
		5

21. How many years have you been working for your present company? 9-
 _____ years 10-
 11-

22. In your highest degree, which of the following best describes the area of study you concentrated in? (READ LIST)

12-
 Math/science ----- 1
 Engineering ----- 2
 Business ----- 3
 Liberal arts ----- 4

23. What was the highest level of schooling you completed? (READ LIST)

13-
 High school ----- 1
 College ----- 2
 Post-graduate ----- 3
 (DO NOT READ) Refused ----- 4

24. Into which of the following age groups do you fall? (READ LIST)

14-
 Under 25 ----- 1
 25 - 34 ----- 2
 35 - 44 ----- 3
 45 - 54 ----- 4
 Over 55 ----- 5
 (DO NOT READ) Refused ----- 6

80-4

(CONFIRM CALLBACK TIME/DATE AND RECORD ON SCREENER)

THANK YOU VERY MUCH FOR YOUR TIME!

INDUSTRIAL SEGMENT

MAIL-OUT QUESTIONNAIRE

QUESTIONNAIRE:THE SOLAR ENERGY EQUIPMENT PURCHASING PROCESS

In the following questionnaire, we ask you for information about your company and the process you use to purchase heating, ventilating and air conditioning (HVAC) equipment.

Some of the information requested may not be immediately available to you. Please use any sources (people, reports) within your company that you need to complete the questions. Note also that we would prefer to get your best guess about any of the questions than to have the answer left blank.

Section I: Attitudes Toward Alternative Systems

We would like to learn your reaction to two industrial solar HVAC systems. The summary description of each system is followed by a list of statements that you will be asked to agree or disagree with.

We are interested in how you FEEL about these systems, based on their descriptions, rather than your quantitative evaluation of the systems. There are NO RIGHT OR WRONG ANSWERS, so feel free to register your opinion about the product described.

A solar absorption cooling system contains three major components: a solar collector array, storage tanks, and an absorption chiller unit. (See Diagram.)

The flat plate collector array consists of a modular set of panels (collectors) installed in a location with maximum exposure to the sun at all times of the year. The collectors are mounted at an angle from the horizontal approximately equal to the installation latitude. Direct attachment to a roof of acceptable slope often produces an esthetically pleasing installation. Each flat plate solar collector is an insulated box, completely glazed on one side enclosing a flat black metal plate which contains closed channels for the passage of heat transfer fluid. In January of 1980 a flat plate collector could be purchased for between \$10 and \$20 per square foot. The thermal performance of flat plate collectors depends on many factors. However, a rule of thumb is that flat plate collectors will deliver the energy equivalent of 1 to 2 gallons of fuel oil, 1 to 2 thousand cubic feet of natural gas, or 30 to 60 KWH of electricity per square foot of collector per year, at a delivered temperature of 150°F.

The insulated hot water storage tank is used as a method of retaining solar heat for use at night or on days when the sun is obscured by clouds. The storage tank is usually sized to hold two days worth of normal heating requirement. In many installations, a thermostatic mixing valve is used in the delivery line from the tank to keep delivery temperature constant.

In addition to hot water storage, chilled water can be stored for later use in cooling building air when solar energy is not available.

The actual air conditioning unit works on the

same principal as a gas refrigerator, with the gas flame being replaced by solar heat. In the refrigeration cycle, a chilled liquid (usually water) expands to cool the building supply air. This liquid is then recompressed through a process of absorbing the lower pressure liquid vapor in a concentrated salt solution. The salt solution and water vapor is produced in a generator driven by solar-heated hot water. During sunless days or at night the system uses hot water storage tanks for driving heat, or draws on stored chilled water. One positive element of solar cooling is the strong correlation between available solar energy and cooling requirements.

As can be seen in the system diagram, the process starts in the generator which is filled with the absorber liquid (lithium bromide solution) and is heated by energy from the solar collector. The absorber boils, producing refrigerant vapor and concentrated absorbent. Heat is rejected from the refrigerant vapor by the cooling water, condensing it to a liquid. The liquid refrigerant flows through the expansion valve separating the High and Low pressure side to the evaporator. At the evaporator the drop in pressure boils the refrigerant producing refrigeration, which is applied to the cooling load. The cycle is completed at the absorber where the concentrated lithium bromide solution absorbs the coolant (water) vapor. The heat exchanger for the absorbent serves to preheat dilute absorbent and cool the concentrated absorbent.

The entire absorption system utilizes standard gas fired refrigeration technology with the generator modified to operate on the 200°F solar-heated water.

<u>System A: SOLAR ABSORPTION COOLING</u>	(Circle one number for each item)							
	Strongly Disagree		Neither Agree nor Disagree			Strongly Agree		Don't Know
The system produces reliable output.	1	2	3	4	5	6	7	8
Adoption of the system protects against power failures.	1	2	3	4	5	6	7	8
Performance of the system is sensitive to climatic conditions.	1	2	3	4	5	6	7	8
The system is made up of field proven components.	1	2	3	4	5	6	7	8
Adopting the system conveys the image of a modern, innovative company.	1	2	3	4	5	6	7	8
The system requires a major retraining effort.	1	2	3	4	5	6	7	8
The system's initial cost is acceptably low.	1	2	3	4	5	6	7	8
The system protects against fuel rationing.	1	2	3	4	5	6	7	8
In adopting this system, we would do our part in reducing pollution.	1	2	3	4	5	6	7	8
System components produced by several manufacturers can be substituted for one another.	1	2	3	4	5	6	7	8
The system can easily be extended to meet increased HVAC needs.	1	2	3	4	5	6	7	8
The system is easily installed.	1	2	3	4	5	6	7	8
The system has too many concepts that have not been fully tested.	1	2	3	4	5	6	7	8
System components are easily accessible for maintenance and repair.	1	2	3	4	5	6	7	8
The system leads to considerable energy savings.	1	2	3	4	5	6	7	8
The system is easily integrated into an industrial building.	1	2	3	4	5	6	7	8
The system is too complex.	1	2	3	4	5	6	7	8
The system's operating cost is acceptably low.	1	2	3	4	5	6	7	8
The system offers a state-of-the-art solution to HVAC needs.	1	2	3	4	5	6	7	8
The system increases the noise level in the plant.	1	2	3	4	5	6	7	8
The system makes use of currently unproductive areas in industrial buildings.	1	2	3	4	5	6	7	8
Adoption of this system will increase construction delays.	1	2	3	4	5	6	7	8
The system is modular.	1	2	3	4	5	6	7	8
Service for the system will be quick and easy.	1	2	3	4	5	6	7	8

SYSTEM B

SOLAR ASSISTED HEAT PUMP

The major components of a solar assisted heat pump system are the collector array, transfer fluid system, solar storage, solar controller and heat pump. (See Diagram.)

The flat plate collector array consists of a modular set of panels (collectors) installed in a location with maximum exposure to the sun at all times of the year. The collectors are mounted at an angle from the horizontal approximately equal to the installation latitude. Direct attachment to a roof of acceptable slope often produces an esthetically pleasing installation. Each flat plate solar collector is an insulated box, completely glazed on one side enclosing a flat black metal plate which contains closed channels for the passage of heat transfer fluid. In January of 1980 a flat plate collector could be purchased for between \$10 and \$20 per square foot. The thermal performance of flat plate collectors depends on many factors. However, a rule of thumb is that flat plate collectors will deliver the energy equivalent of 1 to 2 gallons of fuel oil, 1 to 2 thousand cubic feet of natural gas, or 30 to 60 KWH of electricity per square foot of collector per year, at a delivered temperature of 150°F.

The transfer fluid system consists of a pump, heat exchanger and associated piping. To avoid problems of freezing and corrosion, glycol solutions are usually used as the transfer fluid. The transfer fluid pump is activated by the solar system controller and circulates the fluid across the collectors and through a heat exchanger at the storage tank.

The system controller operates the transfer fluid pump in response to thermostatic sensors. The controller measures the difference between collector and storage temperatures and starts the operation of the pump when a positive difference is measured.

The insulated hot water storage tank is used as a method of retaining solar heat for use at night or on days when the sun is obscured by clouds. The storage tank is usually sized to hold two days worth of normal heating requirements. In many installations, a

thermostatic mixing valve is used in the delivery line from the tank to keep delivery temperature constant.

A heat pump uses the same three components as an air conditioner - an evaporator, compressor, and condenser. However, the cycle is reversed. In effect, a heat pump attempts to cool the outside, and in the process "pumps" heat to the indoor air. In a normal heat pump installation the indoor air absorbs heat from the refrigerant which obtains the heat from the outside air. In a solar-assisted unit the heat is obtained from the stored solar-heated fluid. The higher the temperature of the source fluid, the more efficient the heat transfer. This efficiency is measured by the COP (coefficient of performance). A COP of 2 means that one unit of electrical energy applied to the unit will move 2 units of heat across the unit.

When the temperatures of the solar storage and collector return line are lower than that which can be efficiently used for direct building heating, the solar-assisted heat pump is an effective heating system. In the hypothetical example shown in the system diagram, the heat pump alone would have a low COP (coefficient of performance) because the ambient temperature below freezing decreases the heat source and causes freezing problems on the outdoor coil. The solar system alone, as shown in the schematic, cannot produce transfer fluid temperatures high enough to provide useful heat to the building. However, when coupled in a system as shown in the schematic, the efficiency of both systems is improved.

The heat pump operates on a fluid which has a temperature elevated well above freezing. Even if the solar storage is kept as little as 20°F above ambient, the heat pump COP is improved (as long as the storage temperature is above 35°F). The solar collector efficiency is also improved over a direct solar heating scheme. Since a lower temperature transfer fluid is in use, the collector cover losses are less, increasing efficiency. The collectors can be used during periods of otherwise marginal sunshine such as at the beginning and end of the day and on partly cloudy days, which also increases solar system efficiency.

System B: SOLAR ASSISTED HEAT PUMP	(Circle one number for each item)							
	Strongly Disagree		Neither Agree nor Disagree			Strongly Agree		Don't Know
The system produces reliable output.	1	2	3	4	5	6	7	8
Adoption of the system protects against power failures.	1	2	3	4	5	6	7	8
Performance of the system is sensitive to climatic conditions.	1	2	3	4	5	6	7	8
The system is made up of field proven components.	1	2	3	4	5	6	7	8
Adopting the system conveys the image of a modern, innovative company.	1	2	3	4	5	6	7	8
The system requires a major retraining effort.	1	2	3	4	5	6	7	8
The system's initial cost is acceptably low.	1	2	3	4	5	6	7	8
The system protects against fuel rationing.	1	2	3	4	5	6	7	8
In adopting this system, we would do our part in reducing pollution.	1	2	3	4	5	6	7	8
System components produced by several manufacturers can be substituted for one another.	1	2	3	4	5	6	7	8
The system can easily be extended to meet increased HVAC needs.	1	2	3	4	5	6	7	8
The system is easily installed.	1	2	3	4	5	6	7	8
The system has too many concepts that have not been fully tested.	1	2	3	4	5	6	7	8
System components are easily accessible for maintenance and repair.	1	2	3	4	5	6	7	8
The system leads to considerable energy savings.	1	2	3	4	5	6	7	8
The system is easily integrated into an industrial building.	1	2	3	4	5	6	7	8
The system is too complex.	1	2	3	4	5	6	7	8
The system's operating cost is acceptably low.	1	2	3	4	5	6	7	8
The system offers a state-of-the-art solution to HVAC needs.	1	2	3	4	5	6	7	8
The system increases the noise level in the plant.	1	2	3	4	5	6	7	8
The system makes use of currently unproductive areas in industrial buildings.	1	2	3	4	5	6	7	8
Adoption of this system will increase construction delays.	1	2	3	4	5	6	7	8
The system is modular.	1	2	3	4	5	6	7	8
Service for the system will be quick and easy.	1	2	3	4	5	6	7	8

Next, we'd like to get your feelings about solar:

Section II: Preference Analysis

In the questions below, remember that SYSTEM A IS A SPACE COOLING SYSTEM and SYSTEM B IS A SOLAR ASSISTED HEAT PUMP SYSTEM.

1. Assuming that each system met all of the operating and financial requirements of your firm (as we discussed over the phone), what is the likelihood that you would recommend that your firm purchase each system for a new installation? (Check one line in each column.)

	<u>System A</u>	<u>System B</u>
Certain, practically certain (99 in 100)	_____	_____
Almost sure (9 in 10)	_____	_____
Very probable (8 in 10)	_____	_____
Probable (7 in 10)	_____	_____
Good possibility (6 in 10)	_____	_____
Fairly good possibility (5 in 10)	_____	_____
Fair possibility (4 in 10)	_____	_____
Some possibility (3 in 10)	_____	_____
Slight possibility (2 in 10)	_____	_____
Very slight possibility (1 in 10)	_____	_____
No chance, almost no chance (0 in 10)	_____	_____

2. In financial analysis, many companies use the payback period method for evaluating HVAC equipment. It determines the number of years required to recover an initial cash investment.

Now, considering your feeling about fuel escalation, how long would you require that an investment in each HVAC system payback to:

	<u>System A</u>	<u>System B</u>
(a) Be 100% certain to recommend it over a conventional alternative. (Please answer to the nearest tenth of a year.)	_____ years	_____ years
(b) Be indifferent between it and a conventional alternative (a 50% chance of recommending it).	_____ years	_____ years
(c) Be just willing to consider it for recommendation (a 10-20% chance of recommending it).	_____ years	_____ years

3. Again, SYSTEM A IS A SPACE COOLING SYSTEM AND SYSTEM B IS A HEAT PUMP SYSTEM. Please circle the number which shows how much you agree or disagree with each of the following statements:

	<u>Strongly agree</u>	<u>Moderately agree</u>	<u>Neither agree nor disagree</u>	<u>Moderately disagree</u>	<u>Strongly disagree</u>
a) We can currently obtain a System A that makes economic sense for use in our company.	1	2	3	4	5
b) We can currently obtain a reliable and dependable System A for use in our company.	1	2	3	4	5
c) We can currently obtain a System B that makes economic sense for use in our company.	1	2	3	4	5
d) We can currently obtain a reliable and dependable System B for use in our company.	1	2	3	4	5
e) Solar energy equipment will be widely used in our industry within the next five years.	1	2	3	4	5
f) I understand the financial merits of solar energy systems.	1	2	3	4	5
g) I understand how solar energy systems work.	1	2	3	4	5

Section III: Decision Process Information

4. The purchase of an industrial HVAC system typically involves several participants. In this question, we would like to know more about who would be involved in the important phases of the decision-making process -- both company personnel and people external to the firm.

For each of the "decision phases" in the following chart, please indicate approximately what percentage of the task-responsibilities is that of each category of participants. For instance, Phase I may be the responsibility of the architect (25%), the HVAC consulting firm (25%), and top management (50%).

Of course, a given decision-making phase might be the responsibility of only one category of participants, in which case, you should write 100% in the appropriate box and leave all of the other boxes in that column blank.

	Decision Phases Decision Participants	1 Identification of HVAC alternatives		2 Financial and technical evaluation*	3 Final equipment and source selection**
		New Installation	Retrofit Installation		
INTERNAL COMPANY PERSONNEL	Production engineer	%	%	%	%
	Plant or maintenance engineer	%	%	%	%
	Design engineer	%	%	%	%
	Plant or factory manager	%	%	%	%
	Financial controller or accountant	%	%	%	%
	Procurement or purchasing officer	%	%	%	%
	General management	%	%	%	%
	Other (specify)	%	%	%	%
EXTERNAL PERSONNEL	HVAC/Engineering firm	%	%	%	%
	Architects	%	%	%	%
	HVAC equipment manufacturers/vendors	%	%	%	%
	COLUMN TOTAL	100%	100%	100%	100%

*Decision phase 2 generally involves evaluation of all alternative HVAC systems that meet your company's needs, while

**Decision phase 3 involves only the alternatives (generally 2-3) retained for final selection

Section IV: Company Information

5. At what level in your organization are final HVAC decisions typically made?
(CHECK ONE)

corporate level _____
divisional level _____
individual plant level _____

Call the level noted above the HVAC "decision unit", and answer the following questions in terms of that decision unit.

6. About how many separate plants does your decision unit have?

- 7a. About how many total sq. ft. of plant area does your decision unit have?

_____ thousand sq. ft.

- b. About what percent of this space is owned by the decision unit (not rented or leased)?

_____ %

- c. Of the area in (a), how is it distributed geographically (see map)?

Northeast _____ %
Northwest _____ %
Southeast _____ %
Southwest _____ %

100 %

8a. Where is the headquarters of your decision unit located?

ZIP _____

b. Where is the plant you are associated with located?

ZIP _____

9. What is your expected growth rate in new plant area as a percent of your current plant floor area (do not subtract plant area currently being vacated)?

_____ % annual growth rate

10. What were the sales for your decision unit last year (+ 10%)?

\$ _____ million

11. About how many employees does your decision unit have?

12a. Please estimate your decision unit's annual HVAC energy usage of each of the following fuels. What is your company's unit energy cost of each of these fuels?

	<u>Oil</u>	<u>Gas</u>	<u>Elec.</u>	<u>Coal</u>	<u>Wood</u>	<u>Other (specify)</u>
Annual usage (thousands of dollars)	_____	_____	_____	_____	_____	_____
per unit energy cost	\$/gal	\$/M ft ³	\$/KWH	\$/ton	\$/cord	_____

b. Please check the primary fuel your company uses for each of the following HVAC applications. (Please place only one check in each row.)

	<u>Oil</u>	<u>Gas</u>	<u>Elec.</u>	<u>Coal</u>	<u>Wood</u>	<u>Other (specify)</u>
Space heating	_____	_____	_____	_____	_____	_____
Space cooling	_____	_____	_____	_____	_____	_____
Water heating	_____	_____	_____	_____	_____	_____

Thank you very much for your cooperation! If you would like a copy of the results, please write your name and address below, and we will be happy to send you a copy when they are available.

Name _____

Company _____

Address _____

If you would like to comment on this questionnaire or solar products in general, please use the space below to do so.

Variable System Descriptions

SYSTEM A

SOLAR DOMESTIC WATER HEATING

A solar domestic water heating system is composed of five elements: a collector array, hot water storage tank, transfer fluid circulating system (a pump, pipes and a heat exchanger), system controller and auxiliary heating source. (See Diagram.)

The flat plate collector array consists of a modular set of panels (collectors) installed in a location with maximum exposure to the sun at all times of the year. The collectors are mounted at an angle from the horizontal approximately equal to the installation latitude. Direct attachment to a roof of acceptable slope often produces an esthetically pleasing installation. Each flat plate solar collector is an insulated box, completely glazed on one side enclosing a flat black metal plate which contains closed channels for the passage of heat transfer fluid. In January of 1980 a flat plate collector could be purchased for between \$10 and \$20 per square foot. The thermal performance of flat plate collectors depends on many factors. However, a rule of thumb is that flat plate collectors will deliver the energy equivalent of 1 to 2 gallons of fuel oil, 1 to 2 thousand cubic feet of natural gas, or 30 to 60 KWH of electricity per square foot of collector per year, at a delivered temperature of 150°F.

The insulated hot water storage tank is used as a method of retaining solar heat for use at night or on days when the sun is obscured by

clouds. The storage tank is usually sized to hold two days worth of normal heating requirement. In many installations, a thermostatic mixing valve is used in the delivery line from the tank to keep delivery temperature constant.

The transfer fluid system consists of a pump, heat exchanger and associated piping. To avoid problems of freezing and corrosion, glycol solutions are usually used as the transfer fluid. The transfer fluid pump is activated by the solar system controller and circulates the fluid across the collectors and through a heat exchanger at the storage tank.

The system controller operates the transfer fluid pump in response to thermostatic sensors. The controller measures the difference between collector and storage temperatures and starts the operation of the pump when a positive difference is measured.

The auxiliary heating source is placed downstream of the solar storage tank, and it is essentially a standard hot water heating system. This auxiliary source could be any type of water heater, from steam converter to electric resistance. The auxiliary heating system operates in response to the temperature of the water delivered from the solar storage tank.

SYSTEM B

SOLAR SPACE HEATING

A solar space heating system is composed of six elements. These are a collector array, hot water storage tank, transfer fluid circulating system, heat delivery system, solar system controller, and auxiliary heat source. (See Diagram.)

The *concentrating collector array* consists of collector units mounted on a framework which moves to track the sun, keeping the collectors perpendicular to the sun throughout the day. A single concentrating collector consists of a linear absorber through which the transfer fluid is pumped. This can be as simple as a black pipe. The unit is insulated by one of two methods: either glazing across the outside edges of the reflector and providing foam insulation on the external surface of the reflector, or insulating only the absorber pipe with an evacuated glass tube to produce a Thermos effect. In January of 1980, a concentrating collector array could be purchased for approximately \$30 to \$50 per square foot. This same array will deliver the energy equivalent of 1 to 2 gallons of fuel oil, 1 to 2 thousand cubic feet of natural gas, or 30 to 60 KWH of electricity per square foot of collector per year, at a delivered temperature of approximately 250°F.

The *insulated hot water storage tank* is used as a method of retaining solar heat for use at night or on days when the sun is obscured by clouds. The storage tank is usually sized to hold two days worth of normal heating requirement. In many installations, a thermostatic mixing valve is used in the delivery line from the tank to keep delivery temperature constant.

The *transfer fluid system* consists of a pump, heat exchanger and associated piping. To avoid problems of freezing and corrosion, glycol solutions are usually used as the transfer fluid. The transfer fluid pump is activated by the solar system controller and circulates the fluid across the collectors and through a heat exchanger at the storage tank.

The *heat delivery system* in a hot water based solar space heating system can consist of any standard hot water unit. Fin tube convectors, fan coil units or reheat coils could be supplied by the solar heated waters. Standard circulating pumps and temperature controls are also used in solar heating systems. The only special requirements with a solar heating system is that the sizing of unit coils be matched to the temperature of the delivered hot water.

The *system controller* operates the transfer fluid pump in response to thermostatic sensors. The controller measures the difference between collector and storage temperatures and starts the operation of the pump when a positive difference is measured.

The *auxiliary heating source* is placed down stream of the solar storage tank, and it is essentially a standard hot water heat system. This auxiliary source could be any type of water heater, from steam converter to electric resistance. The auxiliary heating system operates in response to the temperature of the water delivered from the solar storage tank.

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HVAC PROFESSIONALS SEGMENT

TELEPHONE QUESTIONNAIRE

HVAC Questionnaire
April, 1980

Hello, I'm _____ from Dialogue, an independent market research firm. We are conducting a study about solar energy. (IF RELEVANT: we got your name from _____.) It is very important for us to get attitudes of individuals such as you who influence purchase decisions for heating and air conditioning equipment. Do you, personally, work directly with clients in the selection or evaluation of heating or air conditioning equipment?

yes _____ -1 no _____ -2 (IF NO, GO TO (A))

I'd like to ask you to agree to take part in the study. Our questions will only take a few minutes of your time. Of course, any information you provide will be combined with all other responses and will be used for statistical analyses only. Your participation will be completely confidential and your name will never be associated with this survey in any way. In addition, we will make available to you results of the study.

I'd like to ask you to agree to take part. Are there any questions you might have about the study? Will you participate?

yes _____ -1 Great! no _____ -2 (GO TO (A)) [Not Now (GO TO B)]
(GO TO Q.1)

-8

B. When would be a good time to call you back? _____ Day _____ Time.

(A) Who in your organization would be an appropriate individual for us to contact?

Name _____

Telephone _____

Who Else? (PROBE)

Name _____

Telephone _____

Name _____

Telephone _____

(TRY TO GET ONE INDIVIDUAL FROM AN ORGANIZATION)

1a. Are you aware of how active solar energy systems work?

yes _____ -1 no _____ -2

-9

1b. Has your firm actively sought information about solar energy from a solar equipment manufacturer or dealer?

yes _____ -1 no _____ -2 (IF NO, GO TO Q. 2a)

-10

(IF YES, ASK:)

1c. For what kinds of active solar energy systems have you looked for information?

domestic water heating	_____ -1	-11
process water heating	_____ -2	-12
space heating	_____ -3	-13
space cooling	_____ -4	-14

2a. Has your firm considered the use of active solar energy equipment for: (READ LIST)

2b. Has your firm specified the use of solar energy for: (ASK ONLY THOSE ITEMS CONSIDERED AND ENTER IN Col. Q.2b) (IF THERE IS A SYSTEM CONSIDERED BUT NOT SPECIFIED, ASK 2c. OTHERWISE, GO TO 2d.)

	(Q.2a) Considered	(Q.2b) Specified
--	----------------------	---------------------

any domestic water heating application?	_____ -1-15	_____ -1-19
any process water heating application?	_____ -1-16	_____ -1-20
any space heating application?	_____ -1-17	_____ -1-21
any space cooling application?	_____ -1-18	_____ -1-22

(IF NOT CONSIDERED ALL OF THE ABOVE, GO TO 3)

(ASK FOR TYPE NOT SPECIFIED IN Q.2b)

2c. What are the reasons for not specifying solar when it was considered? (DO NOT READ LIST: CHECK ANY BOXES THAT APPLY. NOTE: USE "GENERAL" BOX HERE AND IN Q.2e. WHEN RESPONDENT DOES NOT SPECIFY ANY DIFFERENCE BY SYSTEM-TYPE.)

	<u>General</u>	<u>Water Heating</u>	<u>Process Heating</u>	<u>Space Heating</u>	<u>Space Cooling</u>
cost	_____ -1-23	_____ -1-24	_____ -1-25	_____ -1-26	_____ -1-27
reliability	_____ -1-28	_____ -1-29	_____ -1-30	_____ -1-31	_____ -1-32
manufacturer					
reputation	_____ -1-33	_____ -1-34	_____ -1-35	_____ -1-36	_____ -1-37
client decided					
against	_____ -1-38	_____ -1-39	_____ -1-40	_____ -1-41	_____ -1-42
other (specify)	_____ -1-43	_____ -1-44	_____ -1-45	_____ -1-46	_____ -1-47

2d. (IF ANY TYPE OF EQUIPMENT SPECIFIED IN Q.2b, ASK Q.2d; IF NONE, GO TO Q.3)
How much of your company's business is active solar related?

_____ -1 less than 5%
_____ -2 5% - 25%
_____ -3 over 25%

-50

2e. Would you say your clients have been satisfied or dissatisfied with their solar energy experience? (IF NECESSARY:) Would that be moderately satisfied/dissatisfied or very satisfied/dissatisfied?

	<u>General</u>	<u>Water Heating</u>	<u>Process Heating</u>	<u>Space Heating</u>	<u>Space Cooling</u>
Very satisfied	_____ -1	_____ -1	_____ -1	_____ -1	_____ -1
Moderately satisfied	_____ -2	_____ -2	_____ -2	_____ -2	_____ -2
Unsure	_____ -3	_____ -3	_____ -3	_____ -3	_____ -3
Moderately dissatisfied	_____ -4	_____ -4	_____ -4	_____ -4	_____ -4
Very Dissatisfied	_____ -5	_____ -5	_____ -5	_____ -5	_____ -5
	51	52	53	54	55

3. What types of solar collectors do you know about? What others?
(DO NOT READ LIST)

flat plate	_____ -1	-56
concentrator	_____ -1	-57
evacuated tubes	_____ -1	-58
trickle collectors	_____ -1	-59
air collectors	_____ -1	-60
selective	_____ -1	-61
non-selective	_____ -1	-62
other (specify)	_____ -1	-63
none	_____ -1	-64

4. Are you aware of suppliers or manufacturers of any solar systems?
(IF NO, GO TO Q.6) If so, what names come to mind? Others?
(PROBE AND RECORD BELOW.)
- 5a. Taking these manufacturers and suppliers one at a time, would you
say (READ FROM LIST) makes a reliable or unreliable product? (RECORD BELOW
ON RELIABILITY SCALE.) (REPEAT FOR EACH MANUFACTURER/SUPPLIER LISTED.)
- 5b. Again, taking these manufacturers and suppliers one at a time,
would you say (READ FROM LIST) makes economical or uneconomical
products? (RECORD BELOW ON ECONOMICAL SCALE. REPEAT FOR EACH
MANUFACTURER/SUPPLIER LISTED.)

4. manufacturers/ suppliers	5a.			5b.		
	reliable	unreliable		economical	uneconomical	
-65-66	1	2	-67	1	2	-68
-69-70	1	2	-71	1	2	-72
-73-74	1	2	-75	1	2	-76
-77-78	1	2	-05	1	2	-06
-07-08	1	2	-09	1	2	-10

cc 80-1
dup 1-4

Not Aware of Suppliers ☐ SKIP TO Q.6

(ASK EVERYONE):

6. Do you believe that solar energy equipment will or will not be
widely used within the next five years? (AS NECESSARY, ASK:)
Is that definitely will/will not, or probably will/will not?
(IF DEFINITELY WILL, ASK:) Do you feel fairly certain about
that, or are you just pretty sure?

Definitely will ☐ Fairly certain ☐ -1
☐ Pretty sure ☐ -2

Probably will ☐ -3

Unsure ☐ -4

Probably will not ☐ -5

Definitely will not ☐ -6

-11

7a. Is it likely or unlikely that your firm will specify active solar heating or cooling equipment for some application in the next year? (AS NECESSARY, ASK:) Is that very likely/unlikely, or somewhat likely/unlikely? (IF VERY LIKELY, ASK:) Are you 100% certain or just pretty sure?

How about in the next five years?

Next Year		Five Years	
Very Likely	<div style="display: inline-block; vertical-align: middle;"> <div style="text-align: right;">100% certain</div> <div style="display: inline-block; vertical-align: middle;"> <div style="border-left: 1px solid black; width: 100px; height: 100px; margin: 0 auto;"></div> </div> <div style="text-align: left;"> <div style="border-bottom: 1px solid black; width: 100px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px solid black; width: 100px; margin-bottom: 5px;"></div> </div> </div> <div style="display: inline-block; vertical-align: middle; margin-left: 10px;"> <div style="text-align: right;">100% certain</div> <div style="text-align: right;">pretty sure</div> </div> <div style="display: inline-block; vertical-align: middle; margin-left: 10px;"> <div style="text-align: right;">-1</div> <div style="text-align: right;">-2</div> </div>	Very Likely	<div style="display: inline-block; vertical-align: middle;"> <div style="text-align: right;">100% certain</div> <div style="display: inline-block; vertical-align: middle;"> <div style="border-left: 1px solid black; width: 100px; height: 100px; margin: 0 auto;"></div> </div> <div style="text-align: left;"> <div style="border-bottom: 1px solid black; width: 100px; margin-bottom: 5px;"></div> <div style="border-bottom: 1px solid black; width: 100px; margin-bottom: 5px;"></div> </div> </div> <div style="display: inline-block; vertical-align: middle; margin-left: 10px;"> <div style="text-align: right;">100% certain</div> <div style="text-align: right;">pretty sure</div> </div> <div style="display: inline-block; vertical-align: middle; margin-left: 10px;"> <div style="text-align: right;">-1</div> <div style="text-align: right;">-2</div> </div>
Somewhat Likely	-3	Somewhat Likely	-3
Unsure	-4	Unsure	-4
Somewhat Unlikely	-5	Somewhat Unlikely	-5
Very Unlikely	-6	Very Unlikely	-6
	-12		-13

(IF EITHER 1 YEAR OR 5 YEAR, OR BOTH, ARE "VERY LIKELY", THEN ASK Q. 8, 9a AND 9b. IF NEITHER ARE "VERY LIKELY", THEN SKIP TO Q. 10.)

8. (IF "VERY LIKELY"):

What application/technology do you expect to specify active solar heating or cooling equipment for: (IF NECESSARY, READ LIST)

Solar domestic water heating	-1	-15
Solar space heating	-1	-16
Solar absorption cooling	-1	-17
Solar assisted heat pumps and cooling systems	-1	-18

9a. Would this be for:

Residential use	_____ -1	-19
Industrial use	_____ -1	-20
Commercial use	_____ -1	-21
Municipal/government buildings	_____ -1	-22
Hospitals	_____ -1	-23
Other (please specify)	_____ -1	-24

9b. Are these likely to be new or retrofit installations?

new	_____ -1	-25
retrofit	_____ -1	-26

(ASK EVERYONE):

10. Now I'm going to read a few statements to you. After each statement, please tell me on a scale of 1 to 5 if you agree, or disagree with the statement. An answer of 1 would mean you strongly agree, 5 would mean you strongly disagree, 3 would mean neither agree nor disagree. Remember that we are talking about only ACTIVE solar energy products.

	Strongly agree	Moderately agree	Neither agree nor disagree	Moderately disagree	Strongly disagree	
a. HVAC manufacturers can currently produce cost effective solar energy systems.	1	2	3	4	5	-27
b. HVAC manufacturers can currently produce reliable and dependable solar energy systems.	1	2	3	4	5	-28
c. If my firm recommended a solar HVAC system that proved less <u>economical</u> than we expected, it could harm our reputation.	1	2	3	4	5	-29
d. If I, personally, recommended a solar HVAC system that proved less <u>economical</u> than projected, it could ruin my career.	1	2	3	4	5	-30
e. If my firm recommended a solar HVAC that proved less <u>reliable</u> and <u>dependable</u> than projected, it could harm our reputation.	1	2	3	4	5	-31
f. If I, personally, recommended a solar HVAC that proved less <u>reliable</u> and <u>dependable</u> than projected, it could ruin my career.	1	2	3	4	5	-32

10. (continued)		<u>Strongly</u> <u>agree</u>	<u>Moderately</u> <u>agree</u>	<u>Neither</u> <u>agree nor</u> <u>disagree</u>	<u>Moderately</u> <u>disagree</u>	<u>Strongly</u> <u>disagree</u>	
g.	I find it interesting and exciting to be the first one in my area to try a new product.	1	2	3	4	5	-33
h.	My firm is known in the industry as one that only specifies or recommends systems that are "tried and true".	1	2	3	4	5	-34
i.	The federal government should finance the development of markets for solar energy.	1	2	3	4	5	-35
j.	Day in and day out, solar energy systems can provide a significant fraction of a building's HVAC needs.	1	2	3	4	5	-36
k.	Solar HVAC systems are too complex.	1	2	3	4	5	-37
l.	Specifications of solar HVAC systems will lead to construction delays.	1	2	3	4	5	-38
m.	The widespread adoption of solar energy systems would be the best way for the nation to achieve energy independence.	1	2	3	4	5	-39
n.	A solar HVAC system user conveys a modern, innovative image.	1	2	3	4	5	-40
o.	Solar HVAC systems incorporate too many concepts that have not been fully tested.	1	2	3	4	5	41
p.	I like the concept of using solar energy for HVAC applications.	1	2	3	4	5	-42
q.	Solar HVAC systems protect against fuel rationing.	1	2	3	4	5	-43
r.	Solar HVAC systems are difficult to service.	1	2	3	4	5	-4

11. Now I'd like to review with you the criteria you use in evaluating HVAC systems in general for recommendation to your clients.

First, when you perform an economic evaluation of alternative HVAC systems, which one of the following criteria do you emphasize most:

(READ LIST, CHECK ONLY ONE: THE MOST EMPHASIZED)

- (1) Payback period, balancing differences in investment cost with differences in operating and maintenance costs. _____ -1
- (2) Net present value of the investment and future operating and maintenance costs. _____ -2
- (3) Initial investment cost only _____ -3
- or some other criterion (please specify): _____ -4

12a. Suppose you were retained to recommend an HVAC system for a client. There may be criteria that you use to screen out alternatives that you wouldn't consider recommending. Is there a minimum overall economic life, less than which you wouldn't consider a system?

_____ -1 YES _____ -2 NO

(IF YES): How many years? _____ years

-47-

12b. Is there a minimum factory warranty on HVAC equipment that you require?

_____ -1 YES _____ -2 NO

(IF YES): How many months? _____ months

-50-

12c. Is there a certain minimum number of prior successful installations for a system that you require before you will recommend a system?

_____ -1 YES _____ -2 NO

(IF YES): How many prior installations? _____

-53-

12d. Will you consider recommending a system if you or your firm have had no previous experience with the system's vendor or manufacturer?

_____ -1 YES _____ -2 NO

-1

12a. For a heating system, is there a minimum % energy conversion efficiency that you require?

_____ -1 YES _____ -2 NO

-1

(IF YES): What %? _____ %

-57-1

12f. For a cooling system, is there a minimum coefficient of performance that you require?

_____ -1 YES _____ -2 NO -59
(IF YES): What coefficient of performance? _____ --60-62

12g. Is there a minimum profit margin, or fee for your firm that you require?

_____ -1 YES _____ -2 NO -63
(DO NOT READ): Refused _____ -3
(IF YES): What % of the system's price to the client would that be?
_____ % -64-66

13. When your firm evaluates new HVAC systems introduced to the market, how important is _____ (READ EACH ITEM FROM LIST BELOW. IS IT OF HIGHEST IMPORTANCE, MODERATELY IMPORTANT, OR NOT IMPORTANT?)

ROTATE

	Of highest importance	Moderately important	Not important	
() a. the system's expected life?	1	2	3	-67
() b. the reputation of the system's producers?	1	2	3	-68
() c. previous experience with the system's producers?	1	2	3	-69
() d. ease of installation?	1	2	3	-70
() f. the system's ease of maintenance?	1	2	3	-71
() g. the modularity of the system's components?	1	2	3	-72
() h. the initial investment cost?	1	2	3	-73
() i. the warranty period?	1	2	3	-74
() j. the system's maintenance costs?	1	2	3	-75
() k. client's availability of primary fuel?	1	2	3	-76
() l. future costs of client's primary fuel?	1	2	3	-77

cc 80-2
dup 1-4

Next, I'd like to get some information about your firm.

14. In what city is the principal office of your firm located?

7-10

15. What is your firm's main activity? Is it: (READ LIST)

architecture or design	_____	-1
contracting	_____	-2
HVAC consulting	_____	-3
both HVAC consulting and contracting	_____	-4
other	_____	-5

-11

16. About how many architects or engineering professionals does your firm employ?

_____ -12-14

17. About how many separate HVAC installation recommendations was your firm involved in last year?

_____ -15-19

18. About what percentage of these installations were for: (READ LIST)

municipal or government buildings	_____	-20-22
hospitals	_____	-23-25
industrial buildings	_____	-26-28
commercial buildings	_____	-29-31
multiple family residences	_____	-32-34
single family residences	_____	-35-37
other(Please specify)	_____	-38-40

(CHECK TO SEE THAT TOTAL IS EQUAL TO 100%)

19. About what percent of your firm's dollar business is located in the:

Northeast	_____	z-41-43
Southeast	_____	z-44-46
Southwest	_____	z-47-49
Northwest	_____	z-50-52

20. Does your firm represent a manufacturer of HVAC equipment?

_____ -1 YES

_____ -2 NO

-33

(IF YES): Which manufacturer? _____

-34-35

(IF MORE THAN ONE MENTIONED, ASK: "Which is the primary manufacturer?")

21. What was your firm's average growth rate in total revenue during the last five years?

-56-58

Finally, I would like to get a little information about you for classification purposes:

22. What is your job title?

-59-60

23. Which of the following categories most closely corresponds to your current job responsibility?

architecture	_____	-1
system specification and engineering	_____	-2
sales and customer contact	_____	-3
customer service and maintenance	_____	-4
company management	_____	-5
other (specify)	_____	-6

-61

24. About how many people report to you in your company, directly or indirectly?

0	_____	-1
1 - 3	_____	-2
4 - 10	_____	-3
11 - 30	_____	-4
over 30	_____	-5

-62

25. In your highest degree, which of the following best describes the area of study you concentrated in?

Architecture	_____	-1
Math/Science	_____	-2
Engineering	_____	-3
Business	_____	-4
Liberal Arts	_____	-5

-63

26. What was the highest level of schooling you completed?

Less than college _____ -1
college _____ -2
post-graduate _____ -3
(DO NOT READ) refused _____ -4

-64

27. Into which of the following age groups do you fall?

Under 25 _____ -1
25 - 34 _____ -2
35 - 44 _____ -3
45 - 54 _____ -4
Over 55 _____ -5
(DO NOT READ) refused _____ -6

-65

If you would like a copy of the results of this study, please give me your full name and address:

NAME _____

ADDRESS _____

PHONE #: _____

Thank you very much for your time and cooperation!

INTERVIEWER'S NAME: _____ DATE: _____

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BUILDER/DEVELOPER SEGMENT

PERSONAL QUESTIONNAIRE

Builder's Questionnaire

Hello, I'm _____ from Dialogue, a marketing consulting firm. We're conducting a study for the Department of Energy about marketing active solar energy products. The survey is being done among several different groups, one of which is home builders, and I'd like to ask you to participate. Does your firm build single family residential houses on speculation, that is, build first and find a buyer as the house gets finished?

YES _____ NO _____ (TERMINATE)

And does your firm build only mobile homes?

YES _____ (TERMINATE) NO _____

I'd like to ask you to participate in our study. The interview will take only a short while.

(IF INDIVIDUAL AGREES): Thank you very much. (SEAT RESPONDENT WITH RESPONSE CARD.) In the study we are trying to find out what home builders think about active solar energy systems and also to get their views of home buyers' attitudes about solar energy. This survey will only take a short while. We will be glad to send you the results of the study when it is complete if you stamp this form. (HAND FORM TO RESPONDENT.)

- 1a. To begin with, how many single family residential units, both spec and custom, and excluding mobile homes, did your company build in 1979?

_____ units

5- 9

- 1b. And about what percentage of your detached, single-family residential construction is spec built? What percentage is custom built?

spec built _____ %

10-12

custom built _____ %

13-15

(MUST ADD TO 100%) 100 %

2. Approximately what was the residential construction volume for your company in 1979 in thousands of dollars?

_____ M dollars

16-21

3. (HAND MAP TO RESPONDENT) What percentage of the single-family residential homes that your firm built in 1979 fall into each of these regions? (SHOW MAP, READ LIST)

Northeast _____ %

22-24

Southeast _____ %

25-27

Northwest _____ %

28-30

Southwest _____ %

31-33

(MUST ADD TO 100%) 100 %

4a. Approximately what percentage of the homes that you build are: (READ LIST)

entry level houses	_____ %	34-36
middle price houses	_____ %	37-39
luxury houses	_____ %	40-42
(MUST ADD TO 100%)	100 %	

4b. Consider a typical house you build on speculation. Looking at Scale A on your response card, which of the ranges most closely reflects the selling price of that house?

\$30-50	_____ -1	110-130	_____ -5	
50-70	_____ -2	130-150	_____ -6	43-
70-90	_____ -3	150 & up	_____ -7	
90-110	_____ -4			

5. Next, I'd like to get some information about the kinds of heating, cooling and hot water systems you install when you build a home. First let's talk about the primary fuel used for home heating.

a) What percentage of spec homes that you build use gas as the primary heating fuel? (REPEAT FOR EACH OF THE FOLLOWING):

gas	_____ %	44-46
electricity	_____ %	47-49
oil	_____ %	50-52
solar	_____ %	53-55
other	_____ %	56-58
no heating system	_____ %	59-61

(COLUMNS MUST ADD TO 100%: TOTAL = 100%)

b) What percentage of spec homes that you build use gas as the primary fuel to heat water? (REPEAT FOR EACH OF THE FOLLOWING):

gas	_____ %	62-64
electricity	_____ %	65-67
oil	_____ %	68-70
solar	_____ %	71-73
other	_____ %	74-76

(COLUMNS MUST ADD TO 100%: TOTAL = 100%)

c) In about what percentage of the homes that you build do you install a central air conditioning system?

80- 1
Card 2 Dup 1-4

_____ %

5- 7

d) Have you ever installed a heat pump in a home?

_____ YES -1

_____ NO -2

8-

6. Active solar energy systems are systems with a collector that use a fluid, or air, to move the trapped heat from the collector to where it will be used. Have you included any kinds of active solar devices in any of the homes you've built?

____ YES -1

____ NO -2 (SKIP TO Q. 15)

In all of the following questions when we are talking about solar energy systems, we are only talking about active solar energy systems.

7. What kinds of active solar energy systems have you installed? (READ LIST)
(PROBE FOR OTHER KINDS OF SYSTEMS) (IF "YES" ASK FOLLOW-UP QUESTION):
In how many houses have you installed this kind of system? (RECORD)

	yes	no	Number of houses	
water heating	____ -1	____ -2	-10	____ 11-1
pool heating	____ -1	____ -2	-14	____ 15-1
home heating (and water)	____ -1	____ -2	-18	____ 19-1
solar-assisted heat pump	____ -1	____ -2	-22	____ 23-2
other _____				____ 25-1

8. Who manufactured the systems that you installed? (PROBE) (ASK FOR EACH SYSTEM MARKED "YES" IN Q.7)

water heater names:

_____ } -1

27

don't remember _____ -2

site built _____ -3

pool heater names:

_____ } -1

28

don't remember _____ -2

site built _____ -3

none heating
(and water)

_____	}	-1

29-

don't remember _____ -2

site built _____ -3

solar-assisted
heat pump

_____	}	-1

30-

don't remember _____ -2

site built _____ -3

other type manufacturer

_____	}	31-1

9. Looking at Scale B (HAND SCALE CARD TO RESPONDENT), please tell me the number that best shows how satisfied you are with the _____
(READ EACH SYSTEM TYPE INSTALLED FROM Q. 7), you have installed?

			neither satisfied			
	very	moderately	nor	moderately	very	
	satisfied	satisfied	dissatisfied	dissatisfied	dissatisfied	
solar water heaters	1	2	3	4	5	33-
solar home heating systems	1	2	3	4	5	34-
solar assisted heat pumps	1	2	3	4	5	35-
other: _____	1	2	3	4	5	36-
_____	1	2	3	4	5	37-

10. Were there any specific solar related problems that developed either during or after your installation of any system? What were they?

NO _____ -1

_____	}	-2

38-

11. Do you plan to install any kinds of active solar energy systems in the future?

____ YES -1

____ NO -2

39

12. Have you used any federal or state incentives to reduce your own cost of installing active solar energy equipment?

____ YES -1

____ NO -2(SKIP TO Q.13a)

40-

What incentives did you use?

13a. Did the homebuyer(s) use any federal or state incentives to reduce the cost of purchasing the solar systems that you installed?

____ YES -1

____ NO -2

____ DON'T KNOW -3

(IF "NO" OR "DON'T KNOW", SKIP TO Q.14)

41-

13b. How important were the incentives in getting the purchaser to buy the house? Where they: (READ LIST)

Very important _____ -1

Moderately important _____ -2

Unimportant _____ -3

Don't know _____ -4

42-

Custom designed house _____ -5

14a. Using your most recent spec solar home as an example, did you perform any analysis of fuel savings, compared to the cost of the solar energy system?

____ YES -1

____ NO -2 (SKIP TO Q.18)

____ NO SPEC SOLAR -3
(SKIP TO Q.18)

43-

14b. In what form was the analysis done? (READ LIST) (CHECK ALL MENTIONED)

was it: fuel savings per year _____ 44-1

payback analysis or
years to payback! _____ 45-1

cash flow analysis _____ 46-1

other (please specify) _____ 47-1

(SKIP TO Q. 18)

15a. Have you ever considered installing a solar energy system in one of your spec houses?

YES _____ -1

NO _____ -2 (SKIP TO Q. 16) 48-

15b. What prompted you to consider installing solar? (CHECK ALL MENTIONED)

demonstration _____ 49-1

manufacturer/vendor _____ 50-1

another builder _____ 51-1

just went out looking _____ 52-1

other (please specify) _____ 53-1

16a. What kinds of active solar energy systems for home use are available in your area?

solar water heating _____ 55-1

solar home and water heating _____ 56-1

solar-assisted heat pump _____ 57-1

other (please specify) _____ 58-1

none mentioned _____ 59-1 (SKIP TO Q. 17)

16b. (FOR EACH "YES" IN Q. 16a, ASK:) Please look at Scale C.

Which number on the scale best describes how much you agree or disagree with the statement: "I know a lot about how a _____ system works."

	Strongly agree		Neither		Strongly Disagree	
	1	2	3	4	5	
solar water heating	1	2	3	4	5	60-
solar home and water heating	1	2	3	4	5	61-
solar-assisted heat pump	1	2	3	4	5	62-
other (please specify)	1	2	3	4	5	63-

1... What manufacturers of active solar energy systems do you know of?
What others?

_____ } 64-1

18. Looking at Scale D, which number best describes how likely you are to install a solar energy system in a spec home during 1980?

Certain, practically certain (99 in 100)	___ -10	
Almost sure (9 in 10)	___ -09	
Very Probable (8 in 10)	___ -08	
Probable (7 in 10)	___ -07	
Good possibility (6 in 10)	___ -06	
Fairly good possibility (5 in 10)	___ -05	66-67
Fair possibility (4 in 10)	___ -04	
Some possibility (3 in 10)	___ -03	
Slight possibility (2 in 10)	___ -02	
Very slight possibility (1 in 10)	___ -01	
No chance, almost no chance (0 in 10)	___ -88	

19. Using Scale E, do you believe that a manufacturer or supplier can or cannot currently provide reliable and dependable solar energy equipment for home use?

Definitely can	___ -1	
Probably can	___ -2	
Unsure	___ -3	68-
Probably can not	___ -4	
Definitely can not	___ -5	

20. Again, using Scale E, do you believe that a manufacturer or supplier can or cannot provide solar energy that makes economic sense for home use?

Definitely can	___ -1	
Probably can	___ -2	
Unsure	___ -3	69-
Probably can not	___ -4	
Definitely can not	___ -5	

21. Now look back at Scale C. Please tell me the number on the scale that best describes how much you agree or disagree with the statement "It is easy to obtain financing for a solar energy system".

Strongly agree	___ -1	
Moderately agree	___ -2	
Neither agree nor disagree	___ -3	70-
Moderately disagree	___ -4	
Strongly disagree	___ -5	

22. What number on Scale C best describes how much you agree or disagree with the statement: "Manufacturers of solar systems are mostly little companies that are here today and will probably be gone tomorrow"?

Strongly agree	_____ -1
Moderately agree	_____ -2
Neither agree nor disagree	_____ -3
Moderately disagree	_____ -4
Strongly disagree	_____ -5

71-

23. What number on Scale C best describes how much you agree or disagree that solar energy equipment will be widely used by homeowners within the next five years?

Strongly agree	_____ -1
Moderately agree	_____ -2
Neither agree nor disagree	_____ -3
Moderately disagree	_____ -4
Strongly disagree	_____ -5

72-

24. Now I'd like to ask you some questions about home buyers in your area. Using Scale F, would you tell me how much demand there is among home buyers for solar energy heating systems?
(REPEAT QUESTION FOR SOLAR WATER HEATING SYSTEMS.)

	<u>strong</u> <u>demand</u>	<u>moderate</u> <u>demand</u>	<u>slight</u> <u>demand</u>	<u>no</u> <u>demand</u>
solar heating systems	_____ -1	_____ -2	_____ -3	_____ -4
solar water heating systems	_____ -1	_____ -2	_____ -3	_____ -4

73-

74-

Next, I'm going to give you three lists of criteria that people use to evaluate solar energy systems. (HAND FORMS TO RESPONDENT.) With the first list, I'll ask you to tell me the importance of each criterion as it affects you, in your own business. Then, with the second list, I'll ask you to tell me about your customers. Finally, I'll ask you how a solar manufacturer should evaluate the criteria.

25. On the first list, the criteria are ones that you might consider when thinking about using a solar energy system on a spec house. I'd like you to circle the number in the column indicating how much priority you'd assign to each criterion. Please try to place about three circles in each column.

(ALLOW SUFFICIENT TIME FOR RESPONDENT TO COMPLETE THIS QUESTION.)

- 26a. If you'll now turn the page, you'll see a list of criteria that are often mentioned as ways in which general consumers evaluate solar equipment. Please look at this page and circle the number in the column that indicates how much priority one of your customers would give to each of the criteria in deciding to adopt a solar energy system in a new home. Once again, please try to place three circles in each column.

(ALLOW SUFFICIENT TIME FOR RESPONDENT TO COMPLETE THIS QUESTION.)

- 26b. What other high priority criteria do you think your customers use?

75-1

- 27a. Please turn to the next page. Now, I'd like you to place yourself in the position of a solar product manufacturer. You want to increase sales of your products. Unfortunately, you also have a fixed budget, so you can't do everything that you might like to. Keeping both these goals in mind, I'd like you to look at the list of marketing actions and circle the numbers in the columns to indicate how you'd place your marketing priorities in order to increase your business. This time, please try to place about four circles in each column.

(ALLOW SUFFICIENT TIME FOR RESPONDENT TO COMPLETE THIS QUESTION.)

- 27b. What other actions would you take if you were a solar manufacturer or vendor?

77-1

28. Please turn to the final page. This question is about the various job responsibilities you have. During a typical week, what fraction of your job responsibilities are associated with each of the categories listed on the page? Please place the appropriate percentages in the spaces provided, and note that the total must add to 100%.

(ALLOW SUFFICIENT TIME FOR RESPONDENT TO COMPLETE THIS QUESTION.)

80- 2

Card 3 Dup 1-4

29. Who designs the spec single-family houses that you build? (CHECK ALL MENTIONED)

me _____ 5-1
 staff architect/design _____ 6-1
 outside architect/design _____ 7-1
 other (please specify) _____ 8-1

30. Who chooses the energy system that you install? (CHECK ALL MENTIONED)

me _____ 9-1
 staff engineer _____ 10-1
 outside engineer _____ 11-1
 HVAC contractor _____ 12-1
 other (please specify) _____ 13-1

31. Who else would be involved in making decisions about which kinds of energy systems to install in the houses you build? Who else is involved? (DO NOT READ LIST) (CHECK ALL MENTIONED)

no one	_____ 14-1	firm's owner/officers	_____ 19-1
staff architect	_____ 15-1	legal/financial staff	_____ 20-1
outside architect	_____ 16-1	contractors	_____ 21-1
staff engineer	_____ 17-1	other (please specify)	_____ 22-1
outside engineer	_____ 18-1	_____	_____

32. Suppose that after installing solar water heating equipment you had to increase the price of a typical house by \$3500 to cover costs and profit. Using Scale G, please tell me how the marketability of that house would be affected.

no demand -
 unable to sell

demand
 unaffected

large demand -
 sell immediately

1

2

3

4

5

6

7

23-

don't know _____ -8

33. Suppose that after installing solar home heating equipment you had to increase the price of a typical house by \$8500 to cover costs and profit. Using Scale G, please tell me how the marketability of that house would be affected.

no demand - unable to sell		demand unaffected			large demand - sell immediately		
1	2	3	4	5	6	7	24-

don't know _____ -8

34. In your business, would it be worth your while to keep abreast of research developments in solar assisted heat pump technology? Please look at Scale H and tell me the number that best describes how worthwhile this information would be to you: (REPEAT FOR SOLAR COOLING TECHNOLOGY.)

	would definitely be worthwhile	would be moderately worthwhile	would be slightly worthwhile	would not be worthwhile	
solar assisted heat pump technology	1	2	3	4	
solar cooling technology	1	2	3	4	26-

35. What two or three technical or trade publications do you read most regularly? (IF OTHER THAN ONES LISTED, LIST IN BLANKS)

Professional Builder	_____ 27-1	_____	
Commercial Building	_____ 28-1	_____	
Home Building	_____ 29-1	_____	_____ 31-32
Housing.	_____ 30-1	_____	

36. Company Name: _____

Another portion of this study will involve our interviewing people who are either looking to buy a newly-built spec house or who are building custom - designed homes, or have recently bought a newly-built spec home or custom-built home. In order to do this, we need lists of such people. Would your company be willing to provide us with names of people who have contacted you about buying a newly-built home or who have recently bought a newly-built home?

(IF YES SAY:)

Thank you very much. We will be contacting you in a week or so to get the list of names (MAKE SURE COMPANY NAME, ADDRESS, AND PHONE # ARE RECORDED.) We really appreciate your help.

Name _____

Company Name _____

Address _____

Phone # _____

36	37	38	39	40	41	42	43	44

45	46	47	48	49	50	51	52	53

80-3

384

118

SCALE A

\$30 - 50

50 - 70

70 - 90

90 - 110

110 - 130

130 - 150

Over 150

SCALE B

VERY
SATISFIED

MODERATELY
SATISFIED

NEITHER
SATISFIED
NOR
DISSATISFIED

MODERATELY
DISSATISFIED

VERY
DISSATISFIED

1

2

3

4

5

SCALE C

STRONGLY
AGREE

MODERATELY
AGREE

NEITHER
AGREE
NOR
DISAGREE

MODERATELY
DISAGREE

STRONGLY
DISAGREE

1

2

3

4

5

SCALE D

Certain, practically certain (99 in 100)

Almost sure (9 in 10)

Very probably (8 in 10)

Probable (7 in 10)

Good Possibility (6 in 10)

Fairly good possibility (5 in 10)

Fair possibility (4 in 10)

Some possibility (3 in 10)

Slight possibility (2 in 10)

Very slight possibility (1 in 10)

No chance, almost no chance (0 in 10)

SCALE E

DEFINITELY
CAN

PROBABLY
CAN

UNSURE

PROBABLY
CAN NOT

DEFINITELY
CAN NOT

1

2

3

4

5

SCALE F

STRONG
DEMAND

1

MODERATE
DEMAND

2

SLIGHT
DEMAND

3

NO
DEMAND

4

SCALE G

No demand --
Unable to sell

1

2

3

Demand
unaffected

4

5

6

Large demand --
Sell immediately

7

SCALE H

WOULD
DEFINITELY BE
WORTHWHILE

1

WOULD BE
MODERATELY
WORTHWHILE

2

WOULD BE
SLIGHTLY
WORTHWHILE

3

WOULD
NOT BE
WORTHWHILE

4

Builder's Criteria

	<u>top</u> <u>priority</u>	<u>high</u> <u>priority</u>	<u>medium</u> <u>priority</u>	<u>low</u> <u>priority</u>
1. Profit margin on solar equipment	1	2	3	4
2. Performance reliability of solar equipment	1	2	3	4
3. Ease of installation	1	2	3	4
4. Amount of change from usual building schedules	1	2	3	4
5. Likely customer demand for solar equipped houses	1	2	3	4
6. Installation of solar equipment by other builders in the area	1	2	3	4
7. Building regulations	1	2	3	4
8. Availability of solar equipment	1	2	3	4
9. Willingness of subcontractors to participate in solar installation	1	2	3	4
10. Reliability of suppliers	1	2	3	4
11. Availability of fully integrated solar equipment	1	2	3	4
12. Government certification of solar equipment	1	2	3	4

Customers' Criteria

	<u>top</u> <u>priority</u>	<u>high</u> <u>priority</u>	<u>medium</u> <u>priority</u>	<u>low</u> <u>priority</u>
1. System's expected life	1	2	3	4
2. Initial cost	1	2	3	4
3. Warranty period	1	2	3	4
4. Operating and maintenance cost	1	2	3	4
5. Number of successful installations	1	2	3	4
6. Payback period	1	2	3	4
7. Effect on home appearance	1	2	3	4
8. Yearly savings on energy costs	1	2	3	4
9. Effect on the environment	1	2	3	4
10. Good citizenship	1	2	3	4
11. Protection from fuel shortages	1	2	3	4

Solar Product Manufacturer

	<u>would</u> <u>definitely</u> <u>do</u>	<u>would</u> <u>probably</u> <u>do</u>	<u>might or</u> <u>might</u> <u>not do</u>	<u>would</u> <u>not do</u>
1. Install demonstration units	1	2	3	4
2. Advertise non-financial benefits (energy independence, etc.)	1	2	3	4
3. Sell components only	1	2	3	4
4. Advertise financial benefits	1	2	3	4
5. Reduce price	1	2	3	4
6. Lengthen warranty	1	2	3	4
7. Sell integrated systems	1	2	3	4
8. Provide how-to workshops for installers	1	2	3	4
9. Sell directly to the builder or end-user	1	2	3	4
10. Build sturdier collectors	1	2	3	4
11. Improve system performance	1	2	3	4
12. Sell through local distributors	1	2	3	4
13. Advertise in trade publications	1	2	3	4
14. Have my product certified by the appropriate agencies	1	2	3	4
15. Advertise to the general public	1	2	3	4

Job Responsibilities

Construction management	_____ %
Sales/Marketing management	_____ %
Technical management/engineering	_____ %
Financial responsibilities	_____ %
Procurement or purchasing	_____ %
General management	_____ %
Other _____	_____ %
_____	_____ %

(Total must equal = 100 %)

COMMERCIAL SEGMENT

PERSONAL PROTOCOL

COMMERCIAL QUESTIONNAIRE

1. Name _____

Address _____

Owner (Manager) _____

Title (if applicable) _____

2. Description of facility: number of units, machines, rooms, total sq. feet

3. What system do you currently use for heating water (and space heating if applic. (manufacturer, size, fuel) How satisfied are you with the present system?

4. How much do you currently pay for heating hot water? How much hot water do you use? (gal/room/time, \$/room/time, gal & \$/month, gal & \$/operation)

5. What fuel do you expect to be using to heat water a year from now? What would you expect the cost of that fuel to be a year from now?

fuel _____ cost _____

Five years from now?

fuel _____ cost _____

6. Does your hot water usage (heating) vary seasonally?

7. Do you currently have any plans for expansion of (business) ? Renovation?
What kinds of systems for hot water (heating) are under consideration?

8a. Prior to this survey, had you seen or heard anything about the use of solar energy equipment for water heating or home/business heating?

yes ____ no ____

b. Other than in a picture, have you ever seen a home or business equipped with solar collectors or solar panels?

yes ____ no ____

c. Do you know anyone who is now using solar energy for home or business heating or water heating?

yes ____ no ____

d. Have you actually gone looking for information about solar home/business or water heating equipment from a solar equipment manufacturer or dealer, a builder, or an architect?

yes ____ no ____

9. Have you heard of any kinds of government-sponsored financial incentives for installation of solar energy equipment in businesses?

<u>Incentive</u>	<u>Federal</u>	<u>State</u>	<u>Percent of cost</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

(SHOW DESCRIPTION)

10. Attitudinal questions - Separate sheet

Please read the statements on this sheet, and circle the number on the scale that tells how you feel about that statement; first, as it applies to home use, and second, as it applies to business use

11. The decision to purchase an energy system can be broken down into three major steps: 1) identification of alternatives, 2) financial and technical evaluation, and 3) final equipment and source selection.

For each stage:

Who in your company would be involved in stage _____?
(Probe: staff/outside architect, staff/outside engineer, firm's owner/officers, legal/financial staff, contractors)

Who would be the most influential in decision process? Second?

<u>rank</u>	<u>Identification of of Alternatives</u>	<u>rank</u>	<u>Financial and Technical Evaluation</u>	<u>rank</u>	<u>Final Equipment and Source Selection</u>
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

12. Under what conditions would you personally consider solar? (Importance rankings)

13. What specific data would you want before you would purchase? (financial, other working installations, someone's seal of approval, guarantees)
(Prompt, if no response initially) Importance rankings.

14. How would you evaluate a solar purchase? What financial criteria? How use? What other criteria?

15. Put yourself in the place of a solar manufacturer. What actions would you take now, and over the next few years to get people in (specific business) to buy your product? (demos, advertise non-financial benefits, reduce price, warranty, improve system performance, have product certified)

16. Size of operation:

Number of employees _____

Gross revenues _____

17. Personal:

Person's age _____

Education _____

Years with business _____

- A. Do you believe that you can currently obtain reliable and dependable solar energy equipment for:

home use?

Definitely can _____
Probably can _____
Unsure _____
Probably can not _____
Definitely can not _____

business use?

Definitely can _____
Probably can _____
Unsure _____
Probably can not _____
Definitely can not _____

- B. Do you believe that you can currently obtain solar energy equipment that makes economic sense for:

home use?

Definitely can _____
Probably can _____
Unsure _____
Probably can not _____
Definitely can not _____

business use?

Definitely can _____
Probably can _____
Unsure _____
Probably can not _____
Definitely can not _____

- C. Do you believe that solar energy equipment will be widely used by homeowners/businesses in your area within the next five years?

homeowners:

Definitely will _____
Probably will _____
Unsure _____
Probably will not _____
Definitely will not _____

businesses:

Definitely will _____
Probably will _____
Unsure _____
Probably will not _____
Definitely will not _____

Please circle the number on the scale that indicates how you feel about each of the following statements, first for "home use" and then for "business use".

	<u>Strongly agree</u>	<u>Moderately agree</u>	<u>Unsure</u>	<u>Moderately disagree</u>	<u>Strongly disagree</u>
D. I know a lot about the financial aspects of solar energy systems					
for home use:	1	2	3	4	5
for business use:	1	2	3	4	5
E. I know a lot about how solar energy systems work					
for home use:	1	2	3	4	5
for business use:	1	2	3	4	5
F. If several of my neighbors/other businesses installed solar equipment, I would think much more seriously about installing it myself					
for home use:	1	2	3	4	5
for business use:	1	2	3	4	5