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Solar energy in the housing sector.

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SOLAR ENERGY IN THE HOUSING SECTOR

A Thesis Presented

By

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ABSTRACT

This research is a marketing study on solar energy applications in housing. It is designed to measure awareness, interest and preference for solar energy systems. The data for this study was collected using a telephone survey, and results and conclusions are based on frequency-distributions and judgement. This research represents the first step in the gathering of information pertaining to the possible existence of a solar energy market in housing.

This study revealed that the respondents were not generally aware of solar energy applications and needed more information. It also gave some insights into the demographic characteristics of respondents who were interested in solar energy or had some preference for it.

There is a definite need for information on solar energy systems on all levels. The public as well as the building industry must be sold on the idea if it is to be a successful marketing venture.

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Introduction

The United States is faced with " ... a head-on conflict between a line of development in a society and a new social attitude."[1] The development is represented by a rapid growth in energy consumption, which is closely related to a rising standard of living. The new social attitude is represented by the public's concern over the environment. This public concern has resulted in government standards and regulations in an attempt to preserve the environment.[2]

These two forces are in conflict because " ... every aspect of energy - its production, conversion, and utilization - carries with it either a direct adverse impact on the environment or the threat of it. Stating the conflict in its baldest terms: if energy use threatens the environment and continued growth in energy use means an increased threat, then the growth must be arrested."[3]

This conflict has contributed to the development of our present "energy crisis." It has alerted the public to

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[1] Bruce C. Netschert, "Energy vs Environment," Harvard Business Review, Jan. - Feb. 1973, p. 24.

[2] Ibid.

[3] Ibid.

the environmental problems of conventional fuels and the need for a solution. This research effort investigates one possible solution from a marketing point of view. The research attempts to determine the housing market's reaction to the use of solar energy heating systems. Specifically, the research measures awareness of solar energy applications and attitudes on interest and preference. Data for this research was obtained by utilizing a questionnaire administered to a sample representing the housing market.

The conclusions reached in this study are based on two hypotheses. The first hypothesis stated very simply that respondent awareness would be low, therefore, there would be no strong preferences for or against the use of solar energy in housing. The data proved this hypothesis to be true. The second hypothesis stated that those showing an interest in or a preference for solar energy would tend to be younger, better educated, and have a higher occupational status than the average. The data proved this hypothesis to be false.

This study is broken down into four chapters. The first chapter gives some background on the "energy crisis," and the need for some positive action if we are to continue our consumption patterns. It also gives the reader some background on solar energy - its development, uses, and present state of the art. The second chapter states the problem, research objectives, hypotheses, and methodology.

Chapter three gives the results and analysis of the questionnaire. The last chapter states the conclusions based on the research findings, and indicates the significance of the study for marketing.

Energy Crisis

The conflict between energy consumption and public concern over the environment has contributed to what most observers refer to as the "energy crisis." There is a crisis because energy consumption has grown faster than supplies. There are a number of reasons given for this situation. Among them are the country's high standard of living, wasteful use of energy because it has historically been cheap and abundant, environmental restrictions on the burning of coal and high-sulfur oil, and delays in completion of nuclear power plants. Another factor is that the United States does not have adequate capacity for refining petroleum products. There is also much talk about our reserves, and their development. The oil and gas industry claims that they must charge high prices if they are to engage in expensive exploration, and that the government must allow coastal drilling.[4]

Our energy situation at present, with the current strains and cutbacks on electric power and fuel oil, is serious

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[4] "The Oil Shortage," The New York Times, Nov. 25, 1973, sec. 4, p. 1E.

enough, but the prospect of future shortages may have a more serious impact. Power projects in all stages of development are being delayed on environmental grounds. "Moreover, the scope of issues raised on the environmental front and their effects on future construction schedules appear to be expanding at a substantial rate."[5] Energy consumption is also expanding at a substantial rate, and it appears that the gap between demand and available supply could increase. If this is the case, then any power shortages would act " ... as a brake on employment, economic expansion, productivity, and needed public services, as well as, impeding needed improvements in pollution control measures."[6]

Our past patterns of energy consumption have caused the following significant problems:

(1) The demand and the supply of fuel resources is imbalanced, thus reducing our ability to meet unexpected changes in the availability of any particular fuel.

(2) Our present use and consumption of fuel resources is not environmentally acceptable to the nation.

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[5] John N. Nassikas, "National Energy and Environmental Policy," Public Utilities Fortnightly, June 10, 1971, p. 50.

[6] Ibid.

(3) We can maintain our present growing rate of consumption only if;

(a) we increase the exploration and development of our oil and gas reserves, and develop new and more efficient technologies for use on existing and supplementary energy sources;

(b) we can develop environmentally acceptable uses of coal either through gasification or synthesis;

(c) we can develop a nuclear fast breeder reactor to a state of commercial readiness in the early 1980's.

(4) Those who are environmentally concerned feel that the solutions to the environmental problems are:

(a) to defer all power plant installations including nuclear, hydroelectric, pumped storage, and new steam electric plants using fossil fuels;

(b) to halt the development of offshore oil and gas reserves;

(c) to limit energy use to diminish its adverse effects.[7]

Conventional Energy Consumption

A look at energy consumption might be useful at this point to give us a prospective of where we are and what the

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[7] Ibid., pp. 54-5.

future might look like. In December of 1972 the National Petroleum Council released a report which had some interesting projections on energy consumption. The Council selected high, low, and intermediate levels of demand for their projections. In looking at the intermediate case U. S. energy consumption is expected to increase at an average annual rate of 4.2 percent through 1985. This rate of change will mean that our demand for energy will increase from 67.8 quadrillion BTU of energy in 1970 to 102.6 quadrillion BTU in 1980 and 124.9 quadrillion in 1985.[8]

In 1969 oil and gas accounted for 75 percent of the energy consumed in the United States. Projections show that over the next twenty years the use of oil and gas will almost double and will account for approximately 60 percent of the energy consumed provided current patterns of consumption continue.[9] Table 1 below projects total gross consumption of energy by energy source.

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[8] "Historic NPC Study Lays Out U. S. Energy Options," The Oil and Gas Journal, Dec. 18, 1972, p. 21.

[9] Nassikas, "Energy and Environment," p. 52.

TABLE 1.--Projected Gross Consumption of Energy in the U.S., 1980 to 1990 (quadrillion BTU)[a]

Energy Source	1969 Amount	Percent of Total	1980 Amount	Percent of Total	1990 Amount	Percent of Total
Coal	13.5	20.5	18.0	18.9	18.5	13.2
Gas	21.1	32.1	26.5	27.9	35.7	25.5
Oil	28.5	43.1	38.0	40.0	50.0	35.7
Hydro	2,7	4.1	3.0	3.2	3.6	2.6
Nuclear	0.1	---	9.5	10.0	32.2	23.0
Total	65.9	100.0	95.0	100.0	140.0	100.0

[a] Nassikas, "Energy and Environment," p. 52.

Comparing the projections made by the National Petroleum Council with those made by Chairman John N. Nassikas of the Federal Power Commission, we find that projections for total gross consumption in 1980 are 102.6 and 95 quadrillion BTU, respectively. It should be noted that the National Petroleum Council's figures represent their intermediate case for energy consumption. These figures are our best estimates on energy consumption. Of course, all of these projections are subject to availability, which in turn is subject to political and economic considerations.

In 1970 the United States imported 12 percent of its total energy requirements. It was projected to increase to 20 percent or 25 percent by 1975 with continued increases projected after 1975.[10] With the current Middle East situation and cutbacks in U. S. consumption, these projections on consumption may in reality be high. The demand for energy, nevertheless, will probably continue to grow.

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[10] NPC Study, p. 21.

The outlook for conventional energy sources over the next ten years reveals increasing costs and in some cases insufficient supplies. As Netschert indicates, all energy source prices will tend to rise, but some will rise faster than the rate of inflation.[11] Clearly there is a need for positive action if we are to continue our high energy consuming standard of living. More oil and gas exploration will have to be encouraged, as well as, research and development on the efficient use of these non-renewable resources. Technology will have to develop and refine methods of utilization which are consistent with our environmental policies. These things can be done now, but what about our future energy needs as the non-renewable energy sources run out?

Solar Energy

Solar energy is an inexhaustible potential energy source. It can be converted into heat and power by a number of methods, and many of these are within a few years of commercial availability. Solar energy seems to satisfy more of the forces at work in our "energy crisis" than do

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[11] Netschert, "Energy vs Environment," p. 133.

other alternative energy sources. "Solar energy is rapidly finding new application not only as a result of technological advances, but perhaps more importantly, because of a variety of economic, environmental, and social forces. As limitations on conventional energy sources and the environmental consequences of energy production become more apparent, solar energy stands out as an inexhaustible alternative energy source if it can be harnessed within economic, environmental, and social constraints.[12]

In December of 1972 the joint National Science Foundation and National Aeronautics and Space Administration Solar Energy Panel came out with a report entitled, "An Assessment of Solar Energy as a National Energy Source." This report came up with the following conclusions:

- -Solar energy is received in sufficient quantity to make a major contribution to the future U. S. heat and power requirements.
- -There are numerous conversion methods by which solar energy can be utilized for heat and power, e.g., thermal, photosynthesis, bioconversion, photovoltaics, winds, and ocean temperature differences.
- -There are no technical barriers to wide application of solar energy to meet U. S. needs.
- -The technology of terrestrial solar energy conversion has been developed to its present limited extent through very modest government support and some private funding.

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[12] Peter E. Glaser and James C. Burke, "New Directions for Solar Energy Applications," Briefing before the Environmental Subcommittee of the House Committee on Interior and Insular Affairs, House of Representatives, June 13, 1973, p.1.

-For most applications, the cost of converting solar energy to useful forms of energy is now higher than conventional sources, but due to increasing prices of conventional fuels and increasing constraints on their use, it will become competitive in the near future.
-A substantial development program can achieve the necessary technical and economic objectives by the year 2020. Then solar energy could economically provide up to (1) 35% of the total building heating and cooling load; (2) 30% of the nation's gaseous fuel; (3) 10% of the liquid fuel; and (4) 20% of the electric energy requirements.
-If solar development programs are successful, building heating could reach public use within 5 years, building cooling in 6 to 10 years, synthetic fuels from organic materials in 5 to 8 years, and electricity production in 10 to 15 years.
-Large scale use of solar energy as a national resource would have a minimal effect on the environment.[13]

New Industry

These conclusions clearly indicate that solar energy has a great deal of potential for the immediate future. Arthur D. Little, Inc., is attempting to create a new industry, which will make and sell equipment for solar climate control in homes and industry. They will coordinate and develop the technical and economic information, and will design marketing strategies for companies with solar climate control projects. Dr. Peter E. Glaser, the project director for solar climate control at A. D. Little, said, "this is not a solar energy research program, but a project to develop practical applications in heating and cooling which conserve

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[13] NSF/NASA Solar Energy Panel, "An Assessment of Solar Energy as a National Energy Resource," Dec. 1972, p. 5.

conventional energy resources with no detrimental effects on the environment.[14]

The equipment line for this new industry will include solar collectors, heat storage systems, sources of auxiliary energy, heat actuated air conditioners, auxiliary equipment, and on-site power generators or solar cells. Since most of the equipment has already been developed, A. D. Little hopes to be able to coordinate a program to get it into use. This program will include the identification of potentially successful businesses associated with solar climate control, why they are successful, and how they can be integrated into the construction industry. Once this is accomplished, then specific hardware will be evaluated, and detailed business strategies will be outlined.[15]

There are several reasons why solar energy was not fully developed before. First, there was never a need for an alternative energy source until recently. It was believed that we would always have enough fuel and that the cost of fuel would continue to remain low. A second factor has been that there was never any requirement for the efficient use of energy in building designs. Consumers have primarily only considered the initial cost of a building rather than the

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[14] "Solar Climate Control Markets Under Study," Industry Week, May 21, 1973, p. 21

[15] Ibid., pp. 21, 24.

costs incurred during its lifetime. A third factor is that existing codes and standards would have to be modified to allow the use of some of the equipment and methods. A fourth factor is the introduction of solar climate control systems into the housing industry market, which is already huge and complex.[16] Another limiting factor has been the lack of a well-engineered and economically manufactured and distributed solar heat collector. "The key problem is the development, optimization, production design, and manufacture of such units."[17]

If solar energy is to be effectively used it will require a major effort on the part of architects, engineers, builders, and equipment and building material suppliers. It will take time for major innovations to gain acceptance in the housing industry by both builders and buyers. The time is right and there are several reasons which support the further development of solar heating and cooling. They include:

-rapidly rising fuel costs,
-widespread demand for air-conditioning,
-industrialization of building industry,
-increased sophistication of the construction industry,
-public pressure for environmental quality, and
-governmental actions supporting development of solar energy applications.[18]

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[16] Glaser, "Solar Energy Applications," p. 11.

[17] NSF/NASA, "National Energy Resource," p. 18.

[18] Glaser, "Solar Energy Applications," p. 11.

Applications

There are three residential solar applications, which we will be concerned with. They are water heating, space heating, and space cooling. Buildings may be heated and cooled by solar energy using a solar collector, which transfers the solar heat to a fluid, such as water or air. Present systems include a storage system and an auxiliary heating source to supplement the solar unit. Air-conditioning is also possible using a heat-actuated system. About three-fourths of the heating and cooling needs of a 1,500 square foot home could be provided by a solar energy system utilizing a 600 to 800 square foot collector and a 2,000 gallon hot water storage tank.[19]

The development and use of each of the three residential solar applications differs considerably. Solar water heating, for example, is far more advanced in terms of development and use than the other two applications. Solar water heaters are commercially available in a number of countries and to a very limited extent in the United States. Solar water heaters are technologically well developed, and will decrease in price as they become manufactured on a wider basis. Space heating would be next in terms of development and utilization. There are about 20 experimental solar heated buildings in operation in the United States. A variety of combinations of collectors, heat storage techniques, and heat transfer techniques have been

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[19]NSF/NASA, "National Energy Resources," p. 13.

tried. "Subsequent economic studies have shown that in a wide variety of U.S. climates solar heating is less expensive than electric heating, and in a few locations it is nearly competitive with gas or oil heating." Table 2 and Figure 1, "based on one of these analyses clearly demonstrates that solar heating, even without supplemental savings from cooling, can be a practical alternative to conventional heat sources."[20]

TABLE 2.--Costs of Space Heating (1970 prices) in Dollars Per Million BTU Useful Delivery[a]

Location	Optimized Solar Heating Cost in 25,000 BTU/degree-day house, capital charges @ 6%, 20 years[b]		Electric Heating Usage 30,000 KWH/year	Fuel Heating Fuel Cost Only	
	Collector @ $2/sq ft[c]	Collector @ $4/sq ft[c]		Gas	Oil
Santa Maria	1.10	1.59	4.28	1.52	1.91
Albuquerque	1.60	2.32	4.63	.95	2.44
Phoenix	2.05	3.09	5.07	.85	1.89
Omaha	2.45	2.98	3.25	1.12	1.56
Boston	2.50	3.02	5.25	1.85	2.08
Charleston	2.55	3.56	4.22	1.03	1.83
Seattle-Tacoma	2.60	3.82	2.29	1.96	2.36
Miami	4.05	4.64	4.87	3.01	2.04

[a] R. A. Tybout and G. O. G. Lof, "Solar House Heating," Natural Resources Journal, April 1970, pp. 268-326.

[b] Solar heat costs are from optimal design systems yielding least cost heat

[c] All solar heat costs based on amortizing entire solar system capital costs in 20 years at 6 percent interest. Capital investment based on current prices of solar water heaters at $4 per sq. ft. plus current costs of other components, and on anticipated near-term solar collector price of $2 per sq. ft.

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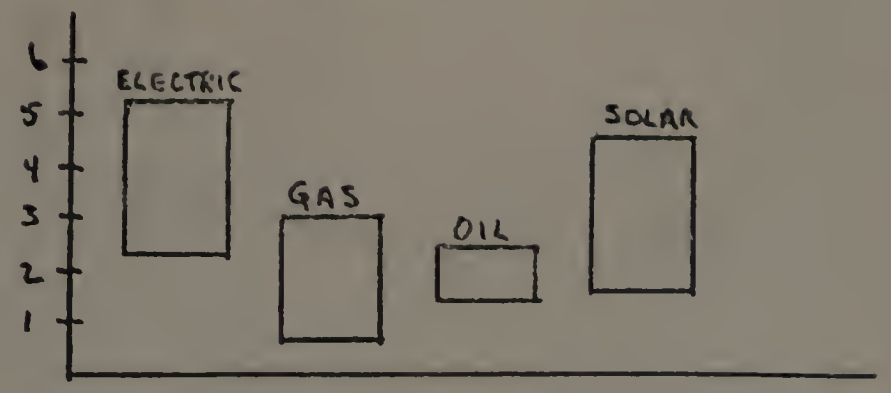
[20] Ibid., pp. 13-16.

FIGURE 1.--Costs of Space Heating[a]



[a] R. A. Tybout and G. O. G. Lof, "Solar House Heating," pp. 268-326.

The development of solar air-conditioning is strictly in the experimental stages, but the outlook is good. Combined systems show great promise since they use the same major components. Economically speaking, combined systems have a higher use factor on capital intensive equipment, such as collectors and storage units.[21]

Of all the potential uses for solar energy it seems that residential heating and cooling have the greatest probability of success. More is known about the technical and economic aspects of these applications. While the cost of development of solar energy systems is high now the future benefits in terms of fuel savings and environmental quality will be worth it.[22]

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[21] NSF/NASA, "National Energy Resources," PP. 16-18.

[22] Ibid., p. 18.

Solar energy could have a significant impact on our energy situation. It is quite possible that 10 percent of the new buildings constructed in 1985 would be heated and ccoled by solar energy, 50 percent in 2000 and 85 percent in2020. These figures represent 1 percent, 12 percent, and 31 percent of total buildings, respectively. They would have a corresponding energy saving of 0.12, 2.1, and 10.5 x 10^{15} BTU/year, with a corresponding fuel saving of $180 million, $3,600 million, and $16,300 million, respectively. The fuel savings are based on an average oil and gas cost of $1.50 per million BTU delivered. Solar energy has some intangible benefits associated with it, such as easing the problem of inadequate gas supplies, reducing excessive and expensive electricity peak loads and their associated power system failures during very hot weather, and the extension of oil and natural gas supplies further into the future.[23]

The work on the development of solar systems continues with new approaches and methods. The University of Delaware has constructed a house which utilizes solar cells incorporated into the solar collector to produce electricity. Solar climate control systems and most building designs can be coordinated so that solar collectors could be mounted on roofs or side walls. Arthur D. Little, Inc. is working on the design of an office building for the Massachusetts Audubon Soceity, which will rely on solar energy to provide 60 percent of its energy

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[23] Ibid., pp. 18-20.

requirements for heating and cooling.[24] Building contractor Richard D. Blazej of Brookline, Vermont, has a twenty unit condominium in the planning stages utilizing solar energy with other alternative sources of energy. The Blazej project is particularly interesting when a comparison of costs are made over a twenty year period between a solar heated unit and a conventionally heated home. Table 3 shows comparative costs.

TABLE 3.--20-Year Cost of Conventional vs Solar Heated Home[a]
(selling price: conventional-$34,500, solar-$37,000)

Item	Conventional	Solar[b]
Down Payment on purchase of home	$10,000	$10,000
20-year amortization cost @ 8¼%	50,880	56,160
20-year operating, maintenance and repair cost	19,200	4,250
Total 20-year cost	$80,080	$70,410

[a] Richard D. Blazej, personal letter, Oct. 15,1973.

[b] The solar energy figures represent 1/20 of the total cost for the entire condominium, and there are certain economies which a single-family dwelling could not match

These projections show that even with a higher initial cost the solar energy system with its fuel saving ability saves money over a 20-year period. It should be remembered that these projections are in theory only, since there is not sufficient data, as of yet, to verify the accuracy of these figures. If, however, these figures prove to be close to reality, then the potential for solar energy could be very significant.

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[24] Glaser, "Solar Energy Applications," p. 9.

"Solar energy applications are still in an early stage of development. It is too early to tell which of the techniques now being investigated would be the most useful option for energy conservation or energy production over the long run. The prospects for developing these applications as alternatives to other techniques appears to be very bright."[25]

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[25] Ibid., p. 12.

C H A P T E R I I

RESEARCH DESIGN

Statement of Problem

The idea of using solar energy heating, cooling, and hot water systems in housing is new, and it represents the introduction of a new product into the housing market. The problem is to determine how much a small segment of the house buying public knows about solar energy, and to determine whether solar energy systems represent acceptable alternatives to conventional home heating systems in the eyes of the consumer. This research effort is not an attempt to determine if a market exists for solar energy systems. It is only designed to measure what a certain group of home-buyers thinks about solar energy systems in housing, and how much they know about them.

There are certain variables or factors which must be introduced into the research effort when defining the problem. The "energy crisis" has had a significant impact on this research study. The people surveyed seemed to be aware of the "energy crisis" and its possible implication for them. The publicity which the "energy crisis" has received has people thinking about energy consumption and considering possible alternatives. The point is that this survey was

conducted during the initial stages of an "energy crisis," and the attitudes expressed may be quite different than those expressed at another point in time. Solar energy seems to satisfy many of the environmental and consumption problems. However, solar energy advocates should not mislead the public into thinking that solar energy is right around the corner. While solar energy is technologically feasible now, it is not economically feasible now. This is the second factor which must be included in the problem statement. Solar energy is very attractive on many fronts, but its initial cost is very high when compared to conventional energy sources. This fact by itself is probably the biggest problem facing solar energy acceptance.

Research Objectives

There are four research objectives which are pertinent to the stated problem. The first is to determine the respondent's awareness of the uses of solar energy. The second research objective is to determine if the respondent has any interest in the use of solar energy in housing. The third objective is to determine if there is any preference for the use of solar energy in housing. The last research objective is to get some demographic clues as to the type of individuals that are interested in solar energy.

The awareness objective will answer the problem of how much is known about the use of solar energy by the consumer.

The interest and preference objectives will suggest whether or not solar energy is seen as an acceptable alternative to conventional sources. The demographic characteristics should give some idea of the type of person that might be a potential buyer of a solar energy system.

Hypotheses

The corresponding hypotheses to the stated problem and research objetcives are as follows: The first hypothesis states that the people surveyed are not generally aware of the advances that have been made in solar energy systems as they are used in the housing sector. Therefore, those surveyed have no strong preferences either for or against the use of solar energy in housing. If this hypothesis is true it may indicate that the public needs to be educated as to the capabilities of solar energy in the housing market. This should be carefully done, as mentioned before, so as not to mislead the public in to thinking that solar energy is a panacea. If the data prove this hypothesis to be false and a public education is not necessary, then it may suggest that there are other reasons why solar energy is not widely accepted and utilized. The most likely reason is the high cost associated with solar energy. Another possible reason is the perceived risk of a new system and being the first to try it.

The second hypothesis is that those who show an interest in and a preference for solar energy will tend to be younger, better educated, and somewhat higher in occupational status than the average. In other words, those who are willing to accept solar energy as an alternative source of energy will tend to be "innovator" types. If this hypothesis is true, it may help to direct marketing activities toward this type of person. If it is false, a more universal market approach would seem to be in order. Since the "energy crisis" has been so prevalent in our news and people have become sensitive to our energy situation, we may find that solar energy will appeal to a more diversified group.

Methodology

Sample technique. A few terms need to be defined for this study. The housing market for this study is comprised of any individual who has purchased a newly constructed home within the last three years or purchased land during that time period with the intention of building on that property in less than three years. This study is also restricted to a particular geographical location. These individuals were selected because it was believed that they would come the closest to representing the actual housing market. Using the actual housing market was not attempted because a survey of regional realtors revealed that an adequate sample size could not be obtained in the time that was available for research.

It was felt that these potential respondents would be aware of the costs of a new home and its related systems, since they had either just purchased them or would be purchasing them in the near future.

The sample must further be defined in terms of geographical location. This study is limited to the geographical area surrounding Brattleboro, Vermont. There are two reasons for the selection of this area. First, this research effort was undertaken to assist Richard Blazej with information relating to his solar energy project in Brookline, Vermont. Since Brookline and the communities around Brattleboro are rural and in the same part of Vermont there should be no difficulty in applying the data to the Blazej project. The second reason for this selection was that this area could be covered with a minimum of cost to the researcher. The towns included in the survey were Brattleboro, Putney, Townshend, Newfane, Vernon, Guilford, and Dummerston.

Potential respondents were identified by going to the Town Clerks of each town and looking through the Land Transfer forms. The forms indicated the type of transaction, description of the property, and selling price. Unfortunately some of the forms were not complete or had been filled out incorrectly. In some cases it was difficult to determine what had transpired. Most of the towns did not have building permits, so the only source of information was the Land Transfer form. This source of information yielded 346 trans-

fers of property which were thought to be applicable to this research.

The resulting list of names from the Land Transfer forms was then matched with telephone numbers obtained from the local directory. This resulted in 188 names and phone numbers for the sample. Out of a possible 188 there were 45 which were not applicable to this research. The main reason that they could not be used in the survey was that the information on their Land Transfer forms was either incorrect or incomplete. Some of the 45 were holding on to the land only for investment purposes and could not be used in the survey. There were 32 out-of-state owners who used their land for second homes and camps, but they could not be contacted. There were 16 people who were residents of Vermont who could not be contacted even though attempts were made at different times and on different days. Only five people refused to answer the questionnaire, and ten people were used for questionnaire pretesting. The final sample size was 80 respondents.

Interviewing was done in the evening hours between 7:00 pm and 9:30 pm in an effort to get the man of the house to answer the questionnaire. It was felt that the man would know more about heating systems and their related costs.

It was not possible to take a random sample because of the small number of potential respondents. The objective in sampling was to obtain as many respondents as possible within

this geographical location. In order to increase response rates an announcement was put in the local newspaper to the affect that research was being conducted by a telephone survey on housing in the area and that it was not a sales promotion and that cooperation would be appreciated. It's difficult to tell if this was an effective method or not.

Questionnaire design. The questionnaire was designed to obtain the maximum amount of information from the respondent without constraining him. The specific-direct-question method was used to achieve this goal. This method is the simplest of the objective techniques, and utilizes primarily multiple-choice or fill-in questions, including the use of open-ended questions. The questionnaire uses all three types of questions plus true-false questions.

The questionnaire was designed to be used for a telephone survey. A telephone survey was selected in order to obtain the highest response rate possible in the available time. Personal interviews were not possible due to the physical size of the sample area and the time that it would require to cover a low density area of this nature. A mail survey was also not feasible due to the limited number of potential respondents and the low response rates of mail surveys. In terms of efficiency, a telephone survey was the best choice in this case.

The questionnaire (see Appendix A) is broken down into four sections. The first section obtains some general back-

ground information on the respondent's present home. Since town records were not entirely complete or accurate, it was necessary to include questions about present ownership and plans to build. The first section also includes questions on the heating system of the home. The next section deals with awareness of solar energy applications. The respondents were asked to identify any new and innovative sources of energy which could be used for heating purposes. If they did not identify solar energy as a new and innovative energy source, then they were asked if they had ever heard of it. This section then moves into a series of true-false questions designed to measure the respondent's awareness of the uses of solar energy. The third section of the questionnaire asks open-ended questions to determine if the respondent has any interest in solar energy, andif he has any preference for it. In this section we also try to determine how much of a premium the respondent would be willing to pay for a solar energy system. The last section of the questionnaire deals with the demographic characteristics of the respondents.

The questionnaire went through two pretests. The first pretest was run on a local banker, two real estate brokers, and a town official. Revisions were made and a second pretest was run on ten individuals from the sample. Further revisions were made, and the questionnaire was reviewed by Martin M. Glesk of Arthur D. Little, Inc.. Some further changes were made and the final form was adopted.

Method of analysis. There are some severe constraints on the type of analysis which can be done on this study. Since randomness could not be achieved, standard tests for statistical significance were not appropriate. Most of the data are nonparametric, dealing with attitudes, and cannot be subject to that type of analysis anyway. Due to the small sample size, one cannot generalize about the results with any great confidence. The main concentration of analysis will be frequency-distributions and the relationship between demographic characteristics and the respondent's attitudes. Most of the analysis will rely on judgemental inference with the support of the frequency-distributions.

There are other factors that should be considered when analyzing the data. The first of these is the definition of the housing market used in this study. The consideration here is how well it actually represents the housing market. The second factor is the local nature of the survey. The greater Brattleboro area may not represent what the rest of the nation is thinking about solar energy, and a word of caution is in order about generalizing.

C H A P T E R I I I

ANALYSIS

The analysis of the data is based on the frequency-distributions and demographic characteristics shown in Tables 4 through 14. The tables are constructed in such a manner so that comparison within demographic characteristics is possible, as well as, comparison with the total sample. The tables give the raw scores and percentages within each demographic category for "correct" and "incorrect" responses. The tables are identified in terms of the questions they represent on the questionnaire. Significant differences in demographic categories will be noted only when they differ by more than 10 percent from the total sample results, which appear at the top of each table. The term "significant difference" will be used throughout the analysis to mean varying more than 10 percent.

Table 4 deals with concern about the "energy crisis" and the possible shortages of home heating fuels. Tables 5 through 12 deal with solar energy awareness. Tables 13 and 14 deal with interest and preference, respectively.

Awareness. The figures in Table 4 represent the respondents concern or lack of concern about the "energy crisis." Slightly over 81 percent of those surveyed were concerned about possible shortages in home heating fuels. There were only three demographic groups which differed significantly from the total

sample results. The graduate school group was more concerned, while the high school graduates and the family size of five or more were less concerned. There is the suggestion of a trend in the education category, and that is that as the educational level of respondents increases the concern for the "energy crisis" increases.

The general awareness of the existence of solar energy as a heating source is illustrated in Table 5. Respondents were asked to identify any new and innovative methods of heating. There was a wide diversity of answers, and only 27.5 percent of the respondents identified solar energy as a possibility. The following groups had a significantly higher percentage of respondents identifying solar energy than the average: professionals, income over $17,000, college graduates, graduate degree respondents, age 45-54, family size of five or more, and homes heated electrically. The following groups had a significantly lower percentage of respondents identifying solar energy than the average: high school graduates, some college, and age 35-44. With the exception of age, the respondents identifying solar energy a higher percentage of the time seem to be the "innovator" type - higher income, better educated, and higher occupational status.

TABLE 4.-- Concern about the possible shortage in home heating fuels

		Concerned		Not Concerned	
	Size	Raw Score	Percent	Raw Score	Percent
Total Sample	80	65	81.25	15	18.75
Occupation					
Professional	30	27	90.0	3	10.0
Non-professional	50	38	76.0	12	24.0
Owners					
Land-onwers	17	15	88.2	2	11.8
New Home-onwers	63	50	79.3	13	20.7
Income					
under $7,000	9	8	88.8	1	11.2
$7,000-12,000	20	16	80.0	4	20.0
$12,000-17,000	23	19	82.6	4	17.4
over $17,000	19	15	79.0	4	21.0
Education					
Some High School	11	8	72.9	3	27.3
High School Grad	20	14	70.0	6	30.0
Technical School	11	9	81.8	2	18.2
Some College	8	6	75.0	2	25.0
College Grad	17	15	88.2	2	11.8
Graduate School	13	13	100.0	--	---
Age					
18-34	39	32	82.1	7	17.9
35-44	18	14	77.7	4	22.3
45-54	12	10	83.3	2	16.7
55and over	11	9	81.8	2	18.2
Family Size					
Two or Less	20	17	85.0	3	15.0
Three	21	18	85.7	3	14.3
Four	26	21	80.8	5	19.2
Five or More	13	9	69.2	4	30.8
Heating Source					
Electric	14	12	85.7	2	14.3
Oil	61	49	80.3	12	19.7
Gas	5	4	80.0	1	20.0

TABLE 5.-- Respondents identifying solar energy as a new and innovative source of energy for heating purposes

		Concerned		Not Concerned	
	Size	Raw Score	Percent	Raw Score	Percent
Total Sample	80	22	27.5	58	72.5
Occupation					
Professional	30	13	43.3	17	56.7
Non-professional	50	9	18.0	41	82.0
Owners					
Land-onwers	17	3	17.6	14	82.4
New Home-owners	63	19	30.1	44	69.9
Income					
under $7,000	9	--	---	9	100.0
$7,000-12,000	20	6	30.0	14	70.0
$12,000-17,000	23	7	30.4	16	69.6
over $17,000	19	8	42.0	11	58.0
Education					
Some High School	11	--	---	11	100.0
High School Grad	20	3	15.0	17	85.0
Technical School	11	2	18.2	9	81.8
Some College	8	1	12.5	7	87.5
College Grad	17	9	52.9	8	47.1
Graduate School	13	7	53.8	6	46.2
Age					
18-34	39	14	35.9	25	64.1
35-44	18	2	11.1	16	88.9
45-54	12	6	50.0	6	50.0
55and over	11	--	---	11	100.0
Family Size					
Two or Less	20	6	30.0	14	70.0
Three	21	5	23.8	16	76.2
Four	26	6	23.1	20	76.9
Five or More	13	5	38.5	8	61.5
Heating Source					
Electric	14	7	50.0	7	50.0
Oil	61	15	24.6	46	75.4
Gas	5	--	---	5	100.0

The questionnaire then moves into specific awareness with a question about the ability of solar energy to generate electricity. Table 6 reveals that 82.5 percent of those surveyed correctly answered this question. Significantly higher differences occurred in the following groups: income $12,000 - $17,000, some college, age 55 and over, and family size of two or less. Significantly lower percentages occurred in the following groups: some high school age 45-54, and family size of four. There are no apparent trends between demographic characteristics and awareness for this question.

The awareness of the use of solar energy for heating buildings and providing domestic hot water was very high, as seen in Table 7. Over 96 percent of those surveyed indicated that solar energy could be used for heating purposes. There are no real significant differences between the percentages of the total sample and those of the demographic characteristics. Table 7 does not reveal any trends between awareness and demographic characteristics.

Table 8 is perhaps the most significant in terms of measuring awareness of the advances that have been made in the solar energy field. Sixty percent of the respondents indicated that solar energy was not practical because of extended periods of cloudy weather. This seems to be inconsistent since in Table 7 over 96 percent said that solar energy could be used to heat buildings. This may suggest

TABLE 6.-- Responses to the question of whether or not solar energy can be used to generate electricity

	Concerned			Not Concerned	
	Size	Raw Score	Percent	Raw Score	Percent
Total Sample	80	66	82.5	14	17.5
Occupation					
Professional	30	26	86.6	4	13.4
Non-professional	50	40	80.0	10	20.0
Owners					
Land-owners	17	14	82.3	3	17.7
New Home-owners	63	52	82.5	11	17.5
Income					
under $7,000	9	7	77.7	2	22.3
$7,000-12,000	20	17	85.0	3	15.0
$12,000-17,000	23	22	95.6	1	4.4
over $17,000	19	14	73.7	5	26.3
Education					
Some High School	11	7	63.6	4	36.4
High School Grad	20	17	85.0	3	15.0
Technical School	11	8	72.7	3	27.3
Some College	8	8	100.0	--	---
College Grad	17	15	88.2	2	11.8
Graduate School	13	11	84.6	2	15.4
Age					
18-34	39	33	84.6	6	15.4
35-44	18	14	77.7	4	22.3
45-54	12	8	66.7	4	33.3
55 and over	11	11	100.0	--	---
Family Size					
Two or Less	20	20	100.0	--	---
Three	21	17	80.9	3	19.1
Four	26	18	69.2	8	30.8
Five or More	13	11	84.6	2	15.4
Heating Source					
Electric	14	11	78.6	3	21.4
Oil	61	51	83.6	10	16.4
Gas	5	4	80.0	1	20.0

TABLE 7.-- Responses for solar energy providing heat and hot water

		Correct		Incorrect	
	Size	Raw Score	Percent	Raw Score	Percent
Total Sample	80	77	96.25	3	3.75
Occupation					
Professional	30	30	100.0	--	---
Non-professional	50	47	90.4	3	9.6
Owners					
Land-owners	17	16	94.1	1	5.9
New Home-owners	63	61	96.8	2	3.2
Income					
under $7,000	9	8	88.8	1	11.2
$7,000-12,000	20	20	100.0	--	---
$12,000-17,000	23	22	95.6	1	4.4
over $17,000	19	18	94.7	1	5.3
Education					
Some high School	11	10	90.9	1	9.1
High School Grad	20	19	95.0	1	5.0
Technical School	11	10	90.9	1	9.1
Some College	8	8	100.0	--	---
College Grad	17	17	100.0	--	---
Graduate School	13	13	100.0	--	---
Age					
18-34	39	38	97.4	1	2.6
35-44	18	17	94.4	1	5.6
45-54	12	11	91.7	1	8.3
55 and over	11	11	100.0	--	---
Family Size					
Two or Less	20	20	100.0	--	---
Three	21	20	95.2	1	4.8
Four	26	24	92.3	2	7.7
Five or More	13	13	100.0	--	---
Heating Source					
Electric	14	13	92.8	1	7.2
Oil	61	60	98.3	1	1.7
Gas	5	4	80.0	1	20.0

that respondents really don't have a firm grasp of solar energy applications or capabilities. Respondents showing a significantly higher degree of awareness were in the following groups: professional, income under $7,000, income over $17,000, some college, college graduates, and electrically heated homes. Those showing a lower degree of awareness were high school graduates, technical school, and family size of two or less. There are no solid trends established here between awareness and demographic characteristics.

The respondents awareness of whether a solar energy system pollutes more than a conventional system is illustrated in Table 9. Eighty-five percent of the respondents indicated that solar energy systems pollute less than conventional systems. There were two groups that responded with significantly higher percentages, and they were the income $7,000 - $12,000 and the age 45-54 groups. Three groups responded with significantly lower percentages, and they were the income under $7,000, some high school, and age 55 and over groups. Again there were no significant trends established between demographic characteristics and awareness.

Awareness on the comparative initial installation costs of solar heating systems and conventional heating systems is given in Table 10. Sixty-five percent of those surveyed correctly indicated that solar systems would cost more to install than conventional systems. Respondents indicating significantly higher percentages of awareness were in the

TABLE 8.-- Respondents answers to the question of whether solar energy was practical because of cloudy weather

		Correct		Incorrect	
	Size	Raw Score	Percent	Raw Score	Percent
Total Sample	80	32	40.0	48	60.0
Occupation					
Professional	30	15	50.0	15	50.0
Non-professional	50	17	34.0	33	66.0
Owners					
Land-owners	17	6	35.3	11	64.7
New Home-owners	63	26	41.25	37	58.75
Income					
under $7,000	9	5	55.5	4	44.5
$7,000-12,000	20	9	45.0	11	55.0
$12,000-17,000	23	7	30.4	16	69.6
over $17,000	19	11	57.9	8	42.1
Education					
Some High Svhool	11	5	45.4	6	54.6
High School Grad	20	6	30.0	14	70.0
Technical SChool	11	3	27.2	8	72.8
Some College	8	4	50.0	4	50.0
College Grad	17	10	58.8	7	41.2
Graduate School	13	5	38.4	8	61.6
Age					
18-34	39	16	41.0	23	59.0
35-44	18	7	38.8	11	61.2
45-54	12	5	41.6	7	58.4
55 and over	11	4	36.4	7	63.6
Family Size					
Two or Less	20	6	30.0	14	70.0
Three	21	10	47.6	11	52.4
Four	26	10	38.5	16	61.5
Five or More	13	6	46.1	7	53.9
Heating Source					
Electric	14	7	50.0	7	50.0
Oil	61	23	37.7	38	62.3
Gas	5	2	40.0	3	60.0

TABLE 9.-- Responses about solar systems polluting more than conventional systems

	Correct			Incorrect	
	Size	Raw Score	Percent	Raw Score	Percent
Total Sample	80	68	85.0	12	15.0
Occupation					
Professional	30	25	83.3	5	16.7
Non-professional	50	43	86.0	7	14.0
Owners					
Land-owners	17	13	76.5	4	23.5
New Home-owners	63	55	87.3	8	12.7
Income					
under $7,000	9	5	55.5	4	44.5
$7,000-12,000	20	19	95.0	1	5.0
$12,000-17,000	23	19	82.6	4	17.4
over $17,000	19	17	89.5	2	10.5
Education					
Some High School	11	8	72.7	3	27.3
High School Grad	20	17	85.0	3	15.0
Technical School	11	10	90.9	1	9.1
Some College	8	7	87.5	1	12.5
College Grad	17	15	88.2	2	11.8
Graduate School	13	11	84.6	2	15.4
Age					
18-34	39	36	92.3	3	7.7
35-44	18	14	77.7	4	22.3
45-54	12	12	100.0	--	---
55 and over	11	6	54.6	5	45.4
Family Size					
Two or Less	20	17	85.0	3	15.0
Three	21	18	85.7	3	14.3
Four	26	21	80.8	5	19.2
Five or More	13	12	92.3	1	7.7
Heating Source					
Electric	14	11	78.6	3	21.4
Oil	61	53	86.9	8	13.1
Gas	5	4	80.0	1	20.0

following groups: college graduates, age 35-44, age 55 and over, family size of two or less, family size of five or more, and electric heated homes. Those indicating lower percentages of awareness were in the following groups: technical school, some college, age 45-54, family size of four, and gas heated homes. There were no trends developing in this question, either.

Table 11 indicates the awareness of comparative operating costs between solar heating systems and conventional heating systems. Slightly over 81 percent of the respondents were aware that operating costs would be less for a solar system. There were four groups which showed significantly greater awareness for this question. They were as follows: land-owners, high school graduates, college graduates, and age 45-54. Respondents showing significantly less awareness were as follows: income under $7,000, some high school, technical school, some college, electric heated homes, and gas heated homes. No solid trends were established in this question.

The last question dealing with awareness of solar energy applications was on the use of solar energy to power air-conditioning. Table 12 reveals that slightly over 66 percent of the sample correctly indicated that solar energy could be used to power air-conditioning. Groups differing significantly on the high side were as follows: income under $7,000, college graduate, graduate school degree, age 35-44, and gas heated home. Those differing on the low side were

TABLE 10.-- Responses concerning comparative installation costs of solar heating systems and conventional heating systems

		Correct		Incorrect	
	Size	Raw Score	Percent	Raw Score	Percent
Total Sample	80	52	65.0	28	35.0
Occupation					
Professional	30	21	70.0	9	30.0
Non-professional	50	31	62.0	19	38.0
Owners					
Land-owners	17	11	64.7	6	35.3
New Home-owners	63	41	65.0	22	35.0
Income					
under $7,000	9	6	66.7	3	33.3
$7,000-12,000	20	14	70.0	6	30.0
$12,000-17,000	23	13	56.5	10	43.5
over $17,000	19	13	68.4	6	31.6
Education					
Some High School	11	7	63.6	4	36.4
High School Grad	20	14	70.0	6	30.0
Technical School	11	5	45.4	6	54.6
Some College	8	4	50.0	4	50.0
College Grad	17	13	76.5	4	23.5
Graduate School	13	9	69.2	4	30.8
Age					
18-34	39	22	56.4	17	43.6
35-44	18	15	83.3	3	16.7
45-54	12	6	50.0	6	50.0
55 and over	11	9	81.8	2	18.2
Family Size					
Two or Less	20	15	75.0	5	25.0
Three	21	13	61.9	8	38.1
Four	26	14	53.4	12	46.6
Five or More	13	10	76.9	3	23.1
Heating Source					
Electric	14	11	78.6	3	21.4
Oil	61	39	63.9	22	36.1
Gas	5	2	40.0	3	60.0

TABLE 11.-- Responses concerning comparative operating costs of solar heating systems and conventional heating systems

		Correct		Incorrect	
	Size	Raw Score	Percent	Raw Score	Percent
Total Sample	80	65	81.25	15	18.75
Occupation					
Professional	30	25	83.3	5	16.7
Non-professional	50	40	80.0	10	20.0
Owners					
Land-owners	17	16	94.1	1	5.9
New Home-owners	63	49	77.7	14	22.3
Income					
under $7,000	9	6	66.7	3	33.3
$7,000-12,000	20	16	80.0	4	20.0
$12,000-17,000	23	20	87.0	3	13.0
over $17,000	19	15	79.0	4	21.0
Education					
Some High School	11	7	63.6	4	36.4
High School Grad	20	20	100.0	--	---
Technical School	11	7	63.6	4	36.4
Some College	8	5	62.5	3	37.5
College Grad	17	16	94.1	1	5.9
Graduate School	13	10	76.9	3	23.1
Age					
18-34	39	31	79.4	8	20.6
35-44	18	14	77.7	4	22.3
45-54	12	11	91.7	1	8.3
55 and over	11	9	81.9	2	18.2
Family Size					
Two or Less	20	16	80.0	4	20.0
Three	21	17	80.9	4	19.1
Four	26	21	80.8	5	19.2
Five or More	13	11	84.6	2	15.4
Heating Source					
Electric	14	9	64.3	5	35.7
Oil	61	53	86.9	8	13.1
Gas	5	3	60.0	2	40.0

in the following groups: income $7,000 - $12,000, high school graduate, and age 45-54. There appears to be a definite trend between increasing educational levels and increasing awareness of solar powered air-conditioning.

If we review the results of these awareness questions in total we will come out with the following demographic profile: a professional, a new home-owner, an income of $7,000 - $12,000, a college graduate, 18-34 years old, family size of five or more, and an oil heated home. This profile fits the "innovator" type outlined in the second hypothesis. However, we are only talking about awareness here and not interest or preference.

The figures in Table 5 through 12 indicate a relatively high degree of awareness about solar energy. However, the high degree of awareness may be due to the use of true-false questions, and the "don't know" answer was not offered as a choice when the questions were read. It is difficult to determine what percentage of the respondents were simply guessing the answers.

More information on respondent awareness may be obtained by reviewing the advantages and disadvantages cited for solar energy by respondents. It should be noted that over 27 percent of the respondents could not think of any advantages or disadvantages, and a majority of those indicating advantages and disadvantages only indicated one or two. There were seven advantages and eight disadvantages mentioned by

TABLE 12.-- Responses to the question of whether or not solar energy can be used to provide air-conditioning

		Correct		Incorrect	
	Size	Raw Score	Percent	Raw Score	Percent
Total Sample	80	53	66.25	27	33.75
Occupation					
Professional	30	22	73.3	8	26.7
Non-professional	50	31	62.0	19	38.0
Owners					
Land-owners	17	10	58.8	7	41.2
New Home-owners	63	43	68.25	20	31.75
Income					
under $7,000	9	7	77.7	2	22.3
$7,000-12,000	20	11	55.0	9	45.0
$12,000-17,000	23	25	65.2	8	34.8
over $17,000	19	14	73.7	5	26.3
Education					
Some high School	11	7	63.6	4	36.4
High School Grad	20	8	40.0	12	60.0
Technical School	11	8	72.7	3	27.3
Some College	8	6	75.0	2	25.0
College Grad	17	13	76.5	4	23.5
Graduate School	13	11	84.6	2	15.4
Age					
18-34	39	26	66.7	13	33.3
35-44	18	14	77.7	4	22.3
45-54	12	6	50.0	6	50.0
55 and over	11	7	63.6	4	36.4
Family Size					
Two or Less	20	13	65.0	7	35.0
Three	21	12	57.1	9	42.9
Four	26	19	73.1	7	26.9
Five or More	13	9	69.2	4	30.8
Heating Source					
Electric	14	8	57.1	6	42.9
Oil	61	41	67.2	20	32.8
Gas	5	4	80.0	1	20.0

respondents. The three most significant advantages of solar energy were "long run saving" with 25 percent of those surveyed, "saving natural resources" with 18.7 percent, and "no pollution" with 12.5 percent. Other advantages mentioned were "availability," "clean," "no strike," and "maintenance." The three most significant disadvantages mentioned were "storage" with 17.5 percent, "risk" with 12.5 percent, and "weather" with 11.2 percent. Other disadvantages mentioned were "cost," "space," "maintenance," "comfort," and "appearance." The disadvantages of "storage" and "weather" may indeed be the same problem, since if you solve one the other diminishes in importance. The disadvantages referred to are significant, but there are others, which the respondents have not thought of that suggest a lack of understanding in the solar energy field. It is significant to note that the disadvantages of "space" and "appearance" combined received only 5 responses. These are very acute problems, which will require some special attention. This may indicate that the respondents are not as aware of all of the ramifications of solar energy as their earlier responses indicated.

Interest. The questionnaire next moves into the area of interest in solar energy systems for housing. Respondents were asked if they would take the time to visit a solar heated home in their area. Table 13 reveals that slightly over 66 percent of the respondents were interested enough to visit a solar heated home. The following groups indicated

a significantly higher percentage of interest than the sample as a whole: some high school, graduate school, age 45-54, electric heated homes, and gas heated homes. Those showing considerably less interest than the sample as a whole were in the following groups: high school graduates, technical school, and age 35-44.

A review of the results on interest suggests the following demographic profile: non-professional, land-owner, income over $17,000, some high school or a graduate degree, age 45-54, family size of four, and an electric or gas heated home. An individual with these characteristics might be rare, but those groups within the sample showed stronger interest percentages. If we compare this profile with the one for awareness, we find that none of the characteristics match. The profile for interest does not match the "innovator" type outlined in the second hypothesis either.

Preference. Preference for solar energy was derived from the question of whether or not a respondent would want to live in a solar heated home. Table 14 indicates that 27.5 percent of the respondents would want to live in a solar heated home, while 21.3 percent would not. In addition to this, Table 14 also includes the number and percentage of respondents indicating they could not make a decision without further information. Some respondents made a choice as to preference and indicated they needed more information. Sixty-one percent of the respondents said they needed more

TABLE 13.-- Respondents interested enough in solar energy to visit a solar home in their area

		Interested		Not Interested	
	Size	Raw Score	Percent	Raw Score	Percent
Total Sample	80	53	66.25	27	33.75
Occupation					
Professional	30	19	63.3	11	36.7
Non-professional	50	34	68.0	16	32.0
Owners					
Land-owners	17	12	70.6	5	29.4
New Home-owners	63	41	65.0	22	35.0
Income					
under $7,000	9	6	66.7	3	33.3
$7,000-12,000	20	14	70.0	6	30.0
$12,000-17,000	23	15	65.2	8	34.8
over $17,000	19	14	73.7	5	26.3
Education					
Some High School	11	9	81.9	2	18.1
High School Grad	20	11	55.0	9	45.0
Technical School	11	6	54.6	5	45.4
Some College	8	5	62.5	3	37.5
Collage Grad	17	12	70.6	5	29.4
Graduate School	13	10	76.9	3	23.1
Age					
18-34	39	26	66.7	13	33.3
35-44	18	10	55.5	8	44.5
45-54	12	10	83.3	2	16.7
55 and over	11	7	63.6	4	36.4
Family Size					
Two or Less	20	13	65.0	7	35.0
Three	21	12	57.1	9	42.9
Four	26	19	73.1	7	26.9
Five or More	13	9	69.2	4	30.8
Heating Source					
Electric	14	11	78.6	3	21.4
Oil	61	38	62.3	23	37.7
Gas	5	4	80.0	1	20.0

information. The following groups indicated a significantly stronger preference for solar energy than the sample as a whole: professionals, income under $7,000, graduate school, age 45-54, family size of two or less, and electric heated homes. The following groups showed a significantly stronger preference against the use of solar energy: technical school, some college, and family size of three. There were four groups that had a higher percentage needing information than the total sample. They were: high school graduates, technical school, family size of three, and gas heated homes. Those claiming significantly lower percentages for the same response were: income under $7,000, some high school, some college, graduate school, age 45-54, age 55 and over, and family size of two or less.

A review of the results on preference suggests the following demographic profile: professional, new home-owner, income under $7,000, graduate school degree, age 45-54, family size of two or less, and an electrically heated home. Here again it would be difficult to find an individual with these characteristics. This profile comes closer to matching the "innovator" type than the profile on interest. However, those showing the greatest preference were not in the younger group, and there is some inconsistency between income and occupational status in this profile. It is interesting to note that the 45-54 age group, which registered the highest percentage of interest and preference, was one

TABLE 14.-- Comparison of respondents showing preference for and against solar energy with those not making a decision, stating they need more information

		Prefer/Not Prefer		No Decision	
	Size	Raw Score	Percent	Raw Score	Percent
Total Sample	80	22/17	27.5/21.3	49	61.2
Occupation					
Professional	30	12/ 6	40.0/20.0	17	50.6
Non-professional	50	10/11	20.0/22.0	32	64.0
Owners					
Land-owners	17	4/ 2	23.5/11.7	12	70.6
New Home-owners	63	18/15	28.5/23.8	37	58.7
Income					
under $7,000	9	7/ 2	77.7/22.3	1	11.1
$7,000-12,000	20	7/ 4	35.0/20.0	13	65.0
$12,000-17,000	23	4/ 5	17.3/21.7	14	60.8
over $17,000	19	7/ 4	36.8/21.0	11	57.9
Education					
Some High School	11	4/ 2	36.3/18.2	5	45.5
High School Grad	20	5/ 3	25.0/15.0	16	80.0
Technical School	11	-/ 5	-/ 45.4	8	72.7
Some College	8	2/ 3	25.0/37.5	3	37.5
College Grad	17	3/ 4	17.6/23.5	11	64.7
Graduate School	13	8/ -	61.5/---	6	46.1
Age					
18-34	39	8/ 9	20.5/23.1	26	66.7
35-44	18	5/ 3	27.7/16.6	12	66.7
45-54	12	5/ 3	41.6/25.0	6	50.0
55 and over	11	4/ 2	36.3/18.2	5	45.4
Family Size					
Two or Less	20	9/ 4	45.0/20.0	9	45.0
Three	21	3/ 9	14.3/42.8	15	71.4
Four	26	6/ 3	23.1/11.5	17	65.4
Five or more	13	4/ 2	30.7/15.3	8	61.5
Heating Source					
Electric	14	6/ 2	42.8/14.3	8	57.1
Oil	61	16/15	26.2/24.6	36	59.0
Gas	5	--/--	-- / --	5	100.0

[a] Some respondents indicated more than one answer

of the lowest in terms of awareness. This supports the idea for public education on solar energy applications and capabilities.

The questionnaire includes a question on the factors that a respondent would consider when purchasing a heating system. This question was included to determine what respondents thought was important in heating systems. Twenty-six percent of the respondents felt that "cost of operation" was most important followed by "cost of installation" with 24 percent. Other factors considered were "comfort" at 13 percent, "clean" at 9 percent, "cost of maintenance" at 8 percent, "availability of fuel" at 7 percent, "reliability" at 7 percent, "pollution" at 4 percent, and "safety" at 2 percent. The two most important factors of "cost of operation" and "cost of installation" are solar energy's big advantage and disadvantage, respectively.

The final question for analysis is whether or not the respondents would be willing to pay a premium price for a solar energy system. Over 83 percent of the respondents were willing to pay more for a solar system that would not pollute and would save at least 50 percent on their monthly heating bills. Thirty-five percent of the respondents were willing to pay $2,000 more for a solar system, while 27.5 percent were willing to pay $1,000 more, 16.75 percent were willing to pay $500 more, 12.5 percent did not know how much they would be willing to spend, 3.75 percent would pay $3,000 or more, and 3.75 percent would pay nothing extra.

These figures indicate that for the most part the respondents would be willing to spend extra to get the savings of lower operating costs, particularly in an "energy crisis." The advantage of limiting pollution seems to be of secondary importance when one looks at the results of the previous question and finds pollution next to last in importance.

C H A P T E R I V

CONCLUSIONS

The conclusions will be based in terms of the research objectives set up at the beginning. From this the hypotheses will either be accepted or rejected, and some general observations will be made.

Research Objectives

The first research objective was to determine the respondents' awareness of solar energy applications. The analysis shows us that the respondents had a relatively high degree of awareness in terms of general knowledge about solar energy. However, the results also show that respondents had fewer correct answers for specific fact type questions. The three true-false questions which had the lowest correct response percentages were the ones on air-conditioning, cost of installation, and practicality in cloudy weather. While general knowledge about solar energy was good, the specific knowledge was only fair. There is further evidence that specific knowledge is lacking when the advantages and disadvantages are analyzed. Over 27 percent of the respondents did not indicate any advantages or disadvantages. A look at the disadvantages shows that the respondents recognized the "storage problem," perceived that it was risky, and also that the cost would be higher. However, very few of them

recognized the problems of "space" and "appearance." So in terms of awareness, the respondents had a general knowledge, but over 61 percent said that they needed more information before they could make definite decisions on preference. This may suggest that the public needs to be educated in solar energy applications and capabilities. When 60 percent of the respondents are not sure if solar energy is practical because of cloudy weather, it seems that information is necessary. This education process should start as soon as possible so that market acceptance is easier when commercial availability becomes a reality.

The second research objective was to determine the amount of interest respondents had in solar energy. Almost 69 percent of the respondents indicated that they would take the time to visit a solar heated home in their area. This was a way of measuring interest in solar energy for the housing sector. The percentage is relatively high when one considers that almost 80 percent of the respondents had moved into new homes in the last three years. The influence of the "energy crisis" is probably responsible for this high positive response. If the research had been conducted six months earlier the response might not have been so high. If it had been conducted six months later it might be even higher depending upon our "energy" situation.

The third research objective was to determine preference for solar energy in housing. Preference for solar energy,

which was determined by the desire to live in a solar home, was under 30 percent. The respondents made their preference decisions without complete and accurate knowledge of solar energy systems. It is difficult to determine if complete knowledge will increase or decrease the percentage preferring solar energy. The percentage may decrease if installation costs remain higher for solar systems than conventional systems. A lower percentage is possible since the cost of installation was one of the most important factors considered in purchasing a heating system. Appearance and space may also have a significant influence on preference, but only increased knowledge will determine that. On the other hand, the percentage may increase since over 80 percent of the respondents indicated that they would be willing to pay more for a solar heating system, which would not pollute and save them at least 50 percent on their heating bill. This may lend support to the idea that people are starting to think in terms of long-run costs and not just initial capital outlays. If this is the case, it would be an advantage for solar energy if its costs could not be brought down immediately to match conventional systems.

The last research objective was to obtain some clues as to the demographic characteristics of the respondents that might be potential purchasers of solar systems. This research effort indicates that a potential buyer might be a professional of some sort, a home-owner, have an income over

$17,000, have a graduate degree, be 45 to 54 years old, have a family size of two, and heat his present home with electric. There are several exceptions to this general description, however. The respondents that made under $7,000 showed the greatest interest and preference for solar energy with the over $17,000 group showing the next greatest. It is important to note that the 18 to 34 group, which was almost half of the sample, did not make the solar buyer profile. They were the most aware and most willing to pay, but their interest was second to the older group, and their preference for solar energy was the least of all groups.

Hypotheses

Drawing on the conclusions made from the research objectives, the first hypothesis can be accepted as true. The first hypothesis states that the people surveyed are not generally aware of the advances that have been made in solar energy systems as they are used in the housing sector. Therefore, those surveyed have no strong preferences either for or against the use of solar energy in housing. The survey revealed that the respondents had a basic knowledge of the existence of solar energy, but they did not have sufficient knowledge to react either favorably or unfavorably. This conclusion is supported by the fact that 61 percent of the respondents indicated that they needed more information on solar energy before they could make a definite decision on

whether they would want to live in a solar heated home. The percentage of respondents that showed a preference for the use of solar energy in housing was 27.5 and those opposing its use 21.25. Those results indicate that the respondents had no strong preferences one way or the other.

The second hypothesis must be rejected based on the conclusions drawn from the research objectives. The second hypothesis states that those who show an interest in and a preference for solar energy will tend to be younger, better educated, and somewhat higher in occupational status than the average. The data collected in this survey cannot support this hypothesis. The respondents that showed the greatest percent of interest and preference were not the younger ones, but the group between 45 and 54 years of age. The other characteristics do hold up fairly well, however. Respondents with more education tended to have higher interest and preference levels, and professionals showed stronger interest and preference than non-professionals. The income figures, however, do not support the choice of the professionals over the non-professionals unless there are a substantial number of professionals making under $7,000 a year.

It is significant to note that in rejecting this hypothesis this survey suggests a potential marketing problem for solar energy systems. Almost half of the respondents in this survey were in the 18 to 34 age group, which for this particular sample represents almost half of the housing

market. If there is to be a market for solar energy in housing this age group will have to be developed, provided that this sample is representative of the population. It seems logical that if younger people are buying the largest percentage of new homes that they would represent a significant part of the potential market for solar systems.

General Observations

Solar energy appears to be a very promising alternative source of energy for the near future. It is technologically feasible now, but it remains to be economically developed so that it is competitive with conventional energy sources. This is the challenge for business and marketing. There should be very little opposition to the development of solar energy on the environmental front, since it does not carry with it many of the environmental hazards that are associated with other energy sources. The development of a solar energy industry along the lines of what Arthur D. Little, Inc. is doing is a step in the right direction. This seems to be the most sensible and efficient way to develop and promote solar energy. It is important that in the development of this industry the participants do not lose sight of the final consumer. Projects like Richard Blazej's are also a step in the right direction and will provide much information toward solar development. The potential is there and the time is right for the development of a solar energy industry and market.

Significance for Marketing

This study represents a preliminary step in the gathering of information about the possible development of a market for solar energy in the housing sector. This study indicates the consumer's degree of awareness and some of his perceptions about solar energy. If a market for solar energy in housing is to be developed, the concentration will in all likelihood be on building contractors and developers. These individuals will want to know if solar energy is marketable. This research effort sets up the ground work on which further research can be done to answer the question of marketability.

This study points out that there is a need for information about solar energy, and this is a marketing function. It also suggests that the public might be willing to pay a higher premium for solar energy if it doesn't pollute and can save at least 50 percent on heating bills. It also gives us some demographic clues on people who are interested in solar energy. This type of information will contribute to the solar energy marketing effort and help in further research efforts.

APPENDIX A

Hello, is Mr. _____ at home? My name is Pritchard Strong of West Brattleboro. I am a graduate student at the University of Massachusetts, and I am doing some research on housing for my thesis. This is not a sales promotion, or anything like that. I would like to ask you some questions concerning your (new home/land) in _____ (town)

FOR LAND ONLY:

1. Have you built or do you plan on building on that site in the near future? IF NO TERMINATE

2. What type of structure do you have in mind for that site?

   New home Vacation home Camp Other

3. At present do you own your own home rent an apartment

   rent a house own a mobile home other

FOR NEW HOME AND LAND:

4. How long have you been living at this location?

5. What type of heating system do you have in your home?

   oil gas or electric

6. What type of hot water system do you have?

   oil gas or electric

7. Do you know how much it cost to heat your home for a year?

   Could you give me a dollar amount?

8. Are you concerned about the possible shortages in home heating fuels, or don't you think there really is a shortage problem?

9. Can you think of any new and innovative sources of energy which could be used for heating purposes?

10. Have you ever heard of using the sun's rays, or solar energy, for heating buildings?

    Do you remember where you heard about it and how it was used?

I am going to ask you a series of true-false questions on solar energy, which is energy that comes from the sun's rays

11. T F DK Solar energy, or the sun's rays, can be used to generate electricity?

12. T F DK Solar energy can be used to heat homes and provide hot water for them?

13. T F DK Solar energy heating systems are not practical because of extended periods of cloudy weather?

14. T F DK Solar energy heating systems pollute more than conventional systems?

15. T F DK You would expect that the initial installation cost for a solar energy heating system would be more than the cost of a conventional oil, gas, or electric heating system because it requires a back-up system?

16. T F DK You would expect that your heating bills would be less with a solar energy heating system than for a conventional heating system?

17. T F DK Solar energy can be used for home air-conditioning?

18. Would you take the time to visit a solar heated home in southern Vermont?

19. Would you want to live in a solar heated home?

    Why, what do you feel the advantages are?

    Why, what do you feel the problems are?

20. What are the factors that you would consider in purchasing a heating system?

21. Suppose that a conventional oil, gas, or electric heating system cost approximately $2,000 to install, how much more would you be willing to pay for a non-polluting solar energy heating system, which would save you at least 50% on your monthly heating bill?

Now, just a few questions about you and your family for statistical purposes only.

22. How many people, including yourself, live in your home at the present time?

23. How many people, including yourself, living at home are presently employed?

24. In which of the following age groups are you?

18-24	35-44	55-64
25-34	45-54	65 & over

25. What was the last grade of school that you completed? (household head)

Grade school or less	Special or technical school
Some high school	Some college
Graduated high school	Graduated college
	Graduate school

26. What is the occupation of the head of the household? Probe, be specific

27. a) What is the approximate fair market value of your home?

b) What is your monthly rent?

28. And one last question. Including all family members living at home, your family's income for last year was in which of the following groups?

under $7,000	$12,000-$17,000
$7,000-$12,000	over $17,000
	Refused

THANK YOU FOR YOUR COOPERATION

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