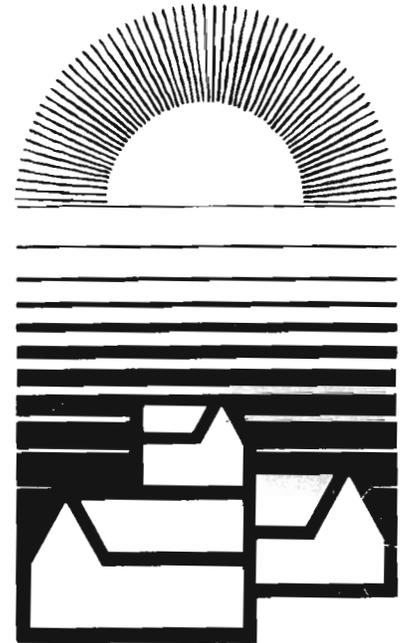


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1980

# RESIDENTIAL SOLAR DEMONSTRATION PROGRAM: FINDINGS OF THE PASSIVE SOLAR RESIDENTIAL DESIGN COMPETITION AND DEMONSTRATION



Autumn 1980

Prepared for Solar  
Demonstration Program,  
Division of Energy,  
Building Technology and  
Standards, Office of  
Policy Development  
and Research, U.S.  
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and Urban Development.

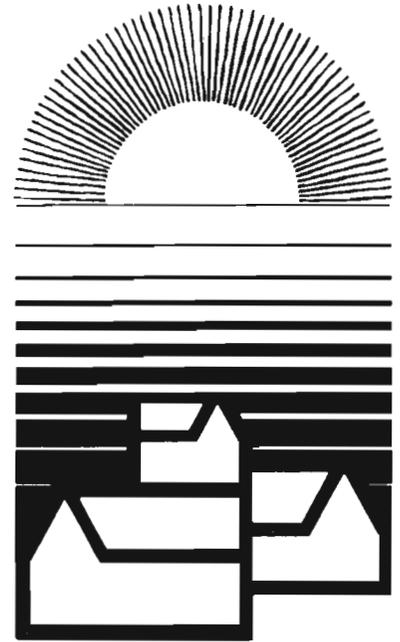
Prepared by

**RERC**

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This report was prepared under contract to the U.S. Department of Housing and Urban Development by Real Estate Research Corporation. The findings and conclusions are those of the contractor, and do not necessarily reflect the policy or views of the U.S. Department of Housing and Urban Development.

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## EXECUTIVE SUMMARY

- The passive living environment is premised on energy self-sufficiency and often exhibits unique features that are yet to be tested widely in the marketplace.
- The "typical" speculative passive home is 1,725 square feet with three bedrooms and less than two bathrooms. The "typical" custom "contractor-built" passive home is 2,000 square feet with two bedrooms and two bathrooms. The "typical" custom "owner-built" passive home is 1,625 square feet with two bedrooms and less than two bathrooms.
- The median sales price for the speculative passive home is \$80,000 and for the custom "contractor-built" passive home is \$96,000. The median cost of construction for the custom "owner-built" passive home is \$68,750. (All prices include land.)
- Most designers and builders involved in the award program had previous or additional passive solar experience and are committed to further passive work. Respondents agreed that the passive homes took longer and were more expensive to design and build, but many believe that the market will bear some additional costs for them. Few experienced major constraints or impediments in the execution of the homes.
- Higher prices; unconventional appearances; and difficulty in defining passive elements were among the marketing problems cited by some respondents, while others considered the passive concept to be a marketing plus.
- The "typical" passive household consists of two well-educated persons in their late 30's. Median household income is approximately \$33,000.
- Purchasers wanted passive homes primarily for environmental reasons and for utility savings. Both initial and follow-up interviews revealed that virtually all were well-satisfied, with expectations generally having been met or exceeded. No major system problems were reported and respondents were almost unanimous in their commitment to passive homes in the future.
- Most financial institutions were not concerned about marketability, and in many cases included the total costs of the passive features in the home's appraisal.



## SUMMARY OF FINDINGS

### A. Introduction

The report which follows summarizes the findings by Real Estate Research Corporation (RERC) of the 1978 U.S. Department of HUD Passive Solar Residential Design Competition and Demonstration (also referred to as the Passive Initiative), a competition and award program to encourage the design, construction and marketing of passive solar homes. Between April 1979 and June 1980, RERC, which serves as consultant to HUD on the Residential Solar Heating and Cooling Demonstration Program, surveyed 42 award sites in 19 states, and conducted almost 200 interviews with associated designers, builders, purchasers and financial institutions.

The data are subject to a number of important constraints, among them: small, non-random sample of homes and of participants by category; award homes and participants only (no control group); large proportion of custom, including owner-built, homes; limited geographic distribution (24 out of 42 sites in the West, predominantly California, Colorado and New Mexico); poor housing market nationwide; and limited ability to compare passive homes to "active" solar and conventional homes.

### B. The Passive Living Environment

Passive solar is viewed by many respondents as part of an overall commitment to ecological and environmental preservation, and to the importance of energy self-sufficiency in everyday life.

The survey consists of 25 speculative ("for sale") houses and 17 custom homes, of which about one-half are "contractor-built" (i.e., where the purchaser did not serve as builder or designer) and the other half are "owner-built" (i.e., where the purchaser was also the designer and/or builder).

The "typical" passive house surveyed is a modern, single-family detached home with a wood exterior; three bedrooms; one and one-half or two baths; garage; and no basement. It is found in a subdivision but not necessarily in an SMSA (Standard Metropolitan Statistical Area); in fact, some passive homes are found in rural or remote locations.

When broken down by speculative and custom housing, however, some differences emerge among selected features. For example, the majority of speculative homes feature three bedrooms and less than two bathrooms; the majority of custom "contractor-built" homes feature two bedrooms and two bathrooms; and the majority of custom "owner-built" homes feature two bedrooms and less than two bathrooms.

The approximate median sizes (living area) of passive homes are 1,725 square feet for speculative homes and 1,800 square feet for all custom homes (2,000 square feet for custom "contractor-built" homes and 1,625 square feet for custom "owner-built" homes).

The most common passive and related features found in the houses are: direct gain heating features; mass Trombe walls; indirect sunspaces; greenhouses; reflector panels; special flooring; thermal chimneys; moveable insulation; sunscreening devices; vents; earth berms; design and siting for natural ventilation; minimum perimeter designs; wood and/or electric back-up systems; and active solar domestic hot water systems.

The least common passive and related features found in the houses are: water Trombe walls; indirect thermosyphons; atriums (as opposed to greenhouses); underground construction; evaporative cooling features; and central air conditioning.

In addition, passive homes often feature:

- smaller-than-normal rooms, especially auxiliary bedrooms
- bedroom/loft arrangements or other spatial, "barrier-free" delineations without full wall partitions
- use of renewable or recycled technology, such as waste composting systems
- the predominance of wood as the primary (or only) heating back-up fuel

Median house prices were determined for a total of 36 homes in three different categories. Six speculative homes were not yet sold at the completion of data collection.

- For speculative homes, median purchase price, including land, is \$80,000 (\$50.00 per square foot).

- For "contractor-built" custom homes, median purchase price, including land, is \$96,000 (\$52.00 per square foot).
- For "owner-built" custom homes, median cost of construction, including land, is \$68,750 (\$44.00 per square foot).

### C. Design and Construction

#### 1. Profiles of Designers and Builders

The majority of designers surveyed are engaged in residential design for local, custom home clients. All have been practicing for at least two years, and over half are trained in other disciplines as well. About two-thirds have had experience with other passive designs, and almost half of the respondents have designed active solar houses and/or houses incorporating both active and passive features.

The overwhelming majority of builders surveyed are small-scale builders (nine units or less per year) who build for local, single-family housing markets. Most build both custom and speculative housing, but about one-third build exclusively for the custom market. The majority of respondents have had between two and ten years general building experience and some additional solar experience. Almost 60 percent had built or were building other solar homes.

#### 2. Design and Construction Processes

In most cases, the designer was the key actor in the process and had initiated the decision to design a passive house, based on a combination of economic and philosophical objectives.

In about half of the cases, the builder had had a previous working relationship with the designer, and was selected by the designer for this particular project. In general, however, builder input was minimal, because of limited knowledge and experience. Participation usually did not go beyond discussion with the designer regarding the choice of passive elements.

##### a. Constraints and Impediments

Apart from budget and other specifications imposed by the custom home client, few respondents reported

any constraints or impediments from public agencies, financial institutions or others. Problems mentioned, however (not all of which were attributed exclusively to the passive nature of the homes), included finding appropriate labor; obtaining appropriate materials; and obtaining construction financing. However, the overwhelming majority either did not experience any problems or constraints, or else found the obstacles to be minimal and surmountable without a major investment of time or effort.

b. Time and Cost Factors

The vast majority of respondents agreed that the houses took longer than non-solar houses to design and build. (Average construction time was about seven months.) However, less than half of the respondents attributed construction delays exclusively to the passive nature of the houses. Because of the extra time required, and the use of extra and more costly materials, it was also generally agreed that the houses were more expensive than similar non-solar houses.

D. Marketing the Passive Homes

Respondents (23) who built speculative houses as part of the award program were asked a series of questions pertaining to market acceptance and marketing techniques.

Virtually all agreed that they were offering a new type of product to their customers and that, in general, public interest was favorable.

About half felt that potential purchasers of passive homes differed from the ordinary buyer, in part because of their heightened interest in energy conservation.

Methods of marketing the award homes varied from none at all to the use of techniques such as areawide advertising; radio spots; and open houses.

Some major marketing problems cited were: added costs associated with passive homes; the need to educate consumers; the need to increase market acceptance of unique elements and appearances; and difficulty in defining passive elements.

Fifteen said that they had built or were building other solar housing and overall were fairly positive about their experiences. About the same number plan to incorporate passive features in future homes. Although there was concern expressed about building passive homes on a speculative basis, the overwhelming majority said that they would currently construct a solar home without a subsidy or award.

In general, most builders--both custom and speculative--indicated market willingness to accept some higher costs associated with passive features, with about one-third confident that the market could bear as much as ten percent more for such features.

At the completion of data collection, six speculative homes were not yet sold. Since the homes came on the market at different times during a period of high interest rates, lack of sales at the close of data collection did not necessarily imply a problem with passive features. Where there was market resistance, reasons given included: high interest rates and the overall state of the economy; seasonal nature of the particular housing market; conservative community; buyer confusion over tax credits; poorly situated or poorly perceived site; and solar system itself.

## E. Passive Home Purchasers

### 1. Profile of Purchasers

The "typical" passive household consists of two persons employed in professional, technical and related occupations. The median age of each adult is approximately 37 years, and median household income is approximately \$33,000. Small household sizes and unique interior layouts (as discussed earlier) suggest that passive homes may be more appealing to childless couples than to families.

### 2. Decision and Purchase Process

Respondents cited environmental concerns and fuel savings among the paramount reasons for wanting a passive home. For speculative home purchasers, solar features and energy-efficiency were important reasons for purchasing their particular house. Most expected their utility costs to be lower than previously, and few speculative purchasers were concerned about purchasing a passive as opposed to a conventional home.

Over half of the respondents--both custom and speculative--felt that they had paid more for a passive solar home as opposed to a "well-designed energy-conserving conventional house," but a significant minority did not agree. Although six purchasers experienced problems with financial institutions, one was offered more favorable terms because of the passive home.

### 3. Purchaser Satisfaction: Initial Interviews

Initial interviews with purchasers (33) revealed that virtually all were well-satisfied with their houses, system performance and comfort level.

For the most part, positive expectations had been met, while in most cases, negative expectations did not occur. Nine reported some problems with their systems, but virtually all agreed they would consider buying another house with solar features. Respondents were divided as to whether or not they would have chosen the particular design for a conventional house; however, twice as many speculative purchasers said they would have chosen the design anyway.

### 4. Purchaser Satisfaction: Follow-up Interviews

Follow-up interviews conducted with a smaller number of purchasers (21) revealed sustained and growing enthusiasm toward passive homes. For the most part, occupants appeared to have adapted well to their living environments over time, and expectations about the systems were fully met in virtually all instances.

All respondents noted that their back-up systems had performed reliably and no major problems with the passive systems were reported, although some elements of dissatisfaction were mentioned.

Although only one purchaser had attempted to sell the house, respondents were almost unanimous in agreeing that they would again purchase a passive house, and almost equally unanimous in expressing their aversion to active solar.

## F. Financial Institutions

Financial institutions may be characterized as neutral participants in the process of opening up the marketplace to passive solar homes. In general, they have not adopted policies to encourage such homes, but they are favorably inclined toward providing financing on a case-

by-case basis with the creditworthiness of the applicant a prime factor, particularly in the cases of construction loans.

The majority of participating institutions were not concerned with the marketability of these homes, and many felt that the passive features added value to the houses. In many cases, the total costs of these features were included in the home's appraisal.

About half of the institutions interviewed have financed or are financing other houses utilizing both active and passive solar energy. The geographic distribution of such lending activity closely parallels the general pattern of passive activity we have found.

G. Additional Passive Solar Activity

Follow-up interviews were conducted with 50 designer and builder respondents to determine the extent of additional passive solar activity undertaken since the award program.

Of the 50 interviewed, 35 have engaged in other, primarily custom home, passive activity, predominantly in California, Colorado and New Mexico. Moreover, virtually all plan to continue with additional passive work.

The most frequently cited problems or constraints experienced by those who were involved in additional passive work were difficulty or delays in obtaining financing; labor; and materials.

Those who were building additional speculative passive homes were emphasizing passive in their marketing techniques and virtually all felt that there was consumer interest in these homes. Marketing problems cited by some, however, included higher prices and unconventional appearance. Others felt that passive was a marketing plus.



FINDINGS OF THE PASSIVE SOLAR RESIDENTIAL DESIGN  
COMPETITION AND DEMONSTRATION



## Chapter I

### INTRODUCTION

#### A. Nature of Report

Real Estate Research Corporation (RERC) serves as consultant to the U.S. Department of Housing and Urban Development (HUD) on the Residential Solar Heating and Cooling Demonstration Program. Since the Spring of 1979, RERC has been engaged in a survey effort of selected custom and speculative passive homes which received awards under the HUD Passive Solar Residential Design Competition and Demonstration (also referred to as the Passive Initiative), a competition and award program to encourage the design, construction and marketing of passive solar homes.

The report which follows summarizes the findings of our data collection and analysis efforts.

#### B. Scope of Survey Effort

Between April 1979 and June 1980, RERC surveyed 42 grant award sites in 19 states and conducted almost 200 interviews with associated designers, builders, purchasers and financial institutions. Initial interviews, most of which were conducted in the field, were intended to assess market readiness, consumer satisfaction and other important issues related to passive solar acceptance and utilization. Follow-up telephone interviews, conducted with respondents at least six months after the initial interviews, were intended to determine changes in consumer satisfaction and market acceptance, and to trace the continuing interest of designers and builders in pursuing additional passive solar activity.

The Tables 1-3 following summarize the scope of the survey effort.

Table 1.

PASSIVE INITIATIVE

Distribution Of Grants By Type

<u>Grant Type</u>	<u>Number of Sites Surveyed</u>
Custom Homes - Design Award only	17
Speculative Homes - Design Award only	3
Speculative Homes - Design and Construction Award	21
Speculative Homes - Construction Award only	<u>1</u>
TOTAL	42

Source: Real Estate Research Corporation.

Table 2.

PASSIVE INITIATIVEGeographic Distribution of Surveyed Sites

<u>Region</u>	<u>State</u>	<u>Number of Sites Surveyed</u>
Northeast (7)	Maine	1
	New Hampshire	3
	New Jersey	1
	New York	1
	Pennsylvania	1
North Central (8)	Indiana	1
	Kansas	1
	Michigan	1
	Minnesota	1
	Missouri	1
	Wisconsin	3
South (3)	North Carolina	2
	Virginia	1
West (24)	Arizona	1
	California	8
	Colorado	6
	New Mexico	5
	Oregon	3
	Utah	1

Source: Real Estate Research Corporation.

Table 3.

PASSIVE INITIATIVENumber of Respondents by CategoryA. Initial Surveys

Builder/Designer/Purchaser <sup>1/</sup>	10
Builder/Designer	14
Designer	19
Builder/Contractor	19
Purchaser - Custom Homes	9
Purchaser - Speculative Homes	14
Permanent Lender <sup>2/</sup>	20
Construction Lender	13

B. Follow-Up Surveys

Builder/Designer	15
Designer	19
Builder/Contractor	17
Purchaser - Custom Homes <sup>3/</sup>	16
Purchaser - Speculative Homes	5

C. Other

House/site forms <sup>4/</sup>	42
--------------------------------	----

<sup>1/</sup> Includes designer/purchaser, builder/purchaser and builder/designer/purchaser respondents.

<sup>2/</sup> Includes those cases where the construction loan and the permanent loan were granted by the same institution, usually as one loan.

<sup>3/</sup> Includes cases where purchaser was also designer, builder, or builder/designer.

<sup>4/</sup> Information on house, subdivision, etc., filled out during initial field visit.

Source: Real Estate Research Corporation.

### C. Limitations of the Data Collection and Analysis Effort

Limitations and constraints which governed both the data collection and analysis phases are presented below. These should be kept in mind as the reader evaluates the findings presented throughout the report.

- Small, non-random sample. Our data base consists of only 42 sites, too small a "sample" from which to generalize or make projections about nationwide trends. Moreover, the data base for any one category of respondents is very limited.
- Award homes and participants only (no control group). Our data base consists only of award-winning passive homes and their associated participants. We did not look at other passive or other non-solar homes for comparison. Moreover, since HUD criteria (e.g., technical acceptability; degree of "active" systems allowed) governed the rules of entry and selection of award winners, the homes in our survey may or may not approximate those passive homes built outside the award program.
- Large proportion of custom homes. Almost half of the sites were custom home sites, yielding little, if any, market information. Moreover, in a number of these cases, the purchaser/occupant served also as the designer or builder, creating a potential "bias" in some of the responses.
- Limited geographic distribution. About half of the sites we surveyed are in the West. Although this may be indicative of market penetration nationwide, it gives the sample a distinct geographic bias.
- Poor housing market nationwide. Our survey coincided with high interest rates and the recent sharp downturn in the housing sector. This situation affected both sales pace and price, and may have impacted plans by builders and designers to continue with additional solar housing.
- Limitations in comparison with active solar homes. From time to time, we make comparisons between the findings of the Passive Initiative program and those of the other grant award cycles, the analysis of which we also performed for HUD. However, RERC's evaluation of the "active" cycles is based on survey of 110 sites and 168 units of all-speculative housing. Therefore, any comparisons between these sets of findings must

be made and viewed cautiously. Moreover, because the time periods of the two data collection efforts vary-- "active" data collection took place primarily between 1976 and 1978--any dollar comparisons of income, housing prices and the like must account for the effects of inflation over time.

- Limitations in comparison with conventional homes. Comparisons with conventional homes must also be made cautiously, since the data for such homes are based on nationwide samples, and the time frames may not be exactly compatible. These caveats also apply to comparisons with the homebuying public at large.
- Evaluation of program findings only. The report which follows is intended to evaluate the findings of the data collection program conducted on a selected, non-random number of sites and participants. The report is not intended to evaluate the merits of the Passive Initiative award program itself.

## Chapter II

### THE PASSIVE SOLAR LIVING ENVIRONMENT

Passive solar is viewed by many respondents as part of an overall commitment to ecological and environmental preservation, and to the importance of energy self-sufficiency in everyday life. For the most part, there is a conscious effort on the part of home purchasers and their designers to create a self-sufficient living environment based on renewable or recycled resources. In some cases, this commitment goes beyond passive solar heating to include such elements as waste composting systems, and wood burning stoves as the primary (or only) heating back-up system.

#### A. General Description of Passive Solar Homes

Our survey of passive homes consists of 25 speculative ("for sale") houses, and 17 custom houses, of which about one-half are "contractor-built" (i.e., where the purchaser did not serve as builder or designer) and the other half are "owner-built" (i.e., where the purchaser was also the designer and/or builder).\*

The passive homes surveyed are all single-family detached, with the majority considered "modern" in style and highly compatible with their surroundings. Most are located in subdivisions, although less than half are found in Standard Metropolitan Statistical Areas (SMSAs); in fact, some passive homes are found in rural or remote locations. The homes tend to be located in moderately strong housing markets that attract purchasers who previously owned their own homes--second time homebuyers. (Purchaser profiles are to be found in a later section of this report.)

The "typical" passive house surveyed has three bedrooms; one and one-half or two bathrooms; garage and no basement.

When broken down by speculative or custom housing, however, some interesting trends emerge with regard to selected features, as discussed on the following page and illustrated by Table 4.

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\* We are using the terms "for sale," "contractor-built" and "owner-built" in order to make comparisons with U.S. Census data using the same categories.

PASSIVE INITIATIVE

Table 4. Comparison of "Typical" Passive, Active and Conventional Houses by Selected Features

Features	<u>1/</u> Passive		Custom ("owner-built")	<u>2/</u> Active		Conventional		
	Speculative ("for sale")	Custom ("contractor-built")		(Speculative - "for sale" only)	Speculative <u>3/</u> ("for sale")	Custom <u>4/</u> ("contractor-built")	Custom <u>4/</u> (owner-built")	
	N = 25	N = 9	N = 8	N = 168		NA	NA	NA
<u>Median Size</u> <u>5/</u> (finished living area)	1,725	2,000	1,625	1,765		1,650	1,675	1,635
<u>Number of Bedrooms</u>				<u>7/</u>				
2 or less <u>6/</u>	8.0%	55.6%	62.5%	X	12.0%	13.0%	20.0%	20.0%
3	84.0%	22.2%	25.0%		64.0%	67.0%	62.0%	62.0%
4 or more	8.0%	22.2%	12.5%		25.0%	20.0%	19.0%	19.0%
<u>Number of Bathrooms</u>				<u>7/</u>				
2	28.0%	77.8%	37.5%	X	51.0%	44.0%	42.0%	42.0%
less than 2	52.0%	22.2%	50.0%		21.0%	30.0%	34.0%	34.0%
more than 2	20.0%	0	12.5%		28.0%	26.0%	25.0%	25.0%
<u>Basem't.</u> (full or partial) (Percent having)	24.0%	11.1%	50.0%	No <u>7/</u>	35.0%	42.0%	53.0%	53.0%
<u>Garage</u> (Percent having)	76.0%	44.4%	62.5%	Yes <u>7/</u>	80.0%	65.0%	62.0%	62.0%
<u>Primary Exterior Finish</u>								
Brick	0	0	0	3.0%	27.0%	32.0%	23.0%	23.0%
Wood or Wood Product (Wood/Brick)	72.0%	55.6%	62.5%	59.0%	37.0%	46.0%	59.0%	59.0%
Stucco	NA	11.1%	12.5%	12.0%	NA	NA	NA	NA
Aluminum	4.0%	11.1%	0	15.0%	18.0%	5.0%	4.0%	4.0%
Other	4.0%	0	0	6.0%	12.0%	10.0%	7.0%	7.0%
	20.0%	22.2%	25.0%	5.0%	7.0%	6.0%	7.0%	7.0%

1/ Data based on houses surveyed between 1979-1980. Includes characteristics of six unsold speculative homes.

2/ Data based on houses surveyed between 1976-1978. Includes characteristics of unsold homes.

3/ Data based on houses sold in 1979. Includes townhouses.

4/ Data based on houses completed in 1979.

5/ For passive, all sizes are approximate due to variations in interpretation of "living area".

6/ No passive homes featured less than two bedrooms.

7/ Based on median or most frequent response.

Sources: U.S. Department of Commerce, Bureau of the Census, Construction Statistics Division; U.S. Department of Housing and Urban Development, Marketing and Market Acceptance Data from the Residential Solar Demonstration Program, Volume I: Detailed Analysis, prepared by Real Estate Research Corporation (Springfield, VA: National Technical Information Service, 1979); Real Estate Research Corporation.

- Number of Bedrooms: Eighty-four (84) percent of all speculative ("for sale") passive homes feature three bedrooms, as do most speculative active solar and conventional homes. However, in contrast to the majority of custom conventional homes, which also feature three bedrooms, the majority of custom passive homes feature only two bedrooms.
- Number of Bathrooms: The majority of speculative ("for sale") passive homes feature less than two full bathrooms, in contrast to the majority of speculative active solar homes and 51 percent of conventional homes. Although 78 percent of custom "contractor-built" passive homes feature two full bathrooms, as opposed to 44 percent of conventional homes in the same category, none of the "contractor-built" passive homes feature more than two bathrooms, in contrast to 26 percent of conventional homes. Fewer bathrooms are also found in the cases of custom "owner-built" passive homes than conventional ones.
- Exterior finish: The majority of both speculative ("for sale") passive and speculative active homes feature wood as the primary exterior finish, whereas a greater mixture of finishes is evidenced for conventional homes in this category. None of the passive homes in this category feature brick exteriors, while this type of finish is found in both active solar and conventional homes. Wood (or wood products) is also the primary finish for custom passive homes, with somewhat compatible trends found among custom conventional homes.
- Basement: Most speculative ("for sale") passive, active and conventional homes do not feature a basement. Although about one-half of all passive and conventional "owner-built" homes have basements, far fewer passive than conventional "contractor-built" homes have one (11 percent vs. 42 percent).
- Garage: The majority of all speculative ("for sale") homes--passive, active and conventional--feature a garage. Although almost two-thirds of all custom "owner-built" homes also feature a garage, fewer passive than conventional "contractor-built" homes feature it.

The median sizes\* of passive homes are approximately 1,725 square feet for the speculative ("for sale") homes and 1,800 square feet for all custom homes. The latter figure can be disaggregated further into custom "contractor-built" homes (median size = 2,000 square feet) and custom "owner-built" homes (median size = 1,625 square feet).

The speculative ("for sale") passive home compares favorably to the "for sale" active solar home (median size = 1,765 square feet) and is slightly larger than a conventional home (median size = 1,650 square feet) in the same category.

The custom "contractor-built" home is quite a bit larger than its conventional counterpart--2,000 square feet vs. 1,675 square feet--but the custom "owner-built" homes are virtually the same (1,625 square feet passive vs. 1,635 square feet conventional).

#### B. Passive and Related Features

The most common (10 or more cases) and least common (under 10 cases) passive and related features found in the surveyed homes are listed below and on Page 11. They are grouped by function and not necessarily in order of frequency.

- Most common passive and related features:

- direct gain heating features
- mass Trombe walls
- indirect sunspaces
- greenhouses
- reflector panels
- special flooring
- thermal chimneys
- moveable insulation
- sunscreening devices
- vents

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\* All sizes refer to net finished living area and must be considered approximate. Although the data were refined as much as possible, there were variations among respondents in interpretation of living area, especially with regard to "finished" basement and passive elements (e.g., greenhouses; definition of "heated space", etc.) which presented problems in compatibility.

- earth berms
  - design and siting for natural ventilation
  - minimum perimeter designs
  - wood and/or electric back-up systems
  - active domestic hot water systems
- Least common passive and related features:
    - water Trombe walls
    - indirect thermosyphons
    - atriums (as opposed to greenhouses)
    - underground construction
    - evaporative cooling features
    - central air conditioning

In addition to passive features, some homes incorporate other unique features not generally found in either active solar or conventional homes. These include:

- smaller-than-normal rooms, especially auxiliary bedrooms
- bedroom/loft arrangements or other spatial, "barrier-free" delineations without full wall partitions
- use of renewable or recycled technology, such as waste composting systems
- the predominance of wood as the primary (or only) heating back-up fuel.

### C. House Prices

Median house prices were determined for a total of 36 homes in three different categories. Six speculative homes were not yet sold at the completion of data collection.

In the cases of speculative ("for sale") homes, median purchase price, including land, is \$80,000 (\$50.00 per square foot).\*

In the cases of custom "contractor-built" homes, where the purchaser did not serve as builder or designer, median purchase price, including land, is \$96,000 (\$52.00 per square foot).\*

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\* All per square foot price and cost figures are approximate, however, because of variation in the way respondents interpreted "living area." See footnote p. 10.

In the cases of custom "owner-built" homes, where the purchaser was also the builder and/or designer, median cost of construction, including land, is \$68,750 (\$44.00 per square foot).\* The lower median total cost and cost per square foot of these homes is most likely attributable to the purchaser's role in design and/or construction.

By way of comparison, the speculative "for sale" passive house costs 32 percent more in total than its active solar counterpart (29 percent on a per square foot basis). However, the time lag in data collection (1979-80 for passive vs. 1976-1978 for active) is anywhere from two to four years. Therefore, these differences must also account for effects of inflation. However, the speculative ("for sale") passive house is also 27 percent more in total (32 percent more on a per square foot basis) than its conventional counterpart built and/or sold during 1979.

With regard to custom "contractor-built" homes, the comparison between passive and conventional homes shows the passive home to be almost twice as expensive on a total basis (73 percent on a per square foot basis) than its conventional counterpart. However, land costs are not included in the statistic for conventional homes as they are for passive homes.

No cost comparisons can be made between passive "owner-built" and conventional homes, since the U.S. Census Bureau does not collect cost figures for this category.

These comparisons are illustrated by Table 5.

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\* All per square foot price and cost figures are approximate, however, because of variation in the way respondents interpreted "living area." See footnote p. 10.

Table 5.

PASSIVE INITIATIVE

Comparison of Median Purchase Prices:  
Passive, Active and Conventional Houses

	<u>Median Purchase Price</u>		<u>Median Cost of Construction</u>	
	<u>Total</u>	<u>Per Sq.Ft.</u>	<u>Total</u>	<u>Per Sq.Ft.</u>
<u>Passive</u> <sup>1/</sup>				
Speculative ("for sale")	\$80,000	\$50.00	NA	NA
Custom ("contractor-built")	\$96,000	\$52.00	NA	NA
Custom ("owner-built")	NA	NA	\$68,750	\$44.00
<u>Active</u> <sup>2/</sup>				
Speculative ("for sale")	\$60,600	\$38.70	NA	NA
<u>Conventional</u>				
Speculative ("for sale") <sup>3/</sup>	\$62,900	\$38.00	NA	NA
Custom ("contractor-built") <sup>4/</sup>	\$50,200	\$30.00	NA	NA
Custom ("owner-built")	NA	NA	NA	NA

<sup>1/</sup> Data based on houses surveyed between 1979-1980. Prices and costs include land. Excludes six unsold speculative homes. Because of variation in the interpretation of "living area", especially with regard to "finished" basements and passive features (e.g., greenhouses), all price and cost figures for passive homes, especially on a per square foot basis, should be considered approximate.

<sup>2/</sup> Data based on houses surveyed and sold between 1976-1978. Price includes land.

<sup>3/</sup> Data based on houses sold in 1979. Includes townhouses.

<sup>4/</sup> Median purchase price based on data for houses started in 1979; median cost per square foot derived from median size data of homes completed in 1979. Land is excluded in this category.

NA: Not applicable

Sources: U.S. Department of Commerce, Bureau of the Census, Construction Statistics Division (for conventional houses); U.S. Department of Housing and Urban Development, Marketing and Market Acceptance Data From the Residential Solar Demonstration Program, Volume I: Detailed Analysis, prepared by Real Estate Research Corporation (Springfield, VA: National Technical Information Service, 1979); Real Estate Research Corporation.

## Chapter III

### DESIGN AND CONSTRUCTION

For all intents and purposes, the passive system is inseparable from the design of the house, and quality construction ensures its effective operation. The following chapter profiles participants and discusses both the design and construction processes associated with the award homes. It is based on interviews with a total of 62 respondents--designers, builders, and builder/designers, some of whom are also purchaser/occupants of the homes.

#### A. Profile of Designers

The profile of designers which follows is based on interviews with 40 respondents who consider themselves "primarily" designer(s) or "both" builder(s) and designer(s). As illustrated by Tables 6 and 7, the majority of designers are engaged in residential design for local, custom home clients. All have been practicing for at least two years, with many having five to ten years experience. Over half of the respondents are trained in other disciplines as well, including engineering; urban planning; building; and mathematics; and about two-thirds have had experience with other passive designs. In addition, almost half of the respondents have designed active solar houses and/or houses incorporating both active and passive features. When asked where they first learned about solar design, respondents cited school; professional colleagues; trade journals; conferences; and, in at least one instance, the solar demonstration program.

Sixteen out of the 40 respondents have utilized computer design techniques, notably:

- ASHRAE GRP-170 and F-Chart
- TEA group data
- LASL (Los Alamos Scientific Laboratory)
- TVA
- PEG Fix and Float
- CAL-ERDA
- NBSGLD\*
- University of Wisconsin F-Chart
- HUD

Moreover, six respondents used such techniques in designing the award-winning houses.

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\* Not specifically for solar.

Table 6.

PASSIVE INITIATIVEProfile of Designers by  
Years of Experience 1/

<u>Years as Architect/Designer</u>	<u>Number</u>	<u>Percent</u>
Less than 2 years	0	0
2 - 4.9 years	11	27.5
5 - 9.9 years	19	47.5
10 - 19.9 years	8	20.0
20 + years	2	5.0
	<hr/>	<hr/>
	40	100.0

1/ Includes responses of designers, builder/designers and builder/designer/purchasers who consider themselves "primarily" designer(s) or "both" builder(s) and designer(s) (N=40).

Source: Real Estate Research Corporation.

Table 7.

PASSIVE INITIATIVEProfile of Designers by  
Type of Activity<sup>1/</sup>

<u>Primarily Residential or Non-Residential</u>	<u>Number</u>	<u>Percent</u>
Residential	25	62.5
Non-Residential	4	10.0
Both	<u>11</u>	<u>27.5</u>
	40	100.0
<u>Primarily Custom or Speculative Residential Design</u>		
Primarily Custom	21	58.3
Primarily Speculative	3	8.4
Both	<u>12</u>	<u>33.3</u>
	36	100.0
<u>Primarily Local, Regional or National</u>		
Primarily Local	25	62.5
Primarily Regional	13	32.5
Primarily National	1	2.5
Mixed	<u>1</u>	<u>2.5</u>
	40	100.0
<u>First Experience with Passive</u>		
Yes	14	35.0
No	<u>26</u>	<u>65.0</u>
	40	100.0

<sup>1/</sup> Includes designers, builder/designers and builder/designer/purchasers who consider themselves "primarily" designers or "both" builder(s) and designer(s) (N=40).

Source: Real Estate Research Corporation.

## B. Profile of Builders

The profile of builders which follows is based on interviews with 30 respondents who consider themselves to be "primarily" builders or "both" builder(s) and designer(s). As illustrated by Tables 8 and 9, the overwhelming majority of participants are small-scale builders (nine units or less per year) who build for local, single-family housing markets. Most build both custom and speculative housing, but about one-third build exclusively for the custom market. The majority of respondents have had between two and ten years general building experience and some additional solar experience. Almost 60 percent had built or were building other solar homes, with passive homes the most frequently cited category.

## C. Design and Construction Processes\*

In most cases, the designer was the key actor in the process and had initiated the idea of a passive house. (In those cases where there was an independent builder, over half of the respondents cited the designer as having initiated the process of developing a passive house. In those cases not initiated by the designer, the client or builder usually requested passive solar.)

The design decision was based on a combination of economic and philosophical objectives. Respondents cited energy conservation; cost effectiveness; self-sufficiency; responsiveness to the environment; and the HUD award among the factors motivating their decision. In the case of a speculative home, a suitable market was also mentioned. The particular design for the house was based on such factors as energy-conservation; responsiveness to the site and physical environment; and responsiveness to the needs and preferences of the client, or, in cases of speculative homes, those of the general market.

In about half of the cases, the builder had had a previous working relationship with the designer, and was selected by the designer for this particular project. In general, however, builder input was minimal because of limited knowledge and experience. Participation usually did not go beyond discussions with designers regarding the choice of passive elements.

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\*Numbers of responses for this section vary by questions and categories.

PASSIVE INITIATIVE

Table 8.

Profile of Builders by  
Years of Experience<sup>1/</sup>

<u>Years in Residential</u> <u>Construction</u>	<u>Number</u>	<u>Percent</u>
One year or less	2	6.6
1 - 1.9 years	0	0
2 - 4.9 years	8	26.7
5 - 9.9 years	8	26.7
10 - 19.9 years	6	20.0
20+ years	<u>6</u>	<u>20.0</u>
	30	100.0

<sup>1/</sup> Includes responses of builders, builder/designers and builder/  
designer/purchasers who consider themselves "primarily" builder(s)  
or "both" builder(s) and designer(s) (N=30).

Source: Real Estate Research Corporation.

PASSIVE INITIATIVE

Table: 9.

Profile of Builders by  
Type of Activity<sup>1/</sup>

<u>Scope of Market</u>	<u>Number</u>	<u>Percent</u>
Local	25	83.3
Regional	4	13.3
National	1	3.4
	<u>30</u>	<u>100.0</u>
 <u>Primarily Residential</u> <u>or Commercial</u>		
Primarily Residential	28	93.3
Primarily Commercial	0	0
Evenly Mixed	2	6.7
	<u>30</u>	<u>100.0</u>
 <u>Primarily Custom or</u> <u>Speculative Residential Activity</u>		
Both	5	17.3
Both, primarily custom	8	27.6
Both, primarily speculative	3	10.3
Custom only	10	34.5
Speculative only	3	10.3
	<u>29<sup>2/</sup></u>	<u>100.0</u>
 <u>Number of Units Per Year</u>		
	<u>Number</u>	<u>Percent</u>
Nine or less	24	80.0
10 - 24	1	3.3
25 - 49	0	0
50 - 99	2	6.7
100-249	2	6.7
250-749	0	0
750+	1	3.3
	<u>30</u>	<u>100.0</u>
 <u>Experience with</u> <u>Other Solar Homes</u>		
Yes	17	56.7
No	13	43.3
	<u>30</u>	<u>100.0</u>

<sup>1/</sup> Includes builders, builder/designers and builder/designer/purchasers who consider themselves "primarily" builders or "both" builder(s) and designer(s) (N=30).

<sup>2/</sup> One nonresponse.

Source: Real Estate Research Corporation.

#### D. Constraints and Impediments

Constraints or specifications imposed on the designer by custom home clients included budget; layout; thermal efficiency; maintenance-free systems; specific materials; and maintenance of the site's integrity. Similar factors were also considered important by those purchasers who served as designers of their own homes.

Few respondents, however, reported any constraints or impediments from public agencies, financial institutions or others. However, the following are examples of specifications and requests that were experienced by some during the design and construction processes:

- financial institutions: specifications to include a conventional back-up system; specifications for a height requirement and an architectural review
- planning and zoning agencies: specifications for setback requirements; specifications for floor size requirements; height restrictions and above-grade building requirements; "style" specifications
- building inspectors: required firewall for an attached greenhouse; insulation specifications
- architectural review committees: required minimum square footage; required that no future solar housing in particular subdivision have the same design
- HUD: design changes

The most frequently cited problems during the construction process itself--not all of which were attributed exclusively to the passive nature of the homes--included finding appropriate labor; obtaining appropriate materials; and obtaining construction financing. Respondents cited difficulty and/or delays in obtaining materials, such as concrete (because of shortage) and insulating curtains and windows, among others; finding suitable builders and subcontractors to work with unconventional designs and unique techniques (such as earth berming); and high bids. Problems in obtaining construction financing included institutional questions about appraising the home, and some uncooperative or un-receptive lending institutions. A few respondents also reported some problems or delays in obtaining utility hook-ups, but none were directly related to passive solar.

However, the overwhelming majority of respondents either did not experience any problems or constraints, or else found the obstacles to be minimal and surmountable without a major investment of time or effort.

Some design respondents reported design change requests from HUD or the client. These changes most often involved additional insulation, fans and vents which generally enhanced energy conservation and increased system efficiency.

#### E. Time and Cost Factors

It was generally agreed that it took longer to design the award-winning passive houses than it would have for conventional houses. Extra design time was attributed to:

- time-consuming thermal calculations, planning and research
- increased interfacing between builder, architect, designer and client
- detailed involvement in site planning
- unique design and engineering factors (e.g., designing a mechanical system which then becomes automatic)

The average length of time to construct the passive house was about seven months.\* Most respondents felt that their schedule took longer than it would have for a conventional house, but less than half of the respondents attributed these construction delays exclusively to the passive nature of the house.

When asked "Do you think that as a package incorporating passive solar features, the house was more or less expensive than a similar non-solar house would have been for the same type of client?," the vast majority of all respondents agreed that it was "more expensive." Respondents attributed added costs to:

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\* According to the U.S. Bureau of the Census, the average construction times for homes completed in 1979 were: "for sale" (speculative): 6.2 months; "contractor-built" (custom): 5.8 months; "owner-built" (custom): 9.0 months.

- extra design time
- extra and more costly materials (e.g., glazing; Trombe wall; masonry floors; support system for floors; insulation; extra concrete; air tight window frames; skylights; shutters; and vents)
- longer construction period
- HUD specifications
- labor

Where cost savings were mentioned, however, they were attributed to such factors as: absence of conventional HVAC systems; minimum perimeter design; slab, as opposed to wooden, floors; underground building and exterior/interior masonry walls (both of which eliminated the need for siding, painting or standard walls); the dual role of builder and designer; and the input of the purchasers. Those few respondents who felt that the costs were "about the same" (3) or "less" (2) had used less expensive materials to be able to include the passive elements; would have included non-solar amenities if passive had not been used; or felt that builders actually underbid to get into the market.

Of the builder and builder/designer respondents who were asked "Were your anticipated costs greater or less than actual costs because of the passive features?," about an equal number felt they were either "greater" or "about the same" with only eight respondents citing "less." However, the overwhelming majority of respondents did not "mark up" the cost of the house because of the "unknown" associated with passive.

Virtually all respondents felt that the passive features added value to the houses, primarily because of their functional aspects and associated utility savings. However, one negative respondent felt that the passive features are not yet generally accepted and the shortage of energy is not yet critical or recognized as such.

Exhibits 1 and 2 illustrate these responses.

PASSIVE INITIATIVE

Exhibit 1. Builders' Perceptions of Construction Process

- "How did your schedule compare with that of a conventional house?"

	<u>Number</u>	<u>Percent</u>
Longer	23	54.8
Shorter	3	7.1
Same	15	35.7
Not Applicable	$\frac{1}{42}$ <sup>1/</sup>	$\frac{2.4}{100.0}$
N=		

- "Were there construction delays due to the fact that the house is a passive solar house?"

	<u>Number</u>	<u>Percent</u>
Yes	17	41.5
No	$\frac{24}{41}$ <sup>2/</sup>	$\frac{58.5}{100.0}$
N=		

1/ Two nonresponses. Data based on interviews with builders, builder/designers, and builder/designer/purchasers (N=44).

2/ Three nonresponses. Data based on interviews with builders, builder/designers and builder/designer/purchasers (N=44).

Note: In the case of one respondent who received two separate awards, responses about each house were counted separately. Hence the "N" increased by one.

Source: Real Estate Research Corporation.

PASSIVE INITIATIVE

Exhibit 2.                    Respondents' Comments on Passive Costs

- "Do you think that as a package incorporating passive solar features, the house was more or less expensive than a similar non-solar house would have been for the same type of client?"

	<u>Number</u>	<u>Percent</u>
More expensive	54	85.7
Less expensive	2	3.2
About the same	3	4.8
Don't know	4	6.3
	N= 63	100.0

- "Were your anticipated costs greater or less than your actual costs because of the passive features?"

	<u>Number</u>	<u>Percent</u>
Greater	17	39.5
Less	8	18.6
About the same	18	41.9
	N= 43 <sup>1/</sup>	100.0

- "Did you mark-up the costs of the house because of the 'unknown' associated with passive solar features?"

	<u>Number</u>	<u>Percent</u>
Yes	2	5.9
No	31	91.2
Don't know	1	2.9
	N= 34 <sup>2/</sup>	100.0

<sup>1/</sup> Not asked of "designers only " (N=19). One nonresponse.

<sup>2/</sup> Not asked of "designers only" (N=19) and builder/designer/purchasers (N=10).

Note: In the case of one respondent who received two separate awards, responses about each house were counted separately. Hence, the "N" increased by one.

Source: Real Estate Research Corporation.

## Chapter IV

### MARKETING THE PASSIVE HOMES

Twenty-three respondents who built speculative houses as part of the award program were asked a series of questions pertaining to market acceptance and marketing techniques.

Virtually all felt that they were offering a new type of product to their customers, and that, in general, public interest was favorable. About half of the respondents felt that potential purchasers of passive homes differ from the average buyer, in part because of their heightened interest in energy conservation. Of the four respondents who felt that passive solar home purchasers differ from active solar home purchasers, two respondents felt that active purchasers are more affluent, and, in one case, more "avant garde."

Marketing techniques used in promoting the award homes varied from none at all to the use of such techniques as: areawide advertising; radio spots; open houses; model homes; and home shows. Marketing methods emphasized such factors as cost-effectiveness and the HUD award. In at least one instance, the local utility company was involved in marketing. Among the major marketing problems cited were: added costs associated with passive homes; the need to educate consumers; the need to increase market acceptance of unique elements or appearances (e.g., underground building; mass and storage areas); and difficulty in defining passive elements.

Fifteen respondents said that they had built or were building other solar housing and overall were fairly positive about their experiences. About the same number plan to incorporate passive features in future homes.

The issue of additional costs associated with passive homes and the ability of the market to absorb these costs were reflected in a series of key questions.

Less than half of the respondents felt that they could "build passive homes for the same costs as good energy-conserving conventional homes," citing the following examples of the conditions under which it was possible to do so:

- use of the most basic passive features (e.g., south-facing glass; concrete floors) which are equivalent in cost to energy-conserving features. Beyond these features, costs will escalate

- use of smaller water heaters and exclusion of unessential options
- absence of air conditioning and conventional heating systems

Moreover, only half of the respondents felt that they could "sell passive homes for the same price as good energy-conserving conventional homes." One positive respondent felt it was possible to sell passive homes for the same price as those conventional homes that include added amenities and luxuries, while negative respondents felt that the passive houses would undoubtedly cost more, and that one would tend to ask more because of their uniqueness and added features.

Responses to these questions are shown on Exhibit 3.

Although at least half of the respondents felt that they could neither build nor sell passive homes for the same prices as good energy-conserving conventional homes, the overwhelming majority said they would currently construct a solar home without a subsidy or award. Reasons given for the apparent willingness to build under such conditions were feasibility; market acceptance; and trade specialization. Two of the negative respondents cited high costs and high interest rates.

When asked "If you were to construct a solar dwelling now without an award or subsidy, do you believe that the costs could be recovered in the sales price of the house?" about half of the respondents agreed that the costs could be recovered, but only for passive homes. Those who disagreed felt that tax credits or low interest loans would be necessary to offset high interest rates, inflation and expensive building materials. One respondent, who felt the costs could be recovered, felt that his profit might be less, since the grant award paid mainly for the paperwork and extra time involved, while another respondent indicated that the entire grant would have to be added to the sales price of the house.\* Despite the apparent lack of consensus on this issue, none of the respondents felt that costs of building purely active solar homes were recoverable in the speculative market. In fact, most respondents expressed concern about building passive homes on a speculative basis. Apart from high interest rates, inflation and lack of general market acceptance, other concerns specific to the speculative market included: the inability to provide many heat gaining features because the home's

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\*The reader should note that in some cases under this award program the grant may have helped to subsidize the purchaser.

PASSIVE INITIATIVE

Exhibit 3. Builders' Perceptions of Market Acceptance<sup>1/</sup>

- "Do you feel that you could build passive homes for the same costs as you could energy-conserving conventional homes? "

	<u>Number</u>	<u>Percent</u>
Yes	9	40.9
No	12	54.6
Don't know	<u>1</u>	<u>4.5</u>
	22	100.0

- "Do you believe that you can sell passive homes for the same price as good energy-conserving conventional homes? "

	<u>Number</u>	<u>Percent</u>
Yes	11	50.0
NO	10	45.5
Don't know	<u>1</u>	<u>4.5</u>
	22	100.0

<sup>1/</sup> Asked of speculative builders and builder/designers only (N=22). Excludes one of two responses of grantee who received two separate awards.

Source: Real Estate Research Corporation.

appearance cannot be too extraordinary; and concern with schedules; buying of materials in bulk; and building in volume.

Finally, the following key market question was asked of both custom and speculative builders and builder/designers: "How much additional cost attributable to passive features do you think the market can bear?," (based on total selling price).

The majority of respondents indicated market willingness to accept higher costs associated with passive, with about one-third of the respondents confident that the market could bear as much as ten percent more for passive features.

Summaries of these responses are found on Exhibits 4 and 5.

Both custom and speculative builders were asked to cite the most important factors influencing the decision to build (or not to build) additional passive units in the near future.

Among the responses were:

- client requests (or lack thereof)
- cost of energy
- marketability
- site availability and adaptability
- interest rate and availability of financing
- availability of grants and subsidies
- cost of components/construction
- confidence in system performance and effectiveness

Factors which would influence the decision to build (or not to build) active solar housing (as opposed to passive) include:

- lack of economic justification and lengthy payback period, except for domestic hot water. At least six respondents cited a willingness to include active domestic solar hot water systems in their passive homes. (Fifteen homes in the survey currently have them.) One respondent felt that storage capabilities associated with active solar were superior to those of passive systems, but they were not yet cost-effective.

Exhibit 4.

PASSIVE INITIATIVE

Builders' Responses Concerning Building  
Without a Subsidy or Award

- "Would you currently construct a solar dwelling that was not part of an award or grant program?"

	<u>Number</u>	<u>Percent</u>
Yes	18	81.8
No	2	9.0
Don't know/not applicable	1	4.6
Other <sup>1/</sup>	1	4.6
N=	22	100.0

- "If you were to construct a solar dwelling now without an award or subsidy, do you believe that the costs could be recovered in the sales price of the house?"

	<u>Number</u>	<u>Percent</u>
Yes, passive only	10	50.0
Yes, active only	0	0
Yes, active and passive	3	15.0
No	4	20.0
Don't know/not applicable	2	10.0
Other <sup>1/</sup>	1	5.0
N=	20 <sup>2/</sup>	100.0

- "Do you have any concerns about building passive homes for a speculative, as opposed to custom, home market?"

	<u>Number</u>	<u>Percent</u>
Yes	15	75.0
No	5	25.0
Don't know	0	0
N=	20 <sup>2/</sup>	100.0

<sup>1/</sup> Respondent would build on custom basis only.

<sup>2/</sup> Two nonresponses.

Note:: Excludes one of two responses of grantee who received two separate awards.

Source: Real Estate Research Corporation.

Exhibit 5.

PASSIVE INITIATIVE

Builders' Perceptions of Market  
Willingness to Bear Costs for Passive  
Features

- "How much additional costs attributable to passive features do you think the market can bear?" (based on total selling price)

<u>Response</u>	<u>Number</u>	<u>Percent</u>
None	2	5.7
1-5 percent	7	20.0
6-10 percent	12	34.3
11-15 percent	6	17.1
16-20 percent	1	2.9
21-25 percent	0	0
26+ percent	0	0
Don't know	7	20.0
	<u>N= 35<sup>1/</sup></u>	<u>100.0</u>

1/ Eight nonresponses.

Source: Real Estate Research Corporation.

- custom client preferences will determine whether to build passive or active. On a speculative basis, active is felt to be too risky, since current market acceptance is felt to be negligible.

## Chapter V

### PASSIVE HOME PURCHASERS

Purchaser data is based on interviews with respondents in 33 households living in both custom and speculative housing.

#### A. Profile

The "typical" passive household consists of two well-educated adults employed in professional, technical and related occupations. The median age of each adult is approximately 37 years, and median household income is approximately \$33,000. Small household size, and unique interior layouts (as discussed earlier) suggest that passive homes may be more appealing to childless couples than to families.

The characteristics of passive home purchasers can be compared--albeit cautiously--to those exhibited by active solar purchasers and the homebuying public at large.\* As evidenced by Table 10, the size of the "typical" passive household\*\* (2) falls in between that of the "typical" active (2.7) and the "typical" conventional (1 or 2) household. Passive purchasers are older than conventional ones (37 vs. 33) but somewhat younger than active purchasers (39.5). The median household income for passive home purchasers surveyed during 1979-1980 (\$33,000) is about 17 percent higher than the 1979 median income of borrowers surveyed by the U.S. League of Savings Associations (\$28,110), and approximately ten percent higher than the mean income of active solar home purchasers.

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\* Characteristics of the homebuying public at large are used with permission from the 1980 study entitled Home-ownership: Coping with Inflation, prepared by the United States League of Savings Associations. This data base was developed from closed conventional mortgages granted by surveyed savings and loan associations. The term "conventional" as used by the U.S. League refers to the type of mortgage issued (e.g., non-FHA, etc.). Our use of the term "conventional," however, refers to the typical U.S. homebuyer, for which the U.S. League data are used as proxy.

\*\*Based on most frequent response.

Table 10.

PASSIVE INITIATIVEComparison of Passive, Active and Conventional Households  
by Selected Characteristics

	<u>PASSIVE</u> <sup>1/</sup>	<u>ACTIVE</u> <sup>2/</sup>	<u>CONVENTIONAL</u> <sup>3/</sup>
Household Size	2 <sup>4/</sup>	2.7	1 or 2 <sup>5/</sup>
Age(s) of Purchaser(s)	37	39.5	33
Household Income	\$33,000	\$29,800	\$28,110
Level(s) of Education	College or above	College of above	NA
Occupation(s)	Professional, technical or related	Professional, managerial	NA

<sup>1/</sup>Data based on surveys conducted between 1979-1980. Includes speculative and custom home purchasers, including builder/designer/purchaser combinations. For age(s), level(s) of education, and occupation(s), data given is for both adult members of household, where applicable. Age(s) and household income data are estimated medians.

<sup>2/</sup>Data based on surveys conducted between 1976-1978 for speculative active solar home purchasers. For age, level of education, and occupation, data is for head of household only. Household size, age and income data are means.

<sup>3/</sup>Data based on 1979 survey by the U.S. League of Savings Associations of savings and loan association. (See below.) Age and income data are medians for borrowers.

<sup>4/</sup>Most frequent response (42.0%). Mean = 2.8; median = 3.0.

<sup>5/</sup>52%.

NA: Not available.

Sources: U.S. Department of Housing and Urban Development, Marketing and Market Acceptance Data from the Residential Solar Demonstration Program, Volume 1: Detailed Analysis, prepared by Real Estate Research Corporation (Springfield, VA: National Technical Information Service, 1979); United States League of Savings Associations, Homeownership: Coping with Inflation (Chicago: United States League of Savings Associations, 1980); Real Estate Research Corporation.

(\$29,800) surveyed between 1976-1978. Both passive and active home purchasers have similar educational and professional backgrounds. (A similar set of characteristics for the conventional borrower was not developed.)

#### B. Purchase Decision Process

Both custom and speculative home purchasers were asked similar questions regarding their awareness of passive solar energy and their decision to either commission or to purchase a passive solar home.

When asked where they first learned about passive solar, or how they first became interested in solar energy, purchasers cited such sources as: literature; friends; school/courses; and professional experience. Reasons given for wanting a house with passive features included efficiency; simplicity; fuel savings; philosophical/environmental tenets; uniqueness; and tax credits.

In the case of speculative home purchasers (14), they were first made aware of the homes' passive features through realtors; builders; newspaper classified ads; and their own observations. "Potential cost savings" was cited most often as the major marketing point. In most cases, purchasers considered the available information on the houses to be adequate. (However, based on follow-up calls to five speculative purchasers, only one had been presented with an owner's manual about the system.) Most speculative purchasers expected their utility costs to be lower than in their previous residences, and only two out of the fourteen respondents had expressed concern about purchasing a passive house as opposed to a conventional one. When asked to specify why they chose to buy into the specific subdivision or neighborhood, the factors considered "very important" were clearly associated more with the houses than with the surrounding environment: house value; house quality; energy savings options; solar features; and potential resale value were among the most frequently cited answers. When asked specifically "why did you buy this house, or what was the main reason you bought this house?" most respondents stressed energy-efficiency and savings; solar features; style and design; and builder/designer reputation. Other answers included HUD award; resale value; price; location; and workmanship.

In the case of the nine custom home purchasers who were not builders or designers of their homes, all had selected their own sites, and most of them (7) had themselves initiated the process of designing a passive solar home. Although all of them had had input into the choice of passive elements, only two said that they had imposed actual constraints on the designers regarding such elements. However, most of these purchasers did impose cost constraints on the designer and/or builder. None of the nine purchasers had lived in a solar house before, but seven of them did expect that their utility costs would be lower in a passive home than in their previous home. (One felt that utility costs would be "about the same" while in the other instance the question was not applicable.)

Over half of the respondents--both custom and speculative--felt that they had paid more for a passive solar home as opposed to "a well-designed energy-conserving conventional house," although a sizeable minority--14 out of 32 respondents--did not agree. This breakdown is shown on Exhibit 6.

Of the 27 respondents who obtained financing for their homes--the rest were self-financed--six experienced problems with lending institutions. Among the problems cited were:

- delays due to the lender's uncertainty and lack of familiarity with passive solar
- refusal of financing because of lack of conventional back-up system (a policy which subsequently was changed)
- difficulty in obtaining financing because of lender's concern with the builder's lack of previous experience and his ability to build solar houses.

One speculative purchaser, however, was offered favorable financing for his solar house because of its uniqueness. He received a conventional mortgage at 11.5 percent (30 years) instead of the then-current interest rate of 14 percent. Unfortunately, we were unable to interview the lender about this.

Exhibit 6.

PASSIVE INITIATIVE

Purchasers' Perceptions of Costs

- "Do you feel that you paid more for a home with passive solar features than you would have for a well-designed energy-conserving house?"

	<u>Number</u>	<u>Percent</u>
Yes	18	56.3
No	14	43.7
Don't know	<u>0</u>	<u>0</u>
	N=32 <u>1/</u>	<u>100.0</u>

1/ One nonresponse.

Source: Real Estate Research Corporation.

### C. Purchaser Satisfaction - Initial Interviews

Initial interviews with passive home purchasers, conducted shortly after occupancy, revealed that virtually all purchasers were well-satisfied with their houses, house performance, and comfort level.

When asked to describe what, in general, they were most satisfied with about their houses, purchasers most often cited design and spatial arrangements; floor plan and layout; and general passive features among the contributing factors, while size--either of the house or of certain rooms or features--was frequently cited as an element of dissatisfaction.

When asked "What were your expectations about living in a solar house, and how do these expectations compare with your current experiences?" purchasers cited energy efficiency; utility savings; comfort; ease of maintenance; and responsiveness to the environment among the expectations that, for the most part, had been met. Conversely, in most circumstances, negative expectations--difficulty in operating system; disruptions to life style; fluctuations in temperature--did not occur. In a few cases, however, expectations about heating and utility savings were not fulfilled, or else it was too early to judge.

Virtually all respondents felt that they realized the desired comfort range through their houses either "always" or "most of the time." Where some rooms were either warmer or cooler than others, this was most often intentional in the design. Most respondents considered the heat (or cool air) to be "very well" distributed throughout the house, with minor daily temperature swings. There was little consensus among respondents, however, when asked how the operating procedures compared to those associated with a conventional HVAC system. Although 14 respondents cited "about the same," the remainder were almost equally divided between "more complicated" and "less complicated."

Less than half of the respondents (10) felt that the system worked better if someone was home during the day, while the remainder said "no" or were not sure.

These responses are shown on Exhibit 7 following.

PASSIVE INITIATIVE

Exhibit 7.      Selected Responses of Purchasers Regarding  
System Operation  
(Initial)

- "How do the operating procedures in this house compare to the operation of the conventional heating and cooling system in your previous home?"

	<u>Number</u>	<u>Percent</u>
More complicated	7	22.5
Less complicated	8	25.8
About the same	14	45.2
Don't know/not applicable	<u>2</u>	<u>6.5</u>
	N= 31 <u>1/</u>	<u>100.0</u>

- "Does the system work better if someone is home during the day?"

	<u>Number</u>	<u>Percent</u>
Yes	10	32.2
No	14	45.2
Don't know/not applicable	<u>7</u>	<u>22.6</u>
	N= 31 <u>1/</u>	<u>100.0</u>

1/ Two nonresponses.

Source: Real Estate Research Corporation.

Of the respondents who have manual controls to operate, virtually none found the daily maintenance of the system inconvenient or disrupting to their life styles. (The most frequently cited category for the time involved in daily operation of manual controls was "14 minutes or less.") However, nine respondents did cite some disruptions or changes to their normal life style by living in the house, such as:

- living with lower room temperatures
- setting aside some amount of time, however small, for manual operations
- being continually aware of the weather and its effect on the temperature and comfort level of the house

Although the overall satisfaction level with passive was high--in contrast to the sentiments of active purchasers who expressed mixed feelings about their systems initially--nine respondents did report problems with their solar energy features during the initial interview. These included:

- glare
- overheating in upstairs rooms
- need for several consecutively sunny days to have the Trombe walls perform efficiently
- need for improvement in moveable insulation
- leaks
- certain features considered "useless" or too experimental to work well

It is interesting to note that, whereas practically all respondents agreed that they would consider buying another solar house, they were almost equally divided as to whether or not they would have chosen this particular design if they had considered a conventional house instead, with speculative purchasers more favorable toward passive design. (See Exhibit 8 following.)

PASSIVE INITIATIVE

Exhibit 8. Respondents' Attitudes Toward Passive Design

- "Would you have chosen this type of design if you had considered a conventionally-heated house?"

	<u>Number</u>	<u>Percent</u>
<u>Custom</u> <sup>1/</sup>		
Yes	5	27.8
No	10	55.5
Don't know	<u>3</u>	<u>16.7</u>
	N=18 <sup>2/</sup>	100.0
<u>Speculative</u>		
Yes	10	71.4
No	4	28.6
Don't know	<u>0</u>	<u>0</u>
	N=14	100.0
<u>Total</u>		
Yes	15	46.9
No	14	43.8
Don't know	<u>3</u>	<u>9.3</u>
	N=32 <sup>2/</sup>	100.0

1/ Includes builder/designer/purchaser category.

2/ One nonresponse .

Source: . Real Estate Research Corporation.

The consensus among negative respondents was that the design is essentially the product of the passive system (and, hence, would not be called for in a conventional house) while positive respondents felt that the "openness" and other design elements (with some modification) would have been requirements in any home they purchased or built.

D. Purchaser Satisfaction - Follow-up Interviews

During the telephone follow-up interview, conducted at least six months after the first interview, purchasers were asked basically the same questions as initially in order to determine whether or not satisfaction levels had changed over time. However, because the number of responses during the follow-up phase was significantly smaller--21 follow-ups as compared to 33 initial responses--comparisons and generalizations must be made very cautiously.

Purchasers interviewed during this phase were generally enthusiastic and well-satisfied with their houses and the performance of the passive systems. Expectations regarding fuel savings; workability; comfort; and environmental concerns were fully met in virtually all instances, although elements of dissatisfaction included: problems with individual features (e.g., glass; mass; insulation; etc.); dissatisfaction with floor plan and elements of design (e.g., no separation of rooms); and experimental nature of materials. The overwhelming majority of respondents (15) however, felt that the heat (or cool air) from the passive system was "very well" distributed throughout the house. Respondents realized the desired comfort range "always" or "most of the time." Moreover, temperature variation among rooms (or lack thereof), was expected to occur and, in some cases, was intentional in the design. Minor daily temperature swings, or larger swings occurring as the result of seasonal changes or fluctuating weather conditions, were noted but generally did not present problems.\* When asked again

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\* It is important to point out, however, that passive home purchasers may be more tolerant of lower room temperatures in the winter and more humidity in the summer, or may have acclimated themselves accordingly. RERC's field staff did experience discomfort because of the cold indoor temperatures in some of the passive homes they visited, and also commented on the humidity factor associated with greenhouses and the predominant use of wood.

how the operating procedures compared to those in their previous conventional home, respondents were about equally divided between the responses "less complicated" and "about the same," with a slightly smaller number who felt these procedures were "more complicated." However, a larger percentage of respondents in the follow-ups-- 33 vs. 26 initially--felt they were "less complicated."

Slightly more than half of the respondents--12 out of 21--did not feel that the system necessarily worked better if someone was home during the day, but one-third felt that it did, citing the need to "fine tune" or otherwise attend to the system in order to maintain the desired temperature range. (However, it was not considered to be a major problem if someone was not home.) Again a larger percentage of respondents in the follow-ups-- 57 vs. 45 initially--felt it was not necessary to have someone home during the day for the system to work better. These favorable trends could mean that people have adapted well to their passive homes over time, although the survey size is too small to invite meaningful generalizations. (See Exhibit 9.)

In virtually all instances, operation of the manual controls was not considered inconvenient, usually taking "14 minutes or less" per day (in many cases, only about five minutes or so), although a small number of respondents felt that the system had caused some disruptions or changes to their normal lives.

All respondents noted that their back-up systems had performed reliably, and no major problems associated with the passive systems were reported. However, lack of familiarity with the system's operation; glare; and leaks were some of the minor problems or inconveniences reported during the follow-up interviews.

In sum, most purchasers are, and have remained, highly satisfied with the performance of their solar homes, and have shown a growing level of enthusiasm over time for the concept of passive solar energy.

#### E. Market Experience - Follow-up Interviews

With regard to market and resale experience, only one of the purchasers interviewed had attempted to sell the house, but at the time of the interview had not yet received any offers. However, the four who were planning to sell their houses in the near future felt that the passive solar features would enhance marketability because of design; comfort; and fuel savings, among other reasons.

PASSIVE INITIATIVE

Exhibit 9.      Selected Responses of Purchasers Regarding  
System Operation  
(Follow-Up)

- "How do the operating procedures in this house compare to the operation of the conventional heating and cooling system in your previous home?"

<u>Follow-Up</u>	<u>Number</u>	<u>Percent</u>
More complicated	4	19.1
Less Complicated	7	33.3
About the same	8	38.1
Not applicable	2	9.5
	<u>N=21</u>	<u>100.0</u>

- "Does the system work better if someone is home during the day?"

	<u>Number</u>	<u>Percent</u>
Yes	7	33.3
No	12	57.2
Don't know	2	9.5
	<u>N=21</u>	<u>100.0</u>

Note: See, also, Exhibit 7, p. 38.

Source: Real Estate Research Corporation.

In terms of attitudes toward solar, those respondents who felt their attitudes had changed since moving into the house agreed that they had become more positive about solar energy; especially passive solar. Respondents agreed that they would again purchase a passive solar house; however, few were favorably inclined toward active solar systems.

## Chapter VI

### FINANCIAL INSTITUTIONS

Our survey of lenders consists of 33 institutions which provided either construction or permanent financing, or both, for the award houses. Most participating lending institutions were either savings and loan associations or commercial banks. In some cases, the entire mortgage, or a significant part of it, was self-financed.

As discussed in other chapters of this report, the vast majority of respondents--builders, designers and purchasers--did not experience problems in obtaining financing. However, there were those who did encounter lender resistance, and some were not able to obtain financing from the institutions they had initially approached. Unfortunately, interviews with institutions that refused financing for passive homes were not part of our survey effort.

Those participating lending institutions that were interviewed, however, can be characterized as neutral participants in the process of opening up the marketplace to passive solar homes. In general, they have not adopted policies to encourage such homes, but they are favorably inclined toward providing financing on a case-by-case basis with the credit-worthiness of the applicant a prime factor, particularly in the cases of construction loans.

#### A. Experience with Subject Houses\*

For the most part, the application for financing the passive home was handled in the same way as were applications for financing conventional houses, and in virtually all cases the terms of the loan were the same. The majority of permanent lenders were aware of the passive features before granting the loan. (In the cases of construction loans, the award program required that interim financing be available to the applicant before the application was submitted to HUD.) However, in some instances the institutions expressed concern with performance; reliability and appearance; and, in cases where the designer and builder were the same, the designer's qualifications as a builder.

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\* This section is based on 38 responses because some institutions provided financing for more than one house.

The majority of respondents did not express concern on behalf of their institutions that the passive units would be difficult to sell or resell, citing a growing market; rising utility costs; presence of a back-up system; and good design. Those who were concerned, however, cited lack of general market acceptance and unconventional appearances of the houses among their reasons.

Exhibit 10 illustrates lenders' responses to a key question--whether or not the passive homes had "over-improvements" when compared to similar non-passive homes. As evidenced by the responses, two-thirds of all lenders felt that passive homes did not have overimprovements, citing cost vs. fuel savings; market acceptance; workability; and system simplicity among their reasons, while those who felt the homes were overimproved questioned these reasons. In many cases, however, the total costs of the passive houses were included in the home's appraisal.

Moreover, over half of the permanent lenders who were asked felt that at the time of resale the seller would be able to obtain additional value because of the passive features.

#### B. General Comments on Solar Homes

When asked whether or not a builder could currently recover the full cost of a passive solar unit without any outside assistance, about half of the respondents felt positively. Negative or ambivalent respondents questioned the greater costs associated with passive homes and the current levels of public acceptance. The vast majority of respondents felt that passive features generally added value to a house and that it would not be difficult to resell a passive house at the present time.

However, respondents were equally divided in their responses as to whether or not there is a difference in value between a house with passive solar features and a good energy-conserving house. Differences in value were attributed to the "unknown"; higher costs; and questionable marketability of the passive houses. Although passive features were considered by some to be more effective, with greater potential fuel savings, energy-conserving features were, for the most part, considered to be more standard; less expensive; and more marketable.

PASSIVE INITIATIVE

Exhibit 10:

Key Question Asked of Lenders of  
Custom and Speculative Homes

- "Do you believe that the passive solar home(s) has (have) 'overimprovements' when compared to other similar non-solar custom homes?"

	<u>Number</u>	<u>Percent</u>
Yes	5	33.3
No	10	66.7
Don't know	<u>0</u>	<u>0</u>
N=	15	100.0

- "Do you believe that the passive solar home(s) has (have) 'overimprovements' when compared to other similar non-solar speculative homes?"

	<u>Number</u>	<u>Percent</u>
Yes	6	26.1
No	15	65.2
Don't know	<u>2</u>	<u>8.7</u>
N=	23	100.0

- Total Responses

	<u>Number</u>	<u>Percent</u>
Yes	11	28.9
No	25	65.8
Don't know	<u>2</u>	<u>5.3</u>
N=	38	100.0

Source: Real Estate Research Corporation.

Likewise, respondents could not agree on whether or not there was a difference in value between active and passive homes. Of those that felt there was a difference, respondents were divided as to which type was more acceptable and workable. One lender felt more comfortable knowing that a back-up system exists with active solar, while another felt that because of their costs, active systems would have a greater negative effect on value and would take longer than passive to win acceptance. Other respondents cited less chance of breakage or need for maintenance with passive, and generally more favorable market response.

Responses to these questions are shown on Exhibit 11.

C. Other Solar Activity

About half of the institutions interviewed have financed or are financing other houses utilizing both active and passive solar energy. The geographic distribution of such lending activity closely parallels the general pattern of passive activity we have found.

D. Knowledge, Policy Outlook and Data Needs

With regard to knowledge, policy outlook and data needs, less than half of the respondents considered their institutions to be knowledgeable about solar energy, although most felt their institutions were favorably inclined toward granting loans for solar housing. While in most cases no special efforts had been made to assess the impact of solar on lending policies, many felt that this would change in the near future, as knowledge of the field increases and the institutions adapt to changing market dynamics.

PASSIVE INITIATIVE

Exhibit 11.            Lenders' Perceptions of Differences Between  
   Passive and Other Homes

- "Do you feel there is a difference with regard to value between a house with passive solar features and a good energy-conserving house?"

	<u>Number</u>	<u>Percent</u>
Yes	12	37.5
No	12	37.5
Don't Know	<u>8</u>	<u>25.0</u>
N=	32 <sup>1/</sup>	100.0

- "Do you feel there is a difference with regard to effect on value between a house with passive solar features and a house with an active solar system?"

	<u>Number</u>	<u>Percent</u>
Yes	9	31.0
No	12	41.4
Don't Know	<u>8</u>	<u>27.6</u>
N=	29 <sup>2/</sup>	100.0

<sup>1/</sup> One nonresponse.

<sup>2/</sup> Four nonresponses.

Source: Real Estate Research Corporation.

## Chapter VII

### FOLLOW-UP INTERVIEWS: ADDITIONAL PASSIVE SOLAR ACTIVITY

Follow-up interviews were conducted with 50 respondents--builders, designers and builder/designers--to determine the extent of additional passive solar activity undertaken since the Passive Initiative award program. Highlights of these brief follow-up interviews are presented below:\*

- Of the 50 respondents, 35 have engaged in other passive activity: designing, building, or designing and building additional passive homes.
- Respondents reported additional solar activity in the following locations:

<u>Location of New Activity</u>	<u>Number of Respondents Reporting Additional Activity</u>
California	10
Colorado	7
Idaho	1
Indiana	1
Massachusetts	1
Minnesota	1
Missouri	1
New Hampshire	2
New Jersey	2
New Mexico	4
Oregon	1
Wisconsin	2
New England	1
Southeast	1

As evidenced, the greatest number of respondents are working in California, Colorado and New Mexico.

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\* Responses include Cycle 5 activity. Follow-up interviews also coincided with high interest rates and their effects on the housing sector nationwide.

- Twenty out of the 35 respondents are engaged in custom home activity, seven in speculative, and eight in both custom and speculative activity.
- Most respondents have worked on one to five additional homes but about one-third have worked on more than five additional homes. These listings include one grant award winner in California who is designing a community, currently in the planning stages, to include 2,000 speculative passive units.

Most design respondents felt that their current passive homes were more expensive to design "than a conventional house of similar size and amenities." Reasons given were similar to those cited during the initial interview: research, analysis, and computer work; added time and detailing for passive design; added client interaction; and additional criteria (e.g., energy-efficiency over and above traditional standards).

The same number, however, felt that their current passive homes were not more expensive to design than the award-winning house designed for the passive competition, in part because of accumulated experience. Of those who thought it more expensive, however, reasons given included: more sophisticated design; siting considerations; land costs; and differences in size associated with the current passive homes. Two respondents--one designer and one builder/designer--who felt that the costs were "about the same" cited a construction method--earth berming--as the only difference, and one considered it equivalent to digging a basement.

Responses to these questions are shown on Exhibit 12.

Of the builder and builder/designer respondents who were asked whether or not their current passive homes were more or less expensive to build "than a conventional house of similar size and amenities," about half of the respondents felt they were "more expensive," because of: materials and insulation; extra time involved in planning and in incorporating the features into the house; use of active domestic hot water systems; and, in one particular instance, additional consultants' fees.

One particular comment is worthy of note. The respondent felt that passive costs were about one to four percent more, but could also be less, depending on the situation. Interior finishing was considered to have the greatest impact on total price, but overall, passive is usually cheaper because the materials perform a dual function. However, integration of house and site is necessary.

PASSIVE INITIATIVE

Exhibit 12. Designers' Evaluation of Current Passive Activity in Relation to Other Homes

- "Was (were) the house(s) more expensive to design than a conventional house of similar size and amenities?"

	<u>Number</u>	<u>Percent</u>
Yes	19	57.5
No	10	30.3
About the same	2	6.1
Don't know/not applicable	$\frac{2}{33} \frac{1}{-}$	$\frac{6.1}{100.0}$
N=	33	100.0

- "Was (were) the house(s) more expensive to design than the award-winning house(s)?"

	<u>Number</u>	<u>Percent</u>
Yes	5	15.2
No	19	57.5
About the same	9	27.3
Don't know/not applicable	$\frac{0}{33} \frac{1}{-}$	$\frac{0}{100.0}$
N=	33	100.0

$\frac{1}{-}$  Two nonresponses.

Source: Real Estate Research Corporation.

The same respondents were also asked whether or not their current passive work was more or less expensive to build than the award-winning home built for the passive competition. The most frequently cited response (7) was "about the same" with an equal number (5) who felt it was either "more expensive" or "less expensive." Those who felt it was more expensive cited more complex or different designs; inflation; solar (active) domestic hot water systems; size differences and other non-passive related amenities. Of those who felt it was "less expensive," reasons cited included more cost-conscious, or simpler, design; the inclusion of fewer passive features; and greater experience. Overall, the current sentiment is that the market can bear about ten percent more in costs attributable to passive solar features.

Responses to these questions are shown on Exhibit 13.

The most frequently cited problems or constraints experienced by those respondents who are currently doing additional passive work were financing; obtaining adequate labor; and delays in obtaining materials. Examples of problems or constraints cited are listed below.

- financing: difficulty with lending institution and FHA, both of which required a full back-up system and a full cellar; general conservative lending policies, and some initial resistance/skepticism; delays because institution wanted design presentation
- obtaining adequate labor: excessively high bids for masonry work; "backward" area for both labor and materials; problems with proper glass installation
- delays in obtaining materials: (e.g., glazing; window quilts; active DHW components)

Respondents were asked if they had followed the progress of the award home, and whether or not there had been any problems or structural modifications. Ten respondents reported such problems or changes, examples of which are listed below.

- insulating curtain assembly malfunctioned
- windows had to be reglued or reglazed
- carpet was removed and stone floor installed
- overhangs were modified and auxiliary fan was added
- additional insulation was installed

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Exhibit 13.

Builders' Evaluation of Current  
Passive Activity in Relation to Other Homes

- "Was (were) the house(s) more expensive, less expensive or about the same to build than a conventional house of similar size and amenities?"

	<u>Number</u>	<u>Percent</u>
More Expensive	10	47.6
Less Expensive	2	9.5
About the same	4	19.1
Don't know/Not applicable	<u>5</u>	<u>23.8</u>
N=	21	100.0

- "Was (were) the house(s) more expensive, less expensive or about the same to build than the award-winning passive house(s)?"

	<u>Number</u>	<u>Percent</u>
More expensive	5	23.8
Less expensive	5	23.8
About the same	7	33.3
Don't know/not applicable	<u>4</u>	<u>19.1</u>
N=	21	100.0

Note: Only asked of those respondents who were building additional passive units (N=21). One nonresponse.

Source: Real Estate Research Corporation.

Virtually all respondents--47 out of 50--plan to continue with additional passive work. Builders and builder/designers were asked whether they would build such homes on a custom or speculative basis; most said either "custom" or "both." Reasons cited included: tenuous market for speculative; greater creativity allowed on a custom basis; and primarily custom business overall. Those who preferred speculative construction felt it was an opportunity to incorporate good design for such a market; there were no client "headaches"; there was market demand for such houses; and it was the nature of their business overall.

A few respondents who plan to build active solar homes will do so primarily on a custom basis or as hybrid homes, since "pure" active is very costly and complex. However, the overwhelming sentiment was that active solar is too expensive; requires too much maintenance; is not cost-effective; and there is too little market demand for it.

Those respondents who are engaged in building additional speculative passive housing (8) were asked a series of questions regarding marketing and market acceptance. Respondents noted that the passive homes were (or would be) marketed through realtors; newspapers; pamphlets/fliers; conventional listings; open houses; and home shows. All respondents were emphasizing passive in their marketing techniques and virtually all felt that there was consumer interest in the homes.

Marketing problems cited by some respondents included higher prices (although the differential was less conspicuous recently because of overall price escalation); unconventional appearance; (considered a "minor" problem); and uncooperative weather conditions (i.e., need for a very cold winter to highlight the need for solar energy). Others felt that passive was a marketing plus.

A detailed table outlining the passive solar activity discussed in this chapter is to be found in Appendix "B" of this report.



## APPENDICES



## Appendix A

### MARKETING PASSIVE HOMES: CASE STUDIES OF UNSOLD HOMES

Six speculative homes were not yet sold at the completion of data collection (June 1980). Since the homes in the survey came on the market at different times, lack of sales at the close of data collection did not necessarily imply a problem with passive homes, since data collection coincided with high interest rates and their ensuing effects on the housing sector nationwide. However, in a few instances, some type of market resistance was clearly at fault. Of course, some of the homes which did sell also may have experienced resistance and longer marketing periods, but we have chosen to focus on the unsold units. Because there are few such units, however, they are identified by general location and discussed narratively, in order to give the reader a better sense of the market dynamics.

- California: The builder/designer was marketing the home himself with the intention of providing an adequate description of the system to prospective buyers. He noted in the initial interview that the area utility company was planning to sponsor an open house; in the follow-up interview, he noted that road signs were especially helpful in drawing visitors to the home.

As of May 1980, the house had been on the market for about five months, but no offers had been received. The original price had been raised from \$125,000 to \$180,000 during construction, and from \$180,000 to \$185,000 since marketing began (Fall 1979) to reflect overall increases in real estate values for the area. The builder/designer expressed concern in both initial and follow-up interviews that consumer interest in solar had not been translated into sales because of "astonomically" high interest rates and the overall state of the economy. He did not seem to feel that the lack of offers was due to the fact that the home is passive solar. Apparently, the home conforms quite well with neighboring ones, although its features include underground building. Passive solar homes are relatively new, however, and this home is only the second or third one in the area.

- California: The home went on the market only two weeks prior to the interview (May 1980) and was listed with a realtor only one week before. An open house was scheduled for the following week. No offers had been received.

The original price--and asking price at the time of the interview--was \$120,000, a competitive price for this "luxury," high-priced market. (The builder/designer noted that land values nearly tripled themselves during the construction period.)

In the initial interview, the builder/designer expressed concern with the unusually high interest rates; the seasonal nature of the housing market (summer); and the poorly situated site of the home. However, it was too soon to tell whether or not these factors would impact marketability.

- Indiana: At the time of the follow-up interview (May 1980), the home had been on the market for ten months, but the builder had received only one offer which he felt was too low. He attributed the lack of offers directly to the solar system, since the passive home was included in a home show along with seven other conventional homes that were sold. The asking price as of May 1980 was \$78,500.

The builder could not understand the apparent consumer reluctance to purchase solar when actual monitoring of fuel costs in this house and another empty one proved that the costs of the passive house were one-fourth those of the conventional home. As early as August of last year, however, he expressed concern with the lack of consumer education.

The construction lender and designer also noted the lack of public acceptance because of solar's experimental nature, but believe that consumers will come around in time. However, both the neighborhood and the financial institutions serving the community were characterized as conservative.

The designer also pointed to the home's lack of conformity with its subdivision; the lack of a basement; and its unusual floor plan, among other factors, and explained that the home's non-passive features have to be emphasized in the marketing presentation.

- Oregon: The first interview was conducted on this site in October 1979. At that time, the asking price was \$79,000. In April 1980, the asking price was quoted as \$90,000, and the house was not yet sold.

During the initial interview, the builder/designer had expressed concern with the stigma attached to the home's site, since it was formerly swampland. He explained there was some consumer interest generally in passive solar, but no sales. (No other passive solar homes are in the area.) He also stated that he would not build passive on a speculative basis without a grant or subsidy because of the risk involved as a result of unusually high interest rates.

The participating lender was unable to comment on the sale or resale of solar homes, or of this home in particular, because of a complete lack of experience with them. The subject home was the first in the area.

- Oregon: This home is found in the same area, and is designed and built by the same company as the other home in Oregon. The initial field visit was conducted in December 1979 when the home had just been placed on the market for \$78,000. As of May 1980, the house was selling for \$82,000 in order to recover interest paid on the construction loan. No offers had been received. The builder/designer explained that solar represents less than one percent of the marketplace in an already-depressed economy that has been impacted by high interest rates.

The home had been made into a model which he hoped would promote its sale. It was being advertised in the newspaper and over radio and television, with emphasis placed on cost-effectiveness and energy conservation.

- Wisconsin: When the house was visited initially in August 1979, marketing had not yet begun. At the time of the follow-up interview in March 1980, the house was on the market for \$69,900, but no offers had been received.

The builder attributes the lack of offers to the tight money situation in Wisconsin, and the cautious, traditional character of the community in which the home is located, noting that the multi-level home is considered somewhat radical in style. The designer pointed to high interest rates as the major marketing problem. He also felt that utility rate structures in the area discriminate against solar and occasional users.

The builder suggested, however, that consumers are interested--an open house drew 500 visitors. The home's asset is its potential for dollar savings. On the other hand, potential purchasers have been confused rather than encouraged by Federal and state tax credits.

- Wyoming: This house was not visited and is not part of our sample. However, it is an interesting case study to note.

In July 1980, we learned that after a year and a half on the market, the house had been rented out by the builder after having lived in it himself for almost a year. The builder had had considerable financing problems and had been unable to obtain permanent financing. At one point, the construction lender was about to foreclose. He blamed his predicament on the poor housing market; construction cost overruns due to grant specifications; and lack of lender interest in financing solar projects.

- Arizona: The comments of one respondent in Arizona are worthy of note, despite the fact that the home did sell. Apparently, however, it required a longer marketing period than normal because it was overpriced relative to its location. (The home cost \$8,000 to \$9,000 more than a conventional home of similar size and amenities in the same subdivision.)

The builder interviewed is the Vice President, Sales and Marketing, of a major nationwide homebuilding corporation, virtually the only one in our study representing such a large-scale organization.

He maintained that home buyers are not willing to pay additional costs attributable to passive solar, at least not in this particular market where the average home is held for three years, a period insufficient to allow a "solar payoff."

He suggested that buyers are skeptical of the systems' workability and would not risk additional dollars for something which might not be effective. Moreover, prohibitive interest rates have disqualified buyers from obtaining mortgages, particularly for a home whose features represent overimprovements.\*

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\*The reader should keep in mind, however, that cooling, rather than heating, is generally the big energy problem in Arizona.

The builder further explained that marketing the passive solar home is difficult, since the home's elements are not clearly definable or easily presented in a diagram, for example. Furthermore, in custom home situations, where financing is not a problem, client demands or preferences (e.g., "spectacular views and lots of windows") often defeat passive design principles, another reason the builder has postponed any plans to build any more passive houses.

B. PASSIVE INITIATIVE

Builder, Designer, Builder/Designer Groups

Additional And Future Passive Activity

Grant Respondent */	Other Passive Activity	How many? Custom or Speculative?	<u>Additional And Future Passive Activity</u>				Passive Features	Passive in Future?	Custom or Speculative?
			<u>Location</u>	<u>Size</u> (Net Living)	<u>Price</u>	<u>Style</u>			
1 - B	Yes	1, Custom	North Hampton, MA	1700-1800	\$100,000	Contemp. SF	Greenhouse	Yes	Custom
1 - D	Yes	1, Custom	New Castle, NH	3000	DK	"1950" Contemp. SF	So. Orient. Glass, Overhangs Greenhouse	Yes	-
2 - B/D	Yes	20 Designs 10 Built (Different homes) (Custom, Spec)	Northern New England	1800-2300	NA-Custom \$39-43,000 Spec	Contemp. SF	Greenhouse Berming	Yes	Custom
3 - B/D	Yes	5 Designs/ 0 Built yet/ Custom	Central NH	1000 1600 2100	\$44,000 \$57,500 \$73,000	Contemp. SF	Direct Gain Shading	Yes	Custom
4 - D	Yes	7, Custom	Northeast U.S. New Jersey	2000 Avg.	Range: \$90- \$180,000	Contemp. SF	Water and Mass Wall, Direct Gain Greenhouse Roof Aperture	Yes	- (Also does Passive Commercial)
4 - B	Yes	1, Custom	East Windsor, NJ	2500	\$135,000	Contemp. SF	Water Trombe Mass Trombe So. Orientation Clerestory	Yes	Custom
5 - B	No	-0-	-	-	-	-	-	Yes	Custom
6 - B	No	-0-	-	-	-	-	-	No	-
6 - D	Yes	5, Both	New Albany, IN (1)	(1)S-1500 (1)C-2000 (3) NA	\$65,000 \$130,000	Mod. SF Contemp. SF	Trombe Sunspace Direct Gain Insulation	Yes	-

B-1

\* Respondents: B = Builder; D = Designer; B/D = Builder/Designer

C = Custom

S = Speculative

DK= Don't Know

NA= Not available.

Source: Real Estate Research Corporation.

PASSIVE INITIATIVE

(cont'd)

Builder, Designer, Builder/Designer Groups

Additional And Future Passive Activity

Grant Respondent*/	Other Passive Activity	How many? Custom or Speculative?	<u>Additional And Future Passive Activity</u>					Passive in Future?	Custom or Speculative?
			<u>Location</u>	<u>Size</u> (Net Living)	<u>Price</u>	<u>Style</u>	<u>Passive Features</u>		
7 - B	No	-0-	-	-	-	-	-	No	-
7 - D	Yes	12, Spec	Southeast U.S. (T.V.A. Region)	Range 1000-2000	\$62,000 \$70,000	Updated Traditional, Contemp. SF	Greenhouse Water Storage Skylights Trombe Direct Gain	Yes	-
8 - D	No	-0-	-	-	-	-	-	Yes - (Custom Primarily) (Though does mostly commercial)	-
9 - B	No	-0-	-	-	-	-	-	Yes	Spec
10 - B/D	Yes	3 Designs/ Built 2 out of 3 Custom	Burnsville + Le Sueur MN	(1) 1950- (1) 2250	DK	Earth-Contemp. SF	Earth-Shelter Glass Insul. floors So. Orient. Greenhouse Storage (gravel)	Yes	Both- (Considering spec condominium)
11 - B/D	Yes	7 Designs; Built 3 out of 7 Custom	Madison, WI area	1500- 2300	\$70,000 \$90,000	Contemp. SF	Combination Direct Gain + Isolated Gain (Greenhouse)	Yes	Both
12 - B	No	-0-	-	-	-	-	-	Yes	Custom
12 - D	Yes	2, Spec	Blackearth and Barneveldt, WI	2050- 960	\$85,000 \$45,000	Contemp. SF and retro-fit SF	Sunspace + Greenhouse "Connective Loop" Design	Yes	-

B-12

\* Respondents: B = Builder; D = Designer; B/D = Builder/Designer

C = Custom

S = Speculative

DK= Don't Know

NA= Not available.

Source: Real Estate Research Corporation.

PASSIVE INITIATIVE

Builder, Designer, Builder/Designer Groups

(cont'd)

Grant Respondent*/	Other Passive Activity	How many? Custom or Speculative?	<u>Additional And Future Passive Activity</u>				Passive Features	Passive in Future?	Custom or Speculative?
			<u>Location</u>	<u>Size</u> (Net Living)	<u>Price</u>	<u>Style</u>			
13 - D	No	-0-	-	-	-	-	-	Yes	-
13 - B	No	-0-	-	-	-	-	-	Yes	Custom
14 - B/D	Yes	5 Designs/ Built 4 out of 5 Custom, Spec.	Columbia, MO Callaway County, MO	1300- 2100	\$60,000 \$85,000	Contemp. SF	Earth Home Direct Gain Mass Trombe	Yes ("Earth Homes") Yes	Both
15 - B	Yes	1, Spec.	Carbondale, CO	1790	\$169,000	Contemp. SF	Trombe, So. Glass, Berming Mass Mov. Insulation Concrete Floors	Yes	Spec
15 - D	Yes	10, Both	Aspen, CO	2000- 2500 (C) 1600- 1800 (S)	DK (C)	Futuris- tic, Con- temp. SF	Trombe, Direct Gain Greenhouse	Yes	-
16 - B/D	Yes	1, Custom (Only built; did not design)	Ft. Collins, CO	2150	\$90,000- 120,000 (Undeter- mined)	Contemp. or up- dated tra- ditional SF	Greenhouse Atrium Masonry Wall Special Floors	Yes	Custom
17 - D	Yes	3, Spec. (Plus 3 larger com- mercial pro- jects)	Carbondale, CO	1600- 1800	\$80,000 \$100,000	Contemp. Ranch SF (Small lot subdivis- ion)	Direct & In- direct Gain Greenhouse	Yes	-
17 - B	Yes	1, Spec *Cycle 5 Award	Carbondale, CO	1750	\$120,000	Convent- ional tract home; Contemp. style	Trombe wall Green "Room" Parabolic re- flectors Movable insul.	Yes	Both

B-3

\* Respondents: B = Builder; D = Designer; B/D = Builder/Designer

C = Custom

S = Speculative

DK= Don't Know

NA= Not available.

Source: Real Estate Research Corporation.

PASSIVE INITIATIVE

Builder, Designer, Builder/Designer Groups

(cont'd)

Grant Respondent*/	Other Passive Activity	How many? Custom or Speculative?	<u>Additional And Future Passive Activity</u>					Passive in Future?	<u>Custom or Speculative?</u>
			<u>Location</u>	<u>Size</u>	<u>Price</u>	<u>Style</u>	<u>Passive Features</u>		
18 - B/D	Yes	15 Designs/ Built 2 out of 15, Custom	Boulder, CO	(Net Living) 1800 avg.	\$100,000 avg.	Contemp. SF	Direct Gain Mass	Yes	Spec
19 - B/D	No	-	-	-	-	-	-	Yes	Both
20 - B	No	-0-	-	-	-	-	-	Yes	Both
21 - D	Yes	1, Spec	Las Cruces, NM	2200	-	Adobe, Contemp. SF	Direct Gain Glass, Cleres- tory Bermed. Mason- ry walls & floors	Yes	-
21 - B	No	-0-	-	-	-	-	-	Yes	Custom
22 - B/D	No	-0-	-	-	-	-	-	Yes (Mostly design)	Spec(Plus an active solar design for a condominium)
23 - D	Yes	3, Custom	Albuquerque and Santa Fe, NM	(1) 2200 (1) 1000 sq. ft. addition (1)1000 Sq. Ft. addition + a re- modeling	(1)\$150,000	(1)Adobe SF  (1)Contemp. stucco  (1)Santa Fe style	Trombe Greenhouse Water Drum Clerestory	Yes	Custom
24 - B	Yes	4, Custom	Santa Fe, NM	2300+	\$150,000- 500,000	Adobe, Contemp.SF	So. Orient. Special floors Heat Sinks Mov. Insulation Adobe walls & cleres- tory	Yes	Both

\* Respondents: B = Builder; D = Designer; B/D = Builder/Designer

C = Custom

S = Speculative

DK= Don't Know

NA= Not available.

Source: Real Estate Research Corporation.

PASSIVE INITIATIVE

Builder, Designer, Builder/Designer Groups

(Cont'd)

<u>Grant Respondent*/</u>	<u>Other Passive Activity</u>	<u>How many? Custom or Speculative?</u>	<u>Additional And Future Passive Activity</u>					<u>Passive in Future?</u>	<u>Custom or Speculative?</u>
			<u>Location</u>	<u>Size</u>	<u>Price</u>	<u>Style</u>	<u>Passive Features</u>		
			(Net Living)						
24 - D	Yes	10, Custom	Santa Fe, NM area	1800-2000 mostly (With a few either 1200 or 2600)	\$90,000 estimate	Pueblo, Spanish-Indian SF	Mov. Insulation Greenhouse Trombe	Yes	-
25 - D	No	-0-	-	-	-	-	-	Yes	-
25 - B	No	-0-	-	-	-	-	-	No	-
26 - B	No	-0-	-	-	-	-	-	Yes	Spec
26 - D	Yes	4, Custom	Colorado City, CO	1200-1600	\$60,000-69,000	Under-ground, Bermed SF	Trombe, Direct Gain Fiberglass tubes	Yes	-
27 - B/D	Yes	Cycle 5, Speculative	Eugene, OR	1500	\$75,000	NA	NA	Yes	Custom

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\* Respondents: B = Builder; D = Designer; B/D = Builder/Designer

C = Custom

S = Speculative

DK= Don't Know

NA= Not available.

Source: Real Estate Research Corporation.

PASSIVE INITIATIVE

Builder, Designer, Builder/Designer Groups

(Cont'd)

<u>Grant Respondent*/</u>	<u>Other Passive Activity</u>	<u>How many? Custom or Speculative?</u>	<u>Additional And Future Passive Activity</u>				<u>Passive Features</u>	<u>Passive in Future?</u>	<u>Custom or Speculative?</u>
			<u>Location</u>	<u>Size</u> (Net Living)	<u>Price</u>	<u>Style</u>			
28 - B/D	Yes	6 Designs, Custom	-	1800-2400	DK	SF	Direct Gain Greenhouse Combined Solar+ Wood Heat Storage	Yes	Custom, (Though considering spec. multi-family)
29 - B	Yes	3, Custom	Woodland CA area	1800-2000	\$70,000-100,000	Contemp. SF	Direct Gain plus Insulated draperies Water Trombe Greenhouse Special floors	Yes	Custom
29 - D	Yes	15, Custom (Which includes a 6-unit condominium and some remodelings)	Sacramento, CA	1300-2800 (New SF homes) 1300-1500 (Condominium units)	\$90,000 average	Contemp. SF	Greenhouse Direct Gain Insul. Drapes Water Trombe Special floors Reflector panels	Yes	-
30 - D	Yes	6, Both(+ a passive barn in British Columbia)	CA and ID	1300-1800(C) 1750(S)	\$40-100,000 (C) \$125 -40,000 (S)	Contem. SF	Direct Gain Mass  Underground building, So. oriented Masonry storage & Columns	Yes	-

8  
1  
5

\* Respondents: B = Builder; D = Designer; B/D = Builder/Designer

C = Custom

S = Speculative

DK= Don't Know

NA= Not available.

Source: Real Estate Research Corporation.

PASSIVE INITIATIVE

Builder, Designer, Builder/Designer Groups

(Cont'd)

<u>Grant Respondent*/</u>	<u>Other Passive Activity</u>	<u>How many? Custom or Speculative?</u>	<u>Additional And Future Passive Activity</u>					<u>Passive in Future?</u>	<u>Custom or Speculative?</u>
			<u>Location</u>	<u>Size</u> (Net Living)	<u>Price</u>	<u>Style</u>	<u>Passive Features</u>		
31 - B/D	Yes	6-12 Designs Custom & speculative	Northern California	NA	\$100,000-200,000	NA	NA	Yes	Both
32 - B/D	Yes	8 designs, Custom	Georgetown, CA	1800	DK	Contemp. + Rustic SF	Greenhouse Skylights Mass	Yes	Spec
33 - D	Yes	1, Custom	La Honda, CA	1500	\$110,000	"Calif. Barn" style SF	Vent System Zones Direct Gain/ Greenhouse/ Trombe, Masonry core	Yes	-
34 - D	Yes	1, Spec 2, Custom + a planned community with 2000 Solar homes (Spec)	Inverness, Los Angeles and Marin County, CA	(1)1500(C) (1)7250(C)  (1)1500(S) 700-2500(S)	(2)DK(C)  (1)\$140,000(S) \$50-200,000(S)	Contem. SF	Greenhouse Direct Gain Trombe Wall Natural Ventilation	Yes	Both
35 - B/D	Yes	3 Designs, Custom	Sacramento County, CA	1300 2000 1850	DK	Ranch 4-plex	Direct & In- direct Gain Envelope Principles	Yes	Both

B-7

\* Respondents: B = Builder; D = Designer; B/D = Builder/Designer

C = Custom

S = Speculative

DK= Don't Know

NA= Not available.

Source: Real Estate Research Corporation.

PASSIVE INITIATIVE

(Cont'd)

Builder, Designer, Builder/Designer Groups

<u>Grant Respondent*/</u>	<u>Other Passive Activity</u>	<u>How many? Custom or Speculative?</u>	<u>Additional And Future Passive Activity</u>					<u>Passive in Future?</u>	<u>Custom or Speculative?</u>
			<u>Location</u>	<u>Size</u> (Net Living)	<u>Price</u>	<u>Style</u>	<u>Passive Features</u>		
36 - D	Yes	2, Custom 1, Spec	Northern CA	(2) 1600-(C) (1) 1650-(S)	\$100,000+ (C) \$140,000+ (S)	Contemp. SF	Slab Storage Greenhouse	Yes	-
36 - B	Yes	3, Custom	Davis, CA	1650	\$85,000	Contemp. SF	Water Wall, Thermal Storage, Greenhouse So. Orient. Mass	Yes	Both

\* Respondents: B = Builder; D = Designer; B/D = Builder/Designer

C = Custom

S = Speculative

DK= Don't Know

NA= Not available.

Source: Real Estate Research Corporation.

