

What Can We Learn from the Failure of Adoption of Passive Solar Homes?



Vicki Garrett, M.S.
Tomas M. Koontz, Ph.D.
ECARP Working Group

August 2007



School of Environment and Natural Resources
College of Food, Agricultural, and Environmental Sciences



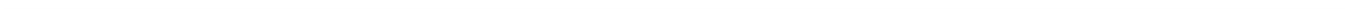
ECARP
(Environmental Communication,
Analysis, and Research for Policy) Working Group

Policy Summary Series #VG2007
School of Environment and Natural Resources
College of Food, Agricultural, and Environmental Sciences
The Ohio State University
210 Kottman Hall
2021 Coffey Road
Columbus, Ohio 43210-1085



Table of Contents

| | |
|--|----|
| Background | 1 |
| Phase 1 - Supply-Side Interviews | 2 |
| Phase 1 Methods | 2 |
| Phase 1 Results | 2 |
| Phase 1 Discussion | 4 |
| Phase 2 - Demand-Side Interviews | 5 |
| Phase 2 Methods | 5 |
| Phase 2 Results | 5 |
| Phase 2 Discussion | 7 |
| Phase 3 - Demand-Side Survey (Conventional Homeowners) | 7 |
| Phase 3 Methods | 7 |
| Phase 3 Results | 7 |
| Phase 3 Discussion | 11 |
| Phase 4 - The Effects of Information | 11 |
| Phase 4 Methods..... | 11 |
| Phase 4 Results | 14 |
| Phase 4 Discussion | 19 |
| Conclusion and Recommendations | 20 |
| Diffusion and Marketing | 20 |
| Government Involvement | 20 |
| Literature Cited | 21 |
| About ECARP..... | 25 |





Background

Passive solar design is a low-tech method of energy conservation. It consists of careful window placement and shading to capture solar heat in winter and exclude it in summer. It has been used throughout history all around the world. The best designs include thermal mass, heavy materials such as brick, stone, or concrete inside the home to hold the heat the sun absorbs during the day and release it at night. Most passive solar homes include extra insulation and other energy-saving measures. Unlike other solar technologies, for instance photovoltaics or solar thermal, passive solar design is relatively simple and low-cost. It has the potential to yield considerable energy savings at very low cost if included in the design stage of homebuilding (Givoni 1991; Yannas 1994; Zydeveld 1998).

Despite the potential for large energy savings at low cost, passive solar design has been adopted only rarely in the U.S. This raises a fundamental question: “Why has passive solar technology not been adopted?” Rational consumer behavior theory predicts that homebuyers would demand a product if it increases their expected benefits. Yet this is clearly not the case with passive solar design.

Several explanations have been offered to explain the lack of passive solar adoption, including demand and supply side factors. On the demand side, many researchers agree that consumer rationality is bounded. One such bound on the demand side is lack of information (Simon 1955). Lack of information is especially challenging in the housing market where energy-saving measures are largely unobservable because they are hidden in construction (Oster and Quigley 1977).

A recent study suggests that supply of, rather than demand for, alternative buildings may be the limiting factor in their adoption. Farhar and Coburn (2006) argue that buyers do not seem daunted by the price of alternative systems when they are included in the price of the home, especially if subsidies are in place. However, passive solar technology is rarely supplied as an option.

Others have pointed out that the effectiveness of an innovation does not guarantee its adoption. Some researchers have called for more attention to the establishment of diffusion agents and strategies, the supply side of diffusion (Craig and Brown 1980; Brown 1981; Glendinning, Mahapatra, and Mitchell 2001). Diffusion agents promote innovations and the policy and infrastructure necessary for their adoption. Without a powerful diffusion agent, it is difficult to get beneficial infrastructure in place, a precondition for adoption (Ormrod 1990; Haddad 1996). Necessary infrastructure for passive solar design would include community design, building codes, energy efficiency standards, zoning, solar access laws, etc.



This paper examines both the supply and demand sides of passive solar building in four separate research phases to suggest answers to the overarching question, “Why has passive solar design only rarely been adopted in the U.S.?”

Phase 1 – Supply-Side Interviews

Interviews with supply-side professionals dealing with passive solar homes in six states were conducted to form a picture of the current situation of passive solar design. These were designed to answer the question, “What are the major factors involved in the lack of adoption of passive solar homes?” In addition, secondary sources of information were gathered to analyze relevant economic factors across the six states.

Phase 1 Methods: Interviews were conducted with six alternative energy advocates, five homebuilders, one building plan examiner, eight policy administrators from six states with policies promoting passive solar building (Arizona, California, Ohio, Oregon, New York, and Pennsylvania), and professionals involved in Energy Efficient Mortgage (EEM) lending including three energy rating company personnel and two EEM lenders. Interviewees were asked questions to get their perspectives on factors affecting the adoption of passive solar homes.

Phase 1 Results: While each profession tended to focus on certain factors, common themes emerged. These supply-side interviewees had a lot to say about both homebuyers’ and builders’ motivations. On the demand side, availability and design were reported as the major obstacles. On the supply side, homebuyer demand and absence of favorable infrastructure were cited. Lack of awareness and economic incentives were seen to affect both the supply and demand sides (Table 1).

Table 1: Factors identified by interviewees as affecting passive solar adoption.

| | | Advocates | Builders | Plan Examiner | Policy Administrators |
|----------------------|--------------------|------------------|-------------------|---------------|-----------------------|
| DEMAND-SIDE | Availability | 6/6 ^a | 5/5 (no plans) | 1/1 | 5/8 (few built) |
| | Design | 5/6 | 2/5 | 0/1 | 1/8 |
| BOTH SUPPLY & DEMAND | Economic Incentive | 6/6 | 4/5 | 1/1 | 3/8 |
| | Awareness | 6/6 | 4/5 | 0/1 | 7/8 |
| SUPPLY-SIDE | Demand | 5/6 | 5/5 | 1/1 | 7/8 |
| | Infrastructure | 4/5 | 1/5 (regulations) | 1/1 | 3/8 |

^a Numbers indicate how many mentioned each factor out of the number of interviewees in that category

Source: Interviews with 20 advocates, builders, and policy administrators.



Interestingly, contrary to what the Ohio interviewees and the author assumed, economic incentives do not necessarily increase demand for passive solar design (see Table 2). This may be because awareness of the policies is very limited. Six of eight policy administrators from states with favorable policies reported little awareness of these policies. Two administrators, one from Arizona and one from Oregon, reported awareness of their states' tax credits only, and one said that was because vendors promote it. Of all the factors differing across states, only the percent of possible sunshine received in each state seemed to make a slight difference. While two administrators from both California and Arizona agreed there was little to no awareness of passive solar design in their states, both were more optimistic than other administrators. Californians are becoming increasingly aware of green building, and most new homes in Arizona take advantage of passive solar design for cooling because of their extreme heat and the utilities' promotion of energy-efficient construction. These are the two states with the highest percentage of available sunshine. Neither policy incentives nor residential energy prices seemed to bear on awareness of or interest in passive solar design.

Table 2: Relevant economic factors across six states.

| | OH | PA | NY | OR | AZ | CA |
|--|----------|----------|----------|----------|----------|----------|
| Average % Possible Sun ^a | 51% | 53% | 51% | 48% | 85% | 72% |
| Residential Energy Prices – Price and Rank: | | | | | | |
| Electricity – cents/kWh ^b | 9.36-#4 | 10.41-#3 | 16.51-#1 | 7.43-#6 | 9.28-#5 | 14.36-#2 |
| Natural Gas – in dollars/ thousand cu ft ^c | 14.65-#4 | 17.05-#1 | 16.03-#2 | 14.30-#5 | 15.47-#3 | 12.28-#6 |
| Awareness/Interest | Little | Little | Little | Little | Little + | Little + |

Sources: ^aNOAA 2005; ^bEnergy Information Administration 2006a, ^c2006b

In fact, the policy administrators in states with favorable policies were aware of their limitations. Like many policies, these may not be as effective as advocates would wish. As Stern (1986) pointed out, marketing the incentives may be more important than the size of the incentives.

Supply-side interviewees identified demand as the number one factor preventing widespread adoption of passive solar design, with availability and awareness tied for second place (see Table 3). If homebuyers are not aware of passive solar homes, they certainly will not demand them. If passive solar homes are not being built for sale, few homebuyers will be aware of them. Without a powerful and effective diffusion agent, the cycle will not be broken.

Table 3: Top barriers to adoption of passive solar design.

| | #1 | #2 | #3 | #4 | #5 | #6 |
|-----------------------|--|--------------------------|---|--|----------------|----------------|
| Advocates | Availability, Economic Incentive, Awareness tied for #1 | | | Design & Demand tied for #4 | | Infrastructure |
| Builders | Demand, (and no plans to build, so Availability) tied for #1 | | Economic Incentive, Awareness, & Design tied for #3 | | | Infrastructure |
| Policy Administrators | Demand & Awareness tied for #1 | | Availability | Economic Incentive & Infra-structure tied for #4 | | Design |
| Total: | Demand | Availability & Awareness | | Economic Incentive | Infrastructure | Design |

Source: Interviews with 20 advocates, builders, and policy administrators.

Diffusion Agents for Passive Solar Homes: Energy Efficient Mortgage (EEM) raters and lenders provided key insights for understanding adoption without a diffusion agent. EEMs allow homeowners or buyers to borrow up to fifteen percent more for energy-saving measures by offsetting the increase in mortgage payment with utility bill savings. One rater explained that raters generally do not favor EEM audits because they are more time consuming, among other reasons. Of the two raters, only one had performed any EEM audits. They do not seem to be favored among the local lenders, either – local lenders in Ohio contacted for this study did not know about EEMs. Moreover, the Fannie Mae representative in central/southern Ohio indicated that there have been no passive solar EEMs in this region, even though passive solar design qualifies for EEMs.

An employee of one of the energy rating companies had been involved in promoting passive solar during the energy crisis of the 1970s and 1980s. He explained that the only industries in a position to profit from widespread application of passive solar design are the concrete and concrete block industries. They would stand to gain in sales if thermal mass became a consideration. However, the motive and wherewithal do not exist together. The poured concrete industry does most of their work in roads. The concrete block industry would profit, but the industry is very fragmented and does not have the resources to promote it. He pointed out that although R-factors (resistance to heat flow) and mass factors (storage of heat) are both part of energy conservation, only R-factors are recognized in building codes because insulation manufacturers are very powerful.

Phase 1 Discussion: According to supply-side professionals, the major factors involved in the failure of adoption of passive solar design, in order of importance, are demand, availability and awareness, economic incentives, infrastructure, and design. These interviews support Yates and Aronson's (1983) view that waiting for the market to determine energy consumption will not work. Infrastructure, including codes, laws, and subsidies, have already been established in favor of more conventional designs. Low cost innovations that do not provide large profits seem des-

tined to be “orphaned innovations,” products that provide social goods without great benefits to powerful diffusion agents. Without such agents who stand to gain, there is little awareness, and therefore little demand. Figure 1 illustrates the problems faced by passive solar and other low-cost innovations. The next phases will explore the issue from the demand side.

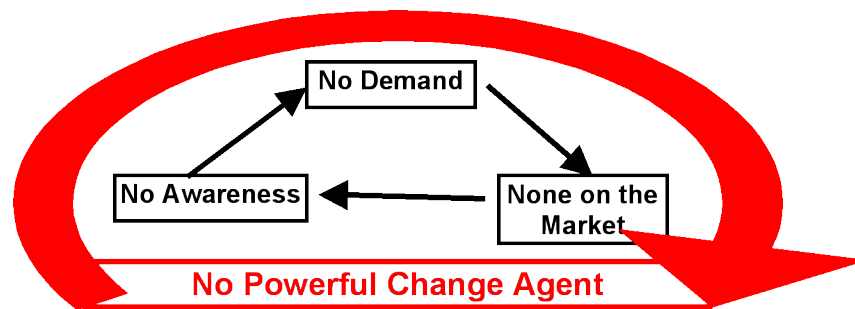


Figure 1: Cycle of non-adoption.

Phase 2 – Demand-Side Interviews (Passive Solar Homeowners)

The Phase 2 demand-side interviews are designed to answer the questions, “Why did people living in passive solar homes choose them?” and “Do owners of passive solar homes reveal reasons for not buying one?”

Phase 2 Methods: Twelve passive solar homeowners were interviewed, either in person or by phone, to suggest why these people bought passive solar homes. The interviews lasted from 15 minutes to two hours, depending on how much detail the homeowners provided. A semi-structured format was followed, based on a set of interview questions for each group. The homeowners fell into three groups: four bought pre-existing passive solar homes; three found a passive solar subdivision and worked with the builder to build a new home; and five initiated the building themselves and were very involved in the construction.

Phase 2 Results: Of the group who bought pre-existing homes, only one of the four chose the home for its passive solar features. The others bought for location, design, and resale value. They found the passive solar to be a bonus, but didn’t base their decision on it. All three of the second group who found the passive solar subdivision bought their homes during the energy crisis of the 1970s and ‘80s to lower their utility costs. Four of the five in the third group who initiated the building themselves are working on or concerned with energy and environmental issues and gave stewardship and sustainability as their reasons.

All groups reported general satisfaction with their homes. Ten of twelve believed their energy bills are lower than those of comparable conventional homes, in most cases, dramatically lower.



(One had never owned another home and could not compare; the other lived in a home built by an unknown architect, probably meant to be active solar, but the panels had been removed, and it was hard to heat.) Eleven of the twelve would rather live in a passive solar home (the other is planning to move south and did not feel passive solar would be necessary). However, all of them are very aware of the difficulty in finding another. One is in the process of moving and is building his new passive solar home himself. The biggest dissatisfaction these homeowners expressed was in their architect's design decisions. Some either insisted on north windows or added them later. Although passive solar homes can be designed in any style, this architect's style was too modern for at least one of the homeowners. Because few passive solar homes are available on the market, existing design choices are very limited.

Only the group who initiated the building of their homes themselves has adopted characteristics different from conventional homebuyers. They know others who live in passive solar homes, belong to more environmental and other organizations, and have lower incomes, although they are well educated (see Table 4). The demographic information supports a recent study indicating few significant differences between conventional homebuyers and buyers of homes with solar features (Farhar and Coburn 2006).

Table 4: Demographic information for passive solar homeowners.

| | Bought Already Built | | | | Builder Initiated | | | Homeowner Initiated | | | | |
|---------------------|----------------------|-------|-----|---------|-------------------|-----|----|---------------------|---------|-----|-----|---------|
| Homeowner: | #1 | #2 | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 | #11 | #12 |
| Know others? | No | No | NA | NA | NA | NA | NA | Of them | Yes | Yes | Yes | Yes |
| Affect decision? | NA | NA | NA | NA | NA | NA | NA | Yes | No | No | Yes | Yes |
| Protect environment | 10 | 8 | 7-8 | 8 | 9 | 8 | 7 | 9-10 | 5 & 8 | 10 | 10 | 10 & 10 |
| Enviro groups | Yes | No | No | No | No | Yes | No | Yes | Yes | Yes | Yes | Yes |
| Organizations | 6 | 0 | 3 | 2 | 3 | 9 | 5 | 13 | 15 | 6 | 5 | 12 & 13 |
| Years planned | 5 yrs. | movng | ∞ | 10 or > | ∞? | ∞ | ∞? | ∞? | ∞ | ∞? | ∞ | 20 yrs. |
| Years last home | 4 | 10 | 9 | 11 | (1st home) | 2 | 6 | 4 | 12 | 10 | 8 | 1.5 |
| Age | 35 | 53 | - | 54 | 57 | 55 | 56 | 51 | 61 & 63 | 43 | 66 | 36 & 36 |
| Kids at home | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |



| | Bought Already Built | | | | Builder Initiated | | | Homeowner Initiated | | | | |
|------------------|----------------------|---------|--------|-----------|-------------------|-----------|-----------|---------------------|-----------|-----------|-----------|-----------|
| Marital status | Never Marr. | Div. | Div. | Marr. | Marr. | Marr. | Div. | Div. | Marr. | Marr. | Marr. | Marr. |
| Income | 120-140k | <20k | 40-60k | 80-100k | 120-140k | 100-120k | 120-140k | <20k | - | <20k | 40-60k | 60-80k |
| Educa-tion | Ph.D | HS grad | MS | Coll grad | MS, MD | Coll grad | Coll grad | Coll grad | MS (both) | Coll grad | Coll grad | MS (both) |
| Other training | - | Yes | Yes | - | - | Yes | - | Yes | Yes | Yes | - | Yes |
| Had P.S. before? | No | No | No | No | No | No | No | Yes | No | No | No | Yes |

Source: Interviews with 12 passive solar homeowners.

Phase 2 Discussion: The groups had different motivations and expectations, but in general, they were satisfied with their homes. Although very small, this qualitative sample revealed no problems that would explain lack of demand for passive solar design. Homebuyers seem to be very open to passive solar homes, as long as they are available with other amenities they require. There are simply very few on the market. This supports the Phase 1 conclusions that availability and awareness are limiting factors. Phase 3 follows up on this research with a survey of new homebuyers not living in passive solar homes.

Phase 3 – Demand-Side Survey (Conventional Homeowners)

The Phase 3 demand-side survey was designed to answer the question, “Are the identified factors supported; if so, which are most important?”

Phase 3 Methods: Results of the Phase 1 interviews were used as the basis of a survey of new homeowners *not living in passive solar homes*. The target population was buyers of new-build homes who were able to make design decisions and influence the new home market. Current records from the Franklin County, Ohio Auditor were compared with Franklin County Development Department building permits issued in 2002 to provide a sample of owner occupants of varied incomes and home values who built homes recently enough to recall design decisions but had lived in their homes long enough not to be affected by post-purchase cognitive dissonance, a psychological discomfort that provokes rationalization of one’s behavior (Festinger 1957). The survey yielded 117 responses (51 % response rate). Questions asked respondents to indicate, on a Likert scale from -3 (strongly disagree) to 3 (strongly agree), their level of agreement with different statements.

Phase 3 Results: A large percentage of the responses fall in the neutral category. This was expected, as it was assumed that some people did not know the answers. Nevertheless, comparing positive and negative answers illustrates clear trends. Design was not as great a factor as



expected (Figure 2). Most respondents did not agree that passive solar homes are unattractive, nor did they object to windows on the south side. Most did, however, prefer a particular home style, a fact that designers should bear in mind. In fact, ordinal regression showed a significant negative correlation between both independent variable statements, “Passive solar homes are unattractive” and “I like a particular home style,” and the dependent variable “I would rather live in a passive solar home than a conventional home.” So while these homeowners did not tend to dislike passive solar design, those who did were significantly less likely to favor passive solar.

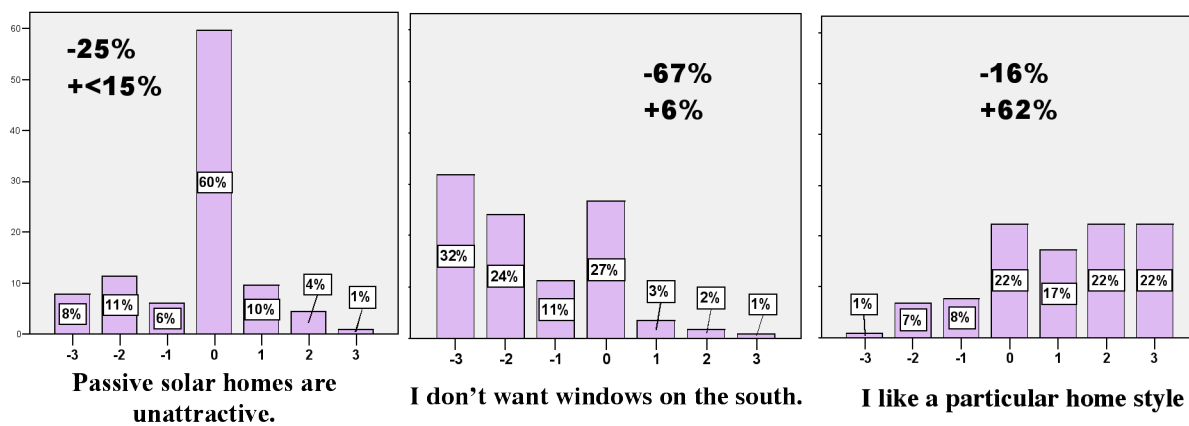


Figure 2: Opinions on Passive Solar Design from -3 (Strongly Disagree) to +3 (Strongly Agree).

Note: Percentages may not add up to 100 percent due to rounding.

Source: Surveys from 117 conventional homeowners.

Figure 3 shows that most respondents agree they are not aware of any tax breaks or other incentives for passive solar homes. However, contrary to what was expected, more disagreed that there isn't an economic benefit, and even more disagreed that heating costs are too low to worry about. However, while they seem to be very unhappy about heating costs, there may a critical point at which search costs for information on energy saving become more acceptable than utility bill costs. Homeowners and homebuyers do not seem to have reached that point yet.

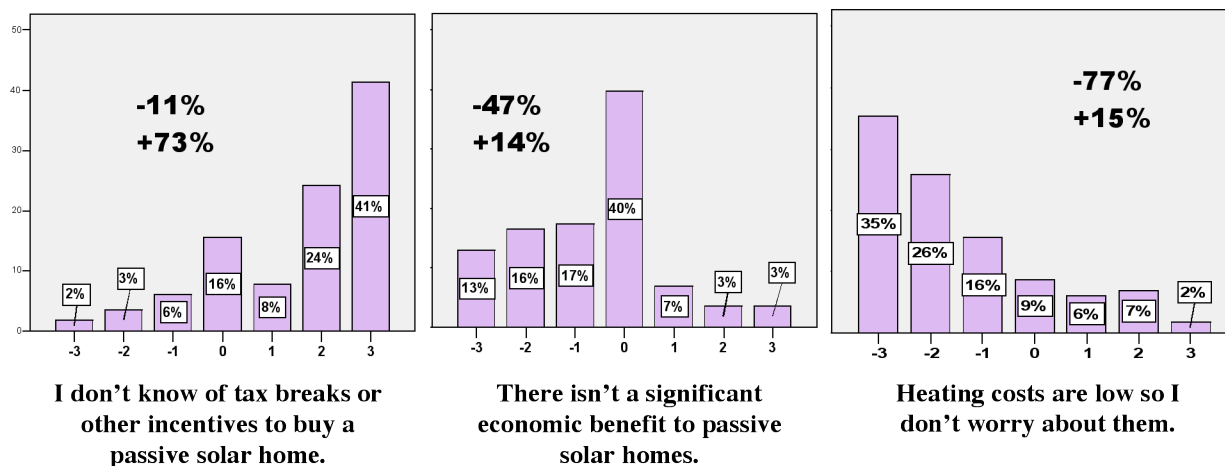


Figure 3: Opinions on Economic Incentives from -3 (Strongly Disagree) to +3 (Strongly Agree).
 Note: Percentages may not add up to 100 percent due to rounding.
 Source: Surveys from 117 conventional homeowners.

As expected, a majority of respondents agreed with all the questions pertaining to availability (Figure 4). This is hardly surprising, given the fact that Ohio builders rarely build passive solar homes at this time.

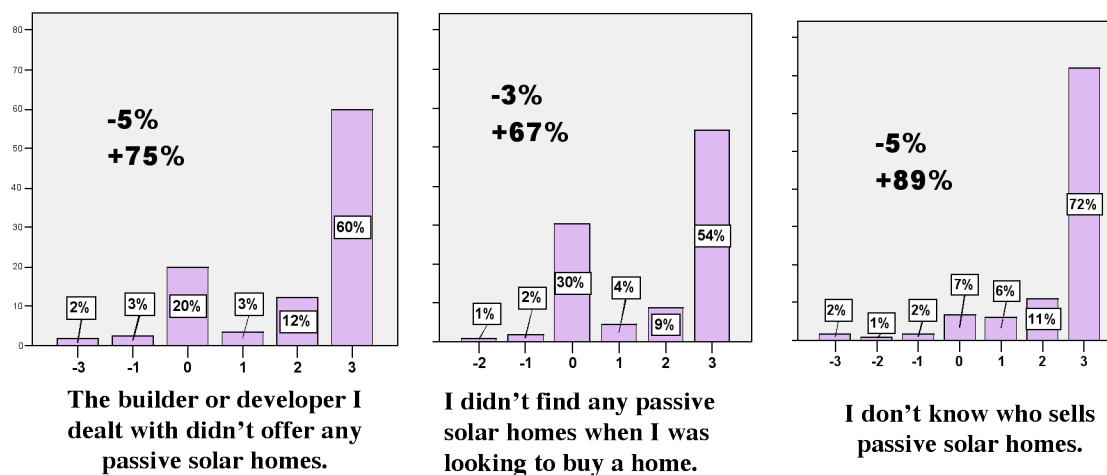


Figure 4: Opinions on Availability from -3 (Strongly Disagree) to +3 (Strongly Agree).
 Note: Percentages may not add up to 100 percent due to rounding.
 Source: Surveys from 117 conventional homeowners.

Awareness, education, knowledge, fear of the unknown, lack of information, and misinformation were all mentioned in the Phase 1 interviews and literature, so it was expected that awareness would be an important factor. In fact, it was found to be important in unexpected ways. There was less misinformation than expected. More respondents disagreed than agreed that passive solar homes are too complicated or will not work in Ohio (Figure 5). However, there was a great lack of knowledge. A full 85% agreed that they did not know much about passive solar homes, with 63% strongly agreeing. Even more enlightening was the large number of respondents (70 %) who indicated they had never heard of passive solar design before receiving the questionnaire.

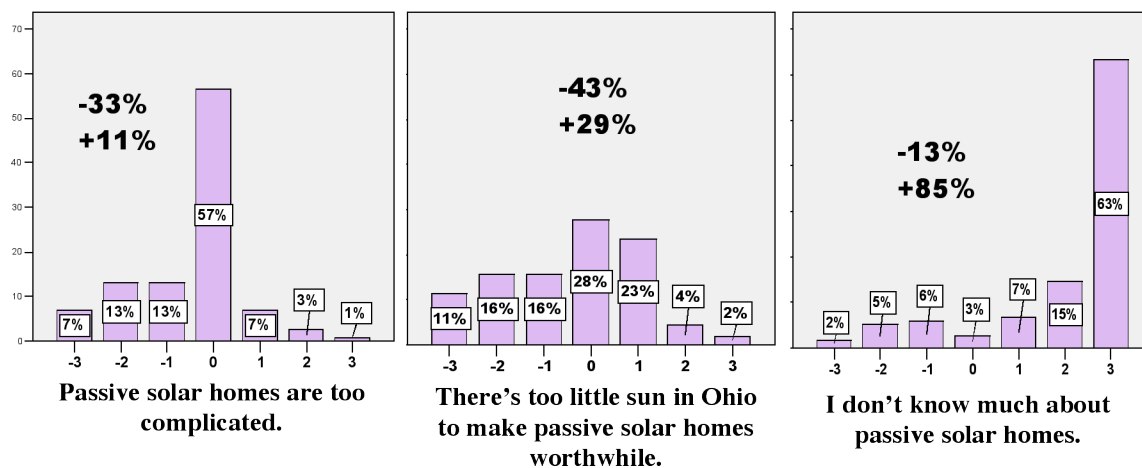


Figure 5: Awareness of Passive Solar Design from -3 (Strongly Disagree) to +3 (Strongly Agree).
 Note: Percentages may not add up to 100 percent due to rounding.
 Source: Surveys from 117 conventional homeowners.

Surprisingly, although most had not heard of passive solar before, more than half agreed they would pay more for a passive solar home (Figure 6). Some indicated that they might pay more if they knew more about passive solar. This suggests that a market exists, if there were a supply available.

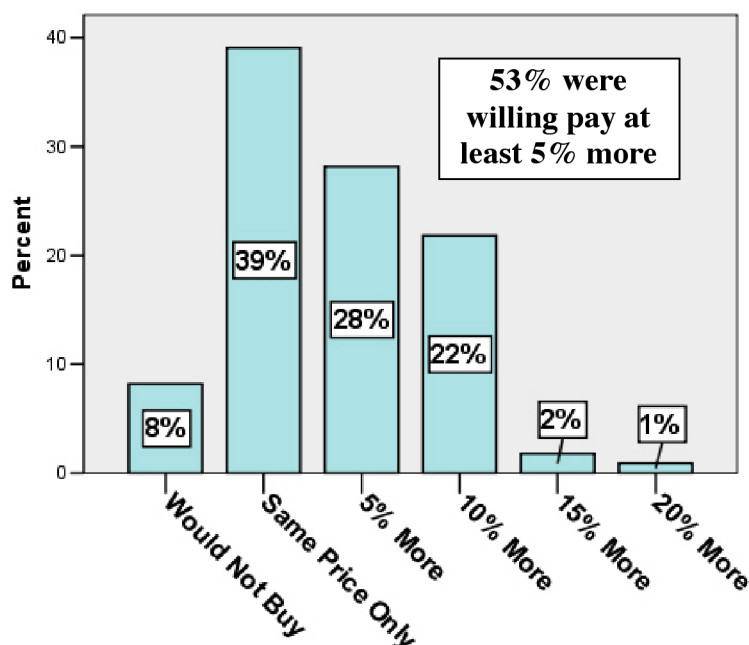


Figure 6: How much more would you be willing to pay for a passive solar home if you were guaranteed 25 percent lower utility bills without changing your thermostat settings?

Phase 3 Discussion: Results of the survey suggested that design and economic incentives are not as important as awareness and availability. The survey supported the Phase 1 conclusions that, because there is no supply, people do not know about passive solar design, therefore, there is no demand. Most of the respondents did not even consider a passive solar home because they did not know about them. However, a majority of respondents indicated a willingness to pay more, even knowing very little about them. The final phase of this study explored the effects of information on willingness-to-pay for passive solar and other energy consumption decisions.

Phase 4 – The Effects of Information

The survey suggested that homebuyers would have an interest and willingness-to-pay for passive solar design, but they lack information. The next step was to design useful and effective information on energy-saving measures, including passive solar design, to see if information increases demand. The Phase 4 quasi-experiment was designed to answer the question, “Does information increase homebuyer demand for passive solar homes?”

Phase 4 Methods: To test the effects of education, two different church groups (n=24 and n=59) with similar demographics to the survey sample were selected. Both groups participated in a quasi-experiment consisting of pretest, treatment, and posttest. In a quasi-experiment, treatments are manipulated, but treatment groups are either not randomly assigned, or a control group is not used (Campbell 1963). In this case, the short duration of the treatment prevented



some threats to validity, and a larger sample size was decided to be more important than a control group.

The pretest and posttest were developed from the survey questionnaire mailed to the new homebuyers in Phase 3. Thirteen questions about energy-saving measures were added to the pretest for the second group (n=59) to measure change in opinions about these measures.

The treatment consisted of a 30-minute presentation with information on passive solar design and other energy-saving measures and their cost/benefit analyses. Interdisciplinary theories and methodologies were employed to ensure greatest understanding, as suggested by other researchers (Stern 1986; Geller 1989; Dennis et al. 1990; Harper 2004). The presentation included concrete, salient examples with cost/benefit information (Tversky and Kahneman 1974) designed to be as specific, detailed, and practical as possible (Stern 1976; Dresner 1990; Dennis et al. 1990) so as to allow participants to know the advantages and disadvantages of each measure and feel in control of their choices (Dennis et al. 1990). Energy savings were described in payback periods, percentages of annual energy use, and monthly dollar savings as suggested by Kempton and Montgomery (1982), rather than in KWh and Btus. The treatment included a PowerPoint™ presentation, models, and worksheets. The models included two home models and a sun track model illustrating the sun's position in June and December and its effect on homes. They were used to add a concrete element to the abstractness of the computer calculations and accommodate more learning styles. The cost/benefit worksheets were designed to be specific and detailed analyses of the two home models (Figure 8). The handouts were referred to throughout the presentation. Cost/benefit analysis was performed with the Energy-10 software¹.

¹The Energy-10 software was developed for architects by the National Renewable Energy Laboratory (NREL), Lawrence Berkeley National Laboratory (LBNL), and the Berkeley Solar Group (BSG) with funding from the U.S. Department of Energy (DOE). The program can be obtained from the Sustainable Buildings Industries Council (SBIC).

A

(2400 square feet, masonry structure, model is 1/8 inch = 1 foot scale) WORKSHEET - PASSIVE SOLAR MODEL

| | Energy Strategy | Cost of Upgrade ¹ | Annual Energy Savings | Monthly Energy Savings in \$\$\$ | Payback Period | Net Monthly Savings or Cost ² |
|----|---|------------------------------|-----------------------|----------------------------------|----------------|--|
| 1 | *Glass (South & North) | \$0 | 6% | \$13.00 | none | \$13.00 |
| 2 | *Mass (Uncarpeted Slab ³) | \$0 | 1% | \$2.00 | none | \$2.00 |
| 3 | *Mass ⁴ (Masonry Walls) | \$0 | 2% | \$4.67 | none | \$4.67 |
| 4a | *Shading ⁴ - Building Features | \$0 | <1% | \$0.58 | none | \$0.58 |
| 4b | Shading ⁴ - Landscaping | ? | ? | ? | ? | ? |
| | Total Monthly Savings of Design⁵: | | 9-10% | \$20.25 | | \$20.25+ |
| 5 | R-60 Attic Insulation | \$1,022 | 1% | \$2.17 | 39 years | -\$9.19 |
| 6 | R-22 Wall Insulation | \$1,598 | 3% | \$6.75 | 20 years | -\$11.01 |
| 7a | Double, Low-e Windows All Around | \$1,312 | 4% | \$9.33 | 11.7 years | -\$5.25 |
| 7b | Triple All Around, Low-e on North | \$1,706 | 5% | \$10.00 | 14.2 years | -\$8.96 |
| 8 | High Efficiency HVAC System ⁶ | \$2,400 | 10% | \$22.75 | 8.8 years | -\$3.92 |
| 9 | *Programmable Thermostat ⁷ (setback/setup 5°) | \$75 | 6% | \$13.50 | <6 month | \$12.67 |
| 10 | *Leakage Control | \$511 | 13% | \$35.00 | 1.2 years | \$29.32 |
| 11 | *Steel or Fiberglass Insulated Doors ⁸ | \$0 | <1% | \$1.00 | none | \$1.00 |

¹ Upgrade costs represent the difference between costs of conventional methods and more energy-efficient strategies.

² Net Monthly Savings or Costs figured as $\frac{\text{strategy cost} \times 30 \text{ years} \times 10\% \text{ interest}}{12 \text{ months}} - \text{monthly savings}$.

³ An uncarpeted slab can cost less if carpet is replaced with stained/polished concrete, or substantially more for granite, marble, etc.

⁴ Mass and shading can cost nothing, if included in features the home would have anyway, or be very expensive, all depending on planning and choices.

⁵ Net monthly savings or costs of design strategies will depend on how the homeowner chooses to incorporate them.

⁶ The cost represents the difference in cost between a conventional HVAC system and a 90% efficient system.

⁷ Programmable thermostats are priced between \$40-100 in the local home improvement stores.

⁸ Steel or fiberglass insulated doors can be either more or less expensive than wood - there's a huge range of styles and prices.

*Asterisked upgrades were selected for home #2 (Sheet C) because they show a net monthly savings.

B

(2400 square feet, model is 1/8 inch scale) PASSIVE SOLAR MODEL - COST VS. SAVINGS

| Strategy | 1. Conventional House | 2. Practical - Using Only the Most Economical Energy Saving Features* | 3. Spare No Expense- Using All Energy Saving Features |
|---------------------------------|-----------------------|---|---|
| Base House Cost: | \$362,700 | \$362,700 | \$362,700 |
| Final Cost: | \$362,700 | \$363,286 | \$370,012 |
| Annual Energy Cost: | \$2,630 | \$1,545 | \$1,338 |
| Monthly Mortgage ¹ : | \$4,030 | \$4,037 | \$4,111 |
| Monthly Utilities: | \$219 | \$129 | \$112 |
| Total Monthly Expenses: | \$4,249 | \$4,166 | \$4,322 |

*Most economical energy saving features are asterisked on Sheet A and show a net monthly savings.

¹ Mortgage costs are figured at 10% interest (for simplicity) and include principal and interest only.

Figure 8: Cost/Benefit Worksheets – Worksheet B compares three scenarios: 1-no extra conservation measures; 2-only those with net monthly savings; 3-all measures.



Phase 4 Results: The quasi-experimental sample was more familiar with passive solar design than the survey sample (58 % of participants had heard of passive solar design before, compared to just 30 % of the survey sample). This is not unexpected, as the survey sample was slightly younger and many may not have been old enough to be aware of the 1970s energy crisis, during which passive solar design became relatively well known.

The quasi-experimental sample corroborated the environmental literature and the survey sample in the reported discrepancy between environmental attitude and environmental action. While the participants reported slightly more environmental concern and willingness to take personal action to protect the environment, their charts are similar in higher levels of concern than action (see Figure 9).

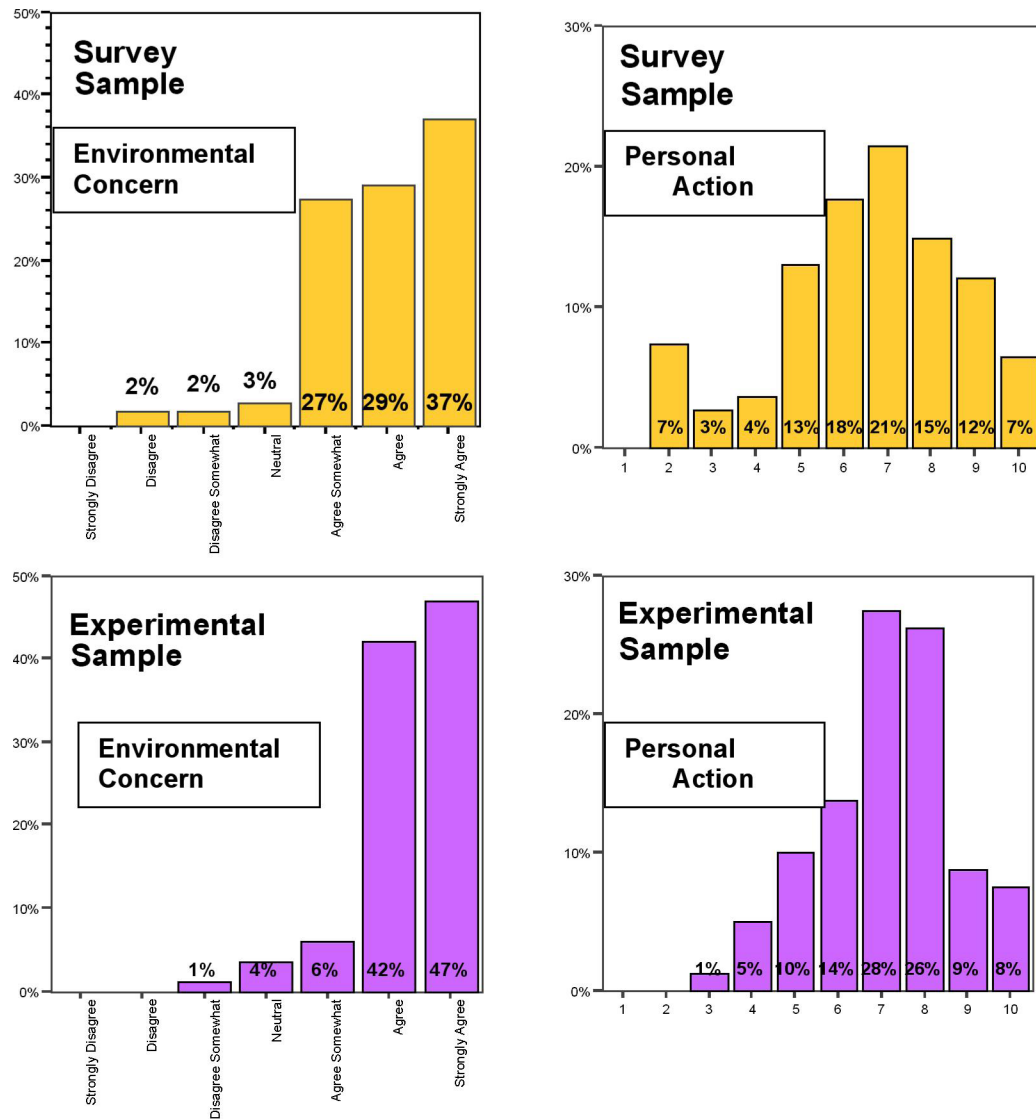


Figure 9: Comparison of survey with experimental groups: “I am concerned about the environment” and “How much importance do you place on taking personal action to protect the environment?” (Likert scale from strongly disagree to strongly agree). Note differences in magnitudes, but similarities of skew. Source: Responses from surveys (n = 117) and experimental sample (n = 83).

Paired t-tests comparing pre- and posttest responses showed significant differences in all agreement levels except two (Table 5). The only two that did not change, “heating costs are low” and “I like a particular home style” are personal opinions and would not be affected by information.

Table 5: Change in agreement level with each factor after presentation.

| Reasons for Not Buying a Passive Solar Home: | Mean | Mean Diff. | n | Std. Dev. | Std. Error Mean | P-value |
|--|-------|------------|----|-----------|-----------------|---------|
| Unattractive-Pretest | -1.01 | .880 | 83 | 1.293 | .142 | <.001 |
| Unattractive-Posttest | -1.89 | | 83 | 1.522 | .167 | |
| Builder Didn't Offer/Not Available-Pretest | 1.06 | 1.530 | 83 | 1.484 | .163 | <.001 |
| Builder Didn't Offer/Not Available -Posttest | -.47 | | 83 | 1.580 | .173 | |
| Costs Low-Pretest | -1.99 | .110 | 82 | 1.338 | .148 | .428 |
| Costs Low-Posttest | -2.10 | | 82 | 1.273 | .141 | |
| Want Particular Style-Pretest | .81 | -.096 | 83 | 1.685 | .185 | .535 |
| Want Particular Style-Posttest | .90 | | 83 | 1.812 | .199 | |
| Complicated-Pretest | -.67 | 1.169 | 83 | 1.389 | .152 | <.001 |
| Complicated-Posttest | -1.84 | | 83 | 1.225 | .134 | |
| No Incentives-Pretest | -.52 | -.434 | 83 | 1.329 | .146 | .023 |
| No Incentives-Posttest | -.08 | | 83 | 1.669 | .183 | |
| Don't Want South Windows-Pretest | -1.58 | .627 | 83 | 1.570 | .172 | <.001 |
| Don't Want South Windows-Posttest | -2.20 | | 83 | 1.068 | .117 | |
| Hard to Find-Pretest | 1.35 | 2.639 | 83 | 1.444 | .158 | <.001 |
| Hard to Find-Posttest | -1.29 | | 83 | 1.597 | .175 | |
| Too Little Sun-Pretest | -.66 | 1.434 | 83 | 1.602 | .176 | <.001 |
| Too Little Sun-Posttest | -2.10 | | 83 | 1.165 | .128 | |
| No Economic Benefit-Pretest | -1.12 | .439 | 82 | 1.494 | .165 | .038 |
| No Economic Benefit-Posttest | -1.56 | | 82 | 1.532 | .169 | |
| Don't Know Who Sells-Pretest | 2.33 | 1.988 | 83 | 1.149 | .126 | <.001 |
| Don't Know Who Sells-Posttest | .34 | | 83 | 1.882 | .207 | |
| Don't Know Much About Them-Pretest | 1.65 | 2.952 | 83 | 1.611 | .177 | <.001 |
| Don't Know Much About Them-Posttest | -1.30 | | 83 | 1.368 | .150 | |

Note: Shaded rows *did not* change significantly.

Willingness-to-pay for passive solar also increased significantly (P-value <.001). While an impressive 65% would pay more before the presentation, the number increased to 75% after the presentation.

Opinions about other energy-saving measures also changed after the presentation. All but two, air leakage control and manually setting back thermostats before going to bed or work, changed significantly. While those measures that had been most popular before the presentation but were also the most expensive dropped in preference, they did not drop as much as expected (Table 6). In fact, while participants chose the most economically efficient bundling of measures when given the choice of three different energy-saving scenarios (Figure 10), when choosing individually, they did not choose the measures that would save the most energy or money, even though they were clearly marked.

Table 6: Ordered comparison of pre- and posttest energy-saving measure choices.

| PRETEST | | | | POSTEST | | | | | |
|-------------------------------------|----------|-------|----------------|--|----------|-------|----------------|-------------------------|-----------------------|
| Energy-Saving Measure | Disagree | Agree | Strongly Agree | Energy-Saving Measure | Disagree | Agree | Strongly Agree | Monthly Cost or Savings | Annual Energy Savings |
| High Efficiency HVAC [^] | 1 | 58 | 48 | Shading (landscaping) ² | 0 | 59 | 41 | ? | ? |
| Efficient Windows [^] | 1 | 58 | 46 | Shading (architectural) | 0 | 59 | 34 | \$0.58 | <1% |
| Extra Attic Insulation [^] | 1 | 58 | 46 | Efficient Windows [^] | 1 | 58 | 39 | -\$5.25 | 4% |
| Extra Wall Insulation [^] | 1 | 57 | 36 | Progr. Thermostat* | 0 | 57 | 42 | \$12.67 | 6% |
| Shading (landscaping) | 1 | 57 | 25 | High Efficiency HVAC [^] | 0 | 57 | 39 | -\$3.92 | 10% |
| Progr. Thermostat* (1) | 2 | 52 | 35 | Extra Attic Insulation [^] | 0 | 56 | 32 | -\$9.19 | 1% |
| Shading (architectural) (3) | 1 | 52 | 16 | Insulated Doors | 2 | 54 | 26 | \$1.00 | <1% |
| Air Leakage Control* | 0 | 50 | 30 | Air Leakage Control* (1) | 1 | 53 | 28 | \$29.32 | 13% |
| Manual Setbacks* (1) | 5 | 47 | 26 | South Windows* (1) | 6 | 50 | 30 | \$13.00 | 6% |
| Insulated Doors | 6 | 43 | 23 | Extra Wall Insulation [^] (1) | 2 | 50 | 23 | -\$11.01 | 3% |

| PRETEST | | | | POSTEST | | | | | |
|-----------------------|----|-----|----|-----------------------|----|----|----|---------|----|
| South Windows* (3) | 4 | 43 | 16 | Manual Set-backs* (1) | 4 | 49 | 29 | \$12.67 | 6% |
| Mass (walls) (1) | 8 | 22 | 4 | Mass (walls) (1) | 4 | 49 | 17 | \$4.67 | 2% |
| Mass (slab floor) (1) | 13 | 15v | 2 | Mass (slab floor) (1) | 14 | 39 | 12 | \$2.00 | 1% |

Note: * identifies 4 greatest money-saving measures; ^ identifies 4 lowest money- or energy-saving measures. Numbers in parentheses indicate missing responses.

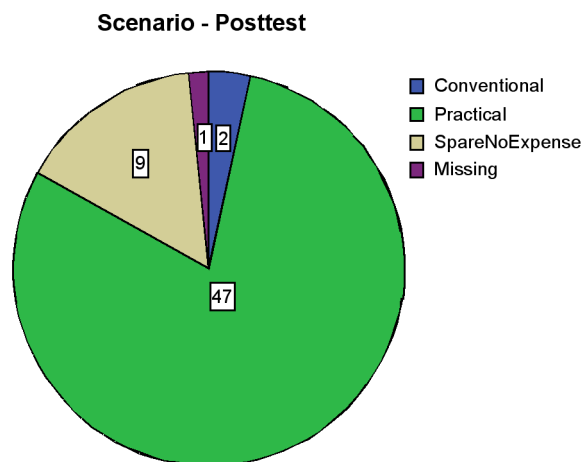


Figure 10: Scenario choice

Source: experimental sample (n = 83).

Discrepancies between scenario choice and individual energy-saving measure choices indicate a decision-making inconsistency. While participants' choices decreased according to economic advantage, and they overwhelmingly chose the economically practical scenario (Figure 10), their choices of individual energy-saving measures suggested a reluctance to let go of the well-marketed measures that are the most profitable for those promoting them. These were first choices in pretests, dropped in posttests, but not to a level consistent with the bundled choices. As Dennis et al. (1990) pointed out, participants' decisions seemed to be biased by formerly held beliefs.

²ENERGY-10 was designed for architects and doesn't provide analysis for landscaping. Participants were told, "according to US DOE EERE, well-placed trees can save up to 25% of your annual cooling costs. A June 2003 DOE study showed just 3 carefully placed trees can save from \$100-\$200 annually."



Decreases in agreement levels between pretest and posttest followed the net monthly costs shown in Worksheet A (Figure 8) very closely. However, *increases* in agreement levels are more difficult to understand (Table 7).

Table 7: Energy-saving strategies ordered by increase in agreement level after the presentation.


| | Increase | Decrease | Monthly Cost or Savings | Annual Energy Savings | Illustrated by. . . |
|-------------------------|----------|----------|-------------------------|-----------------------|------------------------|
| Mass (walls) | 40 | 9 | \$4.67 | 2% | Home Photos (inside) |
| Mass (slab floor) | 33 | 11 | \$2.00 | 1% | Home Photos (inside) |
| South Windows* | 27 | 5 | \$13.00 | 6% | Home Photos (outside) |
| Shading (landscaping) | 23 | 4 | ? | ? | Home Photo & Drawings |
| Shading (architectural) | 22 | 4 | \$0.58 | <1% | Home Photos (outside) |
| Insulated Doors | 20 | 11 | \$1.00 | <1% | Home Photo (inside) |
| Manual Setbacks* | 14 | 9 | \$12.67 | 6% | Drawing |
| Progr. Thermostat* | 13 | 4 | \$12.67 | 6% | Drawing |
| Air Leakage Control* | 12 | 10 | \$29.32 | 13% | Chart |
| Extra Wall Insulation^ | 5 | 24 | -\$11.01 | 3% | Photo (utilitarian) |
| Efficient Windows^ | 3 | 12 | -\$5.25 | 4% | Photo (out of context) |
| High Effic. HVAC^ | 2 | 12 | -\$3.92 | 10% | Drawing |
| Extra Attic Insulation^ | 1 | 21 | -\$9.19 | 1% | Photo (utilitarian) |

Note: *identifies greatest money-saving measures; ^ identifies lowest energy- or money-saving measures.

This is a phenomenon that begs for more research. It is possible that the measures increasing the most did so because they were the most unknown. However, another trend was observed. Energy-saving measures illustrated with slides showing attractive home photographs consistent with expected participant values increased more than those using utilitarian charts, drawings, or photographs taken out of context. This suggests that simple marketing techniques could be used to greater advantage where energy consumption is concerned. Experts in environment and energy may communicate information more effectively by taking hints from advertising theory.

Phase 4 Discussion: Even when survey and quasi-experiment participants knew little about passive solar design, a majority were willing to pay more for a passive solar home. After the informational presentation, the quasi-experiment participants' willingness-to-pay increased, even though it was explained to them that passive solar design need not cost more than conventional design.

The informational presentation made a significant difference in participants' energy-saving choices, but not as expected. After the presentation, participants did choose more economically beneficial measures, but not in a logical, consistent way. The most well marketed energy-saving



measures were the most popular in the pretest and did not decrease consistent with their advantages to consumers. Again, the research supports the Phase 1 interviews: the most profitable technologies for diffusion agents with the wherewithal to promote them successfully will succeed. The way the information was presented seemed to make as much or more difference than the facts presented, presenting a possible theme for future research.

Conclusion and Recommendations

The failure of adoption of passive solar homes provides many lessons for the adoption of environmentally protective innovations. Willingness to buy passive solar homes is not an obstacle once homebuyers are made aware of them. The biggest problems seem to be lack of knowledge and supply. Willingness to pay for other energy-saving alternatives also exists, when consumers are aware of their personal costs and benefits.

Diffusion and Marketing: This research supports the work of Brown (1981), calling for more attention to change agents, and the work of Stern (1986) suggesting that marketing can be more important and cost-effective than the size of an incentive. Many Americans are concerned about climate change and our energy supply. However, as with passive solar homes, consumers may be unaware of effective measures they can take to save energy. While alternative energy sources such as wind and photovoltaics are receiving a lot of media attention, and awareness is very high, consumers may be unaware of measures such as passive solar design that are not championed by change agents. Much could be done to increase awareness and understanding of alternative energy choices that consumers could demand.

This study suggests that environmental educators and alternative energy advocates are not reaching mass audiences with effective information. Alternative energy has generally not gone beyond the innovator stage of adoption, and advocates are not reaching audiences in the next group. Environment and energy advocates need marketing resources and expertise to increase the adoption of certain alternative energy sources. It is important to integrate communication theories in ways compatible with consumers' existing values and learning styles to produce information that makes an impact.

Government Involvement: Because they can be viewed as social goods, housing, environmental, and energy initiatives often fall into the realm of government regulation and promotion. Homes are long-term investments and affect all these areas for many years after construction. Those being built today will impact energy consumption and carbon dioxide emissions long after the original owners are gone. Therefore, improvements in the efficiency of buildings/homes could be considered one of government's greatest priorities.

Incentives on every level would be helpful, but limited funds compel prudence in their use. Because research suggests availability is the limiting factor in the adoption of passive solar homes, incentives for builders & developers would be recommended. Governments can take advantage



of market forces, especially when the housing market is slow. Providing incentives for a large builder to offer efficient homes or alternative energy packages might induce other builders to follow.

Consumers are very receptive to energy-saving measures included in the mortgage of a new home showing immediate monthly savings. Considering the effect of homes on the nation's energy consumption, governments could act proactively by establishing a creative financing program. Long-term, low-interest loans can advance conservation measures and alternative energies by making them affordable. Even showing a net monthly gain of a few cents to one dollar can capitalize on Americans' desire to use green energy

At minimum, governments can build new government buildings using the best energy-saving measures and alternative energy sources and using them as demonstration projects. This would serve to make alternative energy and conservation measures visible and accessible. Their potential can be more fully developed if adequate attention is paid to consumer psychology and marketing theory.

Homebuyers and homeowners have little knowledge of energy-saving measures they can take, and it is very difficult for them to make trade-offs. Decision-making tools to help them balance amenities and make trade-offs would be helpful. One example is the energy modeling software that is readily available and useful in determining the best measures to use in a particular home.


Without profits to be made by powerful change agents, even low-cost innovations that offer great social goods and individual benefits seem unlikely to spread. More effort by governments and marketing resources for non-profits is necessary for passive solar design and other low-cost measures to become viable market forces. These social goods are probably destined to remain orphaned innovations with little possibility of widespread adoption, unless they become part of a successful government and non-profit intervention to conserve energy.


Literature Cited

- Brown, Lawrence A. 1981. *Innovation diffusion: a new perspective*. London: Methuen.
- Campbell, Donald T. and Julian C. Stanley. 1963. *Experimental and Quasi-Experimental Designs for Research*. Chicago: Rand McNally & Company.
- Craig, C. Samuel, and Lawrence A. Brown. 1980. Simulating the spatial diffusion of innovation: a gaming experimental approach. *Socio-Economic Planning Science* 14: 166-79.
- Dennis, Michael L., E. Jonathan Soderstrom, Walter S. Koncinski, Jr., and Betty Cavanaugh.



1990. Effective dissemination of energy-related information: applying social psychology and evaluation research. *American Psychologist* (October): 1109-1117.
- Dresner, Marion. 1989-90. Changing energy end-use patterns as a means of reducing global-warming trends. *Journal of Environmental Education* 21 (Winter 1989-90): 41-6.
- Energy Information Administration. 2006a. Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State. Accessed 5 October 2006. Available at: http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_b.html.
- Energy Information Administration. 2006b. Natural Gas Monthly. Accessed 5 October 2006. Available at: http://www.eia.doe.gov/pub/oil_gas/natural_gas/data_publications/natural_gas_monthly/current/pdf/table_21.pdf.
- Fannie Mae. 2002. "Energy Efficient Mortgage" [Summary Brochure]. Accessed 4 October 2006. Available at: http://www.natresnet.org/resources/lender/fanniemaefnm_summary.pdf.
- Farhar, B.C., and T.C. Coburn. 2006. A New Market Paradigm for Zero-Energy Homes: The Comparative San Diego Case Study. Golden, Colorado: National Renewable Energy Laboratory. Technical Report prepared under Task No. ZB03.3003. NREL/TP-550-38304-01. December 2006.
- Festinger, Leon. 1957. *A theory of cognitive dissonance*. Stanford, CA: Stanford University Press.
- Givoni, B. 1991. Characteristics, design implications, and applicability of passive solar heating systems for buildings. *Solar Energy* 47 (6): 425-35.
- Glendinning, Anthony, Ajay Mahapatra, and C. Paul Mitchell. 2001. Modes of communication and effectiveness of agroforestry extension in Eastern India. *Human Ecology* 29 (3): 283-305.
- Haddad, Louis. 1996. The characteristics of decision making in a well-functioning economy. *International Journal of Social Economics* 23 (4/5/6): 207-220.
- Harper, Charles L. 2004. *Environment and Society: Human Perspectives on Environmental Issues*. Upper Saddle River, N.J.: Pearson/Prentice Hall.
- Kahneman, Daniel, and Amos Tversky. 1979. Prospect theory: an analysis of decision under risk. *Econometrica* 47 (2): 263-91.
- Kempton, Willett and Laura Montgomery. 1982. Folk quantification of Energy. *Energy* 7: 817-27.
- Longstreth, Molly, Anne R. Coveney, and Jean S. Bowers. 1984. Conservation characteristics among determinants of residential property value. *Journal of Consumer Research* 11 (June): 564-571.

-
- 
- March, James G. 1978. Bounded rationality, ambiguity, and the engineering of choice. *Bell Journal of Economics* 9 (2): 587-608.
- National Oceanic and Atmospheric Administration. 2005. "Sunshine – Average Percent of Possible." Accessed 4 October 2006. Available at <http://www.ncdc.noaa.gov/oa/climate/online/ccd/pctpos.txt>.
- O’Riordan, Joan P., and Joseph C. Migani. 1979. Barriers to implementing energy conscious design in housing. In *Proceedings of the Fifth National Passive Solar Conference* held in Kansas City, Missouri 3-5 October 1979, edited by Gregory Franta. Newark, DE: Publication Office of the American Section of the International Solar Energy Society, Inc.
- Ormrod, Richard K. 1990. Local context and innovation diffusion in a well-connected world. *Economic Geography* 66 (2) (April): 109-22.
- Oster, Sharon M., and John M. Quigley. 1977. Regulatory barriers to the diffusion of innovation: some evidence from building codes. *Bell Journal of Economics* 8(2) (Autumn): 361-77.
- RESNET (Residential Energy Services Network). 2007. Home Energy Ratings: A Primer. Accessed 4/17/07. Available at: <http://www.natresnet.org/ratings/overview/resources/primer/HP02.htm>.
- Simon, Herbert A. 1955. A behavioral model of rational choice. *The Quarterly Journal of Economics* 69 (1): 99-118.
- Slovic, Paul. 1995. The construction of preference. *American Psychologist* 50, no. 5 (May): 364-71.
- Stern, Paul C. 1976. Effect of incentives and education on resource conservation decisions in a simulated commons dilemma. *Journal of Personality and Social Psychology* 34 (6): 1285-1292.
- Stern, Paul C. 1986. Blind spots in policy analysis: what economics doesn’t say about energy use. *Journal of Policy Analysis and Management* 5 (2): 200-227.
- Tversky, Amos, and Daniel Kahneman. 1974. Judgment under uncertainty: Heuristics and biases. *Science* 185 (4157): 1124-1131.
- Vollink, Trijntje, Ree Meertens, and Cees J. H. Midden. 2002. Innovating ‘diffusion of innovation’ theory: innovation characteristics and the intention of utility companies to adopt energy conservation interventions. *Journal of Environmental Psychology* 22: 333-44.
- Yannas, S. 1994. *Solar Energy and Housing Design Volume 1: Principles, Objectives, Guidelines*. London: Architectural Association.



Yates, Suzanne M. and Elliot Aronson. 1983. A social psychological perspective on energy conservation in residential in residential buildings. *American Psychologist* 38 (April): 435-444.

Zydeveld, C. 1998. From simple design principles to 4000 solar homes factor 4 in energy savings at no extra cost. *Renewable Energy* 15, 240-242.

Due to the need for conciseness in this report, interview results were summarized. For a more complete discussion and quotes from the interviewees, see the thesis, Adoption of Passive Solar Homes in Franklin County, Ohio: A Study from Both Supply- and Demand Sides at The Ohio State University.

Sincere thanks go to all the interviewees who shared their wisdom:

Thank you to the intrepid Central Ohio solar energy advocates who shared their experience and frustrations with me: Jack Hedge, DesignGroup; Tom Maves, Ohio Office of Energy Efficiency; Dave Panich, Panich and Noel; Terry Smith, Foundations 4 Energy; Bill Spratley, Green Energy Ohio.

Thank you to Central Ohio Builders who gave me the important bottom-line perspective: Derrick Layer, C.V. Perry and Company; Lindsay Mays, B & M Construction; Butch Wahlsmith, M/I Homes; Paul Young, Rockford Homes.

Thank you to the Building Professionals and Energy Specialists from Central Ohio and around the country who shared the realities of sustainability with me: Robert M. Carver, P.E., NYSERDA; Roger Clark, TRF Sustainable Development Fund; Cynthia Flaherty, Fannie Mae Central and Southern Ohio Partnership Office; Rick Mappin, Berks County Community Foundation; Wendy Martinez, Countrywide Home Loans; Mat Northway, Eugene Water & Electric Board; Valerie Rauluk, Venture Catalyst Inc.; Paul Rimelspach, Energy Designed Homes; Frank Ritchey, Columbus Department of Development; Mary Tucker, San Jose Environmental Services Department.

Thank you to the very special passive solar homeowners who gave me their rare points of view: Virginie Bouchard, Geno Centofanti, Len and Sally Gibler, Gary Greeler, Geoff and Michelle Greenfield, David and Patricia Henderson, Daniel Hunt, Kevin Eigel, and Crystal Pipic.

Thank you also to the interviewees who chose to remain anonymous and to all the anonymous survey and informational presentation participants. Your help was invaluable.



About the ECARP (Environmental Communication, Analysis, and Research for Policy) Working Group

Located within the School of Environment and Natural Resources, the ECARP (Environmental Communication, Analysis, and Research for Policy) Working Group is a vibrant and multi-disciplinary research, development, and consultation center staffed by a core group of affiliated faculty members and graduate research associates representing the social, management, and natural sciences. In addition to a core of faculty leaders, ECARP serves as a clearing-house, tailored to particular projects, by gathering research and support personnel from across the campus and nation as needed.

The ECARP has five fundamental objectives:

1. To apply technical knowledge and analytical methods to key environmental and natural resource questions identified by clients such as Federal, State, and local management agencies and private entities.
2. To advance the state of knowledge and disseminate findings for concepts and methods concerned with environmental and natural resource issues.
3. To conduct innovative and valuable research that helps frame thinking and debate about environmental and natural resource issues.
4. To recruit top-quality graduate students to the School of Environment and Natural Resources and provide students with opportunities to work with faculty on projects within the ECARP Working Group.
5. To serve as a focus for student and faculty research by applying for and securing research funding from Federal, State, University, non-governmental, and other sources.



Some examples of the types of research and client-based projects the ECARP might undertake include the research and development of:

- policy analysis tools to gauge the effects of policy instruments on target populations and the environment
- stakeholder collaboration and citizen participation processes in natural resources policy
- structured environmental decision making approaches
- cutting edge research in the natural sciences to inform environmental policy choices
- comprehensive environmental risk communication approaches
- innovative environmental education and interpretive efforts
- courses to be offered in the School of Environment and Natural Resources for students as well as the community of environmental professionals

For More Information

More information is available at the ECARP website: <http://ecarp.osu.edu>

As part of its effort to develop and disseminate knowledge, ECARP publishes analytical reports related to environmental and natural resource issues. These reports are available through the ECARP website.





School of Environment and Natural Resources
College of Food, Agricultural, and Environmental Sciences