BARRIERS AND INCENTIVES TO THE ADOPTION OF INNOVATIVE, ENERGY-EFFICIENT HOUSING: PASSIVE AND ACTIVE SOLAR AND EARTH SHELTERED

by

Rochelle Conway

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Approved:

Savannah S. Day

Glen H. Mitchell

Nancy A. Barclay

Robert J. Thee

Robert P. Schubert

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Blacksburg, Virginia

ABSTRACT

The purpose of this study was to determine intermediaries perceptions of barriers and incentives to innovative, energy efficient housing in Iowa. Data was collected by two surveys. The questionnaire for the first survey collected data from 102 communities in Iowa. Respondents were asked to determine the number of building permits issued for all new single family dwellings between 1975 and 1985 as well as the number of permits issued that were for passive solar, active solar, or earth sheltered housing. A rate of adoption was calculated for each community. The second questionnaire surveyed housing intermediaries drawn from the 102 communities included in the first survey. The sample consisted of 481 builders, building inspectors, realtors, lenders, and solar suppliers.

Intermediary groups differed in their perceptions of barriers and incentives to innovative, energy-efficient housing. Significant differences were found among the intermediaries for whether state mandated solar standards would reduce the risk of inspection of solar energy houses and whether risky resale potential acts as a barrier to building solar energy housing. The major barriers were the "first costs" associated with building active solar and earth sheltered housing and the lack of skills among

subcontractors to build active solar and earth sheltered housing.

There was no significant relationship between rate of adoption among communities and their location in the state. There was, however, a significant relationship between category of building official and rate of adoption among communities. Communities with a high rate of adoption did not cluster in any one quadrant of the state.

Additional differences among intermediaries occurred between lenders who had financed innovative energy efficient housing and lenders who had not. Lenders who had not financed solar or earth sheltered housing perceived the barriers to be greater than those who had. There were fewer differences in perceptions among solar/earth sheltered builders and nonsolar/earth sheltered builders.

In conclusion, variability in perceptions among intermediaries on the barriers and incentives to innovative, energy efficient housing impact on the rate of adoption in communities in Iowa.

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CHAPTER I

Introduction

The oil embargos of 1973-1974 and 1979 forced the United States to think about ways to create energy resources to replace the heavy reliance on oil imports. In the decade that followed the first oil embargo, public reaction to the crisis was mixed as to the severity of the shortage and their willingness to accept solar energy as a substitute for traditional fossil fuels. Consumers, however, could not ignore the steeply rising prices for all fuel consumed by Americans during that period. The price of oil continued to fluctuate, peaking at $40.00 per barrel in 1980 and falling to $18.00 a barrel during the summer of 1987. Even though the major focus on energy conservation came immediately following the 1973 and 1974 oil embargos, the public now recognizes that the oil industry is characterized by a high level of change that will never allow them to count on a stable supply or price of imported oil again.

During the decade of the 70s, the United States government at all levels looked for ways to formulate policies and design programs that would scale down the dependence on nonrenewable energy sources. One government approach to conserve energy was to focus on the energy that could be saved by instituting programs that involved the use of solar technology in building design and energy conservative housing innovations. Twentieth century building design contributed to the energy crisis not by intent but by circumstances. Buildings of the last few decades have been designed in spite of the climate, not with it as Americans have systematically turned their buildings inward in an attempt to control the natural environment by unnatural means. Historically, climate has played a critical role in most environmental and architectural design decisions, but many of this century's buildings have been designed as though the sun, a limitless free resource, was not there.

The government took a wide range of approaches between 1975 and 1985 to establish various energy conservation programs. In the late 70s, President Carter called for a Domestic Policy Review (DPR) of solar energy policy. The goals of the Policy included a review of current programs and an analyses of potential contributions of solar energy to the total energy package, as well as recommendations for future solar stratagies (Roessner, Posner, Shoemaker, & Shama, 1979).

The National Energy Act was the major source for financial incentives for households and small business investment in solar systems. A tax program was designed to provide tax credits to residential purchasers of solar hot water systems; passive solar systems were only partially covered under the act's provisions. The DPR estimated that approximately 150,000 residential energy systems might be installed by 1985 with the incentive offered by this legislation (Warkov & Meyer, 1982).

The states' policies had a more narrow focus than those of the federal government and tended to support solar development primarily through tax incentives to the household. Different kinds of incentives were used by states to foster the diffusion of solar technology ranging from income tax credits or rebates to low interest loans as well as small grants. Tax credits are believed to have been the most effective economic incentive for household energy conservation (Barrett, Epstein, & Harr, 1977).

Starting in 1979 the state of Iowa along with six other states were the first to have property tax exemptions for all solar systems. Iowa also had a state grant and loan program for solar that included both passive and active solar housing (the program is not presently active). Additionally, the Iowa Energy Policy Council (1983) (presently called the Energy Bureau of National Resources) encouraged consumers to incorporate a greater degree of passive solar technology into new construction. In addition to the state supported solar policies that existed in the decade after the oil embargo, other ongoing environmental conditions in the state have the potential to encourage consumers to look to alternative forms of energy such as solar.

Iowa is an energy dependent state, importing nearly 98 percent of the energy consumed in the state (Iowa Energy Policy Council, 1983), causing home heating fuel to be a major expenditure for all households. The high cost of fuel coupled with the severity of Iowa's winters are environmental conditions that will continue to exist. One measure of a state's winter weather is the number of heating degree days in a month. For example, the southern United States may have only 1,000-2,000 heating degree days for the whole winter, while Minnesota typically accumulates 10,000 heating degree days or more per year. In Iowa the total number of heating degree days per year averages a little under 6,000 in the southern part of the state and 7,500 in the northwestern part (Hodges & Block, 1979).

While it is clear that Iowa is among the coldest states in the U.S. with high energy consumption, this does not necessarily mean that there is insufficient solar radiation to justify building of innovative, energy-efficient housing such as solar. According to meteorologists there is often an increase in sunny weather in cold temperatures. Clear and sunny weather is associated with radiative cooling of the ground; clouds absorb infrared radiation from the ground and reradiate heat back to the ground, keeping it warmer. Hodges and Block (1979) used meteorological records for Ames, Iowa to exhibit the variations of performance among different heating seasons to illustrate how useful information may be extracted about the behavior of a solar system under a variety of weather conditions. Analysis of several Ames, Iowa heating seasons revealed that in most cases none of the coldest nights were preceded by any of the coldest days. (Ames, Iowa is centrally located in the state.) Despite adequate environmental conditions for solar heating in the state, most homes built in Iowa continue to be placed in neat rows using the standard grid system, ignoring environmental factors such as sun and wind orientation. It is not uncommon to see glass patio doors and/or major glazing areas placed at random with little concern for cold northwest winds or sun. Despite the need for Iowans to take advantage of alternative and supplemental forms of energy such as solar radiation, innovative forms of housing, such as active and passive solar, exist as only a fraction of one percent of all the housing in the state (Conway, 1987).

Other factors that might have a negative impact on public interest in solar do not seem to be present. According to Warkov and Meyer (1982), the characteristics of the local environment, particularly as they offer clues to the social status, exposure to media, cosmopolitan orientation and socioeconomic conditions may be relevant to variation in the rate of public interest in solar expressed by the public. In 1980 the total number of owner-occupied housing units in Iowa was 756,517, compared to all housing units in the state which was 1,121,314. The median dollar value of owner occupied units was $40,600. When comparing these figures to ten other states in the midwest, Iowa ranked seventh out of a total of eleven, with the highest median unit value at $52,800 for the state of Michigan and the lowest median unit value at $36,600 for the state of South Dakota (U.S. Bureau of Census, 1980). The population for Iowa in 1980 was 2,913,808, over half of which was urban. There was no significant drop in population between 1980 and 1985. When considering income as another relevant variable, a comparison of the U.S. and Iowa per capita income shows Iowa to be nearly identical to the national per capita income figures for the years 1960 to 1983 (Survey of Current Business, April 1984).

Public interest in innovative, energy-efficient house forms increased with the rise in fuel prices but the decision to adopt innovative energy-efficient housing is influenced by perceptions. These perceptions depend on users' needs and desires, designers' appreciation of the implications of the innovation, builders' assessment of the market acceptance and of demand for the product, regulatory acceptance and lenders' policies. Other housing intermediaries may also impede or accelerate the rate of adoption of innovative, energy-efficient housing. Factors that impede the diffusion of an innovation through the housing industry such as zoning ordinances, planning regulations, and equipment standards, may explain why new housing innovations diffuse throughout the industry so slowly. One study estimated that it takes an average of seventeen years from invention to first use in the residential construction industry for even successful innovations (McCue & Ewald, 1970).

Accelerated commercialization of solar housing requires that those in a position to influence the marketing and application of the technology be informed accurately about design methods, materials, technical and economic performance, and applicable codes and standards. Housing intermediaries such as builders, building officials, realtors, and mortgage lenders are in a position of acceptance.

Uncertainty exists concerning the intensity of the prospective market demand for solar housing in light of the existence of potential regulatory and institutional barriers or constraints to this form of innovative, energy-efficient housing. If the nation is to realize substantial energy savings from widespread use of solar housing, the potential constraints and/or incentives to acceptance will have to be understood. Basic theories on the diffusion of innovation or adoption of innovations can shed light on the low rate of adoption and serve to identify barriers in the adoption process.

Theoretical Framework

According to Rogers and Shoemaker (1971) there are several elements required for the diffusion process which are: (1) acceptance, (2) overtime, (3) of some specific item, idea, or practice, (4) by individuals, groups or other adopting units linked to (5) specific channels of communication (6) to a social structure, and (7) a general system of values. There are numerous definitions of the study of the diffusion process, however, several elements are common among the definitions: (1) the innovation, (2), the adopting unit, (3) the communication networks, (4) the acceptance process, and (5) the time element.

The innovation, decision making unit passes from first knowing about a product to the time of forming an attitude about the product and the decision to adopt or reject. This innovation, decision process consists of five major steps which are awareness, interest, evaluation, trial, and adoption, with adoption becoming the stage of continuous use. Other researchers have identified similar stages (Holmberg, as cited in Hayelock, 1971; Lionberg, 1960).

Not all innovations are perceived in the same way or adopted at the same rate. An innovation is any product idea, service or practice which is perceived as new by the consumer. It may be accepted by one group of consumers and still be regarded as an innovation by others (Rogers, 1983; Shama, 1982a). Passive and active solar housing as well as earth sheltered has been adopted by some housing consumers, but is still regarded as an innovation by most consumers in the U.S. The rate of adoption of solar energy innovations, including flat plate collectors and other types of active and passive systems is still only a small percentage of all U.S. households (Farhar-Pilgrim & Unseld, 1982).

According to Shama (1982a), an innovation may go through an appearance-disappearance cycle as in the case of solar housing in the United States. There was some solar development in the U.S. in the early 1940s, but it began to falter by the late 1940s. Increased popularity of household mechanical heating and cooling systems combined with falling fuel prices led to a lack of interest in solar architecture (Butti & Perlin, 1980).

Rogers and Shoemaker (1971) and Rogers (1983) believe that it is the characteristics of an innovation that explain its rate of adoption. Their research defines five characteristics of an innovation which are: relative advantage, compatability, complexity, trialability and observability. Relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes. Compatability is the degree to which an innovation is perceived as consistent with existing values, past experiences, and needs of potential adopters. Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use. Trialability is the degree to which an innovation may be experimented with on a limited basis. Observability is the degree to which the results of an innovation are visible to others.

Additional researchers have also found preceptual variables to be successful predictors of adoption. In a study by Ostlund (1974) perceptual variables were found to be more successful as predictors of the purchase outcome than respondent's personal characteristics. Tremblay and Dillman (1983) also found perceptions to be important predictors of what people will accept in housing alternatives, as did McCray, Tremblay, and Navin (1985). Darley and Beniger (1981) investigated eight dimensions by means of which energy-conserving innovations are evaluated, and concluded that peoples' perceptions of an innovation's characteristics, on these dimensions, determine their decisions to adopt that innovation. These dimensions are: (1) capital cost of the innovation, (2) perceived savings, (3) certainty of savings, (4) value, attitude, and style compatability, (5) innovation and life pattern interactions, (6) trialability of an innovation, (7) dissatisfaction with existing situation, and (8) effort and skill involved in installing the innovation.

Other factors also affect the rate of adoption, particularly when the adopting unit involves a group as well as the individual making the decision to adopt a given innovation. As with most housing the adopting unit for a solar energy innovation such as solar housing or earth sheltered may include the lender, appraiser, builder and inspector as well as the consumer. According to Shama (1982a) the greater the number of people composing the adopting unit, the slower the rate of adoption.

Some innovations are intended for, or require the cooperation of groups as in the case of innovative housing in which the family, the builder, the banker and regulatory agencies may be critical to the adoptive decision (Katz, Levin, & Hamilton, 1963; Kelly & Kranzberg, 1975; Shama, 1982a). They described these as collective adoptions that permit any given individual to adopt or not as with the telephone contrasted with floridation which leaves no room for individual options within a community.

As new technologies are diffused into society it is important to look at variables external to the product that may be sources of influence such as social, legal, and institutional factors. Oster and Quigley (1980) identified four characteristics of the construction industry that may contribute to its low rate of technical progress. They identified (1) wide fluctuations in the demand for housing, (2) smallness of firms in the industry with no research and development, (3) difficulty in evaluating potential housing innovation, and (4) reliance on regulatory processes that rely on local political divisions to set standards for structures.

Similar barriers have been identified by other researchers who have studied the housing industry. According to Hirshberg and Schoen (1974), potential resistance to the diffusion of solar energy systems within the housing industry may be due to the unique characteristics of the industry itself. They grouped characteristics of the industry into three categories; technological, economic, and institutional. Hirshberg and Schoen referred to the institutional factors as self-reinforcing resistances to change. He explained that the housing industry possesses formal and informal social systems which are aimed at perpetuating things as they are rather than initiating major changes. In a discussion of the technological factors, Hirshberg and Schoen (1974) stated that the industry is code constrained and that codes are specification rather than performance oriented.

A new technology often conflicts with political, social or institutional realities. One of the principal mandates of the Federal Solar Demonstration program of 1970 was to determine institutional arrangements that posed barriers to solar utilization. Mara and Engel (1982) identified intermediaries necessary for the entrance of solar heating into the residential market place and discussed institutional experiences that occurred in the residential portion of the demonstration. The program which began in response to the Arab oil embargo of 1973 was monitored by the U.S. Department of Housing and Urban Development (HUD) as to the experiences of the program participants. Their survey data indicate where institutional impediments exist in the market place and their findings revealed that real uncertainties exist concerning the relationship between public utilities and widespread application of the judgements made by permanent lenders about the market value of solar energy systems.

Statement of the Problem

Iowa is an energy dependent state, importing 98% of the energy used. Recently developed innovative, energy-efficient types of housing such as passive solar, active solar, and earth sheltered have great potential for reducing the amount of energy consumed in the state as well as the dependency fo people on depleting supplies of fossil fuels. There is limited research applying diffusion of innovation theory to the adoption of innovative, energy-efficient housing. In particular, there is limited research on the barriers and incentives to consumers' adoption of these housing prototypes. Therefore it is important to distinguish factors that may impede or encourage the adoption of innovative, energy-efficient housing and to determine specifically how intermediaries' perceptions may influence the rate of adoption.

Purpose

The purpose of this study was to examine intermediaries' perceptions of barriers or incentives to the diffusion of innovative, energy-efficient housing in Iowa.

Objectives of the Study

1. To examine and compare intermediaries' perceptions of barriers and incentives to innovative, energy-efficient housing with each other to determine whether perceptions vary among groups.
2. To determine whether intermediaries' perceptions of barriers and incentives to innovative, energy-efficient housing differ by category of community group by population and rate of adoption.
3. To determine whether the rate of adoption of energy-efficient, innovative housing varies by: location in the state; category of building official; or proximity in location to the energy-efficient, innovative housing.
4. To examine and compare perceptions of energy-efficient, innovative housing of builders who have built solar or earth sheltered housing with those who have not to determine whether their perceptions differ.
5. To examine and compare lender groups with each other to determine whether their perceptions of energy-efficient, innovative housing differ.
6. To examine and compare perceptions of innovative, energy-efficient housing of lenders who have lent money

for solar or earth sheltered housing with lenders who have not to determine whether their perceptions differ.

7. To determine whether solar suppliers' perceptions of innovative, energy-efficient housing varies with: community location, community characteristics, availability of financing, size of community, or length of time in business.

Definition of Terms

Active Solar House. A house equipped with solar collectors which utilizes energy from sun for heating and cooling the house.

Barriers. Any factor, relationship, or characteristic that has the potential to retard or limit the introduction and widespread utilization of solar energy systems or earth sheltered.

Builder. A person who contracts for and/or supervises the construction of residential housing and holds himself out to the public as such through advertisement and/or affiliation with the Association of Home Builders.

Building Code. A building code provides minimum standards for the safety, health, public welfare, and the protection of property by regulating and controlling design, construction, use, and quality of materials, occupancy, location, and maintenance of all buildings.

Building Code Official. A law enforcement officer who is responsible for approving building plans, inspecting the construction of buildings, and issuing permits of occupancy and who are affiliated with the International Conference of Building Officials (ICBO).

Building Inspector. An individual who is responsible for approving building plans, inspecting construction of buildings, and issuing permits of occupancy. The term refers to all building inspectors who were respondents in this study, either full time building code officials, or part time municipal officials.

Code Variance. A minimum acceptable construction standard applied within the local jurisdiction that must be modified in order for the builder and/or owner to obtain a permit to build.

Diffusion. The process by which an innovation moves from the source of the invention to the ultimate users.

Earth Sheltered House. A house either partially or totally surrounded by soil for the purpose of reducing heating or cooling requirements. It may also include solar characteristics. Housing prototypes: passive solar, active solar, and earth sheltered.

Incentives. Any action taken or in place that facilitates the widespread use of an innovation.

Innovation. A product, idea, service or practice which is perceived as new by the consumer or user.

Innovative, Energy-efficient Housing Alternatives. Active solar, passive solar, earth sheltered.

Intermediaries. Lenders, builders, realtors, and building code officials as well as solar equipment suppliers.

Lenders. Commercial banks that have a mortgage loan department, Savings and Loan Associations, the Farmers Home Administration.

Model Code. Several model building codes are prepared for adoption into law. The major ones are the Uniform Building Code (UBC), the Basic Building Code (BBC), and the Standard Building Code (SBC). The provisions regarding housing from all of these codes have been combined into a document called the one and two Family Dwelling Code (FDC). These codes generally apply to the variance regions.

Non-solar Builder. A builder who has never built a solar house and who does not hold himself out to the public to be a solar builder.

Passive Solar Energy. A house that is specifically designed to capture and store energy for the purpose of heating the house.

Rate of Adoption. The number of passive solar, active solar, and earth sheltered permits issued between 1975 and 1985, divided by the number of permits issued for new single family units in the same time period.

Limitations

Building permits for new construction and records of numbers of innovative, energy-efficient housing built between 1975 and 1985 were not reasonably or consistently available from communities with no building code official and/or no building codes; therefore, these communities were excluded from the survey. Only communities in which rate of adoption could be calculated were included in the study and only intermediaries from these communities were surveyed with the exception of soalr suppliers. There are only 17 solar suppliers in the state, therefore, all suppliers were surveyed.

An additional limitation was posed in the selection of intermediaries from communities with a population of 2,500 or less. Small communities seldom have a lending institution or an in-residence realtor. In this case, these intermediaries were chosen from close-by communities of the same size and in the same quadrant of the state. Builders who were not affiliated with the

Home Builders Association of Iowa also tended to be located in small communities. It was, therefore, necessary to use the telephone directory in 13 communities in order to complete builder intermediary selection in the 2,500 or less population category.

Economic conditions, particularly high interest rates in the past 10 years on mortgage loans could have influenced intermediaries' responses to the survey instrument. Recently lowered oil prices may have influenced intermediaries' perceptions of the need for energy-efficient housing.

Areas outside the city limits of the communities surveyed were not included in the study. Solar or earth sheltered housing that existed outside the city jurisdiction of a community were not calculated in the rate of adoption for that particular community.

Communities not affiliated with model codes were selected by location in each quadrant of the state, in equal numbers to the code affiliated communities in that quadrant and not by population size.

CHAPTER II

Review of Literature

The review of literature in this chapter is composed of three parts. Part one will review the Theory of Diffusion of Innovation and how it applies to housing technology. Part two will examine the housing industry, its various sectors, and the role intermediaries (inspectors, builders, lenders, appraisers) play in the acceptance of energy-efficient, innovative housing. Part three will discuss the constraints and incentives that impinge specifically on the acceptance of innovative, energy-efficient housing such as passive and active solar as well as earth sheltered.

Part I: Theory of Diffusion of Innovation

The basic concepts of adoption and diffusion of innovation have received considerable attention over the years (Brown, 1972; Griliches, 1957; Hagerstrand, 1968; Mansfield, 1966; Ostlund, 1974; Robertson, 1971; Rogers, 1962, 1983; Rogers & Shoemaker, 1971; Ryan & Gross, 1943). Rogers and Shoemaker (1971) identify seven major and six minor diffusion research traditions in terms of the number of empirical studies conducted in each. They identified as the major traditions, anthropology, early sociology, rural sociology, education, medical sociology, communication, and marketing. The minor traditions identified were agriculture, geography, general economics, speech, general sociology, and psychology.

While each of these traditions offer a different perspective on the diffusion process, they also supplement and complement each other. In a review of technological innovations by Kelly and Kranzberg (1975) they reduced the research traditions identified by Rogers to three; the social-psychological, the economic, and the geographical. They made this assessment by analyzing the similarities studied and the conceptual structures used.

The primary concern in the tradition of geography is with spatial diffusion or the relationship between adoption of an innovation and the adopters relative position in physical space (Kelly & Kranzberg, 1975). Past research has shown that the adoption of an innovation follows a normal, bell shaped curve when plotted over time and frequency basis. If the number of adopters is plotted, the result is an s-shaped curve. The s-shaped adoption distribution rises slowly at first when there are few adopters in each time period. It accelerates until about half of the adopters in the system have adopted and then increases at a gradually slower rate (Rogers, 1983).

Hagerstrand (1968) found that adopters in the early stage are usually concentrated in small clusters, and that adoption spreads outward into what he calls the neighborhood effect while saturation of adoption in the clusters increases. He concluded that major channels through which diffusion occurs are communication and direct observation. Generally communications such as mass media include TV, radio, and magazines and direct observation includes personal sources such as peers, friends and neighbors. Hagerstrand recognized the limitation or the "neighborhood effect" model and acknowledges that there are "receptivity factors" which effect spatial pattern and rate of adoption of innovations. These factors include cost, returns, attitudes, predispositions, and value systems. These can be considered modifiers of the neighborhood effect and must be considered in any multivariate theory of the diffusion process.

The work of Brown, an urban geographer and economist, was also discussed by Kelly and Kranzberg. Brown (1972) was concerned that the Hagerstrand model of spatial diffusion dealt only with early adopters and maintained that it would only work in situations in which there were no active propagators. Hagerstrand's (1968) conceptualization is that adoption is the primary outcome of a learning process which implies that only factors relating to the effective flow of information need be considered.

Brown (1972) distinguishes among macro-, meso-, and micro-scale diffusion within an urban area. Macro-scale diffusion takes place within an entire urban system. Meso-scale diffusion is within a specified sub-area of the whole urban system and micro-scale diffusion consists of diffusion among individuals within a small area or single community. However, when boundaries of an "urban system" are poorly defined, they would not support investigations of the influence from larger aggregations on adopter behavior.

The economists' perspective, like the geographer, brings another viewpoint to bear on diverse sectors. In Griliche's classic work on seed corn (1957) he concluded that the entire process of diffusion and the rate at which it is adopted is largely guided by pay-off.

Mansfield (1966) was concerned with the relationship of "pay-off" from the innovation, although his focus was industrial rather than agricultural. He viewed an innovation's rate of diffusion as consisting of four factors: 1) the extent of the uncertainty associated with the innovation, 2) the extent of the economic advantage, 3) the extent of the commitment required to try the innovation, and 4) the rate at which initial uncertainty regarding the innovation can be reduced.

Both Rogers (1983) and Mansfield (1966) identified complexity as a negative influence on rate of adoption. In addition to complexity Mansfield includes two other aspects of "extent of uncertainty". The first is observable results and the second is that those innovations that are more consistent with existing ideas and beliefs seems to spread more rapidly. Rogers (1983) also generalizes that observability and compatibility of an innovation, as perceived by members of a social system are positively related to its rate of adoption.

The third diffusion research tradition as previously identified by Kelly and Kranzberg (1975) is the social/psychological tradition. This research tradition encompasses the behavioral and attitudinal characteristics of individuals or groups in society as a whole. Mansfield (1966) found that the process of diffusion was slowed by the resistance to change. A new idea must be compatable with the norms of the social system, and the adopter must perceive relative personal advantage before he will adopt.

Rogers generalizes that the relative advantage of a new idea or product by members of a social system is positively related to its rate of adoption. He supported his claim with data from 29 studies (Rogers & Shoemaker, 1971). In a case study of solar housing in the Laders, California community, Rogers and Shoemaker (1971) identified the micro level nature of diffusion and the importance of and possible constraints surrounding interpersonal communication networks. He noted that although objective evaluations were important to the first adopters of a new idea, solar energy home owners who adopted the idea later placed more importance on subjective evaluations. The subjective evaluations of opinion leaders also had more impact on diffusion than did the first adopters of solar who were not opinion leaders.

Anthropological studies, particularly those dealing with historical instances of diffusion, have been critized for their lack of attention to process. The elements common to the diffusion process are: a) innovation, b) the adopting unit, c) the communication networks, d) the acceptance over time process, and e) the element of time. The mass media boradened its studies to take into account the social processes involved in the spread of influence and innovation (Katz, Levin, & Hamilton, 1963). Rogers and Kincaid (1981) point out that in recent years, important advances have been made in methods of investigating communication networks and in theorizing about them. They posit that a communication network consists of interconnected individuals who are linked by patterns of flows of information; that networks have a certain degree of structure or stability that is the patterned aspect of networks that provide predictability to human behavior. The structure consists of cliques and interconnections. Methods of network analyses put individuals into cliques on the basis of their proximity in network links so that individuals who are closer are assigned to the same clique. Communication proximity according to Rogers is the degree to which two linked individuals in a network have personal communication networks that overlap. Personal communication networks consist of those interconnected individuals who are linked by patterned communication flows to a given individual. Rural sociology has accumulated several hundred studies on the communication and acceptance of new farm practices (Lionberg, 1960).

Viewed sociologically, the process of diffusion may be characterized as the 1) acceptance, 2) overtime, 3) of some specific item--an idea or practice, 4) by individuals, groups, or other adopting units, linked 5) to specific channels of communication, 6) to a social structure, and 7) to a given system of values or culture. Few studies incorporate all of these elements and in fact, tend to "favor" certain of the elements rather than others. If any one of the elements may be said to be more characteristic of the diffusion process than the others, it is time (Katz, Levin, & Hamilton, 1963).

According to these researchers time is the element that differentiates the study of diffusion both from the study of mass communication "campaigns" with their assumed immediacy of impact and from traditional distribution studies (Katz et al., 1963). Diffusion takes time. It took ten years for hybrid seed corn to reach near complete acceptance in Iowa communities (Ryan & Gross, 1943). According to Katz et al., time is a crucial ingredient in the diffusion process because it enables the researcher to identify the characteristics of early adopting individuals and to establish the direction of the flow of influence.

Another important component of the diffusion process, and in particular to this study, is the composition of the adopting unit. The adopting unit is an individual or a group making the decision to adopt a given innovation. The adopting unit for solar energy innovation may include the family, the architect, the builder, and the bank. Most diffusion studies concentrate on the characteristics of the individual as the adopting unit (Shama, 1982a). Many of the studies in sociology, rural sociology, and marketing have considered only consumer type items, those intended for adoption by an individual.

Kelly and Kranzberg (1975) took four dimensions of the theory of diffusion that impinge on the decision process by which innovations come to be adopted. They describe the following dimensions: 1) sectors or social systems, 2) characteristics of adopters, 3) characteristics of innovations, and 4) propagation mechanisms. Of the four dimension, Kelly and Kranzberg describe sector characteristics as including adopter units which cannot be understood in isolation from the larger context of which they are a part. Rogers and Shoemaker (1971) use the term social systems to refer to such aggregations. Kelly and Kranzberg argue that these larger aggregations of influence also include units other than potential adopters and therefore they use the term sectors. For example, sectors may be state, county, or municipal governments. In addition to their structural features, sectors may be viewed as communication networks and mechanisms of social interaction. As such they are the primary means by which potential adopters learn of an innovation, its success in context similar to their own, and the actions of significant others (pace setters, opinion leaders, etc.).

Rogers maintains that networks play a very crucial role in diffusion and that individuals tend to be linked to others who are close to them in physical distance and who are relatively homophilious in social networks (Rogers & Kincaid, 1981). If everything is equal, individuals form network links that require the least effort and that are most rewarding. Both spatial and social proximity can be interpreted as indicators of least effort. Interpersonal communications may involve a very limited number of people, but are very effective in convincing the individual to adopt the innovation (Shama, 1982b).

One of the major contributions of diffusion research to understanding the role of information and communication in the diffusion of solar innovations is the identification of "threshold of knowledge" in the spread of new technologies. This threshold describes the self-generated pressures toward adoption of solar innovations as increasing numbers of consumers become aware of the idea. Rogers and Shoemaker (1971) term this informal pressure the "diffusion effect." Their assessment is that there is an increasing amount of influence upon homeowners to adopt solar innovations that result from an increasing rate of knowledge and adoption within the social system. However, according to Shama (1982a) until 20% to 30% of all homeowners are knowledgeable about solar, little adoption of the idea is likely to occur.

Part II: Housing Intermediaries' Role in the Acceptance of Innovative, Energy-Efficient Housing

The construction industry is the nation's largest industry and home building is the largest category in construction. For the most part residential construction is characterized by specialization and smallness with local area markets. The industry includes thousands of small firms classified as builders, general contractors, specialty contractors, unions, material producers, wholesalers and distributers as well as related institutions such as real estate firms, financial institutions and government officials. It is a complex and interrelated group of individuals who rarely respond and act simultaneously to new technology. Each building project is a discrete event, with the major participants coming together in an ad hoc and temporary contractural relationship. A study of the adoption of three new energy technologies (Schoen, 1963) found a history of unsuccessful attempts at implementing and commercially diffusing new technologies within the construction industry.

The small scale of firms in the construction industry may also reduce the incentives for private research and development. In a study of regulatory barriers to the diffusion of innovation, Oster and Quigley (1980) cite four characteristics of the industry that may be cause for its backwardness which are: 1) effective demand for housing is subject to wide fluctuations, 2) small scale firms in the industry may reduce the incentives for private research and development, 3) merits of a particular idea or potential innovation may be hard to evaluate because performance in materials, design or construction methods depends on complex interaction with other parts of the structure, and 4) fragmentation of the market is reflected in a cumbersome regulatory process which relies on local political diversions to set standards and to enforce regulations in materials design and performance and safety characteristics of residential structures.

The Ehrenkrantz Group/Gershon Meckler Associates (1979), under contract with the National Institute of Building Sciences (NIBS), conducted a study of the existing process of introducing innovation into the building industry. They analyzed constraints to building innovations in the consumer, financial, design, construction/labor, information, and regulatory sectors. The major constraint identified was in the regulatory sector with its diversity of requirements for codes and regulations. Constraints that building codes impose on the adoption of housing was a frequently cited barrier in their study of the industry.

According to Field and Rivkin (1975), "building code approval is the gateway through which all construction must pass" (p.42). The code often stipulates what products can be used for building, what processes of construction are acceptable, and who can do specific jobs. These codes are powerful documents favoring certain ways of doing business and excluding others. Building code regulation, like residential construction, has long been considered a local activity.

There is pressure to turn away from local codes because of a growing public criticism of antiquated local code provisions. However, having a model code does not imply that the code is current. Model code associations annually update their codes to reflect revised or newly adopted standards, however, the local revision is much less frequent. Procedures for modernizing and amending local codes are slow and laborious and small communities may find it to be an unjustifiable expense (Field & Rivkin, 1975).

Even with model building codes, building regulation is the political responsibility of the local government and regulations are enforced by a local building official who exercises considerable influence in proposing and evaluating standards (Oster & Quigley, 1980).

Seidel's (1978) research on housing costs and government regulations identified two types of costs attributable to building codes, those associated with the disruption of the free market and those related to administration inefficiencies in implementing the code. He maintains that like any government regulations which change the incentives and impose constraints on the operation of the free market, building codes affect the production efficiency of the industry and inhibit innovation. One of the primary objectives of Siedel's survey of the housing industry was to determine the extent to which government regulations are problematical compared to other aspects of conducting business in the housing industry. His 1976 survey of the National Association of Home Builders membership list showed that government regulations and the attendant bureaucratic controls were considered the most significant problem of doing business followed by inavailability of financing, lack of suitable land, material shortages and labor shortages. Building officials can be a part of the bureaucratic control and are predominantly recruited from the construction industry. This suggests that building officials more readily accept construction products and techniques familiar to them from their own past experiences and are reluctant to approve innovations (Siedel, 1978; Ventre, 1971).

When confronted by novel design proposals, there are few reliable sources from which a building official may obtain the information necessary to pass judgment on a plan. The model code groups offer such a service but Siedel (1978) found in his survey that, more frequently, officials tend to rely on their own experience. Communities that do not use model codes do not have access to technical information from the model code groups (Field & Rivkin, 1975; Siedel, 1978).

The innovative designer must comply with local building codes in order for the owner to obtain a permit to build. When the innovative design falls outside the code it can be difficult to have it accepted. According to the Ehrenkrantz Group (1979), procedures for appealing the situation vary from personal arrangement with the local building inspector to a formal hearing through a board of appeals to either waive code requirements or permit an exception and any of these procedures are time consuming. The development of a new product or process in construction even if it reduces cost without affecting quality will not invariably be welcomed by all interested parties (Oster & Quigley, 1980).

The constraints which building codes and the associated approval process impose upon adoption of housing innovation has long been a frequently cited barrier in the building industry. The Kaiser Committee (1968) reported that the lack of uniformity of building codes and zoning ordinances seriously restricted changes in housing technology. The National Commission on Urban Problems (1968) also identified building codes as a major barrier to the adoption of housing innovation.

Building code officials are responsible for seeing that the code is carried out and are personally liable for their actions in carrying out their duties. The Ehrenkrantz Group (1979) cited that the risk associated with new products and technology may be a factor in the decision of the building code official in approving or disapproving their use in cases where conformance with code provisions is in question. According to Field and Rivkin (1975) most officials come out of the local construction industry trained as members of building trades or as general contractors. This may be a positive qualification but it can also be counter productive. Field and Rivkin point out that while they should be receptive to conventional and innovative applications, their experience, bred of the local construction business confines their expertise to conventional ways.

Builders and the construction industry itself can also impose barriers and constraints to housing innovation. Field and Rivkin (1975) maintain that the residential construction environment strongly influence the extent to which and the manner by which innovation takes place. Entrepreneural behavior in residential construction is influenced by two dominant forces, 1) the instability of production volume from one year to the next and 2) the local nature of demand. The builder must adjust to the extreme local nature of demand for the buyer seeks housing that meets his needs in regard to community, place of work, and public services.

Government's role in regulating construction has long been an established facet of the building process. The earliest of these regulations had as the principal objective the punishment of negligent builders. As society has become more urbanized, the regulatory goal was superceded by the importance of protecting property and lives. Finally, as the complexity of construction techniques increased, codes have also performed the role of insuring the home buyer and the lender of some publicly established minimum of safety and quality (Siedel, 1978).

According to Nelkin (1971) the compartmentalized character of the housing industry has contributed to the lag in technological change and the structure of the industry has been maintained by tradition. Small builders often operate on a handicraft basis and it is difficult for them to fund research and development. They often have little risk capital and little profit motivation to engage in costly and long-term innovative activities. Innovation when it occurs tends to be piecemeal.

There seems to be a measure of agreement among researchers who study the building industry that even though there are varying attitudes in the profession concerning innovation, the prevalent attitude is one of conservatism. The use of new products and technology as well as the development of new technology is costly in terms of time and risk to the various members of the building sector.

According to the Ehrenkrantz Group (1979) building contractors can readily accept new construction techniques and equipment when it reduces costs, simplifies procedures, and shortens construction time. Innovation in actual building construction is a risky problem for the contractor. In a conventional construction contract, the contractor takes responsibility for the procurement, construction,and start-up operation of the building. New products constitute more risk for the contractor since there are often no alternative suppliers and only short-term warranties from manufacturers, no guarantee of effectiveness from the designer, and different installation methods. Hirshberg and Schoen (1974) state that a prior condition for the successful diffusion of a technological innovation is the demonstration of its technical feasibility. In addition to normal engineering issues, feasibility must be demonstrated to the buyer/specifier--in this case the builder. These demonstrations must be of sufficient scale and operated under normal industry conditions so that they are perceived by industry members as demonstrations under real conditions. Industry leaders are rarely impressed by "model house" demonstrations. A second condition concentrates on economic feasibility, but Hirshberg and Schoen (1974) feel that it is seldom sufficient to ensure rapid acceptance and diffusion of a technological innovation, particularly when it does not involve a new service but competes with an existing service.

In their analysis of the various sectors of the building industry the Ehrenkratz Group also found that there are factors in the lending sector that act to reduce the flow of innovation in the industry. Lenders view each building project from the perspective of possible and eventual ownership. The lender s prime concern, with respect to innovation, is where they perceive it detracts from resale potential. For example design style has often been an area in which lenders have made stipulations (Barrett Epstein, & Harr, 1977; Ehrenkrantz Group, 1979). A study that focused on lender's receptivity to housing innovations and energy conservation also revealed that the lenders' primary concern with housing innovation is its impact on the market value of the property (Barrett, et al., 1977).

Given the limited number of solar homes being built in most lending areas today lenders are faced with an absence of comparable sales data. This is not an insurmountable problem but Barrett et al. (1977) feel that "lenders are more likely to evaluate property at a price that does not reflect all the additional solar costs or employ some other risk-limiting strategy that precludes financing or terms equivalent to those available for non-solar heated housing"(p. 25).

Treatment of property appraised for additional costs attributable to a solar energy installation or energy efficient design (such as passive solar) appears to be a most difficult question facing lenders. In the Barrett et al. study none of the loans reported for new solar-heated homes included all the cost of the solar energy installation in the appraised value; most were for 55% or less of the total costs involved. When lenders were asked how they would treat the extra costs of the solar energy system in the appraisal of property value, 57% indicated they would exclude either all or part of additional costs from appraised value (Barrett et al., 1977).

The working papers on marketing and marketing acceptance of the solar and solar heating demonstration program conducted by the Real Estate Research Corporation (1978) found that construction lenders whose institution made a special appraisal of solar units handled the cost of the unit differently. About half included the entire additional solar equipment cost in the value of the home and the other half excluded the cost entirely. In general lending institutions that provide construction financing impact the development of solar energy in three primary ways: 1) the general willingness to provide construction financing for solar equipped units, 2) the terms under which construction loans on solar houses are made relative to similar non-solar units and 3) the valuation of solar units in the institutions' appraisal process (Real Estate Research Corporation, 1978).

Builders may also arrange their own financing for houses they build. The real estate research study shows that similar proportions of both solar and non-solar builders provide assistance to purchasers in arranging permanent financing for their units. The inability of small builders to employ this marketing tool is documented in their findings. According to the study larger builders are more likely to utilize this marketing technique than small builders which could impact on consumers living in areas dominated by small builders.

Real estate appraisers are also in a position to influence innovation in housing. McCray and Weber (1981) interviewed housing intermediaries in Arkansas and Oklahoma in order to identify intermediaries' reaction to earth sheltered and passive solar designs. Intermediaries identified several factors that caused risks to the intermediaries. Real estate appraisers identified lack of knowledge, experience, and comparables, as well as cost data, and consumer knowledge as constraints to the adoption of both passive solar, and earth sheltered housing. Appraisers felt additional research was needed prior to an appraisal of such units and other risks were associated with perceived higher construction costs and financing costs. The researchers concluded that risks associated with the involvement of housing intermediaries must be reduced if the innovative systems are to become diffused in a significant way.

Part III: Constraints and Incentives to Innovative, Energy-Efficient Housing

Recent studies that have examined barriers and/or incentives to the diffusion of innovative, energy-efficient housing, such as passive and active solar as well as earth sheltered, have identified a variety of actions that may impede or encourage adoption. Most of the studies fall into four general categories: 1) economic feasibility, 2) legal and regulatory issues, 3) the structure of the housing market or sector, and 4) reliability of the system (solar applications).

The process of diffusion of innovative, energy-efficient housing is influenced by factors imposed by various sectors of the housing market (Barrett, et al. 1977; Bezdek & Maycock, 1977; Booz-Allen, & Hamilton, Inc. 1974; Combs, 1987; Combs & Tremblay, 1981; Hirshberg & Schoen, 1974; Mara & Engel, 1982; Shama, 1981, 1982a, 1983). Housing intermediaries such as builders, lenders, building officials, and realtors, as members of the various sectors, have the potential to impede and/or facilitate the widespread acceptance of housing innovations. Intermediaries become part of the adopting unit even though the ultimate adopter may be the family or the individual. In a review of literature of residential solar constraints and incentives, Little (1976) suggested that influencing factors are found in the regulatory legal sectors as well as financial areas. Little's review (1976) cites a survey of potential solar consumers and representatives of various industry sectors and government organizations conducted by Booz-Allen and Hamilton, Inc., in which they state that "the economic barriers were considered by all groups to be the most significant" (p.42).

Even if the costs of solar systems are acknowledged to be competitive, the high first cost of the system or additional costs associated with solar housing may pose problems to consumers in providing a down payment. Lenders generally require homeowners to provide a certain percentage of the purchase price of the home as a down payment. Consequently the down payment required for a solar equipped home will be greater than that on an identical home with a conventional fuel system (Barrett et al., 1977). Solar "first costs" present no insurmountable barriers to the individual obtaining a mortgage loan, assuming the borrower has sufficient financial resources to meet the higher down payment, because the lender has the assurance that the cost of a solar system is worth the price to at least one consumer. On the other hand, one of the chief concerns of the construction lender is whether the speculative builder will be able to find a buyer for his home. The present "first costs" for solar heating may cause construction lenders to question the ability of developers to market solar heated homes on a speculative basis, thus posing a potential financial barrier to the speculative builder (Barrett, et al., 1977). Shama (1982b) as well as others have also pointed to high "first costs" of solar equipment as a major barrier to commercialization.

In general, lenders are concerned about present uncertainties of performance and the economics of residential solar systems. A key concern of the lender is the absence of comparative sales data. Although the methodologies of life/cycle costing are well developed, attempts to compare the life/cycle costs of solar and conventional systems are hampered by the paucity of solar systems data (Little, 1976). In the interim, energy output, utility savings, upkeep, and durability will be regarded as indicators of value. Despite the diversity of concerns among lenders, an underlying issue is the impact of including solar heating systems in the value of the loan (Barrett et al., 1977). Some researchers feel there is a need for more financial incentives in order to accelerate the products' adoption rate (Bezdek & Maycock, 1977). The most common financial incentives offered so far are income tax credits for purchase of solar equipment and federal tax credit designed to reimburse purchases of solar equipment as well as property tax exemptions imposed at the state and local level. However, the Booz-Allen and Hamilton, Inc., study showed that property and sales tax exemptions are capable of providing only small unit incentives. State income tax rates are generally not high enough to allow for substantial tax savings from tax deductions.

Shama (1982b) expresses similar views when he states that economic incentives alone may have limited value in accelerating adoption. A recent study shows that adoption rates increase significantly when economic incentives are part of integrated policies stressing information, consumer protection, product quality, and incentives (Koontz, Genest, & Bryant, 1980).

Financing is also a relevant factor influencing the adoption of earth sheltered housing. A paper in the proceedings of the Western Sun 1980 Solar Update stated that the primary problem of financing an earth sheltered house has to do with financing under conditions and guidelines of the existing policies of financial institutions. Financial institutions need more information to allay some of the concerns about resale potential. "Because earth sheltering is not as yet a socially acceptable concept, it is going to take some time to get the financial institutions to change" (Scott, 1980, p. 73).

The Underground Space Center (1980), in a study identifying barriers and incentives to earth sheltered housing, also identified financing as a frequently cited barrier as well as building codes and zoning regulations. They summarize financial barriers as the result of lenders' perceptions about solar or earth sheltered housing due to the newness of the technology in today's housing market.

According to Little (1976) the general consensus of the literature is that despite the variability of building codes, they do not present a serious barrier to the installation of solar heating and cooling systems. "The present model codes do not have provisions that will seriously affect the implementation of solar technology" (p. 86).

Contrary to this way of thinking, Field and Rivkin (1975) express the opinion that regardless of what construction advances are accepted by model code associations or other voluntary organizations, in most states the power to adopt or reject them still rests with local officials. The legal action of promulgation is a local prerogative often jealously guarded as home rule power. Local drafters are not bound to national models; rather they are limited by the discretion afforded them by local politics. Field and Rivkin suggest that as long as the power to decide on code standards and enforcement remains a local prerogative, fragmentation and variation will persist.

If existing standards are not appropriate, building officials, due to liability, may be conservative in their decision with regard to innovations (the Ehrenkrantz Group, 1979). The Westinghouse Phase Ø Report (cited in Little, 1976) reached the conclusion that code officials will have to be educated about solar and that there is a strong need to provide code officials, builders, and equipment manufacturers with information to help them to perform their duties and prevent code barriers. Services offered by model code groups include engineers and experts in construction to assist members in the interpretation and application of model codes but are not of much use if the code does not provide for a particular innovation (Johnson, 1979).

Current treatment of solar energy in existing codes can impact on the rate of adoption. Few code authorities have enacted building code provisions applying exclusively to solar energy systems. Those few that have, concentrated on making sure that the work is done by a qualified person or assuring that solar installations pose no threat to health and safety. There are one or two areas peculiar to solar energy systems that are within the purview of the building officials concern with health and safety. Active solar collector arrays are significant additions to the roof structure and therefore must meet wind, snow, hail, and other roof load regulations. A second area that effects solar energy systems is the requirement that nonpotable substances flowing through a plumbing system in a residence be completely separated from the potable water supply. Although this code requirement was not adopted for solar energy systems, it does have significant impact on all active liquid systems which use nonpotable fluids in the heat transfer medium. There have also been some recent fears expressed that existing codes will pose a problem for passive systems. Some builders in the HUD demonstration program have reported delays in code approval caused by the absence of fire resistance rating for some materials used in passive systems (Johnson, 1979).

The HUD residential solar demonstration program was a part of the national program for the solar heating and cooling of buildings created by Congress through Public Law 93-409. This program was in response to the Arab oil embargo of 1973 and was designed in part to demonstrate the use of readily available solar technologies in residential and commercial buildings. The Department of Housing and Urban Development has conducted extensive monitoring of the experiences of program participants. This information has been used in a number of ways, several of which are relevant to the question of institutional barriers to solar development. The survey data and other results indicate where institutional barriers exist in the market place. In an assessment of the program experiences, Mara and Engle (1982) summarize that building codes have not posed serious problems in the construction of HUD demonstration homes although some builders reported delays that were caused by code officials' unfamiliarity with solar's mechanical interface with the conventional heating system. Areas of uncertainty at the time of their assessment of the program were concerns with the relationship between public utilities and widespread solar applications and the judgements made by permanent lenders about market value of solar energy systems. There were also uncertainties about passive solar applications.

According to Hirshberg and Schoen (1974), codes are a frequently cited barrier to housing innovation among members of the construction industry. Interviews with builders, developers, architects, and others revealed that the list of institutional barriers to widespread diffusion of new energy technologies is extensive and that most of the barriers, as stated earlier, reflect the inherent nature of the construction industry. Little (1976) also cites industry fragmentation as well as the industry's first-cost emphasis, construction/design requirements, dissemination of information, and labor constraints as barriers to the acceptance of solar heating and cooling.

McCray and Weber (1981) interviewed housing intermediaries in Arkansas and Oklahoma in order to identify respondents' reaction to earth sheltered and passive solar designs. Constraints to adoption identified by intermediaries as causing risks were lack of consumer knowledge and resale potential according to intermediaries. These risks were not reduced by energy savings potential or life cycle cost considerations.

A study by Combs (1985) that surveyed homebuilders' perceptions of the acceptability of current solar and earth sheltered designs indicated that many builders perceived it difficult to obtain designs that consumers find attractive, that are acceptable in existing neighborhoods, that consumers find psychologically easy to live in, and that consistently work. A finding particularly relevant to this study suggested that home builders who construct houses primarily in rural areas find it less difficult to obtain designs attractive to consumers and that are acceptable in existing neighborhoods than those who build primarily in urban areas. This is consistent with an earlier study by Combs and Tremblay, Jr. (1981) in which data indicate that solar houses are generally not evaluated as providing the appropriate image of a home.

Appearance or design related factors were also constraints identified by builders in eastern Iowa in a 1983 survey by Conway (1987). The study revealed that builders' assessment of perceived constraints to the use of passive solar design were first costs, appearance, and lack of consumer information.

Restrictive covenants, legal agreements which affect the use of land, may also be a barrier to the adoption of innovative, energy-efficient housing alternatives. Neighborhood disputes have been reported around the country and at least one conflict, Kraye Vs. Old Orchard Association, has required a court judgement for resolution (Johnson, 1979). Some observers have feared that land use and aesthetic restrictions may be a frequent impediment to the installation of solar energy devices (Hayes, 1979; Johnson, 1979; Wiley, 1979; Ziebarth, 1980). Roof mounted solar collectors are prevented in communities with restrictive convenants limiting roofing materials to cedar shingles or forbidding roof top appliances. Covenants that were originally intended to restrict rooftop air conditioners and antennas may ban appliances and installations visible to neighbors. More generally, covenants may establish homeowners associations or architectural review committees empowered to prohibit exterior changes to neighborhood properties (Johnson, 1979).

The energy crisis has fostered a great deal of interest and activity in new forms of housing. One type of dwelling which has been identified along with passive and active solar housing is earth sheltered housing (ESH) or underground housing. Interest has grown over the past 15 years even though the rate of adoption could still be characterized as slow. Prior to 1973 there were only a few scattered examples of underground buildings in the United States. In 1976 it was estimated that there were about 50 houses compared to 1979 when the estimate was 1,500-3,000 houses completed that year (Sterling, 1980).

Most of the houses so far have been individual houses built in rural areas or outer suburban lots. This has minimized the need for harmonizing with existing structures as well as avoiding conflicts that an innovative concept faces in an established area (Labs, 1981; Frenette, 1981; Sterling, 1980; Scott, 1980). The social acceptability of an idea, such as an innovative house form and the attitudes surrounding it, can act as an impediment to its diffusion (Sterling, 1980). One of the problems encountered with ESH appears to be public attitude toward the design and underground living, but the research is sparce according to Dr. Fairherst at the University of Minnesota, Department of Civil and Mineral Engineering (Sterling, 1980). As the housing concept matures, more houses are being built in increasingly urban settings.

The growth in interest in underground space use has caused several centers with diverse backgrounds to take an interest in earth sheltered housing; the Department of Civil and Mineral Engineering at the University of Minnesota; The Underground Space Center in Minneapolis, Minnesota; the Department of Civil Engineering and the Department of Family Management, Housing and Consumer Science, Oklahoma State University; and the University of Wisconsin-Milwaukee Institute for Underground Space Utilization.

In 1978, the Department of Housing and Urban Development's Office of Policy Development and Research contracted with the Underground Space Center to study building codes, zoning ordinances, and financial impediments to earth sheltered housing. The purpose was to assess the extent that such institutional factors might act as barriers to earth sheltered housing. The key results later published in a book prepared by the Underground Space Center were as follows:

1. Building codes present some constraints on design but since local codes as well as earth sheltered design vary widely, it is difficult to generalize. In most cases houses can be designed to meet normal building code provisions.
2. Bureaucracy is an area where the major impediments to earth sheltered housing exists. Some are attitudinal problems, particularly at the lender/public interface. Some financial impediments, however, stem from a lack of information and the newness of the application.
3. Zoning ordinances are locally adopted and administered and there is no model national document that communities can adopt, therefore they vary widely. When existing ordinances, tailored to regulate conventional existing housing are applied to innovative housing types such as earth sheltered structures,

conflicts do arise. Some states such as Minnesota have attempted to clarify issues (that represent constraints to ESH) at the state level in order to encourage change in local ordinances. The Minnesota legislation amends the authority for zoning provision so that no local ordinance may prohibit earth sheltered construction (Sterling, Aiken, & Carmody, 1981).

The HUD research also investigated attitudes and the variance process relating to zoning issues. Some aspects of these zoning ordinances and the process of obtaining variances are quite subjective. Two such areas that are behind the intent of many zoning ordinances are aesthetics and maintaining property values. Local zoning boards are rarely inclined to grant variances in cases where there is reasonable neighborhood opposition.

Public reaction to ESH with regard to such matters of how such a structure might effect surrounding property values or fit into the neighborhood design may act to discourage positive and creative alternatives such as earth sheltered housing or more importantly cause a zoning board to deny a requested variance. However, this type of impediment to ESH is vague and hard to document (Sterling et al., 1981).

More recent research by Bartz and Cook (1987) found that ESH homeowners are more satisfied with their homes than are owners of traditional structures, and in addition, attitudes of ESH owners toward earth sheltered living improves over time. Although attitudes of owners of ESH and potentially others may be improving, the financial barriers expressed earlier in the 1979 HUD research are also being expressed in research published by Impson and Impson (1984), and Hanzal-Kashi and Combs (1987).

Impson and Impson (1984) state that many of the ESH are primarily owner financed. Lenders are concerned about possible resale value of an unconventional structure. This is consistent with the experience described by Scott (1980) in his attempt to find financing for clients wanting to build ESH. Impson and Impson also point out that appraisers, unfamiliar with ESH cannot apply their standard appraisal techniques to this type of structure. They further state that codes and standards are not written for application to ESH and that innovative structures often cannot be accurately evaluated using standards and codes designed for more traditional construction techniques.

Hansal-Kashi and Combs (1987) found that loan officers' attitudes toward earth sheltered housing were not consistent. In their study, even though few loan officers indicated that they made loans on ESH, they had opinions about financing. The loan officers favorable toward ESH, favored the inclusion of energy costs as an appraisal feature and the use of specialists in energy efficient housing in the loan department while those unfavorable toward financing did not support either of these policies.

Summary

Basic concepts regarding the theory of diffusion of innovation have been used by a number of basic research traditions. Rogers and Shoemaker (1971) identified seven major traditions: anthropology, early sociology, rural sociology, education, medical sociology, communication, and marketing. Kelly and Kranzberg (1975) reduced these traditions to three: the social-psychological, the economic, and the geographical. While each of these traditions offers a different perspective on the diffusion process, they supplement and complement each other. The geographical tradition is concerned with spatial diffusion and the adoption distribution pattern of consumers. The economist's perspective adds another point of view such as Griliches' classic work on seed corn. He concluded that the entire process of diffusion and its adoption rate is largely guided by pay-off for the consumer. Mansfield's work (1966) was also concerned with the relationship of "pay-off" from the innovation.

The social/psychological tradition discussed by Kelly and Kranzberg (1975) had to do with behavioral and attitudinal characteristics of individuals and groups.

Mansfield (1966) and others found that the process of diffusion was slowed by the resistance to change. A new idea or product must be compatible with the norms of the social system and the adopter must perceive relative personal advantage before he will adopt.

Important advances have been made in the methods of investigating communication networks and how individuals are connected by patterns of flows of information. Viewed sociologically, the process of diffusion may be characterized as the acceptance over time of some idea, item, or practice by individuals or adopter units linked by specific channels of communication (Katz, Levin, & Hamilton, 1963). Most of the diffusion studies in the past have concentrated on individuals rather than the adopter unit. Shama (1982a) suggests that the adopting unit in the case of solar energy housing may be the family , the architect, the builder, and the bank. Much of his work has focused on the adopter unit. A major contribution to diffusion research and understanding the role of information and communication in the diffusion of solar innovation is the identification of "threshold of knowledge" in the spread of new technologies. Rogers and Shoemaker (1971) call this the "diffusion effect" and that there is an increasing amount of influence upon the homeowner to adopt solar innovations that result from an increasing rate of knowledge and adoption within the social system.

The body of research that has specifically addressed housng intermediaries' role in the acceptance of an innovation tends to focus on the constraints that are imposed by the financial, construction/labor, information, and regulatory process and the barriers they pose to the diffusion of housing innovations. These studies suggest that when confronted by novel design proposals, there are few reliable sources from which the building official may obtain information and that officials tend to more readily accept construction products and techniques familiar to them from their past experiences. The Ehrenkrantz Group (1979) cited that the risk associated with new products and technology may be a factor in the decision of the building code official in approving or disapproving their use in cases where conformance with code provisions is in question. There seems to be agreement among researchers who study the building industry that even though there are varying attitudes in the profession concerning innovation, the prevalent attitude is one of conservatism. The Ehrenkrantz Group (1979) and Hirshberg and Shoen (1974) found that building contractors can readily accept new construction techniques and equipment. When it reduces costs, simplifies procedures and shortens construction time. Other researchers have also found that there are factors in the lending sector that act to reduce the flow of innovation in the industry (Barrett, Epstein, & Haar, 1977; Ehrenkrantz Group, 1979).

Recent studies that have examined barriers and/or incentives to the diffusion of passive and active solar as well as earth sheltered housing have identified a variety of actions that may impede or encourage adoption. They tend to fall into four categories which are economic feasibility, legal and regulatory issues, the structure of the housing market, and reliability of the system (solar applications). In a review of the literature of residential solar constraints and incentives, Little (1976) suggested that influencing factors are found in the regulatory legal sectors as well as financial areas. A survey of potential consumers and representatives of various industry sectors and government organizations conducted by Booz-Allen and Hamilton, Inc. (1974) found that economic barriers were considered to be important barriers. "First costs" may cause construction lenders to question the ability of developers to market solar heated homes on a speculative basis. Some researchers state that there is a need for financial incentives in order to accelerate the solar products' acceptance (Bezdek & Maycock, 1977; Shama, 1982b). Financing is also a relevant factor in influencing the adoption of earth sheltered housing (Scott, 1980).

The Department of Housing and Urban Development has conducted extensive monitoring of solar technologies in residential and commercial buildings. In an assessment of the program experiences, Mara and Engle (1982) summarize that building codes have not posed serious problems in construction of HUD demonstration homes although some builders reported delays that were caused by code officials unfamiliarity with solar's mechanical interface with the conventional heating systems. Other researchers have reached the conclusion that there is a strong need to provide code officials, builders, and equipment manufacturers with information to help them perform their duties (Little, 1976).

Several studies have cited design factors as a constraint to building solar and earth sheltered housing (Hayes, 1979; Johnson, 1979; Wiley, 1979; Ziebarth, 1980; combs, 1985; Conway, 1987).

Other factors that may impede the adoption of earth sheltered housing were published in a book prepared by the Underground Space Center (1980) which were: constraints of building codes or design, attitudinal problems particularly in the lender/public interface, some financial impediments, zoning ordinances and the variance process and the effect of an earth sheltered house on surrounding property values.

CHAPTER III

Methodology

There were two phases to this study, the initial survey and the second survey. The purpose of phase one, the initial survey, was (a) to obtain background information on communities in order to determine the rate at which communities in Iowa were adopting innovative, energy-efficient housing, and (b) to generated a pool of communities from which to draw respondents for the second survey. The purpose of phase two, the second survey, was to determine the perceptions of lenders, builders, building inspectors, realtors, and solar suppliers regarding the barriers and incentives to building innovative, energy-efficient housing in Iowa.

Initial Survey

The methodology utilized to conduct the first survey is described in the following sections a) description of the instrument; b) selection of communities; c) selection of code officials; d) data collection; and e) analysis of data.

Description of Instrument. A one-page questionnaire developed by the investigator solicited information from communities on the number of building permits issued for innovative, energy-efficient housing units in their community as well as the number of building permits issued for single family dwellings constructed within the same time frame (years 1975 through 1985). A copy of the letter and questionnaire can be found in Appendix A.

Selection of Communities. The communities (51) that regulated homebuilding through the use of a model code (Uniform Building Code) and had a building inspector who was a member of the Model Code Association for the state (International Conference of Building Officials) were included in the survey of communities. An equal number (51) of communities who had not adopted the model code at the time of the survey were also included in the study. This particular group of communities consists almost exclusively of those that have a population of 2,500 or less (59% of the communities in Iowa fall into this population category). The way that this second category of communities was chosen was to divide the state geographically into four quadrants. A number of communities were randomly selected equal to the number of model code affiliated communities in each quadrant. The division of the state in this manner using Ames, Iowa as the mid-point, was to allow for any differences in climate between the north and south or east and west that might influence perceptions with regard to the feasibility of building solar or earth sheltered housing. A second reason for this division was to assure that no one part of the state was more represented than another.

Selection of Code Officials. The questionnaire designed to determine the number of building permits issued for new single family dwellings as well as innovative energy efficient dwellings in communities was mailed to the building official (building inspector) in each community. Names of respondents were formulated in the following manner: Names of building code officials from model code communities were obtained from the 1985 roster of the International Conference of Building code officials--all model code communities were used (51 prior to 1985). The model code used in Iowa is the Uniform Building Code and the organization for these code officials is the International Conference of Building Officials (ICBO).

Only those communities in Iowa that have adopted the uniform building code have building code officials who are eligible for membership in the International Conference of Building Officials. The aim of this organization is as follows: publication of the uniform building code and related documents, investigation and research of building safety regulations, development and promulgation of uniformity in regulations pertaining to building construction, education of building officials and formulation of guidelines for the administration of building inspection (nonmember communities could indirectly have access to this information but it would not be a consistant flow of information).

Names of building officials in nonmodel code affiliated communities were obtained through the use of the 1985 statistical profile for Iowa, several other state directories as well as phone calls to the State Building Code Bureau. Many of the non-code affiliated communities employ a municipal official such as a mayor, fire chief, city clerk, or public works director to perform the duties of building inspection. Even though these small communities have not adopted a model code, they may be regulating home building through the use of locally promulgated codes and/or some combination of the State Plumbing Code, Iowa's State Building Code, and/or National Electrical Code. Because this last category represents a large percentage of the communities in the state, it was important to include them in the survey along with the model code affiliated communities.

Data Collection. In the summer of 1985, a one-page questionnaire was mailed to all 51 model code affiliated building officials (Dillman, 1978). The questionnaire included an explanation of the purpose of the project. After two weeks, another copy of the questionnaire was mailed. If a community did not respond after two weeks from the time the follow-up questionnaire was sent, another community was randomly selected from the same quadrant of the state and the same process repeated. There were 65 letters sent before 51 communities responded with a response rate of 74.5%. The final list of communities was composed of 102 responding communities.

Data Analysis. Each of the 102 communities was placed in one of four population categories. A rate of adoption was calculated for each population category by dividing the number of permits issued for innovative, energy-efficient housing units by the number of all single family building permits issued. The same time frame was used for all calculations which was 1975 through 1985.

The communities in the population category of 2,500 or less had the highest rate of adoption which is .0955 (Table 1). Population category 2,500-9,999 had a rate of adoption of .0323, population category 10,000-49,999 had a rate of adoption of .0167, and the largest population category of 50,000-149,999 had the lowest rate of adoption which is .01572.

Building code regulation differed by population category also--the smallest population category of 2,500 or less had only three building inspectors and the other thirty-six communities in that category regulated building construction by utilizing the services of some other municipal official. The second category of communities, population 2,500-9,999 had twenty-five building inspectors and ten municipal officials performing the duties of building inspector. In the population category of 10,000-49,999 building construction was regulated by a building inspector in sixteen communities and by a municipal official in five communities. All of the communities in the largest population category regulated building construction with a building inspector.

Communities are dispersed throughout the state with the highest number of communities in the Southeastern quadrant of the state which is also the most populated part of the state. A list of communities by population category, corresponding rate of adoption, and location can be found in the Appendix B (Tables 1, 2, 3, and 4).

Second Survey

The purpose of the second survey was to examine intermediaries' perceptions of barriers and incentives to innovative, energy-efficient housing in Iowa as described in the initial survey. Therefore, the seven objectives of this study were as follows:

1. To examine and compare intermediaries' perceptions of barriers and incentives to innovative, energy-efficient

Table 1

Community Characteristics by Population

Characteristics	Population 2,500 Or Less (N = 39)	2,500- 9,999 (N = 35)	10,000- 49,999 (N = 21)	50,000- 149,999 (N = 7)
Building Code Officials				
Municipal Official	36	10	5	
Building Inspector	3	25	16	7
Type of Building Permits Issued				
All New Single Family Permits	942	15,487	10,165	12,719
Innovative, Energy-Efficient Permits	90	177	170	200
ROA*	.0955	.0323	.0167	.0157
Location In State				
NE	9	5	3	2
SE	17	13	7	3
NW	4	6	6	1
SW	9	11	5	1

$$*ROA = \frac{\text{Number of permits issued for innovative, energy-efficient units}}{\text{Number of new single family dwelling permits issued}}$$

housing with each other to determine whether perceptions vary among intermediary groups.

2. To determine whether intermediaries' perceptions of barriers and incentives to innovative, energy efficient housing differ among the four community population groups and their associated rates of adoption.
3. To determine whether the rate of adoption of innovative, energy-efficient housing varies with location in the state, category of building official, or proximity in location to other innovative, energy-efficient housing.
4. To examine and compare perceptions of innovative, energy-efficient housing of builders who have built solar and/or earth sheltered housing with those who have not to determine whether their perceptions differ.
5. To examine and compare lender groups with each other to determine whether their perceptions of innovative, energy-efficient housing differ.
6. To examine and compare perceptions of innovative, energy-efficient housing of lenders who have lent money for solar and/or earth sheltered housing with lenders who have not to determine whether their perceptions differ.
7. To determine whether suppliers' perceptions of innovative, energy-efficient housing vary with

community location, community characteristics, availability of financing, size of community or length of time in business.

The methodology utilized to conduct this survey is described in the following sections: a) description of instrument; b) selection of sample; c) data collection; d) response rate; e) hypothesis; and f) analysis of data.

Description of instruments. The instruments were developed using Dillman's (1978) Total Design Method. Singular but separate instruments were developed by the investigator to obtain information from each of the four intermediaries (builders, lenders, building inspectors, and realtors). A description of the instruments is as follows:

The first section (13 questions) and the last question of each questionnaire were identical for each intermediary and obtained information on the intermediaries' perception of barriers and incentives to innovative, energy-efficient housing as well as their assessment of the need and conditions for this type of housing in the state. The last question on each questionnaire elicited demographic data including background information, age, and education of each intermediary.

The second section of each of the four questionnaires obtained information specific to each intermediaries' profession. Questions focused on factors within the profession that could potentially influence the acceptance of innovative, energy-efficient housing and conditions within the community that might be a source of influence.

The fifth questionnaire obtained information from solar equipment suppliers on their perceptions of state codes and regulations, research needs, and information dissemination of the solar equipment industry. This instrument also obtained information on supplier's community size, location in state, and business background. Copies of these five instruments can be found in Appendix C.

A five-point Likert scale with a range from "nonagreement" (scored as 1) to "most agreement" (scored as 5) was selected for respondents to record their level of agreement with each of the statements.

Selection of Sample. The number of intermediaries selected from each community was based on the size of the community. One intermediary from each intermediary group (i.e., lender, builder, building inspector, and realtor) was selected from each of the communities in the population categories of 2,500 or less and 2,500-9,999, as in most cases there was only one of each intermediary. Two intermediaries were selected from each intermediary group in population category 10,000-49,999, and six intermediaries were selected from each intermediary group in population category 50 000-149,999 due to the increase in population size (Table 2).

Names and addresses for housing intermediaries were obtained from several state directories and from community phone directories. Names of builders were obtained from community phone directories. A list of residential builders' names and addresses were generated for each community by selecting names from that community that appeared on the 1986 roster of the Iowa Home Builders Association. A random selection was then made from the list for each community. The number of names selected was based on the population category of the community group size. In communities where no builders were members of the Iowa Home Builders Association, the list of names was generated by using the community phone directory (Yellow Pages) and a random selection was made from that list. All residential builders who were members of the Home Builders Association and worked in one of the 102 communities had a equal chance of being selected.

A list of realtors was generated for each community by selecting all names from that community that appeared on the state 1985 roster of the Iowa Association of Realtors. A random selection was then made from that list. The number of names selected for each community was based on the population category of community by group size. All

Table 2

Number of Intermediaries Selected From Each Population Category

Communities (N = 102)	Builders *	Lenders **	Realtors	Building Code Official	Total Sample Size
Less Than 2,500 (N = 39)	1	1	1	1	155
2,500 - 9,999 (N = 35)	1	1	1	1	131
10,000 - 49,999 (N = 21)	2	2	2	1	144
50,000 - 149,999 (N = 7)	6	6	6	1	233
Total Intermediaries					614

* Ten communities in population categories 2,500 or less and 2,500-9,999 were served by the same builders.

** Two of the Savings and Loan Associations from the original list of Savings and Loan Associations were merged into other associations in January and February of 1987 after the questionnaire was mailed. In addition, 51 Farmers Home Administrators were categorized as lenders, making a total of 206 lenders.

realtor's names on the list generated and who worked in one of the 102 communities had a equal chance of being selected.

The names of lenders were selected from the 1986 directory of Iowa Mortgage Bankers, the roster of the Iowa Savings and Loan Associations, and the state Directory of Farmers Home Administrators. The State Directory of Farmers Home Administrators was used to select an administrator who represented each of the communities of 20 000 population or less. In addition, for each community two lender lists were generated, one list of mortgage bankers and one list of Savings and Loan Associations. The same number of names were chosen in a random selection from each list for each community and the number of selections made was dependent on the population category of community group size. In some communities where the number of banks and/or Savings and Loan Associations were equal to the number of names to be selected (i.e., two lenders), one lender name represented the mortgage bankers and one lender name represented the Savings and Loan Association, if a Savings and Loan Association existed in the community.

One building inspector was chosen for each community. Names for this category of intermediaries were generated in the initial survey previously described. Communities in Iowa have only one building inspector.

Solar equipment suppliers were obtained from a list of suppliers in the state developed by the Iowa Energy Policy Council in Des Moines, Iowa. All 17 names were used because the number is very small.

Data Collection. The five questionnaires were mailed to each of the intermediaries in the state of Iowa at approximately the same time. A separate cover letter accompanied each of the questionnaires. A copy of this letter can be found in Appendix D. The Total Design Method (Dillman, 1978) was used to design the cover letter and the questionnaires and to implement the survey. A second follow-up mailing was sent to nonrespondents exactly three weeks after the original mail-out (Appendix E). A replacement questionnaire and a cover letter containing a restatement of the basic appeal was included in the second mail-out. A third and final follow-up to those not responding was mailed seven weeks after the original mailing (Appendix F). It consisted of a cover letter, another questionnaire and return envelope, and was sent by Certified Mail. (An identification number was stamped on the cover of each questionnaire and its purpose explained in the cover letter.)

Hypothesis Formation

Objectives formulated and presented in Chapter 1 and the beginning of this chapter guided this study and formed the basis for the following hypotheses which were tested. The results are discussed in Chapter 4.

Ho_1 There is no difference among the four types of intermediaries in regard to their perceptions of barriers and incentives to innovative, energy-efficient housing.

Ho_2 There is no difference among intermediary groups (builders, lenders, realtors, and inspectors) in their perceptions of barriers and incentives to innovative, energy-efficient housing among each of the four population categories and their associated rate of adoption levels (Figure 1).

Ho_3 There is no difference in the rate of adoption of innovative, energy-efficient housing when communities are grouped according to:

a) location in state,

b) type of building code official, and

c) proximity to other communities' with innovative, energy-efficient housing.

Ho_4 There is no difference in perception of barriers and incentives of innovative, energy-efficient housing between builders who have built solar and/or earth

2,500 or Less ROA Level 1 (.0955)	2,500 - 9,999 ROA Level 2 (.0323)	10,000 - 49,999 ROA Level 3 (.0167)	50,000-149,999 ROA Level 4 (.0157)
N = 117	N = 126	N = 127	N = 94
Builders	Builders	Builders	Builders
Lenders	Lenders	Lenders	Lenders
Realtors	Realtors	Realtors	Realtors
Inspectors	Inspectors	Inspectors	Inspectors

ROA = Rate of Adoption

Figure 1. Intermediary groups within each population category and associated rate of adoption (ROA) level.

sheltered housing and those who have not built any solar and/or earth sheltered housing.

Ho_5 There is no difference between lender groups (Farmers Home Administration, commercial banks, and Savings and Loan Associations) in regard to their perceptions of barriers and incentives to innovative, energy-efficient housing.

Ho_6 There is no difference between lenders who have lent money for solar and/or earth sheltered housing and lenders who have not lent money with regard to their perceptions of barriers and incentives to innovative, energy-efficient housing.

Ho_7 There is no difference among solar equipment suppliers' perceptions of barriers and incentives to innovative, energy-efficient housing in relation to the following variables:

a) suppliers' length of time in business

b) size of community

c) information dissemination process available

Response Rate

As stated earlier, the major purpose of this study was to examine housing intermediaries' (lenders, realtors, builders, building inspectors and solar suppliers) perceptions of barriers and incentives to the adoption of energy efficient innovative housing in Iowa. Housing intermediaries from 102 communities in the state became the sample group for the study.

Findings in this study were based on the self-reported responses contained in a total of 481 usable returned questionnaires from the 631 that were mailed to the housing intermediaries in the 102 communities. This total represents an overall return rate of 76%. The lender group represented the largest number of respondents (38.14%) while the building inspectors group was the smallest (18.31%). Table 3 contains a tabulation of the total number and percentage of respondents by intermediary group by which the results of this research will be reported.

The total number of usable questionnaires returned was 481, including the supplier group. However, the total number of responses reported for each intermediary group may differ due to missing data.

Analysis of Data

Responses to the items in the initial survey of building officials were analyzed to determine rate of adoption for each of the four population categories of communities. A summary of information on rate of adoption by category of community can be found in Table 1. Rate of adoption (ROA) was calculated for each of the four

Table 3

Sample, Number, and Percentage of Respondents

Intermediary Group	Sample	Number of Respondents	Response Rate	Percent of Total Respondents
Lenders	206	177	85.92	38.15
Builders	148	99	66.89	21.33
Building Inspectors or Municipal Officials	102	85	88.33	18.38
Realtors	158	103	65.20	20.20
Suppliers*	17	17	100.00	.04
Total	631	481	76.00	100.00

* The number of suppliers (17) surveyed represents a total population of suppliers in the state and therefore was not a sample population.

population categories by dividing the number of energy-efficient, innovative housing building permits issued between 1975 and 1985 in each category by the number of all single family housing permits issued in the same category, for the same time period. This information was obtained in the initial survey and is described in that section.

Responses to the items in the questionnaires used in the second survey were entered into the computer and verified for accuracy. The data were analyzed using the SAS CATMOD program (SAS Institute, Inc. 84-86) provided by WEEG Computer Center at the University of Iowa, Iowa City, Iowa.

Frequency analysis and percentage distributions were used on all variables under consideration in this study. In addition, a mean and standard deviation score for each variable were calculated. Data from the first thirteen perception questions (with the exception of 6 and 13.3) were analyzed in the following manner:

For Ho_1 and Ho_2 the linear model approach to two-way analysis of variance (ANOVA) was used to determine dependency between the dependent variables (response variable) and independent variables (intermediary groups and intermediaries by ROA level). In addition, contrast analysis was applied to variables with significant results.

A mean score function with continuous random dependent variables made it possible to apply a categorical data analysis technique, the weighted least squares (GSK) approach, developed by Grizzle, Stramer, and Koch (1969). This analytic technique for categorical data is described in a text on Public Program Analysis (Forthofer & Lehnen, 1981). An ANOVA table was used and the goodness of fit chi-square (X^2_{GOF}) statistic was used to conclude which two factors were significant in the model (rate of adoption or category of intermediary). The .05 level of significance was chosen as the maximum level at which results would be considered significant. The P-values for all tests were calculated. Data on the perceptions of intermediaries were analyzed by using a chi-square test.

Data pertaining to Ho_3 were analyzed using one-way analysis of variance, general linear model. The F-statistic was used as the test statistic to assess differences.

Data pertaining to Ho_4 and Ho_6 were analyzed using the chi-square test of independence. The P-value and a mean score were calculated.

Descriptive statistics and frequency tables were used to analyze the data from the supplier group which was a total population and not a sample group. Data pertaining to Ho_7 was descriptively analyzed because the 17 suppliers constituted a total population. No statistical analysis was carried out for hypothesis seven.

CHAPTER IV

Findings

The major purpose of this study was to examine intermediaries' perception of barriers and incentives to the diffusion of innovative, energy-efficient housing in Iowa. Housing intermediaries (lenders, builders, realtors, and inspectors) became the sample group for this study. The sample was drawn from 102 communities in Iowa. As noted earlier, suppliers were not a sample group but a total population and therefore were not compared to other intermediary categories or groups (Table 3, Chapter 3).

Findings from the study were based on a total of 481 returned questionnaires of the 631 that were mailed to all subjects. This total represented an overall response rate of 76% which included all five housing intermediary groups. The results of the data analysis were presented in the following order: community characteristics, sample characteristics, testing of hypotheses, and other findings.

Community Characteristics

The 102 communities from which the respondents were drawn were divided into four population categories: population 0-2,500 or less, 39 communities; population

2,500-9,999, 35 communities; population 10,000-49,999, 21 communities; and population 50,00-149,999, 7 communities.

Each of these four populations categories had what is referred to in the study as a rate of adoption (ROA) which is explained in Chapter 3, of the initial survey. Rate of adoption level is the total number of building permits issued for innovative, energy-efficient houses built in that population category of communities divided by the total number of building permits issued for new single family dwellings in the same community group in the past ten years (1975-1985). ROA for population 2,500 or less was .0955; ROA for population 2,500-9,999 was .0323; ROA for population was 10,000-49,999 was .0167; and ROA for population 50,000-149,999 was .0157.

Community Building Codes

Another descriptive characteristic of each population category of communities is the type of building code that presently predominates in each of the four categories (Table 4). The predominate code in communities of 2,500 or less was no code or a combination of local and state codes; communities with 2,500-9,999 were divided almost evenly between a combination of local and state codes and model codes; communities of 10,000-49,999 had predominately model codes and all communities of 50,000-149,999 had adopted model codes. Communities in Iowa have recently been

Table 4

Type of Building Code by Category of Community

Category of Codes	Population Categories: 0 to 2,500	2,501 to 9,999	10,000 to 49,999	50,000 to 149,999*
	N = 39	N = 35	N = 21	N = 7
No Code	10	1	0	0
Local Code Only	4	4	1	0
State and/or Local Code	11	13	4	0
State and/or Model Code**	14	17	16	7

* There are no communities in Iowa larger than 149,999 with the exception of Des Moines, Iowa which virtually has no new building within the city limits. Des Moines was not included in the study.

** Eleven of the fourteen model codes adopted in small communities have occurred in 1985 or after.

encouraged to adopt the model code that predominates in the state which is the Uniform Building Code. A number of small communities with populations of 2,500 or less have adopted the model code since 1985. An account of the specific number of communities that fit this description has not been published. It should be noted, however, that every community may amend the model code as it sees fit. Only those communities in Iowa that have adopted the Uniform Building Code (UBC) have building code officials who are eligible for membership in the International Conference of Building Officials.

Sample Characteristics

As previously stated, the sample group for this study was drawn from each of the 102 communities just described. The sample group is comprised of housing intermediaries in four categories: lenders, builders, building officials, and realtors. The demographic characteristics of the respondents are shown in Table 5. Ages range from 18 years to over 65 years, with the largest number of respondents in the 35-44 and 45-54 age range. The realtor group had 37% of the respondents in the 45 and over age group and building inspectors had the 47% of respondents in the three youngest age categories.

Over 75% of the respondents had graduated from college or gone to graduate school. Educational attainment was

Table 5

Demographic Characteristics of Respondents

Demographic Characteristics	Builder N	Builder %	Inspector N	Inspector %	Lender N	Lender %	Realtor N	Realtor %	Total N	Total %
Age (Years)										
18-24	1	1.03	0	.00	4	2.29	0	.00	5	.01
25-34	26	26.79	13	15.48	49	28.00	10	9.71	98	21.53
35-44	30	30.92	27	32.14	57	32.57	36	34.95	150	32.96
45-54	32	33.98	17	20.24	34	19.43	22	21.36	105	23.08
55-64	7	7.22	21	25.00	26	14.86	28	27.18	84	18.46
65+	1	1.03	6	7.14	5	2.86	7	6.80	19	.04
Education										
grades 9-11	4	4.08	0	.00	0	.00	1	.97	5	.01
grad. high school	30	30.62	31	36.90	12	6.86	29	28.16	102	22.42
1-3 years college	37	37.75	28	33.33	35	20.00	32	31.07	132	29.01
grad. college	12	21.43	15	17.86	96	54.86	27	26.21	154	33.85
graduate school	6	6.12	10	11.90	32	18.29	14	13.59	62	13.63
No. of Years in Present Position										
1-5	11	11.22	29	34.52	68	39.04	13	12.62	121	28.21
6-10	13	13.27	24	28.57	32	18.39	19	18.45	88	20.51
10-15	27	27.55	18	21.43	29	16.67	32	31.07	106	24.71
15-20	10	10.20	5	5.95	10	5.75	10	9.71	35	8.16
20+	37	37.76	8	9.52	35	20.11	29	28.16	79	18.41

high for all respondents. Over 75% of them had attended college, graduated from college or attended graduate school. Educational attainment was similar for builders and building inspectors with over 27% of both groups having graduated from college or attended graduate school. Educational attainment of lenders was highest of all the groups. Over 72% of the respondents had graduated from college or attended graduate school.

The majority of the respondents had been in business six years or more. Almost half (47%) of the builders had been in their present position for 15 years or more and over a third (37%) had been in their present position for 20 years or more.

Realtors ranked second with over 37% of the respondents having been in their present position for 15 years or more. Across all categories, builders and realtors had accumulated the greatest number of years experience in the same occupation while the lenders and building inspectors with the fewest number of years of experience.

A review of previous occupations of intermediaries showed that builders and building inspectors came primarily from building related occupations while lenders came primarily from other banking positions or directly from college. Realtors had the most diversity in prior occupations held with teaching, insurance, and farming being the most frequent responses to the question.

A Mean Score Comparison of Intermediaries' Perceptions of Barriers

A mean score comparison on each of the twenty-three perception variables by intermediary group began to provide a profile or pattern of perceptions held by each group as to the barriers and incentives to innovative, energy-efficient housing in Iowa (Table 6). The scale used was a Likert type scale with a score of 1 indicating nonagreement, 2 = weak agreement, 3 = some agreement, 4 = agreement, and 5 = most agreement.

Intermediaries tended to rate the need for the development of innovative, energy efficient housing higher (mean = 3.29) than they do the extent that it is practical in the state (mean = 2.62). Focus on the barriers and what the various groups believed to be the most and least important barriers showed that all groups rated the initial investment or "first costs" associated with building an active solar house as a strong barrier (mean score = 4.04). All groups perceive "first costs" for earth sheltered as an important barrier as well (mean score = 3.72). Two barriers that were not associated with cost that were among the four most highly rated barriers were lack of skills among subcontractors acts as a barrier to building active solar housing (mean score = 3.82) and novelty of design inhibits the building of an earth sheltered house

Table 6

Mean Perceptions of Barriers and Incentives by Intermediary Group

Perceptions of Barriers and Incentives	N	Mean Score for Intermediary Group Builder	Inspector	Lenders	Realtors	Total
General Perceptions						
The State's Need for Solar Housing	460	3.29	3.28	3.23	3.38	3.29
Extent Solar Practical in Iowa	460	2.47	2.58	2.72	2.70	2.62
Perceptions of Barriers						
Lack of Information Barrier to Inspectors	448	3.18	3.17	3.64	3.42	3.49
Extent Financing Available As Compared to Conventional Housing	459	2.97	3.06	3.34	3.29	3.17
Extent Risky Resale Potential	460	3.40	3.32	3.74	3.47	3.48
Lack of Skills Among Subcontractors Barrier to:						
Passive Solar	458	3.40	3.40	3.70	3.68	3.55
Active Solar	458	3.56	3.82	3.90	4.00	3.82
Earth Sheltered	458	3.51	3.58	3.81	3.81	3.68
Availability of Qualified Builders Barrier to:						
Passive Solar	458	2.66	3.29	3.48	3.26	3.17
Active Solar	458	3.12	3.80	3.70	3.53	3.54
Earth Sheltered	458	3.20	3.61	3.67	3.57	3.52
Extent "First Costs" Barrier to:						
Passive Solar	458	3.29	3.64	3.73	3.60	3.57
Active Solar	458	4.13	4.05	4.02	3.96	4.04
Earth Sheltered	458	3.95	3.66	3.77	3.48	3.72

Table 6 - Continued

Mean Perceptions of Barriers and Incentives by Intermediary Group

Perceptions of Barriers and Incentives	N	Mean Score for Intermediary Group Builder	Inspector	Lenders	Realtors	Total
Extent Code Enforcement Inhibits:						
Passive Solar	457	2.56	2.19	2.71	2.77	2.56
Active Solar	457	2.85	2.35	2.85	2.92	2.24
Earth Sheltered	457	3.27	2.72	3.03	3.22	3.06
Extent Novelty of Design Barrier to:						
Passive Solar	458	2.48	2.72	3.10	3.20	2.88
Active Solar	458	3.30	3.10	3.43	3.50	3.33
Earth Sheltered	458	3.65	3.66	3.60	4.31	3.81
Perceptions of Incentives						
Potential For Rising Heating Costs	380	4.06	3.91	3.85	3.94	3.94
Extent Mandated Solar Standards Reduces Risk in Inspection	454	2.47	2.24	2.82	2.10	2.41
Extent 40% Tax Credit Incentive to Build Solar	458	3.47	3.41	3.29	3.48	3.41

(mean score = 3.81). The barrier considered least important of the barriers, by all groups, was that code enforcement inhibits the building of active solar design (mean score = 2.24).

Continuing to focus on perceptions of barriers, but turning to individual intermediary groups (builders, inspectors, lenders, and realtors), it was the lenders and the realtors that rate most of the barrier variables the highest. Builders tend to rate barriers very nearly the same or lower than inspectors with the exception of the code enforcement barrier. Builders rated code enforcement as a greater barrier than inspectors on all three types of innovative, energy-efficient housing. Builders mean scores were: earth sheltered, mean score = 3.27 compared to 2.72; active solar, mean score = 2.85 compared to 2.35; and passive solar, mean score = 2.56 compared to 2.19. A review of the table will show, however, that except for the instance of earth sheltered housing the differences in mean scores between the builder and inspector for passive and active solar housing on the question of code enforcement, was slight.

A Mean Score Comparison of Intermediaries' Perceptions of Incentives

Respondents were asked to react to fewer incentives than barriers but of the three, the potential for rising heating costs was first in importance with a group mean score of 3.94. The 40 percent tax credit was second in importance (mean score = 3.41). The extent that intermediaries believed that state mandated solar standards written into community building codes would reduce the risk of inspection received a relatively low mean score when all intermediaries' scores were totaled (mean = 2.41). Of the four intermediary groups, the realtors had the lowest mean score (2.10) on that particular variable.

Perceptions Held By Individual Intermediary Groups

In addition to the thirteen perception variables on which all intermediaries were compared, the survey instrument elicited additional information from each intermediary group that was specifically related to the profession of each group. The purpose was to further examine the perceptions held by the various groups toward innovative, energy-efficient housing.

Realtors. Most realtors stated that there was no one method for appraising the market value of passive solar, active solar, or earth sheltered housing. When asked if additional research was needed prior to appraising solar or earth sheltered housing, the mean score on a 5-point

Likert scale was 3.64, 3.90, and 3.98 for passive solar, active solar, and earth sheltered respectively. The mean score for realtors was 3.00 when asked if they perceived housing codes to effect appraisals was, and that a structure's energy consumption (mean = 3.67) and orientation would contribute toward determining the value placed on a house (mean = 3.26). Realtors take a slightly more than moderate view of the energy efficiency of a home in appraising its value.

Lenders. Almost three fourths (70%) of the lenders indicated that they did not have a specific method of determining the value of a solar structure. The extent to which most lenders perceived that a solar system would not create additional value for the seller of a solar house was low (mean = 2.06). The lenders rated their institution's attitude toward financing innovative, energy-efficient housing relatively low, with a mean score of 2.84 for financing solar and slightly less for financing earth sheltered (mean = 2.60). When asked to what extent availability of clear cost data on solar energy systems was a barrier to determining market value of a house, lenders had a relatively low mean score of 2.29. Lenders did however, rate the rise in energy prices since 1973 as an important factor in residential financing decisions (mean = 3.58). Most lenders (over 60%) responded positively when asked if they would try to influence a builder to provide conservation features in building a house.

Builders. Builders tended to perceive that additional start-up costs associated with active solar housing and earth sheltered housing acted as a barrier to building innovative, energy-efficient housing (mean = 3.36).

Builders also ranked the length of time it would take to build passive solar, active solar, or earth sheltered housing higher than the length of time it would take to build a conventional structure of the same size and quality. When builders ranked the length of time it would take to build passive solar, active solar, or earth sheltered housing, most ranked the active solar house as taking the most time, with earth sheltered and passive solar following in that order.

Building Inspectors. Building officials had varying mean scores when asked to what extent additional research is needed prior to inspecting passive solar (mean = 2.97), active solar (mean = 3.42), and earth sheltered housing (mean = 3.38). Building officials perceive very little additional research would be needed to inspect a passive solar house and somewhat more for an active solar and earth sheltered structure. A very high percentage (90%) of the building inspectors had not enacted a building code in their community that pertained exclusively to solar energy systems. The most frequent reason given to an open ended question asking "why" was that there was "no need".

Suppliers. The group of suppliers discussed in Chapter 3 was not a sample population but a total population of solar equipment suppliers in Iowa There were seventeen solar equipment suppliers remaining in the state in 1985 (solar energy hot line bulletin). All seventeen suppliers responded to the survey instrument. The suppliers were distributed fairly evenly among the population categories. There was little variability among suppliers as to the length of time they had been in business and the type of collectors or solar systems sold. Most suppliers had been in business 10 or more years and all of them sold several types of collectors and/or systems. The principal type of collectors and/or systems sold were air/liquid collectors, domestic hot water, and space heating. The types of information available to the suppliers were fewer in number in the small communities but fairly evenly distributed in the three largest size of communities (Table 7). As would be expected the suppliers from the smallest category of communities had fewer media sources available for advertising and marketing their product. Radio, newspapers, and manufacturer's literature were sources of information available to all suppliers regardless of community size and television was available to all the suppliers except those in populations of 2,500 or less. Extension offices and work shops were limited in availability to suppliers in the two small population categories.

Suppliers were asked to assess the availability of financing in their community and over 70% of the suppliers had a mean greater than 3.00, indicating that, in general, they did not perceive financing as a major barrier.

There was agreement among suppliers on perceptions of codes and standards. More than 70% of the suppliers had a mean score greater than 3.00 when asked to what extent state mandated solar standards would reduce the risk of building solar housing. Most suppliers rated variation of federal regulations (mean = 3.80) as well as the variations in administration and interpretation of building codes (mean = 3.65) as a barrier to building this type of

Table 7

Suppliers Methods of Disseminating Information To The Public

Sources Of Information	2,500 Or Less N = 3	2 501-9 999 N = 5	10,000-49 999 N = 4	50,000+ N = 5
Extension Office	1	2	3	4
Workshops	0	1	4	5
Television	0	5	4	4
Radio	2	5	4	5
Newspaper	2	5	4	5
Manufacturers' Literature	3	5	4	5

N = 17 Suppliers

housing. The suppliers did not believe that local building codes acted as a constraint in marketing solar supplies or products (mean score = 2.30). Suppliers did believe that private covenants do not restrict or prohibit installation of solar equipment or systems (mean score = 3.75).

Two of the seventeen communities in which solar equipment suppliers were located had enacted building code provisions that apply exclusively to solar energy systems. This information was consistent with the responses given by the building inspectors when asked the same question. In addition, when asked, the suppliers responded that they did not view solar heating and cooling as an unproven technology.

Testing of Hypotheses 1 and 2

The analyses of data were organized under the hypotheses developed to answer each of the objectives listed in Chapter 1. The null hypothesis developed in relation to the first research question was:

Ho_1 There is no difference among the four categories of intermediaries with regard to their perceptions of barriers and incentives to innovative, energy-efficient housing.

The null hypothesis developed in relation to the second research question was:

Ho_2 There is no difference among the intermediary groups (builders, inspectors, lenders, and realtors) in their perceptions of barriers and incentives to energy-efficient housing within each of the four population categories and their associated rate of adoption levels.

Hypotheses one and two were analyzed together using the linear model approach to two-way analyses of variance (ANOVA). A mean score function was determined using weighted least squares, GSK approach. The test statistic used was the χ^2 Goodness of Fit test.

Contrast analysis was used to assess differences between intermediary groups within each population category and its associated level of rate of adoption (ROA) as well as between the four groups of intermediaries. A mean score function was calculated for each of the groups.

Hypothesis 1. In testing Ho_1 significant differences due to variability among intermediary groups were found on eight of the perception variables. Significant differences ($p < .05$) were found for the following variables: mandated standards may reduce risk to building solar, lack of information acts as a barrier, availability of financing acts as a barrier to solar, risky resale potential acts as a barrier, initial investment in passive and earth sheltered housing acts as a barrier, code enforcement may inhibit building active solar as well as earth sheltered housing (Table 8). The first null hypothesis was rejected for these eight variables. There was also a difference among intermediaries as to whether lack of skills among subcontractors may inhibit active solar but the difference was not significant at the .05 level.

Contrast Analysis. The results of contrast analysis indicated that it was the builders and the lenders that most frequently differed in their perceptions of barriers and incentives. The mean score for lenders was significantly higher than for builders on availability of financing, whether solar and earth sheltered housing have risky resale potential, whether lack of skills among subcontractors for active solar housing and initial investment needed for building passive solar is a barrier. In all four instances in which the two intermediary groups differed, it was the lenders who perceived the barrier to be greater than the builders.

The builders differed significantly from the building inspectors on whether code enforcement acts as a barrier to building earth sheltered housing. Builders had a mean score of 3.27 and building inspectors had a mean score of 2.72. There was also a difference in mean scores between the building inspectors (mean = 2.24) and the lenders

Table 8

Differences in Perceptions of Barriers and Incentives by Intermediary Group

Perceptions of Barriers and Incentives	Intermediary	N	Mean Score Function	χ^2	P-value (GSK Method)	Contrast Analysis
To What Extent Do You Agree?						
Mandated Solar Standards Reduce Risks	Builder	97	2.463	21.72	.0001*	Lender vs Inspector
	Inspector	82	2.243			
	Lender	175	2.828			
	Realtor	99	2.393			
Lack of Information Acts As a Barrier	Builder	96	3.302	8.53	.0362*	Lender vs Inspector Inspector vs Realtor
	Inspector	81	3.172			
	Lender	170	3.641			
	Realtor	101	3.415			
Available Financing Acts As a Barrier	Builder	97	2.969	7.75	.0514*	Builder vs Lender Builder vs Realtor
	Inspector	83	3.060			
	Lender	177	3.338			
	Realtor	102	3.294			
Risky Resale Potential Acts As Barrier	Builder	96	3.406	11.65	.0087*	Builder vs Lender
	Inspector	85	3.317			
	Lender	176	3.738			
	Realtor	102	3.470			

Table 8 - Continued

Differences in Perceptions of Barriers and Incentives by Intermediary Group

Perceptions of Barriers and Incentives	Intermediary	N	Mean Score Function	χ^2	P-value (GSK Method)	Contrast Analysis
To What Extent Do You Agree?						
Lack of Skills Among Subcontractors						
Acts As a Barrier	Builder	97	3.556	6.91	.0747	Builder vs Lender
	Inspector	85	3.823			Builder vs Realtor
	Lender	174	3.896			
	Realtor	102	4.000			
Initial Investment in Passive Solar						
Acts As a Barrier	Builder	96	3.291	10.32	.0160*	Builder vs Lender
	Inspector	85	3.635			
	Lender	175	3.731			
	Realtor	102	3.598			
Initial Investment in Earth						
Sheltered Acts As Barrier	Builder	96	3.947	9.33	.0252*	Lender vs Realtor
	Inspector	85	3.658			Builder vs Realtor
	Lender	175	3.765			
	Realtor	101	3.475			

Table 8 - Continued

Differences in Perceptions of Barriers and Incentives by Intermediary Group

Perceptions of Barriers and Incentives	Intermediary	N	Mean Score Function	χ^2	P-value (GSK Method)	Contrast Analysis
Code Enforcement May Inhibit Active Solar	Builder	96	2.854	22.49	.0001*	Builder vs Inspector
	Inspector	84	2.345			Inspector vs Lender
	Lender	175	2.851			Inspector vs Realtor
	Realtor	102	2.921			
Code Enforcement May Inhibit Earth Sheltered	Builder		3.270	11.66	.0086*	Builder vs Inspector
	Inspector		2.717			Inspector vs Realtor
	Lender		3.028			
	Realtor		3.215			

3 DF

*significant at the .05 Level

(mean = 2.83) on the issue of whether solar mandated would reduce the risk of building solar housing. Building inspectors in Iowa have been consistent in their resistance to incorporating mandated standards into building codes.

In a review of the eight perception variables on which the intermediary groups (lenders, builders, inspectors, and realtors) differed the greatest variability among the groups lies with the issue of whether incorporating state mandated solar standards into community codes would reduce some of the risks associated with building passive solar, active solar, or earth sheltered housing. Since none of the intermediary groups had a mean score greater than 3.0 on this variable, it was interpreted that none of the intermediary groups see this as a very important barrier. A more significant factor, however, was that nine of the 17 comparisons in which the perceptions between two intermediaries were significantly different involved builders. This fact alone could constitute a barrier to building innovative energy efficient housing.

Hypothesis 2. In testing hypothesis two significant differences were found between intermediary groups within the four categories of communities and their associated rate of adoption for two variables; the extent of the need for solar in Iowa and whether novelty of design inhibits building active solar housing. The second null hypothesis was rejected for these two variables (Table 9). Although not as great, differences were also found for the following factors: the extent that solar is practical in Iowa, lack of skills among subcontractors acts as a barrier to building earth sheltered housing, the 40% tax credit was an incentive, and code enforcement inhibits building active solar.

Contrast Analysis. The follow-up test using contrast analysis showed that on all factors on which intermediary groups within community population categories and their rate of adoption differed was always the intermediaries in population/ROA level 1 who differed with intermediaries in population/ROA levels 3 or 4. The intermediaries in population/ROA category 1, 2,500 or less, perceived the need for solar and that it is practical in Iowa to be higher than intermediaries in the other population categories. Communities in category 1 also perceived availability of subcontractors to be less of a barrier than intermediaries in population category 3 with a population of 50,000-149,999. Intermediaries in population category 2 also perceived the 40% tax credit to be of a greater benefit to consumers than did population categories 1, 2, and 3. Finally, intermediaries in population category 2 perceived that novelty of design was not as significant a barrier as did intermediaries in population categories 2, 3, and 4.

Table 9

Differences in Perceptions of Intermediaries Within Each Level of Rate Of Adoption (ROA)

Perceptions of Barriers and Incentives Category of Lender	Intermediaries Within Population Categories And Their ROA Level	N	Mean Score Function	χ^2	P-Value (GSK Method)	Contrast Analysis
To What Extent Do You Agree?						
Need for Solar	Pop./ROA Level 1	116	3.508	9.46	.0237*	Level 1 vs Level 4
	Pop./ROA Level 2	124	3.282			
	Pop./ROA Level 3	127	3.299			
	Pop./ROA Level 4	93	3.010			
Solar Is Practical in Iowa	Pop./ROA Level 1	115	3.808	6.40	.0937	Level 1 vs Level 4
	Pop./ROA Level 2	124	2.548			
	Pop./ROA Level 3	127	2.685			
	Pop./ROA Level 4	94	2.478			
Lack of Skills Among Subcontractors Is a Barrier to Earth Sheltered	Pop./ROA Level 1	117	3.615	6.60	.0858	Level 1 vs Level 3
	Pop./ROA Level 2	123	3.650			
	Pop./ROA Level 3	127	3.913			
	Pop./ROA Level 4	93	3.580			
To What Extent Do You Agree?						
40% Tax Credit Is An Incentive	Pop./ROA Level 1	117	3.589	6.59	.0862	Level 1 vs Level 3
	Pop./ROA Level 2	123	3.422			
	Pop./ROA Level 3	127	3.212			
	Pop./ROA Level 4	94	3.382			

Table 9 - Continued

Differences in Perceptions of Intermediaries Within Each Level of Rate Of Adoption (ROA)

Perceptions of Barriers and Incentives Category of Lender	Intermediaries Within Population Categories And Their ROA Level	N	Mean Score Function	χ^2	P-Value (GSK Method)	Contrast Analysis
Code Enforcement May Inhibit Active Solar	Pop./ROA Level 1	114	3.839	7.19	.660	Level 1 vs Level 4
	Pop./ROA Level 2	122	4.073			
	Pop./ROA Level 3	127	4.007			
	Pop./ROA Level 4	92	4.173			
Novelty of Design Inhibits Building Active Solar	Pop./ROA Level 1	116	3.017	12.54	.0057*	Level 1 vs Level 3
	Pop./ROA Level 2	121	3.396			
	Pop./ROA Level 3	126	3.500			
	Pop./ROA Level 4	94	3.472			

3 DF

Level 1 = .0955	Level 2 = .0323	Level 3 = .0167	Level 4 = .0157
Population 2,500 or less	Population 2,500-9,999	Population 10,000-49,999	Population 50,000-149,999

*Significant at .05 level

Differences Due To Two Main Effects. In testing hypothesis one and two using 2-way ANOVA, the Saturated Model reflects two main effects simultaneously. Differences in perceptions are found among intermediary groups, as well as differences between intermediaries within the four population categories and their associated ROA levels. Significant differences were found for these two factors on the following six variables: lack of skills among subcontractors acts as a barrier to passive solar, availability of experienced qualified builders is a barrier to building passive solar, active solar and earth sheltered housing, code enforcement may inhibit the building of passive solar, and novelty of design may inhibit building passive solar. The first and second null hypotheses were rejected for all of these six variables (Table 10). Use of contrast analysis on these same variables reveals that again it was the builder and lender groups that differed in their perceptions of the barriers to innovative energy-efficient housing. However, when contrast analysis was applied to the intermediary groups within the four population categories and their ROA level, no particular pattern emerged as to how groups differed from one another.

Table 10

Differences in Perception Due to Intermediaries Within ROA Levels As Well As By Intermediary Groups

Perceptions of Barriers & Incentives	Residual χ^2	χ^2 For INT Group INT by ROA/Pop.	P-Value	Contrast Analysis by ROA & INT
To What Extent Do You Agree?				
Lack of Skills Among Subcontractors is a Barrier to Active Solar		32.25 (Int)	.0001*	Builder vs Lender
		15.13 (ROA/pop)	.0017*	ROA Level 3 vs 4
	13.70		.1334	
Availability of Qualified Builders Acts As Barrier to:				
Passive Solar		42.43 (Int)	.0001*	Builder vs Lender
		16.20 (ROA/pop)	.0010*	ROA Level 3 vs 4
	16.85		.0511	
Active Solar		16.32 (Int)	.0010*	Builder vs Lender
		10.44 (ROA/pop)	.0152*	ROA Level 3 vs 4
	7.72		.5628	
Earth Sheltered		16.34 (Int)	.0010*	Builder vs Lender
		12.62 (ROA/pop)	.0055*	ROA Level 2 vs 3
	4.08		.9064	

Table 10 - Continued

Differences in Perception Due to Intermediaries Within ROA Levels As Well As By Intermediary Groups

Perceptions of Barriers & Incentives	Residual x^2	x^2 For INT Group INT by ROA/Pop.	P-Value	Contrast Analysis by ROA & INT
Code Enforcement May Inhibit Building Passive Solar		26.63 (Int)	.0001*	Inspector vs Lender
		7.53 (ROA/pop)	.0568*	ROA Level 2 vs 4
	16.31		.0607	
Appearance or Novelty of Design Acts As a Barrier to Passive Solar		18.65 (Int)	.0003*	Builder vs Lender
		11.11 (ROA/pop)	.0111*	ROA Level 1 vs 2
	9.15		.4235	

9 D.F.

ROA 1 = .0955	ROA 2 = .0326	ROA 3 = .01672	ROA 4 = .01572
Population = 2,500 or less	Population 2,500-9,999	Population 10,000-49,999	Population 50,000-149,999

The important aspect of these results was that perceptions between groups of intermediaries as well as within groups varied on the same variables.

As stated previously, the variables having to do with rising heating costs acts as an incentive and novelty of design inhibits building innovative, energy-efficient housing were not analyzed by the same statistical method as the other thirteen perception variables in which intermediaries were compared. A good model fit could not be determine using linear model ANOVA, GSK method therefore a chi-square contingency table was used to determine possible differences between intermediary (INT) groups as well as differences among intermediaries within each population category and its level of rate of adoption (ROA). Differences were found for both factors (INT groups) and (INT in population categories of communities) for two variables, for potential for rising heating costs as an incentive to build solar and novelty of design acts as a barrier to building earth sheltered housing (Table 11).

Significant differences ($p < .05$) were found among intermediaries within each population category and its level of rate of adoption as well as between groups of intermediaries for the variable that pertains to novelty of design as a barrier to building earth sheltered housing.

Table 11

Differences In Perceptions Among Intermediaries Due to Two Factors--Intermediary Groups and Intermediaries by Population Categories And Their of Rate of Adoption Level

Perceptions of Barriers & Incentives	X^2 Factors (INT Group) (ROA/Pop. Level)	P-Value	N
To What Extent Do You Agree?			
Potential for Rising Heating Cost Incentive to Build	14.53 (INT Groups)	.268	380
	20.09 (ROA/pop. Groups)	.065	380
Novelty of Design Acts As Barrier to Earth Sheltered	21.70 (INT Groups)	.041*	461
	20.63 (ROA/pop. Groups)	.056	461

12 D.F.

*significant at .05 level

(ROA/pop. Group) = Population categories and their associated rate of adoption level

Therefore the null hypothesis for the first and second hypothesis were rejected for this variable.

Hypothesis 3

The null hypothesis developed in relation to the third objective was:

Ho_3 There is no difference in the rate of adoption of innovative, energy efficient housing when communities are grouped according to:

a) location in the state

b) category of building official, and

c) proximity to other communities with high rates of adoption.

The third null hypothesis was tested using the general linear model of one-way analysis of variance (ANOVA). The F statistic was used to determine the existence of significant difference among community variables.

Subhypothesis 3a. No significant differences were found in the rate of adoption among the communities in the four quadrants in the state (NW, NE, SW, SE), therefore, the third null hypothesis was not rejected for location factor (Table 12). The highest rates of adoption was found among individual communities with low population levels and these communities are distributed fairly evenly throughout the state.

Table 12

Analysis of Variance Table--Difference in Rate of Adoption Due to Location In the State

Source of Variation	SS	DF	M	F-Ratio	Significance Of F
Due To Location (NE, NW, SE, SW)	.08201630	3	.02733877	1.48	.2243
Residual	1.69585581	92	.01843322		
Total	1.77787211	95			

ROA-NW = .1196

ROA-NE = .0305

ROA-SE = .0564

ROA-SW = .0527

95 of the 102 communities were used in the calculation. Six communities were excluded in which no construction had taken place in the years 1975-1985.

Subhypothesis 3b. Significant differences in the rate of adoption were found between communities who employed a full time building inspector for code enforcement and communities that used a municipal official to act as a building inspector for code enforcement. The ROA level for the 51 communities with full time building inspectors was .0305 while the ROA level for the 45 communities with municipal officials for building inspectors was over three times that with a level of .1011. The third null hypothesis was rejected for category of building official factor (Table 13).

The 102 communities were divided into two groups: communities that had adopted the model code for the region and employed a building inspector for code enforcement, and communities that had not adopted the model code and utilized some existing municipal official to carry out the duties of code enforcement. As stated previously, communities which have not adopted the model code may be using the state building code and/or a locally promulgated code or some combination of the two. It is common not to employ a full time staff person for building inspection in small communities due primarily to small city budgets and/or size of community.

Subhypothesis 3c. Part C of hypothesis three compared the communities with the 20 highest rates of adoption by

Table 13

Analysis of Variance Table--Difference in Rate of Adoption Between Communities With Building Inspectors and Communities With Municipal Officials as Inspectors

Source of Variation	SS	DF	M	F-Ratio	Significance Of F
Due To Building Category (BI, MO)	.11912080	1	.11912080	6.75	0.0109
Residual	1.6587513	94	.01764629		
Total	1.77787211	95			

ROA among communities with BI = 0.0305 N = 51
ROA among communities with MO = 0.1011 N = 45
96 of the 102 communities were used in the calculation. Six communities were excluded in which no construction had taken place in the years 1975-1985.

placing them on a map to determine the proximity of these twenty communities to each other. Eight of the 20 communities with the highest rate of adoption were all (with one exception) below the one percent level (Table 14). Solar adopters are often found in spatial clusters but it is usually within a neighborhood within a community, not between communities. Rogers (1983) maintains that a"tipping point" occurs when a diffusion threshold of 10-20 percent adoption is reached. At this point, clustering is likely to take place.

The communities with the 20 highest rates of adoption do not cluster by quadrant in the state or in distance from each other, therefore, the third null hypothesis for Subhypothesis 3c was rejected for this factor.

Hypothesis 4

The null hypothesis developed in relation to the fourth objective was:

Ho_4 There is no difference in perceptions of barriers and incentives of innovative, energy-efficient housing between builders who have built solar and/or earth sheltered housing and those builders who have never built any solar or earth sheltered housing.

Table 14

Communities With 20 Highest Rates of Adoption by Location in the State

				Building Permits		
			Category of Building	Conventional Houses	Innovative Houses	
Rank	City	Loc	Official	N	N	ROA
1	Manly	NE	MO	30	30	1.0000
2	Kellog	SE	MO	10	7	.7000
3	Arlington	NE	MO	2	1	.5000
4	Stanhope	NW	MO	6	1	.1677
5	Spillville	NE	MO	6	1	.1671
6	Sioux Center	NW	BI	171	27	.1578
7	Springville	NE	MO	13	2	.1538
8	Minburn	SW	MO	7	1	.1428
9	Buffalo	SE	BI	15	2	.1333
10	Postville	NE	MO	15	2	.1333
11	Clarion	NW	MO	43	5	.1162
12	Woodward	SW	MO	35	4	.1142
13	Ogden	NW	MO	71	8	.1126
14	Vinton	NE	BI	45	5	.1111
15	Indianola	SE	BI	200	21	.1050
16	Cresco	NE	BI	10	1	.1000
17	De Soto	SW	MO	20	2	.1000
18	Polk City	SW	MO	20	2	.1000
19	Grimes	SW	BI	40	4	.1000
20	Iowa City	SE	BI	1651	155	.0938

MO - Municipal Official

BI - Building Inspector

This hypothesis was tested by using a chi-square contingency table to examine differences between respondents categorized into two groups: solar and/or earth sheltered home builders (solar builders) and non-solar builders and/or earth sheltered builders. A mean score was determined for both groups on each variable. Significant differences ($p < .05$) were found for the following variables: lack of skill among subcontractors acts as a barrier to building earth sheltered housing, lack of qualified builders acts as a barrier to building earth sheltered housing, and the 40% tax credit was an incentive to build innovative, energy-efficient housing. The mean score for nonsolar/earth sheltered builder was significantly higher for all of the variables except the 40% tax credit incentive. The fourth null hypothesis was rejected for these variables (Table 15).

In additional information gathered, builders were asked whether or not start up costs act as a barrier to building passive solar housing when compared to a conventionally constructed house of the same size and quality. Solar/earth sheltered builders and nonsolar/earth sheltered builders had a mean score of 2.45 and 2.92 respectively. When comparing the length of time in business for the two groups, 33% of the solar/earth sheltered builders had been

Table 15

Difference Between Solar and Nonsolar Earth Sheltered Builders in Their Perceptions of Barriers and Incentives to the Adoption of Innovative Energy-Efficient Housing

Perceptions of Barriers and Incentives Category of Builder	N	Mean	χ^2	P-Value
Need for Solar				
Nonsolar/Earth Sheltered	40	3.23		
Solar/Earth Sheltered	57	3.36	7.19	.126
Solar Practical in Iowa				
Nonsolar/Earth Sheltered	40			
Solar	57	2.54	.448	.978
State Mandated Standards Reduce Risk				
Nonsolar/Earth Sheltered	39	2.51		
Solar/Earth Sheltered	58	2.43	.714	.950
Lack of Information a Barrier				
Nonsolar/Earth Sheltered	40	3.14		
Solar	57	3.21	1.710	.789
Available Financing a Barrier				
Nonsolar/Earth Sheltered	40	2.77		
Solar	57	3.11	3.14	.534
Rising Heating Costs Incentive				
Nonsolar/Earth Sheltered	40	4.06		
Solar	52	4.06	.281	.991
Risky Resale a Barrier				
Nonsolar/Earth Sheltered	40	3.45		
Solar	56	3.35	.797	.939

Table 15 - Continued

Difference Between Solar and Nonsolar/Earth Sheltered Builders in Their Perceptions of Barriers and Incentives to the Adoption of Innovative Energy-Efficient Housing

Perceptions of Barriers and Incentives Category of Builder	N	Mean	χ^2	P-Value
Lack of Skill Among Subcontractors:				
Passive Solar				
Nonsolar/Earth Sheltered	40	3.25		
Solar	57	2.72	6.34	.175
Active Solar				
Nonsolar/Earth Sheltered	40	3.78		
Solar	57	3.40	4.50	.342
Earth Sheltered				
Nonsolar/Earth Sheltered	40	3.65		
Solar	57	3.36	13.24	.010*
Lack of Qualified Builders:				
Passive Solar				
Nonsolar/Earth Sheltered	40	2.93		
Solar	56	2.39	6.04	.197
Active Solar				
Nonsolar/Earth Sheltered	40	3.43		
Solar	55	2.96	3.23	.520
Earth Sheltered				
Nonsolar/Earth Sheltered	40	3.38		
Solar	56	2.86	9.288	.054*
40% Federal Tax Incentive				
Nonsolar/Earth Sheltered	40	3.25		
Solar	57	3.69	10.196	.037*

Table 15 - Continued

Difference Between Solar and Nonsolar/Earth Sheltered Builders in Their Perceptions of Barriers and Incentives to the Adoption of Innovative Energy-Efficient Housing

Perceptions of Barriers and Incentives Category of Builder	N	Mean	χ^2	P-Value
Initial Investment Barrier:				
Passive Solar				
Nonsolar/Earth Sheltered	39	3.26		
Solar	57	3.32	4.05	.398
Active Solar				
Nonsolar/Earth Sheltered	39	4.00		
Solar	57	4.26	7.65	.105
Earth Sheltered				
Nonsolar/Earth Sheltered	39	3.71		
Solar	57	4.11	7.78	.100
Code Enforcement Inhibits:				
Passive Solar				
Nonsolar/Earth Sheltered	39	2.88		
Solar	57	2.23	5.86	.209
Active Solar				
Nonsolar/Earth Sheltered	39	2.95		
Solar	57	2.79	2.40	.662
Earth Sheltered				
Nonsolar/Earth Sheltered	39	3.23		
Solar	57	3.30	3.71	.446

Table 15 - Continued

Difference Between Solar and Nonsolar/Earth Sheltered Builders in Their Perceptions of Barriers and Incentives to the Adoption of Innovative Energy-Efficient Housing

Perceptions of Barriers and Incentives Category of Builder	N	Mean	χ^2	P-Value
Novelty of Design Inhibits:				
Passive Solar				
Nonsolar/Earth Sheltered	39	2.87		
Solar	57	2.25	8.59	.072
Active Solar				
Nonsolar/Earth Sheltered	39	3.38		
Solar	57	3.22	4.60	.330
Earth Sheltered				
Nonsolar/Earth Sheltered	39	3.65		
Solar	57	3.64	3.39	.495

*significant at the .05 level

4 DF

in business 20 years or more while 18% of the nonsolar/ earth sheltered builders had been in business 20 years or more.

Hypothesis 5

The null hypothesis developed in relation to the fifth objective was:

Ho_5 There is no difference between lender groups (Farmers Home Administrators, commercial bankers, and savings and loan association lenders) in regard to their perception of barriers and incentives to innovative, energy-efficient housing.

This hypothesis was tested by using a chi-square contingency table to determine differences among respondents categorized into three groups: savings and loan associations, commercial bankers, and Farmers Home Administrators. In order to determine which groups differed, a mean score was calculated for each lender group. Significant differences were found for the following variables: state mandated standards reduce risk of inspecting solar housing, available financing acts as a barrier to building innovative, energy efficient housing, the 40% federal tax credit acts as an incentive, and initial investment acts as a barrier to building passive solar. The fifth null hypotheses was reflected for these variables (Table 16). No clear pattern emerged among the three lender groups, but a summary of mean scores showed that all the lender groups rank the barriers above a mean score of 3.0 and in many cases well above a mean of 3.5. All of the lender groups had a mean score close to 4.0 or above on the question of whether initial investment in active solar housing acts as a barrier to building that type of dwelling and whether novelty of design acts as a barrier to building earth sheltered housing. Lack of skills among subcontractors was seen as a barrier for all three categories of innovative, energy efficient housing. (The fifth null hypothesis was rejected for these variables, see Table 16).

Additional information obtained from lenders showed that differences were also found between lender groups in how they would rate their institution's attitude toward providing financing for solar energy and earth sheltered housing as well as earth sheltered. The Farmers Home Administrators group had a mean response function of 2.2 compared to savings and loan associations and commercial bankers with a mean response function of 3.10 and 3.09 respectively. It would appear that the Farmers Home Administrators take a more conservative attitude toward providing financing.

Table 16

Differences Among Lender Groups in Their Perceptions of Barriers and Incentives to the Adoption of Innovative Energy-Efficient Housing

Perceptions of Barriers and Incentives Category of Lender	N	Mean	χ^2	P-Value
Need for Solar				
Savings & Loan	21	3.06		
Commercial Bankers	110	3.19		
Farmers Home Administrators	45	3.37	5.95	.652
Solar Practical in Iowa				
Savings & Loan	21	2.75		
Commercial Bankers	110	2.87		
Farmers Home Administrators	45	2.53	5.95	.652
State Mandated Standards Reduce Risk				
Savings & Loan	21	3.14		
Commercial Bankers	110	2.77		
Farmers Home Administrators	44	2.82	20.137	.010*
Lack of Information a Barrier				
Savings & Loan	21	3.63		
Commercial Bankers	105	3.70		
Farmers Home Administrators	44	3.47	5.37	.717
Available Financing a Barrier				
Savings & Loan	21	3.71		
Commercial Bankers	111	3.02		
Farmers Home Administrators	45	3.93	20.829	.008*
Rising Heating Costs Incentive				
Savings & Loan	20	3.80		
Commercial Bankers	88	3.87		
Farmers Home Administrators	36	3.83	5.96	.651

Table 16 - Continued

Differences Among Lender Groups in Their Perceptions of Barriers and Incentives to the Adoption of Innovative Energy-Efficient Housing

Perceptions of Barriers and Incentives / Category of Lender	N	Mean	χ^2	P-Value
Risky Resale a Barrier				
Savings & Loan	20	3.69		
Commercial Bankers	111	3.65		
Farmers Home Administrators	45	3.97	9.74	.283
Lack of Skill Among Subcontractors:				
Passive Solar				
Savings & Loan	20	3.62		
Commercial Bankers	110	3.72		
Farmers Home Administrators	45	3.66		
Active Solar				
Savings & Loan	20	4.00		
Commercial Bankers	109	3.90		
Farmers Home Administrators	45	3.84	4.059	.852
Earth Sheltered				
Savings & Loan	20	3.87		
Commercial Bankers	110	3.82		
Farmers Home Administrators	45	3.77	6.764	.562
Lack of Qualified Builders for:				
Passive Solar				
Savings & Loan	20	3.37		
Commercial Bankers	110	3.55		
Farmers Home Administrators	45	3.33	11.898	.156
Active Solar				
Savings & Loan	20	3.93		
Commercial Bankers	109	3.69		
Farmers Home Administrators	45	3.64	11.279	.186

Table 16 - Continued

Differences Among Lender Groups in Their Perceptions of Barriers and Incentives to the Adoption of Innovative Energy-Efficient Housing

Perceptions of Barriers and Incentives Category of Lender	N	Mean	χ^2	P-Value
Lack of Qualified Builders for:				
Earth Sheltered				
Savings & Loan	20	3.93		
Commercial Bankers	110	3.68		
Farmers Home Administrators	45	3.55	5.470	.706
40% Federal Tax Incentive				
Savings & Loan	20	2.95		
Commercial Bankers	111	3.33		
Farmers Home Administrators	45	3.33	21.223	.007*
Initial Investment Barrier to:				
Passive Solar				
Savings & Loan	21	3.33		
Commercial Bankers	109	3.82		
Farmers Home Administrators	45	3.71	16.753	.033*
Active Solar				
Savings & Loan	21	4.25		
Commercial Bankers	108	3.99		
Farmers Home Administrators	45	4.02	13.63	.092
Earth Sheltered				
Savings & Loan	21	3.68		
Commercial Bankers	109	3.68		
Farmers Home Administrators	45	4.00	10.68	.220

Table 16 - Continued

Differences Among Lender Groups in Their Perceptions of Barriers and Incentives to the Adoption of Innovative Energy-Efficient Housing

Perceptions of Barriers and Incentives Category of Lender	N	Mean	χ^2	P-Value
Code Enforcement Inhibits:				
Passive Solar				
Savings & Loan	21	2.31		
Commercial Bankers	109	2.87		
Farmers Home Administrators	45	2.42	11.331	.184
Active Solar				
Savings & Loan	21	2.63		
Commercial Bankers	110	2.92		
Farmers Home Administrators	45	2.75	11.308	.185
Earth Sheltered				
Savings & Loan	21	2.94		
Commercial Bankers	110	3.03		
Farmers Home Administrators	45	3.04	4.86	.772
Novelty of Design Inhibits:				
Passive Solar				
Savings & Loan	21	2.69		
Commercial Bankers	111	3.27		
Farmers Home Administrators	45	2.77	7.063	.530
Active Solar				
Savings & Loan	21	3.50		
Commercial Bankers	110	3.60		
Farmers Home Administrators	44	2.977	12.347	.136

Table 16 - Continued

Differences Among Lender Groups in Their Perceptions of Barriers and Incentives to the Adoption of Innovative Energy-Efficient Housing

Perceptions of Barriers and Incentives Category of Lender	N	Mean	χ^2	P-Value
Novelty of Design Inhibits:				
Earth Sheltered				
Savings & Loan	21	4.31		
Commercial Bankers	111	3.8		
Farmers Home Administrators	45	3.57	5.014	.756

Nonsolar refers to Passive Solar, Active Solar, and Earth Sheltered

*significant at the .05 level

4 DF

Hypothesis 6

The null hypothesis developed in relation to the sixth objective was:

Ho_6 There will be no difference between lenders who have financed for solar and/or earth sheltered housing and lenders who have not financed with regard to their perception of barriers and incentives to innovative, energy-efficient housing.

This hypothesis was tested by using the chi-square test to determine differences among three pairs of lender groups: lenders who had financed active solar housing and lenders who have not; lenders who had financed passive solar housing and lenders who had not, and lenders who have financed earth sheltered housing and those who had not. In order to further explain differences between groups, a mean score function was calculated for each lender group.

Differences Between Lenders Who Had Financed Active Solar Housing and Lenders Who Had Not. Significant differences were found between lenders who had financed active solar and lenders who had not for the following variables: state mandated standards would reduce risk, lack of skill among sub-contractors acts as a barrier, initial investment acts as barrier to building passive solar and active solar (Table 17). The sixth null hypothesis was rejected for these four variables.

Although not significant, there appeared to be differences found between lenders who had financed active solar and those who had not for the following additional variables: is solar practical in Iowa, cost of energy an incentive to build, code enforcement may inhibit the building of passive solar and earth sheltered housing. A review of mean scores shows that the nonactive solar lender perceived the barriers to innovative, energy-efficient housing on all variables on which there were differences higher than the lender who had experience lending money for active solar housing. The greatest difference between active solar and non-solar lenders was on the question of whether state mandated solar standards would reduce the risk of building solar housing.

Differences Between Lenders Who Had Financed Passive Solar Housing and Those Who Had Not. Significant differences were found between lenders who had lent money for passive solar and those who had not for the following variables: availability of experienced qualified builders acts as a barrier to passive solar, initial investment acts as a barrier to building passive solar housing and novelty

Table 17

Comparison of Lenders' Perceptions Lenders Who Have Financed Active Solar Housing With Lenders Who Have Not

Perceptions of Barriers and Incentives Category of Lender	N	Mean	χ^2	P-Value
Solar Practical in Iowa				
Nonsolar lender	145	2.737	8.31	.081
Solar lender	31	2.612		
State Mandated Standards Reduce Risk				
Nonsolar lender	144	2.895	11.807	.019*
Solar lender	31	2.516		
Rising Heating Costs Incentive				
Nonsolar lender	120	3.875	7.818	.098
Solar lender	24	3.750		
Lack of Skill Among Subcontractors Acts As Barrier to Active Solar				
Nonsolar lender	144	3.909	10.334	.035*
Solar lender	30	3.833		
Initial Investment Acts As Barrier:				
Passive Solar				
Nonsolar lender	145	3.779	11.628	.020*
Solar lender	30	3.500		
Active Solar				
Nonsolar lender	144	4.062	12.71	.013*
Solar lender	30	3.833		
Code Enforcement May Inhibit Building:				
Passive Solar				
Nonsolar lender	145	2.744	9.00	.061
Solar lender	31	2.548		
Active Solar				
Nonsolar lender	145	2.972	8.931	.063
Solar lender	31	3.290		

4 DF

significant at .05 level

of design acts as a barrier to building passive solar housing. The sixth null hypothesis was rejected for these three variables (Table 18).

Although not significant, there appeared to be a difference between lenders who had financed passive solar and lenders who had not for availability of financing acts as a barrier to building passive solar housing. Mean scores were calculated to assess the extent of the differences on all four variables listed on Table 18, the non solar lender perceived the barriers to be greater than the passive solar lender. The greatest difference was found for the barrier of whether the initial investment needed for building passive solar acts as a barrier to building this type of housing.

<u>Differences Between Lenders Who Had Financed Earth Sheltered Housing and Those Who Had Not</u>. Significant differences were found between lenders who had financed earth sheltered housing and those who had not for the following variables: there is a need for innovative energy-efficient housing in Iowa, and initial investment needed for passive solar acts as a barrier to building. The nonearth sheltered lender perceived the barrier of the initial investment needed for passive solar to be higher

Table 18

Comparison of Lenders' Perceptions: Lenders Who Had Financed Passive Solar Housing With Lenders Who Had Not

Perceptions of Barriers and Incentives Category of Lender	N	Mean	χ^2	P-Value
Availability of Financing Acts As a Barrier to Build Passive Solar				
Nonsolar Lender	116	3.465		
Solar Lender	61	3.098	8.486	.075
Availability of Experienced, Qualified Builders Acts As Barrier to Build Passive Solar				
Nonsolar Lender	115	3.617		
Solar Lender	60	3.216	11.59	.021*
Initial Investment Acts As A Barrier to Build Passive Solar				
Nonsolar Lender	116	3.827		
Solar Lender	59	2.543	16.64	.002*
Novelty of Design Acts As A Barrier to Build Passive Solar				
Nonsolar Lender	116	3.327		
Solar Lender	61	2.655	13.717	.008*

4 DF

*significant at the .05 level

than the lender who had lent money for earth sheltered housing. The nonearth sheltered lender had a higher mean score on the question of the need for energy-efficient housing in Iowa than the earth sheltered lenders. The sixth null hypothesis was rejected for these two variables (Table 19). Although no significant differences were found between the earth sheltered lender and nonearth sheltered lender on whether the initial investment needed for building an earth sheltered house acts as a barrier to building both of these lender groups had a mean score greater than 3.5 for this factor and would appear to perceive it as a barrier.

Discussion of Findings

Perceptions of Intermediary Groups. Builders, inspectors, lenders, and realtors varied somewhat in their perceptions of barriers and incentives to building innovative, energy-efficient housing in Iowa. This was expected in that the variability among intermediaries is probably reflected in the low rate of adoption in the state (less than 1%). Shama (1982a) refers to intermediaries such as builders, inspectors, lenders, and realtors as an adopter unit that participates in the decision making process to adopt an innovation. One of the necessary conditions for the diffusion of an innovation within the

Table 19

Comparison of Lenders' Perceptions: Lenders Who Had Financed Earth Sheltered Housing With Lenders Who Had Not

Perceptions of Barriers and Incentives Category of Lender	N	Mean	χ^2	P-Value
There Is a Need for Innovative Energy-efficient Housing In Iowa				
NonEarth Sheltered Lender	121	3.32	11.36	.023*
Earth Sheltered Lender	55	3.01		
Initial Investment Acts As a Barrier to Passive Solar				
NonEarth Sheltered Lender	121	3.83	10.83	.029*
Earth Sheltered Lender		54	3.50	
Initial Investment Acts As a Barrier to Earth Sheltered				
NonEarth Sheltered Lender	121	3.85	8.77	.067
Earth Sheltered Lender		54	3.57	

4 DF

*significant at the .05 level

housing industry is some level of consensus among members of the adopter unit.

Perceptions Held By All Intermediary Groups. While there was a good deal of variability among intermediaries perceptions of innovative, energy-efficient housing, some factors were clearly perceived as barriers by most of the intermediary groups. Other factors were perceived as barriers by only one or two specific groups. For instance, the initial investment or "first costs" that are associated with building passive solar, active solar, and earth sheltered housing was perceived as an important barrier by most of the intermediaries; particularly the "first costs" associated with an active solar dwelling. On the other hand, there was a significant amount of variability in perceptions among intermediaries as to whether adopting state mandated solar standards into community codes would reduce the risk of building solar housing. Few building code authorities have enacted building codes that apply exclusively to solar energy systems (Mara Engle, 1982). There was significant variability among intermediary groups as to whether code enforcement acts as a barrier to building passive and active solar housing and to a lesser degree, earth sheltered housing. It is important to remember that building codes address only issues or concerns that may effect health or safety of occupants

(Environmental Law Institute, 1977). Building codes are not concerned with the performance of heating or mechanical systems; therefore a number of solar specific technical concerns probably will never be of concern to the building inspector.

Individual Intermediary Groups. In many instances it was the builder, realtor, and lender groups' that varied with each other in their perceptions of barriers and/or incentives. Lenders tended to rate most of the barriers higher than the other intermediary groups. This could be due to the nature of their business. According to Barrett, Epstein, and Haar (1977), lenders are concerned about present uncertainties in performance and economics of residential solar heating. The major issue among lenders is the impact of including solar heating in the value of the property in times of resale. On the question of whether the risk of reselling a solar or earth sheltered house is a barrier, both the lender and the realtor groups perceived this to be a more important barrier than the builders or the building inspectors.

Perceptions Of Intermediaries When Grouped By Population Categories And Their Associated Rate Of Adoption. When communities were grouped according to their population category and its associated rate of adoption it was assumed that the perceptions of the intermediaries in each of the four categories of community groups would vary with each of the other community groups. Because the rate of adoption in each community group is less than 1% in all cases, it was not surprising that the differences in perceptions among intermediaries in each of the population groups was not great. The greatest variation appeared to be contributed by population level Group 1, 2,500 or less. This group of communities has the highest rate of adoption (.0955) of the four population categories.

There are also other characteristics associated with this smallest group of communities that are not common to the other community groups and may contribute to its higher rate of adoption. Most of the communities in population group (2,500 or less) have the following characteristics in common: 1) they have not adopted a model building code, 2) the predominate code used by these communities is a state building code, 3) most of these communities do not have a full time building inspector and building inspection is carried out by a municipal official who performs some other municipal office (i.e., mayor, fire chief, city clerk, etc.), 4) this is the only category that also has some communities with no building code or in some cases only locally promulgated codes. According to Field and Rivkin (1975), the building official breathes life into the written code. Whereas the code specifies what type of construction is permissible, the official insures that the standards are met. The building official is responsible for approving building plans, inspecting the construction of buildings, and issuing permits of occupancy. This definition does not take into account the influences that bear upon him. He reacts to different factions of the local building industry interested in securing favorable code decisions.

On the other hand, the lack of any code or very minimal code requirements allow the builder a great deal of latitude. The positive aspect of this is that potential constraints found in a model code and its enforcement by the building inspector is no longer a barrier. In the case of earth sheltered housing the most innovative houses are found in rural areas where building codes may be nonexistant or not strictly enforced (Sterling, Aiken, & Carmody, 1981).

It is interesting to note that the only factor on which there was significant differences in perceptions among intermediaries between population categories of communities was on the perception of the extent of need for solar housing in Iowa. Intermediaries in population group 1 perceived the need to be greater than the intermediaries in any of the other community population group. Inter-mediaries in the four population groups differed in their perceptions of other barriers but not as frequently. In all instances, it was the intermediaries in the 2,500 or less population category that differed with population group 3 (10,000-49,999) and population group 4 (50,000-149,999). Intermediaries in population group 2,500 or less also perceived solar housing to be more practical in Iowa than did the intermediaries in the other three population groups. The fact that community population group 1, 2,500 or less, had the highest rate of adoption is supported by Ostlund's findings (1974) that the relationship between perceptions of an innovation and innovative behavior are generally positive.

Differences In Rate Of Adoption According To Location And Type Of Building Official. When the communities in the state were grouped not by population category, but according to their location in the state, rate of adoption was not significantly different between the northwest, southwest, northeast, and the southeast quadrant of the state. However, when communities were grouped into two building code groups; the model code affiliated communities with full-time building inspectors and noncode affiliated communities with part-time municipal officials who were building inspectors, the rate of adoption among non-code affiliated communities with part-time municipal official/ building inspectors was significantly higher. This may support the premise that codes inhibit innovation in design (Ehrenkrantz Group, 1979; Hirshberg & Schoen, 1974).

The codes that predominate in the communities that use municipal officials to fulfill the duties of a building inspector on a part-time basis are state codes and/or locally promulgated codes or in some cases no code. The lack of a strong code enforcement system in the small population category of communities and the fact that it has a higher rate of adoption may be partially explained by the premise that codes may impede housing innovation such as solar energy applications (Hirshberg & Shoen, 1974).

The codes that predominate in the communities that use municipal officials to fulfill the duties of a building inspector on a part-time basis are state codes and/or locally promulgated codes or in some cases no code. The lack of a strong code enforcement system in the small population category of communities and the fact that it has a higher rate of adoption may be partially explained by the premise that codes may impede housing innovation such as solar energy applications (Hirshberg, & Shoen, 1974).

Communities With the Highest Rate of Adoption. Twenty of the 102 communities with the highest rate of adoption were compared to see if in any way they were clustered together in proximity to each other. This did not occur even by quadrant in the state. Communities with high rates of adoption were fairly evenly distributed throughout the state. However, according to Rogers (1983), clustering does not occur until a diffusion threshold of 10-20% has taken place. Given the low rate of adoption for the state, it would not be likely that clustering would occur even among communities with the highest rate of adoption.

Perceptions of Solar/Earth Sheltered and Nonsolar/Earth Sheltered Builders. When the perceptions of builders who had experienced building either passive solar, active solar, or earth sheltered housing were compared to builders who had never built any type of solar or earth sheltered house, the two groups differed significantly on only three of variables. However, an examination of the mean scores on all of the variables revealed that in most instances it was the nonsolar/earth sheltered builder who perceived the barrier to be greater than the solar/earth sheltered builder. Both groups of builders perceived the initial investment associated with active solar and earth sheltered housing to be an important barrier. The nonsolar/earth sheltered builder tended to perceive code enforcement as a greater barrier to building passive solar or active solar than the solar/earth sheltered builder which may be why the nonsolar builder hasn't built any solar or earth sheltered housing. The nonsolar/earth sheltered builder also perceived novelty of design to be a greater barrier than the solar/earth sheltered builder, which may also contribute to this group's having not built any innovative, energy-efficient housing.

In general, the two builder groups did not differ significantly from each other on most of the variables. The most significant finding from these two builder groups is that both groups perceived the initial investment associated with passive solar, active solar, and earth sheltered housing as an important barrier to building these types of housing. In an additional question, builders responded that building any kind of innovative, energy-efficient designed house would take longer than building a conventional structure of the same size and quality. This could be a major barrier for either group of builders. Length of time to build a solar house was a barrier expressed by builders in a 1983 study by Conway (1987).

Perceptions of Lender Groups Toward Innovative, Energy-Efficient Housing. There were variations in receptivity to housing innovations among lender types or groups and therefore the perceptions of the three lender groups included in this study were compared with each other. However, the variation in receptivity did not hold true for this particular study. The three lender groups perceived the barriers very much the same way with few exceptions. Most of the lender groups perceived the barriers to innovative, energy efficient design to be fairly important. Among the most important barriers were: lack of skills among subcontractors, lack of qualified builders, initial investment associated with active solar and earth sheltered, and novelty of design.

The perception among lender groups that novelty of design would act as a barrier is supported by the findings of Barrett, Epstein, and Haar (1977). In their study of lenders' attitudes toward solar housing in New England, lenders emphasized a preference for traditional-looking homes. Barrett, Epstein, and Haar maintain that this attitude prevails in other regions as well. They sum up lenders' position on visual aesthetics by stating that lender uncertainty about how the average home buyer will react to the aesthetics of solar houses will be reflected in the value assigned to that home.

In comparing the three lender groups on the question of their institutions' attitude toward financing of solar energy housing, the Savings and Loan Associations rated their institutions' attitude higher than did the commercial bankers. The Farmers Home Administrators rated their institutions attitude the lowest of the three groups. This was also supported by Barrett, Epstein, and Haar (1977), who found that thrift institutions (such as savings and loans) will generally be more receptive to proposals for financing innovative housing than other lender types as they are lending mainly for their own portfolios. Commercial banks are usually next in line as far as positive attitude toward financing solar housing. Barrett, Epstein, and Haar (1977) also maintain that size of bank may have a great deal to do with a bank's initiative in making "untried" types of loans. Small banks do not have the staff or time to risk an occasional bad loan. For the most part, the majority of banks in Iowa would be considered small banks and this too may contribute to the low rate of adoption.

Perceptions of lenders were also compared between lenders who had financed active solar, passive solar, and/or earth sheltered housing and lenders who had not. In the case of active solar lenders, there were more than four times as many nonsolar lenders as solar lenders. It is not surprising that on all barriers which solar and nonsolar lenders differed, it was always the nonsolar lenders who rated the barrier higher than the solar lenders. Again, both the solar and nonsolar lenders responded that the initial investment was an important barrier to building active solar housing. The solar lenders perceived code enforcement as a greater barrier than the nonsolar lenders which could be interpreted that this group had experienced some problems with codes.

As might be expected, the passive solar lenders and nonpassive solar lenders did not differ on as many barriers. The ratio of passive solar lenders to nonpassive solar lenders was two to one compared to active solar lenders and nonactive solar which was four to one. Passive solar is not as controverisal or different from conventional construction as active solar or earth sheltered housing. Recent newspaper accounts indicate that many Iowans have experimented with solar greenhouses, or "sun spaces" which has given intermediaries and consumers in the state an opportunity to try solar on a limited basis (Iowa Energy Hot Line). As would be expected the nonpassive solar lender perceived the initial investment needed for passive solar as an important barrier and much more important than the passive solar lender. The passive solar lender who has actually experienced lending for this type of housing may not have experienced the initial investment to be a negative factor or viewed a passive solar structure as "different".

There was very little variability between earth sheltered lenders and nonearth sheltered lenders. They differed on only three factors. As in the case of the other groups of lenders, both the earth sheltered lender and the nonearth sheltered lender perceived the initial investment needed for earth sheltered housing to be an important barrier. Sterling, Aiken & Carmody (1981) state that most people consider financing to be the biggest single obstacle to more widespread construction of earth sheltered housing. One factor to be considered is that very few earth sheltered loan applications are received and therefore there is little need to set up procedures to deal with this type of construction. The fact that earth sheltered lenders and nonearth sheltered lenders do not differ on many factors could be significant in itself. Lenders in general, perceived the code enforcement and novelty of design to be the greater barrier to earth sheltered housing than either passive solar or active solar housing.

The lack of consensus among intermediary groups surveyed in this study may explain the low rate of adoption in the state. Rogers theorizes that innovations can be adopted or rejected by individual members of a system or by the entire system, which can decide to adopt an innovation by collective decision. In the case of the adoption or rejection of solar or earth sheltered housing, the individual may not be able to adopt innovative housing until other members of the adoptive unit collectively decide to accept or reject the innovation. The greater the number of people who make up the adopting unit, the more diverse their motives, consequently the slower the rate of adoption.

CHAPTER V

Summary Conclusion, Implications, And Recommendations For Further Research

A summary of the study including methodology and findings is presented in this chapter. Conclusions based on the findings are also presented along with implications of the study. Finally, recommendations are made for further research.

Summary

The major objective of this study was to examine housing intermediaries' perceptions of barriers and incentives toward innovative, energy-efficient housing. Specific objectives were to determine: (1) whether intermediary groups differed in their perceptions of barriers and incentives to innovative, energy-efficient housing; (2) whether intermediary groups differed in their perceptions of barrier and incentives to innovative, energy-efficient housing among each of the four population categories and their associated rate of adoption; (3) whether there was a difference in the rate of adoption of innovative, energy-efficient housing when communities were grouped according to their location in the state, type of building official, or proximity to other communities with innovative energy-efficient housing; (4) whether there was a difference in perceptions of barriers and incentives to innovative, energy-efficient housing between builders who had built solar/earth sheltered housing and builders who had not; (5) whether there was a difference between lender groups (Farmers Home Administrators, commercial bankers, and savings and loan associations) in their perceptions of barriers and incentives to innovative energy-efficient housing; and (6) whether there were differences in perceptions of barrier and incentives to innovative, energy-efficient housing between lenders who had financed passive solar, active solar, or earth sheltered housing and lenders who had not.

A one page questionnaire was developed soliciting information from building inspectors in communities in Iowa. Inspectors were asked to determine the number of building permits issued for single family housing in their community between the years 1975 and 1985. Inspectors were also asked to estimate how many permits of those issued in that time frame were for passive solar, active solar, and earth sheltered housing. This questionnaire was mailed in the summer of 1985. The number of communities responding was 102 out of a possible 116 for a 87% response rate. A rate of adoption was then calculated for each community by dividing the number of building permits issued for passive solar, active solar, and earth sheltered by the number of building permits issued for single family dwellings. These communities were located in all four quadrants of the state and formed the pool from which the sample was drawn. Of the 102 communities, half had adopted a national model building code and the other half had not.

The sample consisted of housing intermediaries (builders, building inspectors, lenders, and realtors) drawn from 102 communities in Iowa. Suppliers were also included in the survey but were not compared to the other intermediaries because they were a total population and therefore, were not a part of the sample group.

The respondents were drawn from each community by using various state directories. The following sources were used: The Iowa Home Builders Association, the membership roster of the Iowa Chapter of of the International Conference of Building Officials, the Directory of the Iowa Municipalities, the Directory of the Iowa Mortgage Bankers, the roster of the Iowa Savings and Loan Association Directors, the state Directory of the Farmers Home Administrators, and the roster of the Iowa Association of Realtors. In a few instances the telephone directory from several of the small communities was used to obtain names when no names appeared on a particular directory.

The survey instrument used was a questionnaire designed specifically for each of the five intermediary groups. The questionnaire was developed to obtain the responses of the four intermediary groups on thirteen variables having to do with perception of barriers and incentives to building innovative, energy-efficient housing in the state. Additional questions where asked in each questionnaire specific to the profession of the intermediary to whom the questionnaire was directed. The last question of each questionnaire elicited information regarding demographic characteristics of the respondents. A 5-point Likert like scale with a range from "nonagreement" (scored as 1) to most agreement (scored as 5) was selected for respondents to record their level of agreement.

The questionnaire was mailed in December 1986 to 631 intermediaries in 102 communities in the State of Iowa with 481 questionnaires returned for an overall response rate of 76%.

The sample group comprised of housing intermediaries in four categories, lenders, builders, building inspectors, and realtors were a well educated group. Over 75% of all of the respondents had attended college, graduated from college or attended graduate school. The lender group had the highest level of educational attainment with 72% of this group of respondents who had graduated from college or attended graduate school. Ages among respondents ranged from 18 to over 65 years of age with the largest number of respondents in the 35-44 and 45-54 age range. The majority of all of the respondents had been in business a minimum of six years with almost half of the builders having been in business 15 years or more. Over one third of the realtors had been in business 20 years or more.

Intermediaries' Perceptions of Important Barriers and Incentives. The overall perceptions of intermediaries on the 18 possible barriers and incentives revealed that the initial investment or "first costs" associated with building an active solar home to be a major barrier. "First costs" associated with earth sheltered housing, although to a lesser degree, were also considered an important barrier. Two barriers, not associated with cost, were also considered to be important and they were the lack of skills among subcontractors of design associated with earth sheltered housing. The barrier considered least important of all the barriers was the extent that code enforcement acts as a barrier to building active solar housing.

Differences in perceptions among intermediary groups on the 23 perception variables as well as differences between groups of intermediaries within the four population categories and their associated rate of adoption were determined using two way analysis of variance.

Objective 1. Intermediary groups differed significantly on six factors ($p < .05$). These were (a) mandated solar energy standards may reduce the risk to building solar, (b) lack of information acts as a barrier, (c) availability of financing acts as a barrier to solar, (d) risky resale potential acts as a barrier, (e) initial investment associated with passive solar and earth sheltered housing, and, (f) code endorsement may inhibit building active solar and earth sheltered housing.

Although not a significant difference, some difference was found on whether lack of skills among subcontractors acts as a barrier.

Objective 2. Intermediaries within each of the four populations categories differed significantly with each other on two factors ($p < .05$). Significant differences were found on (a) the extent of the need for solar in Iowa, and (b) whether novelty of design inhibits building active solar housing. Although not as great, differences were found for the extent that solar is practical in Iowa, lack of skills among subcontractors acts as a barrier to building earth sheltered housing, the extent that the 40% tax credit was an incentive, and code enforcement inhibits building active solar.

Differences among intermediary groups as well as differences among intermediary groups within population categories and their associated rate of adoption differed simultaneously on six factors. Significant differences were found ($p < .05$) for lack of skills among subcontractors acts as a barrier to active solar; availability of qualified builders acts as a barrier to passive solar, active solar, and earth sheltered housing;

code enforcement may inhibit building passive solar; and appearance and novelty of design acts as a barrier to passive solar.

A Chi-square contingency table was used to determine whether intermediary groups as well as intermediaries within the four population categories and their associated rate of adoption on the variables for potential for rising heating costs is an incentive to build solar and whether novelty of design acts as a barrier to building earth sheltered housing. Significant differences were found among intermediary groups for the variable of whether novelty of design acts as a barrier to building earth sheltered housing.

Objective 3. One-Way analyses of variance to determine whether rate of adoption among the 102 communities varied when they were grouped according to location in the state, and according to the category of building official serving the community. Communities were also compared to determine if the twenty communities with the highest rate of adoption were close in proximity. No significant differences were found in the rate of adoption among communities in the four quadrants in the state (NW, NE, SW, SE). Significant differences were found in the rate of adoption between communities who employed a full-time building inspector for code enforcement and communities that employed municipal officials to act as a part-time building inspector for code enforcement. Rate of adoption was significantly greater among non-code affiliated communities. Twenty communities with the highest rate of adoption were compared to determine if they were clustered together in one part of the state or were possibly close in proximity. When these 20 communities were placed on a map, the communities did not cluster by quadrant or in distance from each other.

Objective 4. A Chi-square contingency table was used to determine whether there was a significant difference in perceptions between builders who had built solar or earth sheltered housing and builders who had not. Of the twenty-three perception variables on which builder groups were compared, significant differences ($p < .05$) were found for three variables, (a) lack of skills among subcontractors acts as a barrier to building earth sheltered housing, (b) lack of qualified builders acts as a barrier to building earth sheltered housing, and (c) the 40% federal tax credit was an incentive.

Even though builders varied on only three of the possible twenty-three variables, a review of builders mean scores shows that builders who had not experienced building any kind of solar or earth sheltered housing perceived the barriers to be greater than those builders who had.

Objective 5. A Chi-square contingency table was used to examine differences in perception toward innovative, energy-efficient housing among lender groups (savings and loan associations, commercial bankers and Farmers Home Administrators). Significant differences ($p < .05$) were found for four variables, (a) the state mandated standards reduce the risk of inspecting solar housing, (b) available financing acts as a barrier to building innovative energy-efficient housing, (c) the 40% federal tax credit acts as an incentive, and (d) initial investment acts as a barrier to building passive solar.

Lender groups varied significantly on four out of a possible 23 variables. When the mean scores of the three lender groups were compared for each of the variables, no clear pattern emerged as to their rating of the barriers or incentives. In other words, Savings and Loan respondents did not rate the barriers much differently from the bankers or the Farmers Home Administrators.

Objective 6. A Chi-square contingency table was used to examine differences in perception of barriers and incentives to innovative energy efficient design between lenders who had financed either passive solar, active solar, or earth sheltered housing and those who had not.

The first comparison was made examining the perception of lenders who had financed active solar housing and lenders who had not. Significant differences ($p < .05$) were found for three variables, (a) lack of skills among subcontractors acts as a barrier to active solar, (b) state mandated standards would reduce the risk of inspection, and

(c) initial investment acts as a barrier to building passive solar and active solar. Although not significant, differences were found on the variables, solar is practical in Iowa, rising heating costs act as an incentive, and code enforcement may inhibit building passive solar and active solar housing.

Differences in perceptions of barriers and incentives to innovative, energy-efficient housing between lenders who had financed passive solar housing and those who had not were also examined. Significant differences ($p < .05$) were found for three variables (a) availability of experienced qualified builders acts as a barrier to passive solar, (b) initial investment acts as a barrier to building passive solar and (c) novelty of design acts as a barrier to building passive solar housing. Although not significant, differences in perceptions were found for availability of financing acts as a barrier to building passive solar.

Differences in perceptions of barriers and incentives to innovative, energy-efficient design, between lenders who had financed earth sheltered housing and those who had not were also examined. Significant differences ($p < .05$) were found for the need for solar housing in Iowa, and initial investment acts as a barrier to passive solar housing. Although not significant, differences in perceptions were also found on the variable for initial investment as a barrier to building earth sheltered housing.

Conclusions

On the basis of this study the following conclusions about intermediaries' perceptions of barriers and incentives to innovative, energy-efficient housing in Iowa seem to be justified:

1. Rate of adoption among the four population categories does not vary substantially except for the smallest population category of 2,500 or less which has the highest rate of adoption among the four groups of communities.
2. Three factors on which variability might be expected to occur among intermediaries are on the extent of the affect of state mandated standards on residential building inspectors, whether or not solar energy houses have a risky resale value and whether the initial investment associated with passive solar and earth sheltered housing poses a barrier to building this type of housing.
3. Intermediary groups overall seem to perceive that the "first costs" associated with an active solar house acts as a barrier to building this type of structure and that lack of skills among subcontractors and builders also contribute a barrier to building all three types of innovative,

energy-efficient housing (active solar, passive solar, and earth sheltered housing).

4. The intermediaries in the smallest population category (2,500 or less) tend to perceive the extent of the need for solar to be greater than the intermediaries in the largest population categories (50,000-149,000). The intermediaries in the smallest population category do not perceive the design of an earth sheltered house to be as great a barrier as the intermediaries in the population category of 10,000-49,999.
5. Factors on which both intermediary groups and intermediaries within population categories vary are in their perceptions of the skills among subcontractors for building solar housing, whether or not there are qualified builders to build passive solar, active solar, or earth sheltered housing, and whether code enforcement and novelty of design inhibit the building of passive solar housing.
6. Rate of adoption does not vary among the Iowa communities in this survey according to their location in the state (NW, SE, NE, SW).
7. The rate of adoption is higher among non-code affiliated communities with a municipal official serving as building inspector, therefore rate of

adoption may be influenced by the category of building official serving the community.

8. There is no clustering effect or physical grouping of Iowa communities among the 20 communities with the highest rate of adoption.

9. The variability between solar/earth sheltered builders and nonsolar earth sheltered builders is relatively small. Instances of variability between the two groups occur on:

    a. Lack of skills among subcontractors acts as a barrier to earth sheltered housing.

    b. Lack of qualified builders is a barrier to earth sheltered housing.

    c. The 40% federal tax credit was an incentive to build solar.

10. The lender groups do not perceive the barriers and incentives to active solar, passive solar, or earth sheltered housing much differently from each other. Lender groups vary on questions of the availability of financing with the Farmers Home Administrators perceiving the availability of financing to be a greater barrier than the other lender groups. Lender groups vary on the extent to which state mandated solar standards reduce the risk of inspection but, in general, do not perceive the implementation of state mandated

standards to be an important incentive. Lender groups perceive the initial investment in passive solar differently but, in general, rate the initial investment associated with passive solar, active solar, and earth sheltered housing to be an important barrier.

11. The lenders as a group tend to perceive the barriers to be greater than do the builders as a group in the state of Iowa.
12. Lenders who have not financed active solar housing perceive the barriers to innovative, energy-efficient housing as greater than the lenders who have financed active solar housing.
13. Lenders who have not financed passive solar housing perceive the barriers to innovative, energy-efficient housing as greater than the lenders who have financed passive solar housing. They differ significantly on the following variables:
    a. The availability of qualified builders to build passive solar housing.
    b. Whether the initial investment acts as a barrier to building passive solar housing.
    c. Whether novelty of design acts as a barrier to build passive solar housing.
14. Lenders who have not financed earth sheltered

housing perceive the barriers to innovative, energy-efficient housing higher than the lenders who have financed earth sheltered housing. They differ significantly on the following:

a. The need for solar in Iowa.

b. Whether the initial investment associated with passive solar acts as a barrier to building passive solar.

c. Whether initial investment acts as a barrier to building earth sheltered housing.

15. Suppliers as a group do not perceive availability of financing for innovative, energy-efficient housing as a barrier.

16. Suppliers tend to agree that state mandated standards incorporated into local community codes would reduce the barriers associated with building inspection.

17. Suppliers tend to rate the variation in federal regulations, as well as variation in administration and interpretation of building codes as an important barrier to building innovative, energy-efficient housing.

Implications

Do intermediaries perceptions of barriers and incentives to innovative, energy-efficient housing in Iowa, explain a rate of adoption of less than 1% for the state?

The diffusion of a product as complex as innovative energy-efficient housing requires a concert of perceptions among the builders, building inspectors, lenders, and realtors involved in the adoption process. Clearly, intermediaries do vary in their perceptions, however, there is agreement on some perceptions that have important implications. Intermediaries do not vary in their perceptions on the need for solar energy housing in Iowa. The perception is that there is a need for energy-efficient housing. In line with that perception is that the rise in heating costs is an important incentive to build innovative, energy-efficient housing. The implication is that given the agreement on these two factors, the potential for building innovative, energy-efficient housing is in place if some of the perceived barriers can be addressed. Two of the barriers on which intermediaries agree as to their importance is that "first costs" associated with active solar, and to a lesser degree, earth sheltered housing acts as a barrier. Additionally, lack of skills among subcontractors is perceived as a barrier to building active solar housing.

The fact that builders and lenders, in particular, perceive "first costs" as a barrier is a factor that needs to be explored. The housing market is well known for its preoccupation with first costs as opposed to life cycle costs, a phenomenon associated, in part, with the fact that most home purchasers are young and have a rising income. Both builders and lenders perceive the "first costs" associated with passive solar housing to be less of a barrier than for active solar or earth sheltered housing. The implication here might be that passive solar housing should be the type of innovative house to promote. Passive solar housing is one way of introducing other types of innovative, energy-efficient housing at a later time. Newspaper accounts substantiate that Iowans are adding sun spaces or solar green houses to their homes as a type of low-risk trial of passive solar design.

Risky resale is perceived as a potential barrier to building innovative, energy-efficient housing. This could have implications for financing for either passive solar, active solar, or earth sheltered housing. Often financial problems stem from the newness of the application and the concerns that lenders have for public acceptance and hence its resale potential. Once energy conscious design is diffused into the market and it becomes more widely known, some of the risk involved in selling this type of house will be reduced. Financing problems should be transitional once market data is established for active solar, passive solar, and earth sheltered housing.

An interesting factor to emerge from this study is that nonadopters, such as builders who have not built any type of innovative energy-efficient housing or lenders who have never financed a solar energy house perceived the barriers to innovative, energy-efficient housing to be greater than the adopters such as solar/earth sheltered builders or solar/earth sheltered lenders. The implication here is that familiarity with a product may reduce some of the perceived barriers.

The fact that intermediaries perceive novelty of design associated with earth sheltered and active solar housing as a barrier could be an important factor in explaining the less than 1% rate of adoption in the state. Lenders are concerned about how a potential homebuyer will react to the aesthetics of a solar house and this has the potential to be reflected in the value assigned to the house in question.

Other factors to emerge from this study that are important to consider are that most intermediaries perceive that there is a need for solar housing in Iowa and that rising heating costs are a major incentive for building energy-efficient housing. Iowa has not experienced a decline in home heating fuel as the state imports most of its heating fuel which is natural gas. Consumers experienced a leveling of natural gas prices in 1983 after eight consecutive years of 20% increases however, there was a 3% increase again in 1984 and 1985 (L.L. Dombrowski, personal communication, Iowa Energy Policy Council, July 8, 1988). If we were to calculate life cycle costs of solar or earth sheltered housing, the rise in the cost of home heating fuel would reduce or shorten the payback period.

The perception that none of the intermediaries consider code enforcement to be a barrier to innovative, energy-efficient design, particularly passive solar and active solar housing, should be encouraging to intermediaries and consumers alike.

Attitudes and values of intermediaries play an important role in the acceptability of an idea, or a product. The extent to which diffusion of innovative, energy-efficient housing will take place depends on a reasonable level of agreement among the intermediaries involved. Numerous studies find that perceptions are related to the rate of adoption. Identifying and anticipating the potential conflicts that may arise among intermediaries in the process of introducing housing such as solar or earth sheltered can sometimes smooth the way for its introduction and eventual diffusion.

Recommendations For Further Research

The following recommendations are made for further research in the area of the diffusion of innovative energy-efficient housing:

A. The development of educational efforts to help loan officers to become more knowledgable about passive solar, active solar and earth sheltered housing. This could result in a standardized method of assessing the cost/benefit of a design before it is built.

B. Establish educational efforts that would maximize help for builders and subcontractors interested in building innovative, energy-efficient housing. This could be in the form of workshops or informational sessions conducted by state universities, trash associations, extension agents or state energy policy councils.

C. A survey of early adopters in the state to determine barriers and incentives encountered as well as the financial processes used by early adopters.

D. Research that will identify the social political and technical barriers to more rapid utilization of innovative housing technology and potential strategies for surmounting those barriers.

E. Research that will provide better and more timely forecasts of changes that take place in the composition, disposition and other housing related characteristics of the Iowa population. This kind of information could be used by builders and lenders alike in making housing marketing decisions.

F. Research that will improve the technical and cost/benefit assessment basis for regulations affecting land development that accommodates solar housing.

G. Identification of the role of the federal government in housing technology research that promotes innovative, energy-efficient housing such as solar or earth sheltered. This would include the identification of how the government could assist in the research not necessarily their role in conductng research.

H. State support of Energy policy councils that would consolidate solar energy housing data which would include performance data as well as technical information for potential consumers. This could be made available through a solar energy "hot line" just as general energy data is presently made available to consumers.

I. State support of building code inspection, tax assessment, and zoning enforcement processes that specifically address solar issues.

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APPENDIX A

Letter To Building Inspectors

The University of Iowa
Iowa City, Iowa 52242

The Department of Home Economics
38 Macbride Hall

(319) 353-3178

1847

Substantial technological and design advances have been made in housing in recent years, but many of these innovations have not been adopted by the housing industry or the public. We know that some innovative energy-efficient houses have been built in Iowa; however, no compilation exists regarding their number or types.

This letter is being sent to all building inspectors in Iowa. Its purpose is to solicit the help of building officials in determining the number of passive and active solar and earth sheltered single family houses built in Iowa in the past ten years.

Please answer the four questions listed below in regard to your community. The following definitions are included for clarification:

Active Solar: A house equipped with solar collectors which utilize energy from the sun for heating and cooling the house.

Passive Solar: A house that is specifically designed to capture and store energy for the purpose of heating the house.

Earth Shelter: A house either partially or totally surrounded by soil for the purpose of reducing heating or cooling requirements.

1. How many building permits for new single family dwellings were issued in your jurisdiction in the past 10 years? _____

2. How many of those permits issued were for passive solar dwellings? _____

3. How many of those permits issued were for active solar dwellings? _____

4. How many of those permits issued were for earth sheltered structures? _____

You may receive a summary of the results by writing "solar results requested" on the back of the return envelope and printing your name and address below it. Please return the questionnaire in the enclosed envelope.

I appreciate your help in this matter. If you have questions, please write or call (319) 353-3176.

Sincerely,

Rochelle Conway, Assistant Professor
34 McBride Hall, The University of Iowa
Iowa City, Iowa 52240

APPENDIX B

Tables of Community Characteristics

TABLE B1
COMMUNITY CHARACTERISTICS OF
POPULATION CATEGORY LESS THAN 2,500
(ROA LEVEL 1)
.0859

COMMUNITY N-39	LOC	TYPE OF BUILDING OFFICIAL MO OR BI	NO. OF D.U.S. CONVENTIONAL CONSTRUCTION	10 YEARS INNOVATIVE CONSTRUCTION
Walford	SE	MO	7	0
Durango	NE	MO	0	0
Buffalo	SE	BI	15	2
Hills	SE	MO	34	1
West Branch	SE	MO	32	0
Woodward	SW	MO	35	4
Cambridge	SW	MO	0	0
Birmingham	SE	MO	0	0
Arlington	NE	MO	2	1
Strawberry	NE	MO	11	0
Minburn	SW	MO	7	1
Panora	NE	MO	26	1
Springville	NE	MO	13	2
Ogden	NW	MO	71	8
Manly	NE	MO	30	30
Wheatland	SE	MO	1	0
Waukee	SW	MO	40	2
Northwood	NE	MO	62	1
Kellogg	SE	MO	10	7
Manson	NW	MO	141	2
Spillville	NE	MO	6	1
South English	SE	MO	12	1
Stanhope	NW	MO	6	1
St. Charles	SW	MO	13	1
Coggon	NE	MO	31	1
North Liberty	SE	BI	100	5
Grimes	SW	BI	40	4
Postville	NE	MO	15	2
Jewell	NW	MO	8	0
Wall Lake	NW	MO	28	1
Polk City	SW	MO	20	2
De Sota	SW	MO	20	2
Kelley	SW	MO	14	1
Coon Rapids	SW	MO	25	1
Ocheyedan	NW	MO	7	0
Lake View	NW	MO	41	0
Dexter	SW	MO	0	1
Weldon	SE	MO	0	1
Robins	SE	MO	50	2

MO - Municipal Official
BI - Building Inspector
DUS - Dwelling Units

TABLE B2
COMMUNITY CHARACTERISTICS OF
POPULATION CATEGORY 2,500 to 9,999
(ROA LEVEL 2)
.03026

COMMUNITY N-35	LOC	TYPE OF BUILDING OFFICIAL MO OR BI	NO. OF D.U.S. CONVENTIONAL CONSTRUCTION	10 YEARS INNOVATIVE CONSTRUCTION
Storm Lake	NW	BI	239	1
Harlan	SW	BI	176	5
West Liberty	SE	BI	60	0
Maquoketa	SE	MO	300	4
Camanche	SE	MO	144	8
Sibley	NW	BI	10	0
Vinton	SE	BI	45	5
Coralville	SE	MO	224	4
Osceola	SE	MO	0	0
Carroll	SW	MO	59	5
Clarion	NW	MO	43	5
Clive	SW	BI	200	0
Sioux Center	NW	BI	171	27
Algona	NW	BI	304	0
Windsor Heights	SW	BI	11	0
Altoona	SE	BI	300	1
Clear Lake	NW	BI	175	4
Webster City	NW	BI	133	2
Grinnell	NE	BI	174	7
Charles City	NE	BI	132	2
Waverly	NE	BI	230	3
Winterset	SW	BI	75	0
Eldridge	SE	BI	315	15
Missouri Valley	SW	BI	21	0
Evansdale	NE	BI	314	10
Independence	NE	BI	244	5
Adel	SW	BI	20	0
Creston	SW	MO	213	10
Johnston	SW	BI	235	11
LeMars	NW	BI	232	13
Mount Pleasant	SE	MO	220	3
Decorah	NE	MO	148	13
Perry	SW	MO	150	12
Spirit Lake	NW	BI	201	1
Cresco	NE	BI	10	1

TABLE B3
COMMUNITY CHARACTERISTICS OF
POPULATION CATEGORY 10,000 to 49,999
(ROA LEVEL 3)
.01672

COMMUNITY N-21	LOC	TYPE OF BUILDING OFFICIAL MO OR BI	NO. OF D.U.S. CONVENTIONAL CONSTRUCTION	10 YEARS INNOVATIVE CONSTRUCTION
Marion	SE	MO	866	1
Ottumwa	SE	BI	45	2
Oskaloosa	SE	MO	75	0
Newton	SE	BI	75	4
West Des Moines	SE	BI	1102	17
Clinton	SE	MO	200	10
Fort Dodge	NW	MO	300	3
Ankeny	SE	BI	757	31
Urbandale	SW	BI	1549	17
Marshalltown	NE	BI	509	5
Mason City	NE	BI	350	4
Bettendorf	SE	BI	1454	2
Burlington	SE	BI	416	2
Indianola	SE	BI	200	21
Keokuk	SE	BI	252	5
Cedar Falls	NE	BI	800	8
Boone	NW	BI	282	4
Muscatine	SE	BI	553	4
Fort Madison	SE	BI	125	8
Spencer	NW	MO	200	4
Ames	NW	BI	1055	18

TABLE B4
COMMUNITY CHARACTERISTICS OF
POPULATION CATEGORY 50,000 to 149,999
(ROA LEVEL 4)
.01572

COMMUNITY N-7	LOC	TYPE OF BUILDING OFFICIAL MO OR BI	NO. OF D.U.S. CONVENTIONAL CONSTRUCTION	10 YEARS INNOVATIVE CONSTRUCTION
Waterloo	NE	BI	1596	7
Iowa City	SE	BI	1651	155
Davenport	SE	BI	2978	10
Cedar Rapids	SE	BI	3044	10
Dubuque	NE	BI	1302	3
Sioux City	NW	BI	1415	7
Council Bluffs	SW	BI	733	8

APPENDIX C

QUESTIONNAIRES

QUESTIONS 1-13 IDENTICAL IN EACH QUESTIONNAIRE

QUESTIONNAIRE ONE - REALTORS
QUESTIONNAIRE TWO - LENDERS
QUESTIONNAIRE THREE- BUILDERS
QUESTIONNAIRE FOUR - BUILDING CODE OFFICIAL
QUESTIONNAIRE FIVE - SOLAR EQUIPMENT SUPPLIERS

The following questions pertain to conditions, as you see them, that exist within the state or your community regarding energy-efficient, innovative housing such as passive or solar as well as earth sheltered.

Please circle one number that comes closest to expressing your perception of the statement, with "1" representing the least agreement and "5" representing the most agreement.

Q-1. How would you characterize the state's need for the development of energy-efficient, innovative house design such as passive or active solar, as well as earth sheltered? (Please circle number)

Low priority — 1 2 3 4 5 — High priority

Q-2. To what extent do you believe active solar systems in residential construction are practical in this area of the country? (Please circle number)

Not practical — 1 2 3 4 5 — Very practical

Q-3. To what extent would state mandated solar standards incorporated into your communities' building and housing codes reduce some of the risk in inspecting a house with a solar heating system? (Please circle number)

Very little — 1 2 3 4 5 — Greatly

Q-4. To what extent do you believe lack of adequate information on solar housing and equipment acts as a barrier to the inspector making an inspection of energy-efficient, innovating housing? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

The following questions or statements pertain to potential incentives and/or barriers to building an energy-efficient, innovative house such as passive solar, active solar or earth sheltered. I would like to have your perceptions of these barriers and/or incentives.

Q-5. To what extent do you believe available financing for energy-efficient, innovative house design acts as a barrier to building this type of housing as compared to conventional housing? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

Q-6. To what extent do you believe the potential for rising heating costs acts as an incentive to the consumer to build energy-efficient, innovative house design? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

Q-7. To what extent do you believe risky resale potential acts as a barrier to building energy-efficient, innovating housing? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

Q-8. To what extent do you believe lack of specific skills among building sub-contractors, unfamiliar with innovative, energy-efficient housing, acts as a barrier to the building of housing such as:

1. Passive solar? (Please circle number)

Not at all — 1 2 3 4 5 — Very much

2. Active solar? (Please circle number)

Not at all — 1 2 3 4 5 — Very much

3. Earth sheltered? (Please circle number)

Not at all — 1 2 3 4 5 — Very much

Q-9. To what extent do you believe that availability of experienced qualified builders acts as a barrier to the building of the following types of energy-efficient, innovative housing such as -

1. Passive solar? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

2. Active solar? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

3. Earth sheltered? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

Q-10. To what extent do you believe the 40% federal tax credit served as an incentive to the consumer to build energy-efficient, innovative housing? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

Q-11. To what extent do you believe that initial investment or "first costs" acts as a barrier to the building of innovative, energy-efficient housing such as:

1. Passive solar? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

2. Active solar? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

3. Earth sheltered? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

Q-12. To what extent do you believe that code enforcement may inhibit energy-efficient, innovative building practices such as:

1. Passive solar? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

2. Active solar? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

3. Earth sheltered? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

Q-13. To what extent do you believe appearance or novelty of design acts as a barrier to the building of energy-efficient, innovative house design such as:

1. Passive solar? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

2. Active solar? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

3. Earth sheltered? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

REALTORS

Q-14. Is there an agreed upon method of appraising the market value of the following types of houses? (Please check)

Passive solar	( ) Yes	( ) No
Active solar	( ) Yes	( ) No
Earth sheltered	( ) Yes	( ) No

How would you determine resale value on:

1) Passive solar ______________________________

2) Active solar ______________________________

3) Earth sheltered ______________________________

Q-15. To what extent do building codes effect housing appraisals? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

Q-16. To what extent is additional research needed prior to appraising the following types of houses? (Please circle number)

1. Passive solar

None — 1 2 3 4 5 — A great amount

2. Active solar

None — 1 2 3 4 5 — A great amount

3. Earth sheltered

None — 1 2 3 4 5 — A great amount

Q-17. How many appraisals have you made in the past five years of the following types of houses? (Please indicate how many in appropriate box)

Passive solar	( )
Active solar	( )
Earth sheltered	( )

Q-18. To what extent would a structure's energy consumption be a factor in determining value of a home? (Please circle number)

Very little — 1 2 3 4 5 -- A highly important factor

Q-19. To what extent would you consider orientation of the house a factor in determining value of a home? (Please circle number)

Very little — 1 2 3 4 5 -- A highly important factor

The following background information questions are included only to help us statistically interpret your response to questions. Your responses here and throughout the questionnaire will be held strictly confidential.

Q-20. 1. What is your age? (Please check)

( ) 18-24
( ) 25-29
( ) 30-34
( ) 35-44
( ) 45-54
( ) 55-64
( ) 65 or over

2. What is the highest level of formal education you have completed? (Please check)

( ) grade 8 or less
( ) grade 9-11
( ) graduated high school
( ) 1-3 years of college
( ) graduated college
( ) attended or completed graduate school

3. Number of years in present position. (Please check)

( ) 1-5
( ) 6-10
( ) 10-15
( ) 15-20
( ) 20 or over

4. Position prior to present one. ______________________________

BUILDERS

Builder

Q-14. How many years have you been in the building business? (Please check)

( ) 5 years or less
( ) 6-10 years
( ) 11-20 years
( ) 20 years or more

Q-15. Over the last 10 years, how many of each of the following units did you build?

Single family conventional design	________	units
Single family passive solar design	________	units
Single family active solar design	________	units
Single family earth sheltered design	________	units
Apartments	________	units

Q-16. Does your business primarily involve: (Please check)

( ) Residential construction (using finished lots)
( ) Both land development and construction
( ) Land development only
( ) Other (specify) ________________________

Q-17. Would you agree to build any of the following types of homes? (Please check)

( ) Passive solar
( ) Active solar
( ) Earth sheltered

If you would not agree to build any one of the above structures, why not?

____

Q-18. Comparing construction costs of building a conventional house with a solar house of the same size and quality, to what extent do you believe additional start-up costs required for solar and earth sheltered housing acts as a barrier to building -

1. Passive solar? (Please circle number)

Very little — 1 2 3 4 5 — Greatly influences

2. Active solar? (Please circle number)

Very little — 1 2 3 4 5 — Greatly influences

3. Earth sheltered? (Please circle number)

Very little — 1 2 3 4 5 — Greatly influences

Q-19. To what extent does availability of materials and equipment act as a barrier to building energy-efficient, innovative housing such as:

1. Passive solar? (Please circle number)

Not very much — 1 2 3 4 5 — Greatly

2. Active solar? (Please circle number)

Not very much — 1 2 3 4 5 — Greatly

3. Earth sheltered? (Please circle number)

Not very much — 1 2 3 4 5 — Greatly

Q-20. The time needed and resulting costs associated with seeking code changes for building solar and earth sheltered housing may discourage builders from building this type of housing. To what extent do you agree with this statement? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

Q-21. To what extent would the hiring of competent subcontractors be a problem for you in building a passive or active solar house or earth sheltered structure? (Please circle number)

Not a problem — 1 2 3 4 5 — A great problem

Q-22. Please rank the following types of houses in order of length of time it would take to build, given all other aspects of the structure were equal.

( ) Passive solar
( ) Active solar
( ) Earth sheltered
( ) Conventional structure

The following background information questions are included only to help us statistically interpret your responses to questions. Your responses here and throughout the questionnaire will be held strictly confidential.

Q-23. 1. What is your age? (Please check)

( ) 18-24
( ) 25-29
( ) 30-34
( ) 35-44
( ) 45-54
( ) 55-64
( ) 65 or over

2. What is the highest level of formal education you have completed? (Please check)

( ) grade 8 or less
( ) grade 9-11
( ) graduated high school
( ) 1-3 years of college
( ) graduated college
( ) attended or completed graduate school

3. Number of years in present position. (Please check)

( ) 1-5
( ) 6-10
( ) 10-15
( ) 15-20
( ) 20 or over

4. Position prior to present one. ______________________________

LENDERS

Q-14. Please indicate the type of institution that you represent. (Please check one)

( ) Savings and Loan
( ) Commercial Bank
( ) Farmers Home Administration

Q-15. In terms of loans for new construction, how much emphasis does this institution place on these types of properties?

	Primary	Substantial Involvement	Little or No Importance
1-4 family homes	______	______	______
Multi-family condo	______	______	______
Multi-family rental	______	______	______

Q-16. What is the geographic area in which you are making loans? (Please check one)

( ) Rural (20,000 or under)
( ) Small cities (20,001-49,999)
( ) Metropolitan (50,000 or more)

Q-17. Have you lent money on any of the following types of energy-efficient housing in the past 10 years? (Please indicate how many in appropriate box)

( ) Passive solar
( ) Active solar
( ) Earth sheltered

Q-18. Do you have a specific method of determining the value of a solar system?

( ) Yes ( ) No

Q-19. to what extent do you believe that a house with a solar system will create additional value for the seller at the time of resale. (Please circle number)

Very little — 1 2 3 4 5 — A great deal

Q-20. How would you assess your institution's attitude toward providing financing for solar energy houses? (Please circle number)

1. Not at all favorable — 1 2 3 4 5 — Very favorable

For earth sheltered houses? (Please circle number)

2. Not at all favorable — 1 2 3 4 5 — Very favorable

Q-21. To what extent does the lack of clear system cost data on innovative, energy-efficient housing act as a barrier to determining market value of that house? (Please circle number)

Very little — 1 2 3 4 5 — A great deal

Q-22. Since the rise in energy prices that began in 1973, to what extent do you believe energy costs have increased in importance as a factor in your residential financing decisions? (Please circle number)

Somewhat — 1 2 3 4 5 — A great deal

Q-23. What is your general perception of the likely effect on home value of the inclusion of a solar energy heating system? (Please circle number)

No effect on value — 1 2 3 4 5 — Greatly effects value

Q-24. Would you, as a lender, try to influence a builder to provide energy conservative features that are efficient on a life cycle basis?

( ) Yes ( ) No

Lenders

The following background information questions are included only to help us statistically interpret your responses to questions. Your responses here and throughout the questionnaire will be held strictly confidential.

Q-25. 1. What is your age? (Please check)

( ) 18-24 ( ) 45-54
( ) 25-29 ( ) 55-64
( ) 30-34 ( ) 65 or over
( ) 35-44

2. What is the highest level of formal education you have completed? (Please check)

( ) grade 8 or less
( ) grade 9-11
( ) graduated high school
( ) 1-3 years of college
( ) graduated college
( ) attended or completed graduate school

3. Number of years in present position. (Please check)

( ) 1-5
( ) 6-10
( ) 10-15
( ) 15-20
( ) 20 or over

4. Position prior to present one. ________________________________

BUILDING OFFICIALS

Q-14. What is the technical basis for your communities' current building code covering residential construction? (Please check)

( ) state code, specify: ______________________________

( ) model code, specify: ______________________________

( ) locally promulgated code, specify: ____________________

1. What year was the code first adopted? ________

2. How many professional staff members are included in your department? (Please check)

( ) 1 part-time
( ) 1 full-time
( ) 2-5 people
( ) 6-25 people
( ) 25 or more

Q-15. Have you enacted building code provisions that apply exclusively to solar energy systems?

1. ( ) Yes ( ) No

2. If not, why not? ______________________________

Q-16. Do you believe state and local policy support for solar energy is great enough to act as an incentive for building passive solar, active solar or earth sheltered housing?

( ) Yes ( ) No

Q-17. Sunlight exposure requirements of a solar system might necessitate a pattern of building placement that cnflicts with current zoning and/or land use policy. To what extent is this a problem in your community? (Please circle number)

No problem at all	—	1	2	3	4	5 —	A great problem

Q-18. To what extent is additional research needed prior to inspecting the following types of houses? (Please circle number)

1. **Passive solar**

   None -- 1 2 3 4 5 -- A great amount

2. **Active solar**

   None -- 1 2 3 4 5 -- A great amount

3. **Earth sheltered**

   None -- 1 2 3 4 5 -- A great amount

The following background information questions are included only to help us statistically interpret your responses to questions. Your responses here and throughout the questionnaire will be held strictly confidential.

Q-19. 1. **What is your age? (Please check)**

( ) 18-24
( ) 25-29
( ) 30-34
( ) 35-44
( ) 45-54
( ) 55-64
( ) 65 or over

2. **What is the highest level of formal educaiton you have completed?**

( ) grade 8 or less
( ) grade 9-11
( ) graduated high school
( ) 1-3 years of college
( ) graduated college
( ) attended or completed graduate school

3. **Number of years in present position. (Please check)**

( ) 1-5
( ) 6-10
( ) 10-15
( ) 15-20
( ) 20 or over

4. **Position prior to present one.** ______________________________

SUPPLIERS

Q-14. To what extent do you believe that state mandated solar standards incorporated into building and housing codes would act as an incentive to the consumer for the adoption of solar system? (Please circle number)

Not at all -- 1 2 3 4 5 -- A great deal

Q-15. Diversity of requirements between the various building codes and federal regulations make it difficult to introduce innovation that conforms to all of these requirements. To what extent would you agree with the above statement? (Please circle number)

Not at all -- 1 2 3 4 5 -- Completely

Q-16. To what extent do you believe there is statewide variation in the administration and interpretation of bulding and housing codes as they apply to the installation of solar energy equipment? (Please circle number)

No variation -- 1 2 3 4 5 -- Great variation

Q-17. To what extent do you believe that availability of conventional fuels at lowered prices would reduce the advantage of installing a solar system to the homeowner? (Please circle number)

No reduction -- 1 2 3 4 5 -- Greatly reduce

Q-18. There is a higher risk associated with new products such as solar heating equipment than with standard heating products used in construction. To what extent would you agree with this statement? (Please circle number)

Not at all -- 1 2 3 4 5 -- Completely

Q-19. To what extent do you believe there is a need for improved consumer information about solar heating systems? (Please circle number)

No need -- 1 2 3 4 5 -- A great need

Q-20. Additional space requirements for an active solar system acts as a barrier to integrating solar systems into building design. To what extent do you agree with this statement? (Please circle number)

Not at all -- 1 2 3 4 5 -- Completely

Q-21. To what extent do you believe local building codes act as a constraint for the supplier in marketing his product? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

To what extent do you believe builders view solar heating and cooling as an unproven or experimental technology? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

Q-22. To what extent do you believe lack of sufficient data or a systems performance and costs which permit comparison of solar with conventional systems act as a constraint to the adoption of solar systems? (Please circle number)

Not at all — 1 2 3 4 5 — Greatly

Q-23. In your experience, to what extent do private convenants directly restrict or prohibit some portion of the solar installation?

Not at all — 1 2 3 4 5 — Greatly

Q-24. How would you rate the availability of financing for housing with solar systems in your area? (Please circle number)

Very poor — 1 2 3 4 5 — Very good

Q-25. Have code authorities in your community enacted building code provisions that apply exclusive to solar energy systems? (Please check)

( ) Yes ( ) No

Q-26. What type of information dissemination processes are commonly available to you in your area? (Please check)

( ) Newspaper
( ) Radio
( ) Television
( ) Workshops
( ) Extension office
( ) Manufacturers literature

APPENDIX D

The University of Iowa
Iowa City, Iowa 52242

The Department of Home Economics
38 Macbride Hall

(319) 353-3178

Current trends in energy use indicate that the public is concerned about energy prices and is trying to conserve energy. According to the April Wall Street Journal/NBC Poll, the public expects that energy prices will go up again before long. While energy conservation practices may make it possible for the consumer to reduce some energy consumption in the home, other energy requirements still remain. There is the potential for innovative, energy-efficient housing such as passive or active solar as well as earth sheltered to meet the remaining requirement. Yet, this type of housing represents only a fraction of one percent of all single family dwellings in the state. There is a need to identify the barriers and/or incentives that may exist in Iowa in order to fully understand this situation.

Your input is needed. Please take a few minutes to give me your perceptions regarding this important issue. It could help many Iowans to more efficiently spend their energy dollars.

You may be assured of complete confidentiality. The questionnaire has an identification number for mailing purposes only. This is so that we can check your name off the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire.

The results of this research are available by writing "copy of results requested" on the back of the return envelope, and printing your name and address below it. Please do not put this information on the questionnaire itself.

I would be happy to answer any questions you might have. Please write or call. The telephone number is (319) 353-3176.

Thank you for your assistance.

Sincerely,

Rochelle Conway
Assistant Professor

APPENDIX E

The University of Iowa
Iowa City, Iowa 52242

The Department of Home Economics
38 Macbride Hall

(319) 335-0484

About three weeks ago I wrote to you seeking your opinion on various factors that might effect the adoption of solar and earth sheltered housing in Iowa.

I have undertaken this study because of the belief that housing professionals have information with regard to solar and earth sheltered housing that can be very valuable in the formation of an energy conservation policy for the state.

I am writing to you again because of the significance each question has to the usefulness of this study. Your name was drawn through a scientific sampling process in which a proportionate number of housing professionals were chosen from select communities in Iowa. In order for the results of the study to be truly representative of the opinions of housing professionals in the state, it is essential that each person in the sample return their questionnaire.

In the event that your questionnaire has been misplaced, a replacement is enclosed. If you have completed the questionnaire and returned it please accept my sincere thanks. Your cooperation is greatly appreciated.

If you have any questions, please feel free to call me at (319) 335-0509.

Sincerely,

Rochelle Conway
Assistant Professor

APPENDIX F

The University of Iowa
Iowa City, Iowa 52242

The Department of Home Economics
38 Macbride Hall

(319) 335-0484

I am writing to you about my study of housing professionals' perceptions of barriers and incentives to solar and earth sheltered housing. I have not received your completed questionnaire.

The large number of questionnaires returned is very encouraging. But whether I will be able to accurately describe how housing professionals and institutions related to the housing industry feel about this issue depends on you and others who have not yet responded. This is because my past experiences suggest that those of you who have not yet sent in your questionnaire may hold quite different perceptions of the existing barriers and incentives to solar and earth sheltered housing than those who have.

This is the first state wide study of this type that has ever been done. Therefore, the results are of particular importance to builders, lenders, realtors, and code enforcement officials now considering what type of energy-efficient, innovative housing should be encouraged (or for that matter discouraged) so as to best meet the housing needs of Iowans.

It is for these reasons that I am sending this by Certified Mail to insure delivery. In case my correspondence did not reach you, a replacement questionnaire is enclosed. May I urge you to complete and return it as quickly as possible.

I will be happy to send you a copy of the results if you want one. Simply put your name, address, and "copy of results requested" on the back of the return envelope. I expect to have them ready to send by this summer.

Your contribution to the success of this study will be appreciated greatly.

Most sincerely,

Rochelle Conway
Assistant Professor

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