SOLAR TECHNOLOGIES AND THE SOFT PATH: AN EMPIRICAL EXAMINATION

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ABSTRACT

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A U.S. national probability sample of 2,023 traditional energy users and a purposive sample of 3,809 solar energy technology owners are compared to assess whether those who owned solar energy technologies in 1980 have more soft path preferences (SPP) (e.g. attitudes and behaviors compatible with soft energy path developments) than do those who did not own such technologies. It is suggested that SPP is a necessary but not sufficient condition for the social structural transformation of society to the soft energy path proposed by Amory Lovins.

A soft path preferences scale is developed. The scale values for solar and nonsolar homeowners, for active and passive solar technology owners, and for those owning the technologies for four different time periods are compared. The nonsolar homeowners, passive technology owners, and those who owned the technologies from one to five years have the highest SPP scores. The greatest differences were found in the dimension of natural resources conservation.

Partial least squares structural equation modeling is used to examine an extension and specification of Lovins' theory of soft energy path development. A model is created which focuses on the process of SPP development. Energy vulnerability needs, contextual resources, type of solar technologies, technological problems, and evaluation are the independent variables of the model.

The hypothesis that the solar energy technologies have the strongest influence on the development of SPP was not supported except for the passive solar technologies owners. Contextual resources provided the strongest influence, although it was negative for the solar technology owners and positive for the nonowners.

It is proposed that the symbolic nature of the solar technologies dominates the experiences of the owners. A bifurcation of the renewable energy base change process is suggested: (1) supportive of the hard energy path, changes driven by "energy as commodity" orientation of active solar systems owners and (2) changes more compatible with the energy path proposed by Lovins and driven by "energy as a natural resource to be conserved" perspective of passive solar technology owners. Policy, programmatic and research implications are explored.

This work is dedicated to my parents, LOIDA AND FLOYD GRADY and my husband, WELDON A. LODWICK. They have believed in me.

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I am most grateful to Denton Morrison who has constantly responded "beyond the call of duty" to my fledgling efforts through the years. Bonnie Morrison has also been important.

Weldon, Ryan and Stephen thanks for leaving me alone and carrying some of my home tasks. Maybe now I can play!

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CHAPTER I

THE PROBLEM: OVERVIEW AND ORGANIZATION OF THE STUDY

<u>Introduction:</u>

Sociologists have long been concerned with the interaction of technology and society. This concern is scattered throughout the discipline, including the classical theorists such as Weber, Marx, Ogburn, Mannheim and others.

Macro theories have examined the interaction of technology and society using either technology or society as the dependent variable. Many of the thinkers concerned with the Industrial Revolution have treated technology primarily as an independent variable restructuring society. Other theorists have examined technology as dependent.

An important strand of the macro level tradition is captured by "energetic theories" (Rosa and Machlis, 1983), which portray technology as an intervening variable between physical energy and society. These theories have predominantly portrayed social change as a dependent variable.

The second major approach to the study of technology and society has focused on the micro-level interactions. Studies in the diffusion of innovation tradition and in the social psychology of values and behavior have been part of this approach. Micro theories have generally treated energy or technology as dependent variables affected by socially structured choices and values of individuals or households.

Few studies have integrated the two levels of analysis looking at the intersection of technology, values, and the restructuring of society. In fact, Gaston (1980:496) has suggested that values have been neglected in the sociology of science and technology.

This study empirically examines Amory Lovins' influential claim that the use of "soft" energy technology (SET) affects a package of attitudes and behaviors which will directly restructure society's energy base and indirectly its political and economic systems. "Soft" energy technologies are, according to Lovins, those that have "soft" characteristics and impacts. They are: (1) natural resource conserving, (2) renewable resource using (e.g. based on renewable energy flows), (3) usually small in scale, (4) understandable (e.g. simple), (5) diverse, (6) matching energy quality to end-use needs, and (7) under the control of the end user (e.g. usually decentralized) (Lovins, 1977; 1978).

I have called the package of values and behaviors soft path preferences (SPP)[1]. This is based on Amory Lovins' work (1976, 1977, 1980). He has labelled the restructured society, which is based on SET's the "soft energy path (SEP)." This path is

> characterized as a complex, interacting set of mutually reinforcing, internally consistent features that together constitute an energy system that is, in effect, a sociotechnical system.
>
> (Morrison and Lodwick, 1981:365)

Lovins et al. clarified their evolving perspective on the meaning of a "path" by saying that "The soft technologies form the base for an alternative policy known as the soft energy path" (Lovins et al., 1983:57). The path change assumes that a summation of micro-level household and community choices eventually translates into changes at the macro-level unless constraining barriers are erected preventing such a social structural transformation.

Specifically, I examine the effect which the ownership of solar hot water heating and home heating and cooling systems has on household members' attitudes and behaviors. The central question I address is: Are the preferences expressed by households which own solar energy technologies more consistent with those needed for a social-structural transformation to the soft energy path than among those who do <u>not</u> own the technologies?

I address this question by developing a theoretical schema and model about the process of SPP development from the Lovinses'[2] and others' research. I then operationalize the model and test it with data from a national sample of households.

In the following chapters, the present research is set in the context of broadly relevant social science thinking on technology and society, on energy and society, and the relevant social science empirical research on energy. The theoretical schema and model are discussed in detail in Chapter IV. The following brief overview of Lovins' ideas is a preliminary orientation to what will later be considered more thoroughly.

Overview of the Lovinses' Ideas:

Amory Lovins (1976, 1977, 1980) explores ways in which energy, through technologies, influences society. Although he has not been concerned with disentangling the precise causal relationships between energy, technology, social structure and values he basically posits the energy base of society as the independent variable affecting social structure (1977:153). His primary concern is how to counter the power of current socioeconomic and political structures which have developed what he claims is a destructive trajectory for the social system i.e. the hard energy path (HEP) through use of an inappropriate energy base.

Lovins favors changing the energy base of societies built on energy stock forms (e.g. oil, coal, gas, and especially uranium) to one based on flow forms (e.g. solar, wind, water) (Lovins, 1977:169; Morrison and Lodwick, 1981:367). If the technological and the accompanying sociopolitical structures of the energy base are changed, then there will be a change to the soft energy path which will entail significant social change (Lovins, 1977:54; Morrison and Lodwick, 1981).

Individual choices made for technologies based on energy flows are grounded in personal values of "thrift, simplicity, diversity, neighborliness, humility and craftsmanship" (Lovins, 1977:57). Lovins claims choices based on these values will aggregate and, in turn, lead to changes in the political-economic system.

The argument he makes is that the characteristics of technologies create opportunities for the expression of these values although the technological characteristics are not a sufficient condition for the development of soft path preferences.

The previously sketched characteristics of SET's include the importance of socially organizing their implementation in a "soft" fashion. This implementation process is noncoercively based on user participation in making, operating and maintaining the technology (Morrison and Lodwick, 1981:366).

The "soft" characteristics of the technologies as well as the "soft" implementation process are both necessary and sufficient conditions for creating "soft" social impacts e.g. a move to SEP. If both conditions are not present, then the technology only has the potential for being a soft technology (Lovins, 1977:42; Morrison and Lodwick, 1981:369).

Lovins claims that rapid value changes are currently occurring in the U.S. which supplement the sociotechnical changes (1977:36) and which in turn are further reinforced by the use of the new energy technologies. There are five major dimensions of preferences that define a conceptually integrated package of these values:

(1) Central to this package is the importance of decentralizing the primary economic and social institutions of the nation. This is captured in the notion of self reliance preferences. Values, attitudes and behaviors which support local (e.g. community and neighborhood) political and economic activities as opposed to national or international activities are an integral part of SPP i.e. grassroots democracy (Lovins et al., 1983; Lovins and

Lovins, 1982; Kinsley, 1984; Morrison and Lodwick, 1981).

(2) The <u>personal gain preference</u> is also an important component of SPP. Lovins relies on the "free market" concept suggesting that if individuals make choices based on their individual economic and noneconomic benefits, these choices will help drive other aspects of SEP(e.g. resources conservation, equity). This has not occurred in the past because the market has been distorted by government subsidies to organizations driving the development of the hard path e.g. oil companies, centralized utility companies, etc. (Lovins, 1977; 1978; 1980; Lovins et al., 1983; Morrison and Lodwick, 1981).

(3) The third dimension, <u>natural resources conservation</u> preferences, embraces an increased recognition of the finiteness of the physical world and of the need to conserve many types of natural resources so that other generations and nations have sufficient resources to experience a better quality of life than if the resources are not conserved (Lovins, 1976; 1977, 1980; Lovins and Lovins, 1982; Lovins et al.; 1983).

(4) The fourth preference which is part of SPP is a concern for <u>equity</u>. Lovins suggests that a more equitable access to

and distribution of energy resources is an important outcome of the implementation of the soft energy path for individuals, communities, social classes, nations and generations. This access and assumed control will occurr with the implementation of soft technologies in a decentralized manner. It will create a greater surplus of energy resources than if the soft path is not implemented (Lovins, 1977, 1978; Lovins and Lovins, 1982; Lovins et al., 1983;Morrison and Lodwick,1981).

(5) Social diversity preference is also a result of the implementation of energy technologies based on end-use, non-coerciveness, economic self-interest and grassroots democracy (Lovins, 1976, 1977; Lovins and Lovins, 1982; Lovins et al., 1983; Morrison and Lodwick, 1981).

These last two are major social impacts of the development of the soft path. They will occur regardless of the values involved in implementation simply as a result of the use of diverse technologies and increased availability of energy. However preferences for such impacts are compatible with and theoretically should speed the development of the soft path.

Thus Amory and Hunter Lovins are part of the theoretical tradition defining technology as the translator of the impacts of energy onto the social system. The amount and type of energy used in a society are the primary forces behind social structure and social change. While Amory

Lovins[3] is not a social scientist, but rather a physicist turned energy activist, his ideas fit into a sociological tradition which examines the interaction of technology and society.

The Lovinses' ideas have been socially and social scientifically important and influential. While somewhat general and abstract, they are sufficiently specific to lend themselves to further theoretical development, operationalization and testing. They have been basically unexamined theoretically and empirically, thus inviting further study.

<u>Organization of This Study:</u>

In Chapter II, I review what social scientists have previously analyzed about the relationship of energy, technology and social change. I begin with a brief look at the classical theorists, then focus on energy and society analysts.

In Chapter III, details of more recent studies bearing directly on the issues at hand are discussed. Social scientific criticisms of the Lovinses' ideas are also reviewed. Using the criticisms and social scientists' research as a foundation, I extend the Lovinses' theory of social change, specifying how soft path preferences are developed at the household level. This specification is then translated into a testable model of the process in Chapter IV.

Chapter V includes the research design and a description of the sampling and data gathering processes. Descriptive information about the samples is also presented.

In Chapter VI, the model's variables are operationalized and measurement issues are presented. In Chapter VII, I discuss the partial least squares analysis technique and specify how I used it to model soft path preferences development.

Chapter VIII presents the findings of the study. Finally, in Chapter IX, I discuss my conclusions, policy implications and future research.

CHAPTER II

APPROACHES TO TECHNOLOGY, ENERGY AND SOCIAL CHANGE

I begin by discussing the classical theories about the relationship between technology and society which were fomented by the Industrial Revolution in Europe and the U.S. The second theoretical tradition examined is of the energetic theories. A discussion of research about the interrelationships between technology, values and behavior then links research on technology, energy, and social change to the diffusion of innovations research traditions. The diffusion of energy conservation practices, and of solar energy technologies, are two very relevant areas of research for notions of soft path changes.

Classical Theories of Technology and Society:

Sociology has examined the interrelationship of technology and society from the moment of its birth as part of the social sciences. Bernard de Mandevilles first expressed this concern as he watched the birth of the Industrial Revolution in England (Weinstein, 1982:12).

The classical theorists of technology and society are primarily concerned with how technology is used by elites to structure the social system for the purposes of industrial production to serve the bourgeois and control the political processes of society. The gulf between elites and the general population (e.g. the proletariat) is a major concern of these thinkers. The interplay of the values of the dominant social class and technological developments is thus part of the contributions of this literature.

Karl Marx and Friedrick Engels' writings on the impacts of the new industrial as well as of the ancient and prehistoric technologies on the organization of the economy, the state, the family, and culture have identified them as one of the earliest "technology assessors". They perceived technology as a force of production and examined the struggle between the means and relations of production which assured conflicting and uneven developments. The material base creates a social stratification system based on these conflicts (Weinstein, 1982).

Max Weber was also concerned with technology although his influence has been more strongly felt through his focus on bureaucracy, organization and method. This became dominant in American sociology, taking over from the emphasis on social problems and concerns with the impacts of automation on social relations.

There were, however, several exceptions to the dominant Weberian emphasis. Thorstein Veblen (1857-1929) and William F. Ogburn (1886-1959) both stressed how "values and social

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relations are systematically affected by - and affect - technological innovation" (Weinstein, 1982:44). Both in Veblen and in Ogburn's work, the emphasis on technology as a human, culturally-bound system with its potential for good or for evil became apparent. This is a theme which has appeared repeatedly in sociological studies of technology and society.

Thorstein Veblen reasoned that engineers (e.g."technocrats") were constrained by the profit motive of the business class, thus preventing the freeing of technology to guide the evolution of society. His interest in the way cultural values, as expressed in the behavior of the social classes, affected technological developments, was examined through a comparison of England and Germany's experience with the technology of the Industrial Revolution (1939). German frugality, rather than ostentatious class consumption, created a more productive social context for the industrial revolution. To Veblen, technocrats were some of the most creative people of society who were stifled by their cultural milieu (Weinstein, 1982:49). They were not, therefore, able to positively guide societal change.

William Fielding Ogburn explored many facets of the relationships of social change and technology, producing the first recognizable social impact assessment (see for example, Ogburn, 1938). He also agreed that social groups, e.g. elites, used technology "to mask real interests" (Weinstein, 1982:56). Ogburn made an important contribution to legitimating the study of technology within sociology and in developing the notion of "cultural lag" (1922). But his emphasis on the independence and strength of technology in creating social change and his oversimplification of its effects on social life, have tended to label him a technological determinist (Weinstein, 1982:59).

Karl Mannheim (1950) focused on the developments of what he termed Big Science in the late 1930's and early 1940's, a a trend which increased in speed during the post WWII period (Price, 1963). He took the position, that technological society is increasingly shaped by elite technicians and planners unresponsive to and insulated from the effects of the free market, public opinion, or egalitarian ideals. The increased specialization of the technological delivery system has made the rule by elites and the lack of public participation in the development of those systems inevitable. He was concerned with how the technological delivery system has replaced the laissez faire norms of the marketplace.

Mannheim's work suggested that social scientists could help develop a centralized democratic society which planned for freedom, for social justice, and for cultural standards. He was a precursor of Lovins in calling for planning without regimentation (Mannheim, 1950;29). He proposed that value changes (e.g. "moral and religious awakening") needed to occur along with technological change to transform society. Some of the new values were to recapture pride of craftsmanship (Mannheim, 1950:223) and attendant responsibility. This is a theme repeated in Lovins' benefits of the soft path (Lovins, 1977; Morrison and Lodwick, 1981).

The interaction of the "power elites" with engineers and technology in societal development processes was one focus of C. Wright Mills (1959, 1963). He was interested in the use of the sociological imagination to free people, a theme compatible with Lovins.

The need for freeing the populace from elite technological dominance was developed further by members of the Frankfurt Institute for Social Research, established in Germany in 1923. Technology, in combination with economic and psychological forces, is perceived as the key package of variables shaping modern society and in turn being shaped by the society. This technology "has contributed significantly to the general dehumanization and trivialization of our lives, thoughts and aspirations" (Weinstein, 1982:103; Marcuse, 1968).

More recently, Jurgen Habermas (1970) has called for consciously mediating technical developments and life in major industrial societies (Habermas, 1970;60). Habermas suggests that the production relation legitimates itself and adapts political relations to the economic subsystem. Science and technology have become a legitimating force as they are perceived to serve economic development.

Habermas claims that a new "conflict zone" is replacing class antagonisms "in the public sphere administered through the mass media" where the questioning of the nation's "technocratic background ideology" is depoliticized (Habermas, 1970:120). This conflict zone has been entered by the Lovinses. They have pointed to the technocratic ideology and its effects, suggesting a substitute.

The themes expressed by the classical theorists are consistent with Lovins' theory of technologically mediated social change. They include: (1) issues of technology control, (2) conflicts engendered by ownership of technology, (3) isolation of the controllers from the users of the technologies, (4) the importance of planning for change, and (5) the interaction of technology and values.

The Lovinses have stressed the negative effects of the dominance of the technocratic elite through the hard energy path. They have called for technical decisions on the part of households and local communities for technologies which are more consistent with prevalent values of the nonelites (Lovins, 1977; Morrison and Lodwick, 1981). Although the Lovinses' ideas are constrained by scientific and technical ideology supporting economic development, they have proposed creating social change by modifying the basic energy technology type of society (Kinsley, 1984; Lovins and Lovins, 1982; Lovins et al., 1983).

Energetic Theories of Society:

The second major theoretical tradition informing this research project in more specific ways than the classical tradition discussed above, examines the relationship between energy and society. In this tradition energy is the primary force driving technology. Energetic theorists often conclude that energy drives all of the facets of society. They also show that their concern has traditional roots. For example, in 1862, Herbert Spencer wrote:

> Whatever takes place in society results either from the undirected physical energies around, from these energies as directed by men, or from the energies of men themselves.
>
> (quoted in Carniero, 1967:xxxv by Rosa and Machlis, 1983:1)

These theorists further examine the interaction of values with the way which energy is captured by certain types of technologies to create social change.

The "energy crisis" of the 1970's called attention to some of the implications of energy's permeation through the social system creating "system vulnerability" (Schnaiberg, 1983).

Lewis Mumford (1934, 1967) was one of the earliest social thinkers to specifically link technology, energy, and social values. He argued that knowledge of the amount of energy used by a technology was not sufficient to predict its use. The "culture that was ready to use" the technology also had to be examined (Mumford, 1934:4). He suggested that cultural development usually occurred before <u>and</u> after the use of a physical technology. This included values <u>and</u> social organization. To develop this thesis, he examined the interactions of values, technology, and energy during different periods of civilization.

He identified coal and electricity as important sources of power helping to develop new civilizations. The coal based eighteenth century was described as a period when

> Mankind behaved like a drunken heir on a spree. And the damage to form and civilization through the prevalence of these new habits of disorderly exploitation and wasteful expenditure remained, whether or not the source of energy itself disappeared. The psychological results of carboniferous capitalism - the lowered morale, the expectation of getting something for nothing, the disregard for a balanced mode of production and consumption, the habituation to

> wreckage and debris as part of the normal human environment - all these results were plainly mischievous.
>
> (Mumford, 1934:158)

He also critiqued classical economics for not giving adequate attention to the energy base of economic activity. For once energy is converted by the technology, it "runs down hill, in gathering and shaping the raw materials, in transporting supplies and products, and in the process of consumption itself" (1934:378). Thus he predated the writings of Georgescu-Roegen (1971), Odum (1971), and Rifkin (1980).

Mumford puts it succinctly when he says:

> The real significance of the machines, socially speaking, does not consist either in the multiplication of goods or the multiplication of wants, real or illusory. Its significance lies in the gains of energy through increased conversion, through efficient production, through balanced consumptions, and through socialized creation. The test of economic success does not, therefore, lie in the industrial process alone, and it cannot be measured by the amount of horsepower converted or by the amount commanded by the individiaul user; for the important factors here are not quantities but ratios: ratios of mechanical effort to social and cultural results.
>
> (Mumford, 1934:378)

In his examination of the evolution of humanity, Mumford (1967) stressed the numerous "democratic technologies" of daily living (baskets, pots, barns, etc.). Many of these were created by women (1967:141). They coexisted with an authoritarian technology (e.g. centrally directed by dominant minorities) which was based on large scale social organization of people, the "megamachine" (Mumford, 1967:189).

> Almost from beginning of civilization, we can now see, two disparate technologies have existed side by side: one 'democratic' and dispersed, the other totalitarian and centralized. The 'democratic' mode, based on small-scale handicraft operations, was kept alive in a multitude of little villages, in partnership with farming and herding, though spreading into the growing country towns and finally lured into the cities.
>
> (Mumford, 1967:236)

This theme of the two technologies foreshadowed the struggle Lovins claims exists today between hard technologies and soft technologies, which are socioculturally incompatible (1977).

Anthropologist Leslie White closely examined the relationship between energy and social progress. He determined that the degree of progress (e.g. economic development) was based on the amount of energy harnessed. It is the relationship between technology, its efficiency, and energy that directly and indirectly affects change in the culture and the social organization of societies. Societies evolve through finding new ways of harnessing and concentrating solar energy for culture building (White, 1959).

This "culture building" serves the elites, claims Richard (1975). Social power evolves and becomes more concentrated as increased energy is generated and used by society. Energy is thus a driving force in social stratification and change carried by "mentalistic" (e.g. values carried as information) systems.

As Rosa and Machlis report, these theorists "argued that societal change and progress were directed by the amount of energy harnessed" which in turn was determined by the technology of the society (1983:11). These thinkers, however, had very little concern with the limiting aspects of the Second Law of Thermodynamics.

Fred Cottrell (1955) focused on the limiting nature of energy. He suggested that the change from a low-energy society (e.g. agricultural) to high-energy society (e.g. industrial) depended on generating energy surplus which was reinvested into technology of high-energy converters. His position is that the essential requirement for this conversion is a "system of values that promotes the creation and reinvestment of energy surplus" (Rosa and Machlis, 1983:14).

The investment of energy into high energy developments concerns Georgescu-Roegen (1975). He claims that society will have to rely on energy stocks (e.g. coal, oil, gas) for such developments because energy flows (e.g. solar, wind, water) are too limiting in their dissipated forms. Since energy stocks are limited, having been created over millions of years, overconsuming behavior of the present population will use up the energy base of society. He does not think that resources are infinitely substitutable or that technologies can be continually created to compensate for the decreased quality of the energy. In this, he was strongly attacking a classical economic perspective as have others (Rifkin, 1980; Thurow, 1980).

Contradicting Lovins' proposal of creating a more resilient energy system through individual efforts, Howard Odum (1971) warned about the dangers of giving individuals control over their energy base. Social coordination is necessary to prevent individuals from succumbing to "environmental whimsy." He developed a systems approach to the influence of energy on society, suggesting that energy flows influence economics, politics and religion.

Amory Lovins' ideas are not tightly embedded in the social science literature, but nevertheless the basic conceptual framework of Lovins flows directly from the energetic theorists concern with the way in which the societal energy base affects the social structures of societies. Some of the themes of this tradition which inform his work are:

(1) the importance of value complexes (e.g. culture) as a context and result of technological implementation, (2) the existence of dual technological streams, (3) the limiting nature of energy stock, and (4) the influence of the energy base on social structures.

Lovins concern with equity is reflected in his desire that energy surplus created by an energy flow base be captured by the populace rather than social elites. He proposed the marketplace as the main mechanism for distributing technologies to change the energy base of society. This will help counter the historical concentration of energy, claims Lovins.

Values, Behavior and Technology:

The theories examined so far raise questions about the influence of culture and values as well as of whose values or culture dominate technologically driven social change. Mannheim (1950) called for concomitant value and technological changes. He wanted technology to not be as closely controlled by insulated technocrats. C. Wright Mills, Marcuse, Adams, and Habermas fundamentally agree with his concerns about elites' control.

Lovins is closest to Mumford in identifying two paths which are the results of implementing two different technologies -

the authoritarian (energy stock based technologies, elite controlled) or the democratic (energy flow based technologies, controlled by end users). Lovins and Mumford are also similar in suggesting that cultural changes (e.g. value changes) usually occur before the implementation of types of technologies as well as after their implementation. The question of whether technological change occurs in response to supportive cultural values or whether it changes values has a long and distinguished career.

Robert Merton (1970) continued the tradition as he traced the evolution of the Industrial Revolution in seventeenth century England to cultural complexes such as Puritanism. On the other hand, Gouldner and Peterson (1962) examined 71 societies of the Human Relations Area Files to determine what were the most critical elements in social change. After conducting factor analysis of various societal characteristics, the authors concluded that the dominant factor was technology and the second one, values. Their conclusion was "technology influences the normative" (Gouldner and Peterson, 1962:xv). However, echoing Pitirim Sorokin (1937-1941), they also suggest that the dominance of technology may simply reflect a transitional historical period.

The logical relationships between technology and values was closely traced by Emmanuel Mesthene (1970). He suggested that technology leads to value changes both directly and indirectly. Directly, technology "appears to lead to value change either by bringing some previously unattainable goal within the realm of choice, or by making some values easier to implement than in the past, that is, by changing the costs associated with realizing them" (Mesthene, 1970:50). Indirectly, technology changes values through "the mediation of some more general social or cultural changes produced by technology" (1970:54).

The effects of technology on values and social change within Lovins' work was traced by Schnaiberg (1983) as indicated in Figure 1.

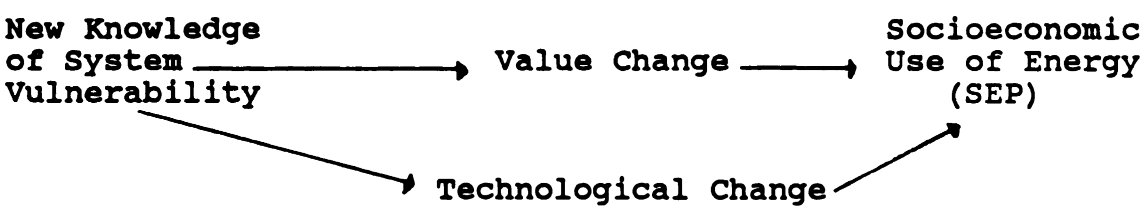

Fig. 1: LOVINS' VALUES AND TECHNOLOGICAL CHANGE MODEL (Schnaiberg, 1983:219)

Social change therefore occurs directly as a result of value changes <u>or</u> as a result of straight technical fixes. I think it is truer to the Lovins' perspective, however, to also include an arrow to show the interactive relationship of technological and value changes.

As presented in Figure 1, Schnaiberg's interpretation of Lovins is that new knowledge of system vulnerability is sufficient for technological or for value changes. This, however, is a misrepresentation of Lovins' argument. According to Lovins, it is not simply the new knowledge of system vulnerability that is the driving variable motivating individuals to change. Lovins proposes that the alternative energy base will be implemented because the renewable technologies provide a better expression of nonelite values than do the nonrenewable energy technologies. In his early work, Lovins emphasized the personal noneconomic and economic gains to be obtained from the renewable technologies. In later publications, the Lovinses have stressed community-wide gains such as using energy technologies as economic development strategies (Lovins and Lovins, 1982; Lovins et al., 1983).

In suggesting that technologies are implemented when they express value preferences, Lovins is supported by Hornick and Enk's close examination of the interaction of values and technologies. They argue that "new technologies can play an important role in retargeting or implementation of our values by giving us new means to obtain our goals" (Hornick and Enk, 1980:85).

Yet it is often true that there is <u>not</u> a high correspondence

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between expressed values and actual behavior (Schuman and Johnson, 1976; Hornick and Enk, 1980). This issue has been explored repeatedly in examining whether attitudes cause behavior or vice-versa.

Bentler and Speckart (1981) examined the issue and concluded that one needs to examine specific domains to reach appropriate conclusions. They found that in three out of four situations which they examined - in dating, studying and exercise - attitudes preceded behaviors. However, behaviors preceded attitudes in one "studying" instance. They suggest that possibly behaviors influence attitudes when "internal cues are weak or ambiguous" (Bentler and Speckart, 1981:236). Once a behavior has occurred, it tends to create a more favorable attitude to more of that kind of behavior. They underscore, however, the critical effect of the domain on the interaction of behaviors, intentions and attitudes.

Stern and Aronson (1984) pursue the idea that the use of technologies may change values at the individual level. They argue that people tend to rationalize choices they have made in a difficult decision situation. The more the commitment in cost, effort, and irrevocability, the stronger and more permanent the effect. Therefore, once a person makes a commitment in a direction, such as by using solar energy technologies, that person is more likely to make a further large commitment than someone who is uninvolved (Stern and Aronson, 1984:69).

This cognitive dissonance argument can be made for the direct influence of solar energy technologies in further developing behaviors and attitudes supportive of soft path changes. This is especially true if the implementation of the technologies is perceived as a commitment to natural resources conservation, self-reliance, greater equity, and social diversity - the dimensions of soft path preferences.

Solar energy technologies have been identified as strongly symbolic of benign, clean living (Barbour et al., 1982; Hornick and Enk, 1980). Even though homeowners may not have thought of the values associated with the soft path when they acquired solar energy systems, the technology may serve as an instrument to further associate them with people and ideologies supportive of soft path preferences.

However, energy is invisible to households, argue Stern and Aronson (1984). Numerous studies indicate that householders do not know their actual energy expenditures, the cost of solar technologies, or even how their technologies are operating (Unseld and Crews, 1980; Farhar et al., 1980; Farhar-Pilgrim and Unseld, 1982; Eastman, 1982). Energy's visibility is increased when people consider the use of solar te

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solar technologies or when users are actually committed to energy conservation. Energy conservation may be the first behavioral commitment to the soft energy path and the use of solar energy technologies, the second step.

Keating et al. (1982) explored the interaction of attitudes and behavioral intention using the Fishbein[4] and diffusion models to predict solar adoption. The variables used in this prediction were: (1) environmental concerns, (2) perceptions of the seriousness of the energy situation, (3) number of contacts with homeowners having solar equipment, (4) voluntary simplicity lifetsyle behaviors, and (5) socioeconomic variables of income, education and occupation. They found that the most important predictor was attitudes toward solar technologies, followed by positive economic perceptions, negative economic perceptions and educational attainment. They suggest that the normative orientation of others was not important at this early stage of solar adoption when social expectations may not yet be formed (Keating et al., 1982).

While Keating et al. examined individual level adoption of solar technologies, Gilmer focused on how technology influences institutional developments. He argued that: (1) technology constrains but does not determine institutional possibilities, and (2) some technologies are more easily managed than others (Gilmer, 1980:3). This opinion is echoed by others who suggest that technology creates one of the "outer frameworks of constraints on individual lifestyles" (Hornick and Enk, 1980:4; Barbour et al., 1982).

DIFFUSION OF INNOVATIONS CONTRIBUTIONS

Two areas of diffusion research are especially relevant to the development of the soft path: (1) studies about the adoption of energy conservation practices, and (2) studies about the adoption of solar energy technologies.

Diffusion researchers have examined the interaction of technology, values and behavior using a microsociological approach. This tradition reverses the causal order developed by macrosociologists by focusing primarily on the ways in which values, social class, lifestyle, etc. of individuals and households affect energy use (Rogers, 1983). In these studies, energy is a dependent variables (Rosa and Machlis, 1983:37).

A tremendous amount of research has developed out of the diffusion of innovations tradition, making the steps involved in the adoption of different technologies very clear. Rogers presents the innovation-decision process model as including prior conditions (a) previous practice, (b) felt needs/problems, (c) norms of the social systems which provide the context for the five stages of adoption which are connected through communication channels: (1) knowledge (characteristics of the decision-making unit such as socioeconomic characteristics, personality variables, and communication behavior), (2) persuasion (influenced by the perceived characteristics of the innovation regarding relative advantage, compatibility, complexity, triability, and observability), (3) decision (adoption or rejection), (4) implementation, and finally (5) confirmation of the adoption with continuance of the use of the technology (Rogers, 1983:165).

Theoretically, it is at the fifth stage of the innovation-decision process that the impacts of the technologies will be felt and will feed back into the model either to confirm or eventually lead to the rejection of the technologies. Rogers claims that discontinuance is more frequent when innovations are less compatible with the individual's beliefs and past experiences (Rogers, 1983:188). He states that "90 percent of all new products fail within four years of their release" (Rogers, 1983:211).

The diffusion model recognizes the interaction of values and technology with the assumption that potential adopters' values are harnessed by change agents to increase the adoption potential of a new technology. The Lovinses have performed the function of change agent through efforts to show how the use of renewable energy technologies will more fully implement the values held by the American population. Their emphasis on the social impacts produced by the renewable energy technologies have differentiated them from most diffusion change agents.

Very few diffusion researchers have examined the consequences of innovations. This is true because traditionally positive results of the adoption of an innovation are assumed and because "consequences are difficult to measure" (Rogers, 1983:378).

Rogers, however, does show sensitivity to some of the impacts of innovations on social stratification systems.

> A system's social structure partly determines the equality versus inequality of an innovation's consequences. When a system's structure is already very unequal, it is likely that when an innovation is introduced (especially if it is a relatively high-cost innovation), the consequences will lead to even greater inequality in the form of wider socioeconomic gaps.
>
> (Rogers, 1983:402)

He hints at the importance of concomitant restructuring of society if technology is to have appropriate social impacts as he comments on diffusion research:

> A means to social revolution it is not. A helpful tool for social change and development, when accompanied by a basic restructuring of society, it may be.
>
> (Rogers, 1983:125).

He therefore questions the feasibility of using technologies to create changes which are different from the dominant patterns of society, such as using solar energy technologies as a tool for changing to the soft energy path.

Considerable work has been done out of the diffusion tradition on energy technologies and practices and on solar energy technologies.

<u>The Diffusion of Energy Conservation Practices:</u>

The Lovinses have stressed steps in the change to the soft energy path. The first step is to use energy more efficiently (e.g. energy conservation) and the second is to use renewable energy technologies to provide a new energy base for society.

As shown by the early theorists of energy, technology and social change, a close association was assumed between the amount of energy consumed by society and the degree of industrial development of that society. In fact the amount of energy per capita use was considered a primary indicator of economic development (Hirst et al., 1983). As empirical societal comparative studies were conducted, it became clear that energy use and industrial development are not as tightly coupled as previously thought. Studies of Sweden and Germany (Schipper, 1982; Lonnroth et al., 1980) were instrumental in severing the assumption of tight coupling.

These studies indicated that there were European countries where the level of industrial development and quality of life were as high or higher than that found in the U.S.; yet the amount of energy consumed per citizen was much smaller.

From 1960 to 1973 both GNP and energy consumption growth increased at proportional rates in the U.S. However that link was severed after the 1973 oil embargo and from 1973 to 1980 the energy use rate increased at a lower level than the GNP rate. By 1983 less energy was used per GNP dollar than in 1974. Conservation was responsible for about 5 percent of the energy savings in 1980 (Axelrod, 1984:214; Hirst et al., 1983). Several researchers examined how energy conservation occured in households.

In a study conducted in 1978, Kempton et al (1982) examined the perceptions of energy conservation among Michigan householders. Responses were placed in three categories of energy conservation: (1) efficiency investments, (2) management (e.g. turning down the thermostat) and (3) sacrifice of amenities or comfort. Using open ended telephone interviews, the researchers found that the three most commonly used measures were, "lighting reductions, lower thermostat setting, and adding insulation" (1982:6). They also found that the respondents overestimated the savings of "sacrifice and management" while underestimating the savings of "efficiency investments" (1982:11).

In further examining the actual use of efficient energy technologies, Schipper (1982:10) found that consumers "seem uninterested in anything that takes more than five years to pay back". Williams et al. (1983:284) set the range at 2-4 years. Furthermore, Goldstein (1983) found that customers would not invest an extra $150 to buy a more efficient refrigerator model which would give them a $600 savings over the life of the appliance.

The first step advocated by Lovins for changing to the soft energy path has been substantially implemented. Energy conservation measures have diffused quite successfully through the American society (Hirst et al., 1983; Williams et al., 1983; Farhar-Pilgrim and Unseld, 1982; Levine and Craig, 1985). In fact Schnaiberg (1983) has contended that one of the few successes of the soft path advocates[5] has been to increase conservation.

In a study of public acceptance of energy conservation strategies, conducted in Washington State, 1981, Olsen (1983) found that soft path preferences, measured by preferences for policies based on renewable energy resources and conservation as opposed to oil, coal and nuclear sources, was the strongest predictor variable for the acceptance of energy conservation strategies. The second strongest predictor was perceived seriousness of the national energy problem as measured by the questions "Do you consider meeting the United States' energy needs during the next ten to twenty years to be: not a serious problem, a somewhat serious problem, a serious problem, or a very serious problem?" (Olsen, 1983:190). Olsen reports that his Soft Path Preference Index was most strongly related to energy conservation strategies which involved voluntary community programs of conservation, land-use changes through zoning to discourage urban sprawl, and setting consumption limits based on energy supplies. Those perceiving energy as a serious problem were more likely to see efficiency standards as the primary method of increasing energy conservation.

Lovins (1976, 1977) claimed that conservation is a measure economically important for all to take no matter what the policy preference. Both the soft and hard path advocates agree that energy conservation is important.

The Diffusion of Solar Technologies:

The second and most important step in a change to the to soft energy path is the implementation of flow energy base changing to renewable sources of solar, wind, and water.

Public opinion surveys and reviews of the early 1980's indicated the same result: the public favored solar energy technology developments more than nuclear technology and nonrenewable energy source developments as the energy base of the future (Yankelovich and Lefkowitz, 1980; Farhar et al., 1980; Farhar-Pilgrim et al., 1979; Mitchell, 1980, Mitchell, 1984, and Olsen et al., 1982). In fact Olsen et al. summarize the data by saying:

> The conclusion to be drawn from these recent studies is unequivocal. A substantial majority of the American public opposes further development of nuclear power plants. Conversely, a large majority of the public supports efforts to promote greater energy conservation, especially in the residential, commercial and industrial sectors...And almost everyone favors increased use of solar power.
>
> (Olsen et al., 1982:5)

Although the public favored the renewable energy base for a future time period, it is not clear that it is moving to the implementation of such a change in the present. Several researchers have suggested reasons for the lag between attitudes and behaviors.

Yankelovich and Lefkowitz (1980) reported that the level of trust that the American public has in technology's ability to find solutions to problems of shortages and natural resources was down to 52% from nearly universal support for technological solutions after WWII. The confidence in technology ranged from 69% confidence among the older, less well-educated lower-income segments of the population to a

29% confidence among college students.

Bezdek et al. (1982) suggested that one of the barriers to making solar energy 20% of the national energy base by the year 2000 was that the public has "lack of confidence in solar energy technologies" (Bezdek et al.,1982;339). The public opinion surveys previously mentioned indicate questioning the feasibility of implementing solar technologies.

While supporting the increased personal control of the availability and type of energy use and the decentralized energy production, Bezdek et al. propose achieving those goals "will require a major national commitment to resolve the obstacles hindering the development of solar technologies" e.g. reliable solar equipment for some technologies, high capital cost, existing legal and institutional barriers, lack of market infrastructure and manufacturing capabilities, and lack of public knowledge and confidence in the technologies (Bezdek et al., 1982:339)

Bezdek et al. used several models to examine the implications of three levels of solar technology penetration into the U.S. markets. They concluded that because solar technologies "require higher initial capital investment per unit of energy produced than do alternative, conventional energy sources" the amount of private and federal expenditures required to put them in place would range from $450 billion to $1.2 trillion (Bezdek et al., 1982:349). They argue that this support was not feasible given that a shortage of capital was perceived as one of the most serious problems facing the nation in the 1980's and 1990's.

The Mitchell (1980) data indicated that 28% of the public nationally had considered installing a solar system while 1% had actually done so. About 0.5% of the American population reported owning solar heating systems in 1979, showing no change since 1978 (Farhar et al., 1980:160).

In examining the market penetration of solar systems, Roessner concluded that 1.5% was the maximum penetration of solar technologies in California, this figure probably representing one of the highest penetrations in the nation. Nationally, penetration was very low, "in the order of 0.3% of the maximum potential U.S. market by 1980. In the national residential market, penetration can be said to have barely begun" (Roessner, 1982:10).

The diffusion rate is less clear in studies of passive solar technologies. Nelson and Honnold (1980) examined the diffusion of passive solar designs in an attempt to discover the pattern of a technology which is not centralized in design or promoted by a social change agent. They suggest that perhaps people who adopt decentralized systems are different from those who use traditional energy systems or systems with active solar components. Nelson and Honnold concluded that "bureaucratic action has retarded 'passive technologies' diffusion in the past" (Nelson and Honnold, 1980:5). However the meaning of "bureaucratic action" was not specified further.

Other researchers have suggested that the nature of passive solar technologies gives little incentives for corporate or governmental involvement (Davis, 1982; Williams et al., 1983).

The diffusion of passive solar technologies was examined by Eastman (1982) in a study of "a breadbox solar water preheater, a window box heater, and a retrofit trombe wall" (Eastman, 1982;1) which were introduced to low income residents or public facilities buildings in New Mexico.

A follow-up study of the 381 workshop participants was conducted two years later. Forty of the 122 who were interviewed had installed some kind of solar device since the workshop - greenhouses, trombe walls, solar water heaters, and some type of solar home. All the adopters expressed a high degree of satisfaction with their devices, though few could estimate their energy savings (Eastman, 1982:4).

However, with "two exceptions and despite effusive praise, the solar demonstration recipients were either not using or were benefiting very little from their solar devices" (Eastman, 1982:8). Eastman concluded that perhaps one of the reasons why the technology failed to diffuse was that the recipients were, with two exceptions, aged, infirmed or socially inactive.

Therefore, although public opinion was very strongly in favor of changing the energy base of society through solar energy technologies, it is not clear that the households were adopting one type of renewable energy technology necessary to change the energy base.

CHAPTER III

RESEARCH RELEVANT TO DIMENSIONS OF SOFT PATH PREFERENCES

In this chapter I discuss the social context in which Lovins' ideas became influential. Then I review research specifically relevant to the dimensions of soft path preferences.

The dimensions are the central values which form the core of a consistent package of attitudes and behaviors which are congruent with soft energy path structural changes. The dimensions are: (1) natural resource conservation preferences, (2) self-reliance preferences (e.g. participation in decision-making), (3) personal gains preferences, (4) cross-generational, crossnational, and cross-class equity preferences, and (5) social diversity preferences.

THE SOCIAL CONTEXT OF THE LOVINS PROPOSAL

Lovins' seminal paper (1976) comparing the hard and soft energy paths was published at a very propitious moment in history. Morrison (1980) traces the enthusiasm of environmentalism through the 1960's, peaking on Earth Day 1970. The 1973 oil embargo highlighted national and international equity issues of resource constraints, sensitizing some environmentalists to the potential equity impacts of their concerns.

The appropriate technology movements's founder had already published his catalytic book (Schumacher, 1973) identifying technology as a force of inequitable international development. Schumacher's assertion of two broad technology types driving different types of social changes was permeating the thinking of scholars and social activists. The inappropriate technologies had characteristics compatible with the hard path technologies criticized by Lovins. The appropriate technologies were more broadly focused (e.g. crop production, water, etc.) than the soft energy technologies proposed by Lovins but had similar characteristics[6].

The anti-nuclear movement was also gaining momentum. It supported soft energy technologies as a positive alternative to nuclear power (Morrison, 1980)[7]. These historical events plus the changing cultural values of Americans produced a very responsive social environment for Lovins' proposal.

<u>Changing Cultural Values:</u>

Yankelovich and Lefkowitz (1980) record significant changes in Americans' perceptions of economic growth by noting:

> From the 1950s to the late 1960s Americans characteristically believed the present to be a better time for the country than the recent past and anticipated that the future would inevitably improve over the present. In 1971 the pattern changed. Then Americans saw the past in a rosier light than the present, but anticipated that the future would once again brighten up for the country.
>
> In 1978 for the first time the pattern of the 50s totally reversed itself. Now Americans believe that the past was a better time than the present, and they anticipate that the present, however bad, is likely to be better than the future. This, indeed, is a historic shift away from traditional American optimism to an uncharacteristically bleak outlook.
>
> (Yankelovich and Lefkowitz, 1980:102).

The historical cultural assumption that the country could provide material stability and security for its populace had been challenged by: (1) a redefinition of success to include more nonmaterial standards of personal growth; (2) a pressing for safer and healthier environments; (3) a pervasive distrust of the dominant institutions of society, especially big business and government, and (4) a questioning of U.S. continual dominance in the world economy.

There had been a shift in expectations. However, people still hadn't come to terms with the "conflict and disappointment created by the need to adapt to new, unwelcome conditions" (Yankelovich and Lefkowitz, 1980:99). Value changes interacted with the "energy crisis" to create a very unstable situation.

Others writing around the early 1980's also were concerned with the instability of the cultural system. Anderson (1983) and others (Schurmann, 1983; Morrison, 1983, 1980) suggest that new choices were being made cutting across liberal and conservative frames of references.

> What appears to be happening in the world is a simultaneous march of events in opposite directions: Going one way, a parade of decentralist and separatist movements - there is scarcely a national government in the world that is not struggling with one or more of these - and, going the other way, an unprecedent increase of global trade, global communication, global migration, global interdependence. Things flying apart and at the same time coming together.
>
> (Anderson, 1983:6)

Carlson et al. (1982) conclude that "the societal incentive system tends to be out of synchronism with shared social interests and individual concerns" (Carlson et. al, 1982:155). Lovins' presented his proposal in the midst of society's turbulent inconsistencies.

The "Energy Crisis":

The "energy crisis" reflected and fed the unstable characteristics of the period. Even while people were slowly believing that the "energy crisis" was real - as opposed to something contrived by "big business and government" - there was fear about facing a reality which would be increasingly bleak. As Yankelovich and Lefkowitz (1980:110) express it:

"In short, the public is caught between two feelings: the emotion that 'somehow it cannot be' and the emotion, 'my God, it may be worse than we think'." Energy is one of the first forces of the modern era to create a confrontation with limits. Schnaiberg (1983) argued that this made energy technologies more visible.

The ambivalence of the population's reactions was documented in the research findings of the period. Farhar et al. found that "most people do not believe there is an energy crisis but perceive instead a serious national energy problem". created by big business (especially oil companies) and government (Farhar et al., 1980:143). In a national study, Farhar-Pilgrim and Unseld (1982) indicate that homeowners did <u>not</u> perceive serious impacts on their households' lifestyle.

On the other hand, Olsen et al. (1982) report that perceptions of the U.S. "energy situation as very serious" were associated with support of energy conservation as a national energy policy (Olsen et al., 1982:7). Also, concerns about energy shortages were second only to inflation in an opinion survey commissioned by the Council on Environmental Quality (Mitchell, 1980).

Although there were diverse findings, public opinion studies of the 1970's and early 1980's indicate a general prevalence of perceptions of system vulnerability generated by energy issues (Schnaiberg, 1983;Levine and Craig, 1985).

A sense of urgency to resolve the uncertainties generated by perceived system vulnerability was captured by Amory Lovins' presentation of the dilemma as a choice between a "hard path", representing the old vulnerable order, and the "soft path" which represented a positive response to the vulnerability. Lovins (1976, 1977) urged a soft path social policy choice soon, a choice that would be implemented by individuals and local social organizations' decisions to respond to economic and noneconomic incentives to change. The social structural changes would occur as the choices aggregated. Carlson et al., (1982) urged similar decision-making speed about the societal energy strategy.

> The longer it takes society to make up its mind with regard to its ultimate dominant energy strategy,the more difficult will be the implementation of whichever path is chosen.
>
> (Carlson et al., 1982:151)

In later writings (Lovins and Lovins, 1982; Lovins et al., 1983), local communities were especially urged to become the key decision-making units to choose the soft path.

The Solar Technology Choice:

Given the prevalent perception of system vulnerability, were solar energies being chosen as tools for resolving that dilemma? The recorded diffusion of solar energy technologies was, as noted previously, slow.

Even if solar technologies were chosen as a strategy for changing the societal energy base, some reseachers doubt that the technologies will contribute to further cultural value changes (Barbour et al., 1982; Hornick and Enk, 1980). Yet others propose value changes as a likely social impact of solar energy technologies (Piernot et al., 1981).

The interaction of solar energy technology use and cultural values is not clear. This project is a contribution to examining this linkage.

RESEARCH ON THE DIMENSIONS OF SOFT PATH PREFERENCES

While not directly related to the theory of soft path social change, some relevant studies about the claims of the soft path preferences are reviewed to assess whether or not they support Lovins' claims.

Natural Resources Conservation Preferences:

Several studies (Mitchell, 1980; Farhar et al., 1980:153) have reported that opinions about energy-environment trade-offs were polarized, with sizable minorities favoring each side. At the same time, there was an inclination towards valuing an adequate energy supply.

Mitchell (1980, 1984) traces the emergence of environmental concerns through the 1970's and the stability of those concerns into the 1980's. He claims that in the 1970's, the environment was perceived as being in crisis. By the early 1980's, the polls indicate that the American public no longer regarded it as being in crisis but was still supportive of protecting the environmental (Mitchell, 1984:10).

In the 1980's a clean, healthy environment is perceived as citizens' right or "entitlement" so therefore it is less salient, he argued. In 1982, people perceived that the environment in the U.S. "had grown worse" (48 percent) compared to 10 years previously. Only 34% felt that it had improved (Mitchell, 1984:14). Thus the risks of environmental decay are a public concern.

The reliability and risks of solar technologies have been addressed in several different ways. Holdren et al. (1980, 1982) have compared the environmental risks imposed by renewable and traditional energy technologies. They conclude that "the use of passive solar design in architecture will produce smaller environmental impacts than those resulting from supplying an equivalent amount of energy from any of the 'active' technologies" (Holdren et al., 1980:249).

The land use requirements of solar heating and cooling systems have been difficult to anticipate. However, if neighborhood-scale solar energy systems and district cogeneration were used, then a high demand for land would not occur. Furthermore, land used for decentralized solar energy technologies could also be used for other purposes. Bezdek et al. (1982) consider the demands for land as one of the larger drawbacks to the development of solar technologies.

While admiting that in the long run solar technologies are less polluting and resources using than other energy sources, Bezdek et al. (1982) note that initially they are resource-intensive and pollution creating thus degrading the environment in the short run.

The amount of degradation posed by different types of renewable energy technologies was more closely examined by Holdren et al. (1980). They indicate that the potential for catastrophic accidents among the renewable technologies could only occur with large, centralized facilities, e.g. large hydro-electric dams and satellite power stations. Irrigated biomass plantations are the renewable energy forms with greatest potential for producing major climatic impacts. Although these three technologies use the renewable energy base, they do not have the other properties of "soft" energy technologies especially, they are large scale, centralized, and not in control of the end-users (Lovins et al., 1983).

Lovins and Lovins (1981) argue that the way to reduce current worldwide air pollution is to use solar energy technologies even without changes in lifestyle and assuming full industrialization of countries which are not currently industrialized. Noncatastrophic characteristics become more important as issues of the catastrophic potentials of highly complex interdependent systems are more salient (Perrow, 1984).

The relationship between the amount of environmental degradation per unit of energy produced has been the focus of researchers from the Department of Energy (Bezdek et al., 1982) and from the academic sector (Holdren et al., 1980) who reached similar conclusions. Some renewable energy technologies have the possibility of reducing environmental costs per unit of energy produced to well below those which have been produced by oil and coal. The more benign renewable options are: (1) passive solar heating and cooling, (2) increased electricity generation by adding generators to some of the existing dams, (3) electricity generation by wind turbines, and (4) biogas digestion of sewage and feedlot manures (Holdren et al., 1980:283).

The health implications of developing renewable energy technologies have also been examined. Inhaber (1979) proposed that the health risks of renewable technologies are "much greater than those of natural gas and nuclear power and comparable in many cases to those of coal and oil" (cited in Holdren et al., 1980:267). Holdren et al. reach a much different conclusion concerning a comparison of such systems, namely

> the total occupational effects for all stages of the renewable energy system fuel cycles conceivably could be equal to the total occupational effects of obtaining an equivalent amount of energy from coal.
>
> (Holdren et al., 1980:270)

The technical and economic risks and reliabilities of mixing wind and solar systems with conventional energy systems have also been examined. Kahn concluded that "exogenous, unplanned risks have a smaller impact on the wind energy system than on the conventional one" (1979:343). Further, unrestricted entry into decentralized application of wind and solar energy conversion will have a destabilizing effect on the electric utility industry (Kahn, 1979:347). "Wind and solar energy are more economically competitive at lower standards of reliability" (Kahn, 1979:337) than conventional energy systems. But even in California, with a 55% state tax credit for solar systems, this only partially "offsets the subsidies to conventional heating sources" (Kahn, 1979:345). Thus Kahn agrees with Lovins' claim that solar technologies are more economically efficient than traditional energy technologies, but face more restrictive barriers.

As seen above, these findings generally support Lovins' claims that renewable energy technologies are more environmentally benign and resilient than nonrenewable energy technologies. They also suggest the potential for conflict with the utility companies (e.g. controllers of the hard energy system) of a change in societal energy base.

Self-Reliance, Decentralization and Grassroots Democracy: Another dimension central to the development of the soft energy path is the belief in the value of public participation in governance. . .or "grassroots democracy" rather than reliance on centralized governmental institutions.

Yankelovich and Lefkowitz (1980) record that a dramatic change which occurred during the decades of the 1960's and 1970's was a decline of trust in government. This was reflected in the findings that the government and oil companies were perceived as most responsible for the nation's energy problems (Farhar et al., 1980; Farhar-Pilgrim et al., 1979; McFarland, 1984; McKie, 1984). Mitchell (1980) also records the predominance of public sentiment that government does not provide ways for expression of their thoughts about the environment, and that interest groups, which are perceived as being separate from the general population, had greater influence with the government.

Concerns with personal self-reliance were shown in Yankelovich and Lefkowitz's (1980) findings that people were increasingly seeking to claim control over their own destinies. McFarland (1984:514) suggests that the U.S. is "probably the industrial democracy that most highly values local political participation and policymaking, as opposed to the politics and policies of the central government." These public opinion polls and reviews support Lovins' strategy of noncoercive participative local control of energy systems (Lovins, 1977; Lovins et al., 1983; Morrison and Lodwick, 1981).

The meaning of decentralization and self-reliance is examined with the question, "how much power to which people?" Cose suggests the following self-reliance options: (1) let the marketplace function without barriers by reducing the roles of local and federal governments; (2) give federal resources and responsibilities to local governments; (3) turn the responsibilities to solve problems to corporations or other private entities (Cose, 1983:11). The Lovinses propose following strategies one and two (e.g. allow the market to function freely and local communities to have the resources and control over their own energy developments).

Decentralization of the energy supply and the resulting self-reliance is viewed by the Lovinses, as a positive result of the implementation of the soft energy path in the U.S. The federal government was providing some incentives for such developments in 1980. The impacts of these incentives on increasing energy conservation and the diffusion of solar technologies have been examined by several researchers.

One of the early studies of the effects of federal incentives was conducted by Seymour Warkov to examine whether or not the HUD Solar Hot Water Grant Program was able to speed the adoption of that solar heating and cooling technologies with a $400 grant. The HUD Program was started in 1975, and by 1980 HUD had funded the installation of solar space and or domestic water heating systems in nearly 12,000 houses or apartments buildings with a total expenditure of more than $21 million (Roessner, 1982:6).

Warkov found that the most important variables for adoption of the technologies were support from personal networks and perceived private benefits for the Connecticut homeowners. This is fully compatible with the Lovins' notion. Warkov also found that "measures of knowledge about legal and financial incentives, etc., and evaluations of HUD program effectiveness did not predict household adoption of this technology" (Warkov, 1979:ii).

Roessner (1982) further reviewed the results of governmental strategies for solar commercialization in effect from 1974 to 1980. The National Energy Plan was the foundation for governmental strategies of making the energy economy a "joint public/private concern and responsibility" (McKie, 1984:344). It was incorporated in the five bills of the National Energy Act (NEA) passed by Congress in 1978 and later. The NEA provided income tax credit of 30% of the cost of solar energy technologies up to $2,200. This was increased to 40% credit for a maximum expenditure of $10,000. About 35,000 people claimed solar energy tax credits in 1978, costing the government $32 million. This figure rose to $44 million in the 1979 tax year (Roessner, 1982:6).

Beginning in 1975 and 1976, several states enacted legislation creating solar financial incentives. The largest was in California with a 55% tax credit (Roessner, 1982; Levine and Craig, 1985). Others are listed in Farhar-Pilgrim and Unseld (1982). These incentives were based on the assumption that economic factors were the primary barriers to the dissemination of solar energy systems (Roessner, 1982).

In a study of ten Western states Carpenter and Chester (1982) found that 63% of those who had installed solar water or space heating technologies claimed that they would have done so without the tax credits. The authors concluded, that "for large expenditure energy conserving devices a tax credit appears to be required" (Carpenter and Chester, 1982:10). This finding was also supported by Farhar-Pilgrim and Unseld (1982). These adopters, however, are early adopters who generally have many socioeconomic resources.

The studies reviewed above focused primarily on active solar energy technologies since they were the ones supported with governmental incentives in 1980. Vine differentiates between active and passive solar adopters in his study of members of solar energy voluntary citizen groups. These people had more passive solar systems than active or mixed systems (Vine, 1980:132). He suggested that their prime motivation in acquiring the technologies was economic while saving energy was the most common second reason. "Very few [less than 10%] installed solar because of their support for the idea of solar energy or because of their desire to become less dependent on the utility company" (Vine, 1980:132).

In New Mexico, installers believed governmental rebates encouraged solar use; builders (who were selling passive solar designs) did not find them useful (Eastman, 1982).

Generally, then, governmental policies in existence during the "energy crisis decade" were not very effective in speeding early household adoption of solar energy technologies.

The effects of governmental incentives on energy conservation were also investigated. Shippee (1980) found that information, attitudes toward the energy crisis and demographic factors were very low in predicting energy conservation. Financial incentives, depending on their timing and amounts, were important, as was feedback tied to committed efforts to reduce energy consumption (Shippee, 1980).

On the other hand, Carpenter and Chester (1982) found that 86.8% of their respondents in Western states were aware of federal tax credits for energy conservation practices. Of these, 34.5% had made a claim but only 6% said that they would <u>not</u> have taken the conservation measures without the tax credits. This, generally, was the result of many studies. Conservation measures, especially the less costly ones, have been implemented in residential homes without tax incentives (Williams et al., 1983; Levine and Craig, 1985:575).

Roessner concluded his analysis of the effects of federal and state tax incentives by saying:

> Studies of the consequences of state solar financial incentives and of the factors that influence homeowners to purchase or not purchase residential solar heating systems provide evidence that environmental concerns, self-reliance, and propensity to innovate are at least as important, and may be more important, than cost savings in decisions to diffuse solar heating systems during the early stages of market penetration.
>
> These findings indicate support for Lovins proposed importance of noneconomic incentives for the acquisition of solar energy technologies.
>
> (Roessner, 1982:18).

These findings indicate support for Lovins proposed importance of noneconomic incentives for the acquisition of solar energy technologies. Some communities have passed local codes to encourage energy conservation and the use of alternative energy sources.

Davis, California is a classic case. Dietz and Vine (1982) assessed the impacts of an Energy Conservation Building Code to determine if the code reduced the amount of energy used. Although there had been a significant reduction in energy consumption, the researchers could not determine the influence of the code because it was too small during the 1970-1979 period.

Besides examining issues about the role of the federal and state governments in creating economic and legal incentives for decentralized energy technology adoption and conservation, researchers have analyzed the effect of feedback to the government from the population.

Alford and Friedland (1975) warn about the dangers in assuming that power and participation are associated. "Participation may be associated with power, but power can exist without participation" (Alford and Friedland, 1975:430) through the creation and maintenance of social structures which reinforce the power of elites.

It is the elites' "power without participation" which the Lovinses want to change through "power with participation" of the populace. Again Alford and Friedland warn that "for nondominant interests, participation has been a symbolic substitute for power, a means of reproducing the absence of political power" (Alford and Friedland, 1975:474).

McFarland empirically examined the role of energy lobbies such as the Solar Lobby in influencing federal policies. He concluded that most of the governmental policies of solar power had been based on an "enthusiastic President with a positively disposed Congress" during the Carter administration and an antagonistic President and advisers during Reagan's administration. During neither period were the changes based on power vested in citizens' interest groups. Congress perceived solar energy and energy conservation as being popular with the voters (McFarland, 1984:519).

Lovins and Lovins (1982) have argued that energy decisions should be made at the community level. They claim that there is a sense that when there is another disruption in energy supplies "it will be every community for itself" (Lovins and Lovins, 1982:301). Community-based action "is the fastest and surest way to build a resilient energy system" (Lovins and Lovins, 1982:332). Stern and Aronson (1984) suggest that local solutions may simply be easier to achieve than national solutions.

Their commitment to local communities was the source of the Lovinses' criticisms of the Carter administrations' approach to the energy crisis. Carter used a "permanent emergency" authoritarian institution to implement changes rather than noncoercive grassroots participation (Lovins et al., 1983:66). Communities "are the level at which, at least in energy policy, solutions are possible."

> Community is in the unique position of being large enough to mobilize resources needed to meet such a threat as energy but small enough to understand and protect the community's diversity, to allow for constructive individual participation, and to tailor the solution to meet individual needs.
>
> (Lovins et al., 1983:75)

The federal government should help communities serve the national interest by implementing their own plans for energy self-reliance propose the Lovinses (Lovins et al., 1983).

This preference for community based energy decision-making has been strongly criticized by some social scientists. Local developments can lead to conflicts between neighboring facilities and will probably not meet the needs of society as a whole, they warn. Programs implemented under a set of local conditions cannot be transmitted to another set of conditions (Stern and Aronson, 1984:166).

Other criticisms have focused on the Lovinses' assumption that small technologies will necessarily lead to greater democracy. Self-reliant and decentralized technologies may need to be managed in a very centralized manner (Gerlach, 1981:57). They may require mass production and distribution systems or centralized control (Barbour et al., 1982). Wood stoves, for example, are decentralized technologies with central control, as illustrated by Denver, Colorado's passing legislation to prevent their use on high pollution days (Kowalski and McBean, 1986).

The national public good may be threatened by community-based energy decisions/policies. Turning over all energy policy formation to state and local governments is "unrealistic" for they cannot deal competently with things such as oil import quotas. In this Cose (1983) agrees with Alford and Friedland (1975) who claim that

> The decentralization of funds, policy, and implementation discretion to the city level of government thus reinforces the urban polity as the unit of political participation for response to problems whose causes lie outside the urban system; this insulates from any kind of political challenge dominant interests whose political power and economic organization are located elsewhere.
>
> (Alford and Friedland, 1975:464)

Personal Gains Preferences:

Lovins (1977) clearly advocates free market transactions for distributing renewable energy technologies. The ability of the marketplace to distribute solar energy technologies has been examined primarily through studies of the role of "big business" in the solar energy market. This focus is consistent with Barbour et al.'s (1982) proposal that one way individuals can participate in decision affecting their lives is to have the freedom from the pervasive power of large organization's control over productive activity.

Reece (1979) was one of the first to systematically examine the evolving centralization of solar energy markets. He and others (Levine and Craig, 1985; Ridgeway, 1982) report that the early emphasis of the federal government was on large scale solar energy technologies such as satellite solar technologies and a large scale power tower in California's Mojave Desert (Ridgeway, 1982) rather than on home heating (Reece, 1979:76). Furthermore, Reece documents how large corporations have "concentrated sufficient control over the solar industry to squeeze out smaller competitors and effectively prevent the entry of others" (Reece, 1979:187).

Dietz and Hawley (1982) have explored the case of photovoltaics, concluding that ". . .the future of U.S. [photovoltaic] industry innovation is in the hands of large diversified, and primarily oil, corporations. . .since the late 1970's through mid-1982 there has been an apparently high concentration ratio among U.S. producers" (Dietz and Hawley, 1982:25).

They indicate, that the photovoltaic industry is a global industry (Dietz and Hawly, 1982:25) with primary markets in Third World countries and in competition with other countries, particularly Japan and European nations. Most of the photovoltaics were subsidized by parent companies, thus seeming less costly than they actually were. Global corporate members feared that the companies would go out of business unless there was an improvement in the prices at which they could sell their products.

Purdy (1985) also documents the increased concentration of traditional energy corporations and of their control over other energy resources including 75% of the solar industry (Purdy, 1985:9). For example

> petroleum corporations own five of the nine leading solar energy firms, with Exxon and Atlantic Richfield owning half of the solar photovoltaic cell industry.
>
> (Purdy, 1985:16)

Through their diversification and wealth translated into power, the individuals at the pinnacle of these corporations "make decisions concerning the size and rate of growth of many sectors of the economy, as well as the direction and implementation of various types of technology" including, especially, active solar systems and photovoltaics (Purdy, 1985:28).

Ridgeway (1982) further examined the centralized controls over solar energy technologies concluding:

> Even Government programs for demonstrating solar collectors at homes throughout the country have been steered to the larger firms. Almost 70 per cent of the $6 million available through the Department of Housing and Urban Development's solar demonstration program for 1977 went to seven major corporate solar manufacturers. All but two were solar subsidiaries of large American corporations, including Exxon, Aarco, and Grumman. Some of the long-time solar pioneers were excluded from the program because, ironically, their systems were too cheap (Ridgeway, 1982:346).

The solar energy technologies have not only been coopted by large corporations, but the political control of energy has also become more centralized. Davis (1982) examines the interaction of the development and control of energy industries based on their political context and on the physical characteristics of different types of energy sources.

He suggests that coal is one of the least regulated industries because of the historical period when it developed, while natural gas is the most regulated one. "The political process determines the issues of ownership, prices, and quantity consumed, which in coal and oil are decided privately" (Davis, 1982:164).

Davis claims that the "ecological ethos" of the current era has created a situation where the "new fuels evoked quasi-religious support. Sunlight, geysers, and the wind were natural, God given and nonpolluting" (Davis, 1982:244). These fuels are symbols of environmentally benign living.

The difference between the centralized control of active solar technologies and the decentralized local control of passive technologies is analyzed by Davis. Since solar power, especially passive, can be provided by a single homeowner, there are no natural monopolies "requiring government supervision nor. . .any advantage for large corporations" (Davis, 1982:246). Thus passive solar technologies' small scale and flow characteristics encourage no federal governmental involvement.

Yet, since 1975, there has been bureaucratic and legislative reorganization centralizing energy politics and shifting energy problems into the political system rather than into the economic system (Davis, 1982:283). McKie (1984) cited market failure as a reason why the federal government has attempted to regulate the energy economy. Issues of national security, equity, threats to the environment, and long term needs are not adequately addressed by market mechanisms (Williams et al., 1983; Craig and Levine, 1985). However in 1981, there was a partial return to the market with Reagan's energy policy. Reagan was unlikely "to entertain any more claims of 'market failure' to justify new regulations" (McKie, 1984:346).

Ronald Reagan's free-market approach to energy policy has been condemned for reducing financial support for renewable energy sources while continuing support for nuclear energy (Green et al., 1984). The 1984 budget requests for solar and renewable energy showed that the hardest hit programs were the solar programs being reduced from $61.1 million to $21.9 million (Axelrod, 1984:211; Green et al., 1984; Levine and Craig, 1985). Reagan's argument is that solar and renewables programs have been so successful that they no longer need governmental support (Axelrod, 1984:212).

This review has not found documentation for the success of the diffusion of solar renewable technologies.

Equity Impacts:

One of claims made about the social impacts of using soft energy technologies is that there will be more natural resources available for everyone than if hard energy technologies are used. Therefore, there will be greater equity within and across nations and generations (Lovins, 1977; Lovins, 1980; Lovins and Lovins, 1982; Lovins et al., 1983). When energy resources are scarce or expensive, people with few economic resources are more adversely affected.

Unless there is a change in the energy base of society, some may have to choose between eating and keeping warm, claim the Lovinses (Lovins et al., 1983). Cooper et al. (1983) document how low income groups' energy expenditures rose from 11% of their income in 1972 to 23.2% percent in 1981 while the higher income households' expenditures increased from 2.5% of their income to 3.5% during this same period. A review of the energy literature records how specific low income groups experienced the "energy crisis". Older people reported more adverse effects of the energy situation than younger people; nonwhites experienced more negative financial impacts due to energy shortages than whites (Farhar et al., 1980).

Cooper et al. (1983) summarize the situation by suggesting that lower income houses have already cut back on energy use. If future energy price increases occur, there will be greater vulnerability in that segment of the population than what it experienced in the past.

Although many of the Lovinses equity concerns are expressed in relation to cross-national and cross-generational issues, the impacts on lower income classes are consistent with their equity concerns. Critics have charged that decentralizing energy policies will decrease equitable access to energy resources (Cose, 1983; Stern and Aronson, 1984; Barbour et al., 1982).

Social Diversity Impacts:

While social diversity impacts have not been directly addressed, they have been assumed by critics of the soft path social change theory. Most of the criticisms have centered on the potential transitional or permanent conflicts engendered by a change to the soft energy path.

Suggestions that decisions made at the household level could have negative effects on centralized energy institutions create a potential for conflict. Gilmer (1980) examined the historical, technical and economic advantages of central station power generation. He concluded that should those competitive advantages change "either because of uncertainties plaguing the utilities or advances in decentralized solar technology, these organizational advantages and the simplicity of social control may begin to weigh heavily in favor of solar energy" (Gilmer, 1980:23). The utilities would be the losers if many consumers began relying on their own power systems.

Energy base conflicts have been more closely examined by several researchers. Morris (1982) claims that the transition period will not be smooth or painless as implied by Lovins. "Energy wars" have already broken out. Communities have reacted against attempts of utility companies to increase distribution of electricity to urban centers.

Gerlach (1981;1982) examined some of the "energy wars" and found that the parties involved in the disagreements used whatever rhetoric was most supportive of their political purposes. For example, the soft path rhetoric was used by farmers to support their position against large energy companies but was changed when doing so was more politically advantageous.

The theme of the conflictual reorganization of society, has been strongly argued by Schnaiberg (1983), Perelman (1980), and Perelman et al. (1981). Schnaiberg suggests that it is <u>not</u> correct to argue that opponents will simply accept the necessity for changing their values and behaviors. The change to the solar path is a change in the production system of society. Such a change provides an enduring base for conflict as it touches on "the economic interests and political influence of powerful economic interest groups" (Schnaiberg, 1983:229).

The Lovins' theory must be broadened to include social conflicts and social interests. As part of this, Schnaiberg suggests that it is important to distinguish between ". . . changes in the forces of production (physical technology) from those in the relations of production (social class structure)" (Schnaiberg, 1983:229).

Scholars (Stern and Aronson, 1984; Cose, 1983; Perelman, 1980) have concluded that placing energy decision-making in the hands of diverse decentralized areas would increase the conflict between neighborhoods, communities, states and nations of the world, contradicting Lovins.

Cose (1983) speaks very forcefully of conflicts engendered at the community level. However, citizen groups, despite loud and visible protests, are incapable of threatening communities as much as major corporations which propose witholding investments or leaving. He concludes

> The specter of conflict . . . looms over the land . . . perhaps more so than at any time since the Civil War. Energy is not the only cause of conflict between states. Competition over defense dollars and corporate investments accounts for much of it. But a number of disputes have centered around energy.
>
> (Cose, 1983:86)

Perelman agrees:

> The transition which will occur in the course of the next century or so is likely to be a period laden with intense social conflict, and probably violence. Exactly what kind of society will emerge from this transition period is an extremely speculative question, subject to all sorts of alternative possibilities in light of unstable nature of the transition process itself.
>
> (Perelman, 1980:394)

<u>Transition Period Issues</u>:

In his original paper, Lovins (1976) suggested that policy decisions would have to be made soon, either in favor of the hard or the soft path, because the time and resources absorbed by the hard path would "make the soft path less and less attainable" (Lovins, 1976:86). He did allow, however, the use of nonrenewable energy technologies during the transition period.

The proper type and mix of energy for the "transition period" and beyond have been examined by various scholars and policy-makers challenging Lovins' claim for the "exclusiveness" of flow based technologies in the long term. Sweden opted for a national energy policy of keeping both types of energy systems rather than prematurely closing options (Lonnroth et al., 1980). Some researchers argue that the two paths are not mutually exclusive (Bezdek et al., 1982; Barbour et al., 1982). A mix of large and small energy systems is necessary for the diverse types of requirements of society. They do warn, however, that "such a mix will require a deliberate effort to develop the largely untapped potentialities of smaller systems" (Barbour et al., 1982:74).

Schnaiberg (1983) suggests that by allowing the use of some hard energy technologies during a transitional period, Lovins and other advocates of the soft energy path have been coopted by the hard path.

Other Criticisms of the Soft Path Theory:

Besides the early criticisms which focused on the precision of the figures used by Amory Lovins to estimate the need for a change to renewable energy based technologies (Inhaber, 1979; Nash, 1979; Edison Electric Institute, 1977), there have been criticisms of the theoretical relationships between technology, values, and social change.

The argument which the Lovinses develop challenges the control of the economic and political organizations of society. However, it does not challenge the ideologies which support those structures. The Lovinses do not challenge the legitimacy of science and technology as the foundation of economic development or the ideology of the free market. Yet these ideologies have supported the current hard path. The Lovinses propose redirecting those ideologies to support the soft path.

Very little critical attention has focused on the micro-level implementers of the energy base changes at the community or the household levels. These are the primary actors proposed by the Lovinses to develop the soft path. Assumptions are made that households and communities will perceive it to their economic, political and personal advantages to withdraw from the current nonrenewable energy base of society and to develop an alternative energy base. The Lovinses assume that household members are aware of the current system vulnerability and have sufficient knowledge, economic, political resources and will to develop an alternative once governmental subsidies to the nonrenewable base are removed.

In a previous section, I have discussed the perceptions of system vulnerability during an historical period when energy vulnerability was made quite salient in the 1970-1980 decade. Perceptions that an energy problem (e.g. system vulnerability) did exist were not widespread. The historical developments since that period have further undermined perceptions of energy based system vulnerability.

The Lovins' theory also assumes that individuals will <u>want</u> to develop an alternative system. The empirical evidence for this is sketchy. Although many households did adopt energy conservation measures without external subsidies, the energy base of the households (e.g. adoption of solar technologies or other renewable technologies) generally was not changed. Federal, state and community policies supportive of such a change seem to <u>not</u> have been very useful in stimulating the adoption of the solar technologies.

The Lovins theory assumes that attitudes favorable to developing a new energy base are closely associated with implementing behavior. The social scientific literature is replete with examples where this is not so (Schuman and Johnson, 1976). However, the relationship remains an empirical question in the case of solar energy technologies. This is examined in this project.

CHAPTER IV

THEORETICAL SPECIFICATION AND MODEL: SPP DEVELOPMENT

Some of the criticisms of the Lovins' theory are based on lack of a specification of the conditions under which households and communities will participate in developing the soft path. There has been lack of attention to interest groups supportive or antagonistic to soft path developments and to potential conflicts. The relationship between the implementation of the renewable energy based technologies and their effects on attitudes and behaviors supportive of the soft path also has not been adequately explored.

I begin by an explicit statement of Lovins' theory as a series of related propositions. Then I briefly describe a general natural resources vulnerabilities model. A specification and modification of Lovins' theory focusing on householders' use of solar energy technologies, is proposed. In turn, I describe the primary factors influencing the development of soft path preferences and their interrelationship with the soft path's restructuring of society. Finally, I present a model of soft path preferences development with empirically testable hypotheses.

LOVINS' THEORY OF SOFT ENERGY PATH SOCIAL CHANGE

Lovins Ideas:

Lovins' theoretical argument is more formally specified as follows:

1. Currently the world is on a destructive trajectory created by the characteristics of the energy base and attendant social structures of industrialized societies (i.e., the hard energy path).

2. The stock energy base has created systemic vulnerabilities due to the centralized, technocratically controlled and dangerous nature of the energy resources (e.g. uranium) of that energy system.

3. The nature of the energy system has created negative impacts on people in nations following the hard energy path.

People of the industrialized nations experience alienation and lack of control over local community developments and resources because these are controlled by distant elites.

The negative impacts also include:(a) chaos when the centralized energy system does not work appropriately, (b) international and national regional conflicts over control of energy resources, (c) greater social inequality between generations, nations and classes as resources consumption differentials are exaccerbated and (d) potentially catastrophic dangers created by sabotage of nuclear facilities and materials, and by terrorists.

4. The negative effects of the hard energy path can be reduced by changing the energy base of society.

5. The energy base of society should be changed to a renewable energy base which is under the control of the energy end-users, e.g. the general population.

The type of renewable energy technology used in this change should be determined by the <u>work</u> expected from the unit of energy (e.g. energy quality and end-use critera). Therefore, a variety of renewable energy technologies will be used.

Most of the renewable energy technologies will be small, decentralized, natural resources conserving, and understandable to the user.

6. The decision to use the renewable energy technologies will be made noncoercively by the general population and communities. The population will be motivated to acquire

the renewable energy technologies because those technologies are more compatible with their values than are the centralized elite controlled hard energy technologies which currently constitute the hard energy path.

Attitudes which are compatible with the soft energy path have developed in the American population. These include values of "thrift, simplicity, diversity, neighborliness, humility and craftmanship" (Lovins, 1977:57). They also include: (a) self-reliance, (b) natural resources conservation, (c) personal economic and noneconomic gains, (d) equity, and (e) social diversity.

7. The barriers created by governmental units and utility companies' subsidies of the hard energy path technologies make those technologies seem more economical than the soft energy technologies. The subsidies should be eliminated to allow the renewable energy technologies to show their competitiveness in the marketplace with the hard energy technologies.

7. The marketplace should provide the technological delivery system for renewable energy technologies. The market should however be locally based in order to provide economic multiplier effects to the community. This, plus a reduction in economic resource leakage to other places will

increase the employment and other economic resources available to the local population.

Communities should also democratically and noncoercively participate in the diffusion of decentralized renewable energy technologies. The aggregation of households at the community level will benefit from the economic multiplier effects and the self-reliant control over the energy system.

8. There are several direct effects of the implementation of renewable energy technologies using the soft processes described above: (a) The effects on the local community will include greater self-reliance and economic development; greater democracy and social cohesion; greater social equity, thus lower stratification, and greater diversity. There will also be fewer socially catastrophic possibilities created by its energy system.

(b) The direct effects on individuals and households include greater self-reliance and control, greater economic gains, greater access to the political processes of the community through democratic decision-making, and less alienation.

(c) The direct effects on the natural environment create more resources for communities, nations, and generations. They include more natural resources conservation and less pollution and other environmental problems.

The indirect effects include the social structural transformations to the soft energy path as described by Lovins (1976, 1977).

9. Although the renewable energy technologies will eventually change the social structure, there are some measures to be taken during the transitional period.

First, energy must be conserved to provide more resources and time for the transition. This step is economically beneficial for everyone.

Second, a mix of nonrenewable and renewable energy technologies is allowed for the transition period until society is restructured creating fewer barriers for the renewable energy technologies.

Eventually, there will be a complete change to a renewable energy base.

10. Once the renewable energy base has been acquired by the population, the indirect effects of the renewable

technologies will restructure society into the soft energy path even without changes in values and lifestyle. The world will then have more energy resources and will have pulled back from its trajectory toward a catastrophic brink.

Suggested Additions:

I have taken Lovins' basic proposal, added some variables to more clearly specify the theory, and then suggested some unspecified steps which exist between the change in the energy base of society and the social structural transformation of that society.

Lovins starts from the assumption that the social system is currently in a very vulnerable situation but he does not develop the idea of perceptions of vulnerabilities or of many barriers in his theory. Schnaiberg (1983) is the first one to formally propose that knowledge of system vulnerability is an important part of the Lovins' theory. Since I agree with him, I have included the knowledge about system vulnerability and household experiences of that vulnerability in the specification of Lovins' ideas in Figures 2 and 3.

The second addition which I have made to Lovins' thought is in more carefully specifying the resources which are needed for household acquisition of renewable energy technologies. Not only must the "barriers" of policies and subsidies be considered, but other resources, such as personal network support and access to household socioeconomic resources should be examined. Increased resources and decreased barriers will reduce the cost of implementing values through the use of the technologies.

Thirdly, I have suggested that not only is the adoption of technology affected by values, but technologies also affect the development of values. In this, I am agreeing with Veblen, Ogburn, Mumford, Stern and Aronson, and Mesthene. In fact, compatible attitudes and behaviors must proceed from these values to guide the use of the increased energy resources which are created through the use of renewable energy technologies, otherwise there will simply be a continuation of the hard energy path.

Energy conservation is the initial expression of the values, followed by acquisition of solar energy technologies and behaviors which are also supportive of other natural resources conservation. These values will be expressed in the attitudes and behaviors captured with the soft path preferences scale.

Fourth, although not formally proposing this variable in the soft path preferences development model, it is imperative to consider the conflicting groups and consequences of a change to a renewable energy base. These are presented as obstacles to the implementation of social structural changes in Figure 2.

SPECIFICATION OF NATURAL RESOURCES VULNERABILITY

According to Lovins, household-implemented technical solutions will aggregate to lead directly to changes in the social structure of society (e.g. socio-cultural, economic and political impacts). Although Lovins' theory has focused on energy, its basic argument is relevant to any resource which is a basic need of the population such as air, water or food (Kinsley, 1984).[8] The modified theory in its most general form is specified in Figure 2.

Figure 2

Vulnerability Needs:

The first variable driving the model is perceived vulnerability needs. System vulnerability will be perceived as an aggregate problem when the household members acknowledge the existence of a crisis in the resource base of their social system. This aggregate social system vulnerability will be perceived at either the national, regional, or community level depending on the salience given to the crisis by the political (policies), economic (advertisement) and communication systems (mass media, personal, or other) which operate within the social environments of the household.

This aggregate system vulnerability will also be experienced as household vulnerability. Economic signals of rapid price increases, for basic resources may be one stimulus to the perception of household and system vulnerability.

Whether or not the household decision-makers change the household resource base will be influenced by the structure and composition of the household. The number of people dependent on the household, the stability of their relationship and their ages will affect resource use and demand elasticity.

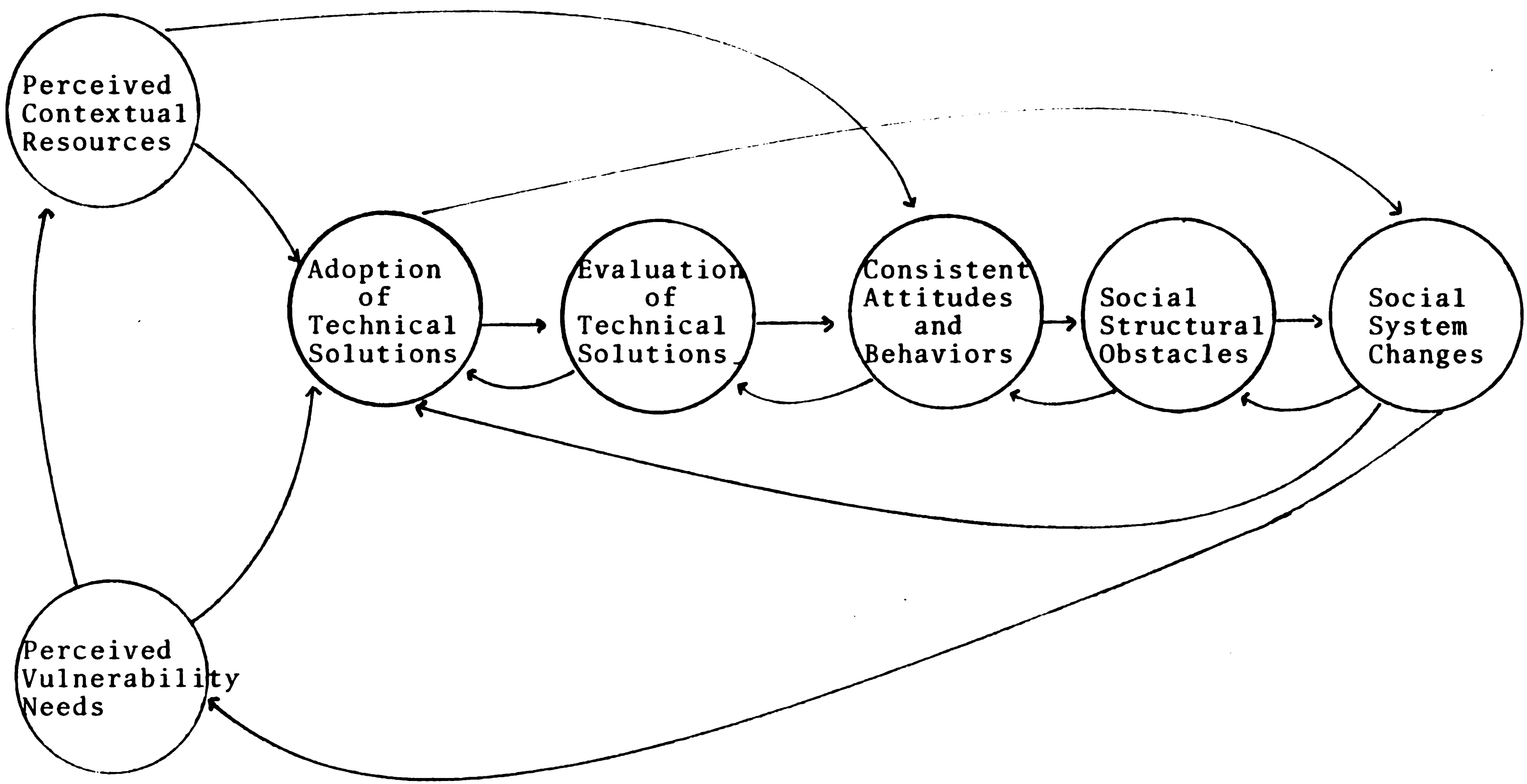


Figure 2: BASIC NATURAL RESOURCES VULNERABILITY

The interrelationships among these factors create the perception of vulnerability needs. The needs are weighed against the resources available to the household (e.g., possible substitute resources) and a decision is made about adopting a technical solution. The perceived household and societal vulnerability needs will directly affect the creation of consistent attitudes and behaviors as seen in Figure 2. Greater perceived system and household vulnerabilities are also associated with more supportive attitudes and behaviors. The available contextual resources affect the outcome of household decision-makers' weighing the economic and social costs of meeting the needs (e.g., resolving the disequilibrium of vulnerability). The contextual resources may be supportive, neutral, or in conflict with the perceived needs. The more resources available to the household, the less the cost of satisfying the needs and the greater the probability of adopting a technical solution.

The contextual resources are composed of those which belong to the household, and those which are available in the community. The contextual resources which facilitate or impede the household's needs satisfaction include conflicts experienced in attempts to influence, acquire or use the household's resources. These processes may occur through interactions with extended family, friends, work associates, neighbors and other acquaintances. They also are experienced with political systems, through national, regional, or community-based laws and policies, and with economic structures, such as lending, selling and service institutions.

Adoption of Technical Solutions:

Issues of economic cost, performance, reliability and risks of alternative technologies are assessed as part of the total costs and benefits to the household. If the assessment is generally positive, the household will resolve its vulnerability needs by acquiring a technical solution . These will further develop supportive attitudes and behaviors as barriers impeding such developments are reduced.

Evaluation:

For those households which adopt a technical solution to the perceived resource vulnerability, the experience of using the technologies will affect their evaluation of the technologies and therefore their attitudes and behaviors. Are their experiences with the technical solution consistent with the original perception of needs? Was this solution implemented in ways consistent with a restructuring of society?

Consistent Attitudes and Behaviors:

I have argued that technical changes are not sufficient. These must be associated with a package of consistent attitudes and behaviors which are supportive of the restructuring of society. This package directs the increased resources resulting from implementation of the technical solution.

Social Structural Obstacles or Support:

Although Lovins proposes that implementation of technological solutions will directly lead to social structural changes, this has been strongly questioned by some social scientists. Besides having a package of values to guide the results of the technical solution, those proposing to change the social structure of society encounter barriers created by present practices and control of societal resources as well as potential hostile forces of the dominant elites. This is where the walls created by "power without participation" are encountered. When these obstacles are overcome, then there will be social system changes.

Social System Changes:

The social system changes which will occur may be very different from those sought by the drivers of the changes. These changes will be the results of the interplay of various forces: (1) experiences with the technological solutions; (2) the package of values (as expressed through attitudes and behaviors) which is reinforced by the technologies, and (3) interactions with elites, societal policies and practices, and with other people.

The technical resolution of resource vulnerability needs also creates some social-structural impacts regardless of attitude and behavioral changes. These social system changes then provide feedback through pressure to reduce structural obstacles further changing attitudes and behaviors to become more consistent with the "new" social structure. The changes also encourage further positive evaluation and implementation of technical solutions consistent with the new structures. The feedback process will further decrease the vulnerability needs as presented in Figure 2.

The general resource vulnerability model is specified to soft energy path structural changes, as follows.

Specification to Energy Vulnerability:

Between 1970 and 1980, household members perceived the existence of an energy crisis making the U.S. vulnerable to international economic and political forces. This energy vulnerability was also experienced by households through increased cost of meeting basic heating and cooling needs. This vulnerability was felt more strongly by larger households in dwellings which consumed more energy.

The contextual resources of households include their income and educational levels. Those having greater income and higher education have more knowledge of resources and disposable income to address the perceived energy vulnerability. The support which personal networks (family, work, friends, neighbors) provide in identifying the vulnerability and solutions is a contextual resource.

Policy and legislative support for changing to a renewable energy base includes information distribution, financial incentives for acquisition of solar energy technologies, and laws requiring renewable technologies and conservation behaviors. Economic support includes lending institutions' willingness to provide loans for the acquisition of solar energy technologies, insurance coverage, and reasonable technology costs. The technical support includes repair services, solar builders and contractors, and solar stores.

If the household has high income and education, support for solar technologies in its personal network, plus governmental, business and technical support, then the perceived cost of acquiring solar energy technologies is reduced and the technologies are more favorably evaluated.

The evaluations include characteristics of the technologies themselves such as their performance, reliability, and economic costs. For those who adopt the solar energy technologies, the assessment includes the experiences of owning the technologies.

When the renewable energy technologies are implemented in a manner consistent with the theoretical ideas of soft path structural changes, this will have greater impacts on systemic changes. To be consistent with soft path changes, the solar energy technologies should be implemented in a participative fashion, based primarily on local community and neighborhood resources. Their operating problems should also be locally resolved.

Passive solar systems for water and home heating and cooling meet the criteria of soft technology more completely than do active solar systems. Passive systems are appropriate to the end use of heating water or the home to a warm temperature. They can be made of locally available stones, plastic, black paint, etc. and use a renewable resource (e.g. solar energy). The principles of heat absorption of the rocks, black paint, and the convection currents which are used to circulate the heat in the water or home are also easy to understand. The technology is under the control of the user for the user must participate in the activities of opening and closing windows, opening and closing apertures, etc. The technologies are also decentralized in the home of each user and self-reliant, for they don't require an external source of electricity.

The acquisition process of passive solar energy technologies is more congruent with the theoretical characteristics of soft technologies than active solar energy systems as seen in Table 1.

Table 1

The owners of passive technologies participate in the construction of the technologies and use local firms more often than active solar technologies owners. The latter predominantly use contractors and national firms. Passive solar owners do more of their own system design and installation, building them directly into their homes on site. Active solar systems tend to be added to the house as components or packages. These characteristics indicate that the passive solar energy systems are more congruent with Lovins' notions of soft energy technologies and the

Table 1

SOLAR TECHNOLOGY ACQUISITION PROCESS

	Active System 1		Active System 2		Passive System 1		Passive System 2	
Attached to House	n = 2435				n = 923			
Built in	27	(868)	31	(153)	70	(767)	63	(183)
Added	70	(2240)	61	(301)	24	(262)	26	(77)
Room added	3	(96)	9	(43)	6	(70)	11	(31)
Missing data*	5	(173)	76	(2880)	7	(275)	28	(1083)
Built								
On site	15	(490)	34	(171)	80	(859)	79	(222)
As component	28	(907)	33	(166)	11	(114)	13	(37)
As package	54	(1733)	31	(149)	8	(84)	7	(19)
Other	2	(70)	1	(11)	2	(19)	1	(4)
Missing data*	5	(177)	85	(2880)	8	(298)	29	(1092)
Installation								
Self	27	(864)	44	(221)	42	(453)	51	(142)
Self and contractor	1	(43)	1	(5)	2	(24)	2	(7)
Contractor/ other	72	(2303)	55	(272)	56	(605)	47	(132)
Missing data*	5	(167)	76	(2879)	21	(292)	29	(1093)
Design Active								
Small local firm	38	(1025)	37	(151)	-	-	-	-
Small national firm	21	(559)	21	(86)	-	-	-	-
Large national firm	31	(853)	26	(105)	-	-	-	-
Foreign/other	10	(283)	16	(65)	-	-	-	-
Missing data*	6	(166)	86	(2479)	-	-	-	-
Design-Passive								
Self					51	(548)	56	(159)
Acquired plans	-	-	-	-	3	(35)	4	(10)
Professional/ other	-	-	-	-	46	(500)	40	(113)
Missing data*	-	-	-	-	8	(291)	29	(1092)

* Missing data include those respondents for whom the question is not applicable. For example, passive solar owners would be classified as missing if the acquisition process is applicable only to active systems. The non-missing values should add to 100%.

development of soft path preferences.

development of the SPP.

Holdren et al. (1980) support this in concluding

> We think it likely that, assuming sensible materials choices, the use of passive solar design in architecture will produce smaller environmental impacts than those resulting from supplying an equivalent amount of energy from any of the 'active' technologies.
>
> (Holdren et al., 1980:249)

Nebraska homebuilders found passive solar systems easier and more cost effective to build, and easier to explain to the consumer. They reported building or seriously considered building more passive systems than active systems. Loan officers were very positive about making loans for passive solar homes (Combs, 1983).

Vine (1980a) reports that members of solar energy associations used more passive systems or mixed systems (active and passive) than active systems. Vine (1980a) examined the differences between active and passive owners concluding

> Owners of active solar systems are more likely to be wealthier, married, and homeowners than owners of passive and hybrid systems. Not surprisingly, the hybrid group is usually located between the other two groups in their socioeconomic characteristics. The three groups do not statistically differ in sex, age, occupation, education, and ideology.
>
> (Vine, 1980a:156).

Federal programs researchers (Farhar-Pilgrim and Unseld, 1982: Vine, 1980a) have examined primarily active solar sytem owners. It is theoretically important to conserve the distinction between these two types.

Finally, the households which experience energy vulnerabilities and resolve them by changing to renewable energy base are hypothesized to have different attitudes and behaviors than the households which do not change their energy base. These preferences will affect the type of path changes which will develop as seen in Figure 3.

Figure 3

The complete theory of the transition to the soft energy path moves from perceptions at the household level to social structural impacts at the societal level. Much of the household level decision-making process is assumed by Lovins, who focuses primarily on the social structural impacts.

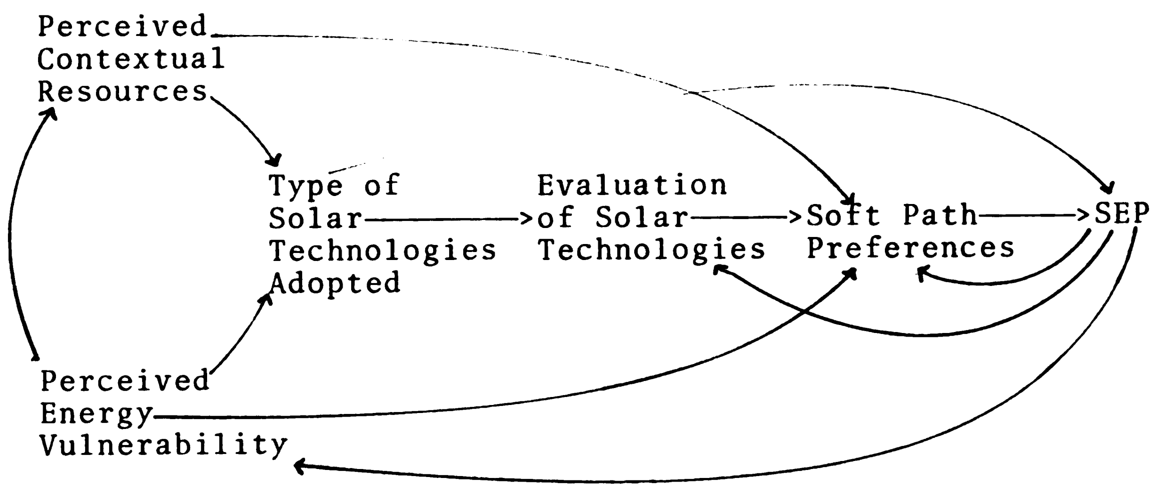


Figure 3: TRANSITION TO THE SOFT ENERGY PATH

My study, however, examines the household level dynamics assumed to be occurring to produce the changes to the soft path. The model I am examining is expressed in Figure 4, showing households which have not and households which have changed to a renewable energy base.

MODEL SPECIFICATION

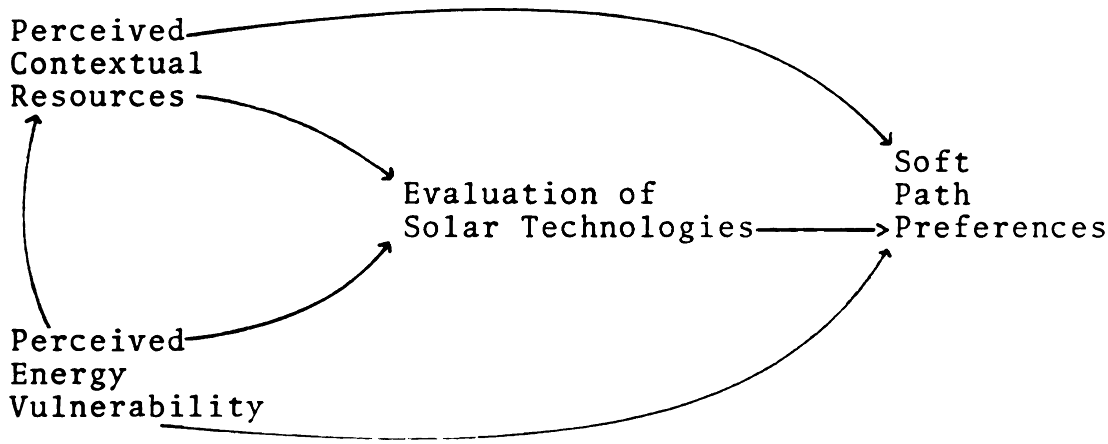
An examination of the soft path change theory requires community level impact measures (Morrison and Lodwick, 1981). However, it is possible to examine part of the theory using household data.

Figure 4 shows two models of part of the theory which I am analyzing. I will focus on the development of the soft path preferences which are supportive of soft path changes. I am omitting the social structural impacts and their feedback influences which have been shown in the previous section. The models are specified for two different groups, renewable energy system owners and nonrenewable system owners.

Figure 4

Since the nonsolar households do not have experience with ownership of renewable energy technologies, their opinions of solar technologies and the contextual external resources, are necessarily more abstract. Energy issues are more invisible to them. The model allows me to examine how this

(Nonsolar)



(Solar)

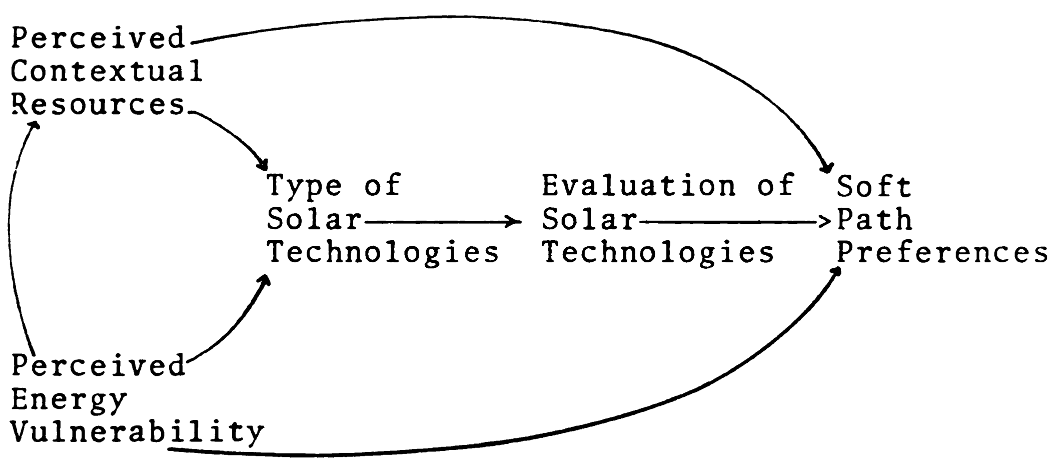


Figure 4: DEVELOPMENT OF SOFT PATH PREFERENCES

influences the process of soft path preferences development for the nonrenewable energy system owners.

The model is also expanded to include the experiences of the renewable energy technology owners. Their perceptions of contextual resources, solar technology type and evaluation are disciplined by experiences. Their household energy vulnerability needs are based on the results of already having a behavioral resolution to perceived disequilibrium. Therefore energy issues are more visible to them.

The soft path preferences measures are the same for both the renewable and nonrenewable system owners. The models allow me to examine how the process of SPP development is affected by perceptions of energy vulnerability needs, contextual resources for solar energy technology acquisition, evaluation of the technologies with and without the experience of owning the technologies and the influence of the characteristics of the active and passive solar technologies.

The model's variables have been specified above. The operationalization of the variables is discussed in Chapter VI.

The model will be examined empirically using a U.S. national probability sample of nonrenewable energy system homeowners using a stock energy base for their heating and cooling needs and a purposive sample of renewable energy technology owners who use primarily[9] solar energy technologies for home heating and cooling. The solar system sample will be further subdivided into (1) active and passive solar technology owners, and (2) different ownership-length samples.

There are three basic questions addressed by this project:

1. Is there a greater degree of soft path preferences among those who have changed the energy base of their household compared to those who have <u>not</u> changed their energy base?

<u>Operationally:</u>

H1: There is a greater amount of SPP among solar homeowners than among nonsolar homeowners.

<u>If</u> the values and attitudes of the homeowners who have changed their energy base are more consistent with the soft path, then that is an indication of potential support for a transition to the soft energy path. Both the renewable energy base technologies and soft path preferences are necessary for social structural changes of the soft path.

2. What has the greatest influence on the development of SPP of the solar and nonsolar homeowners?

   <u>Operationally:</u>

H2: The solar technologies are more strongly associated with the soft path preferences than the perception of energy vulnerability and the availability of contextual resources.

   If this hypothesis is correct, then I conclude that the use of solar energy technologies is more critical to soft path changes than further emphasis on the dimensions of soft path support.

3. Does the type of solar technology and the length of ownership of the technologies have an influence on the development of SPP? Hypothesis three will compare owners of the different types of technologies while hypothesis four examines the whole solar sample.

   <u>Operationally:</u>

H3: Passive solar energy technology owners have more SPP than active solar energy technology owners.

H4: Length of ownership of solar technologies is positively associated with degree of SPP.

If hypothesis three is correct, then there is an indication of further consistency in the relationship of soft renewable energy technologies and soft path changes. Support for hypothesis four suggests that the influence of the renewable energy technologies is developmental over time. Alternatively, solar owners may simply experience short term enthusiasm and then a return to the hard path rather than providing a solid foundation for soft path changes.

To the extent that these hypotheses are supported empirically, then there is some basis for claiming that a change in the U.S. residential energy base is providing a supportive cultural context for the development of a restructured society. However, it is important to recognize that only 20% of the energy consumed in the U.S. in 1980's was used by home heating and cooling (Green et al., 1984).

This project does not address the very critical linkage between the positive cultural context and the social structural impacts of changing the societal energy base. It also does not address the role of elites in controlling such a change except as experienced indirectly through householder's perceptions of contextual resources and conflicts.

CHAPTER V

RESEARCH AND SAMPLING DESIGN AND SAMPLE CHARACTERISTICS

In this chapter, I describe the research design and then the samples. The sampling design, data gathering methods and instrument development are then discussed. Finally I compare some of the characteristics of the solar energy technology owners with those of the nonsolar energy technology owners.

RESEARCH DESIGN

This study uses data gathered from a U.S. national probability sample of homeowners who did <u>not</u> own solar technologies and a purposive sample of homeowners who owned them in 1980. Face to face interviews were conducted with the nonsolar respondents by fieldworkers of the Gallup Organization Inc., while a mailed questionnaire was sent to the solar respondents by SERI (the Solar Energy Research Institute) under the direction of Dr. Barbara Farhar-Pilgrim.

The solar homeowners sample was then subdivided into passive (9%, n=326) and active (60%, n=2278) solar technology owners. These were self defined solar technology owners who claimed to own <u>only</u> passive or passive hybrid or <u>only</u> active systems.

The 32% (n=1205) who claimed to own both passive and active solar technologies were not used for further analysis. The active and passive technology owners are theoretically representative of two approaches to changing the energy base of society. Later I will argue that the passive solar technologies are more "soft" than the active solar technologies.

Finally, the solar sample was divided into four subgroups based on length of technology ownership in 1980: (1) ten years or more (n=116), (2) 5-9.99 years (n=285), (3) 1-4.99 years (n=2728), and (4) less than one year (n=680).

A soft path preferences (SPP) scale was developed. The solar and nonsolar homeowners, the active and passive solar technology owners, and length of ownership samples' SPP scale scores are compared in order to determine which group had preferences more congruent with the development of soft path social change.

Finally, the variables influencing the development of their soft path preferences were compared for the solar and nonsolar homeowners and the active and passive solar technology owners using the SPP development model proposed previously. These comparisons provided the data used in examining the hypotheses of this study.

DATA GATHERING PROCESSES

Sampling Design:

The population of the nonsolar sample was defined as "all owner-occupied year-round housing units in the 48 contiguous states, including mobile homes, but excluding town houses, condominiums, and military bases" (Farhar-Pilgrim and Unseld, 1982:34). This is because people living in those dwellings did not have decision-making power over the external appearance of the building. Those living in attached houses who did have such power, as ascertained through a screening question, were included in the sample.

The number of households in the U.S. in 1978, which was the latest available figure at the time the surveys were conducted, was 50,283,000. This figure was updated to include information from the 1980 Census. The Gallup Organization then used the relationships between the population and the number of owner-occupied housing, and between the population and the number of households to estimate that there were 52.2 million year-round owner-occupied housing units in the contiguous states - excluding Alaska and Hawaii - in the fall of 1980.

The Gallup Organization has a national probability sampling frame of 362 interviewing areas. All the areas were included in the sample design. The sampling method included replicated, probability sampling to the block level for the urban areas and to segments of townships for rural areas.

The sample size of approximately 2,000 was determined by analytical needs for having subgroups of sufficient size for predetermined levels of accuracy. The estimated standard errors for the questions based on sample variability ranged from .009 to .018. "The 95 percent confidence interval for estimates with standard errors in the middle of this range would be about 2.6 or 2.7 percentage points, plus or minus" for the whole sample (Farhar-Pilgrim and Unseld, 1982:36). The final useable sample size of the nonsolar homeowners was 2,023.

In 1980, it was impossible to identify the solar homeowners' universe. "'Solar homeowners' were defined as owners of homes employing any type of residential renewable energy systems" (Farhar-Pilgrim and Unseld, 1982:37). Those who had wood-burning stoves or fireplaces as their only renewable energy systems were not counted, however.

A list of 6,911 names of probable solar homeowners was compiled from the National Solar Heating and Cooling Information Center, state energy offices, from other researchers, from nineteen published directories of solar owners and also from direct responses of individuals to three press releases in over 1,500 publications throughout the U.S. About 40% of the solar respondents volunteered to participate in the survey, so it is impossible to determine how well the sample represented average solar homeowners of that period.

Of the names on the original mailing list, 767 were identifed as nonsolar homeowners or the addresses were inaccurate. Therefore the sampling frame was reduced to 6,144. After several follow-up procedures, 3,809 completed survey instruments were returned for a response rate of 62%.

Of the 2,335 persons who did not complete a questionnaire, 2,157 did not respond at all. The following reasons for nonparticipation were given by 96 individuals who responded: (1) 44 gave no explanation, (2) 21 showed "displeasure with the survey", (3) 9 said they were having problems with their solar systems, (4) 6 were unhappy with the Federal government, (5) 5 said the survey was a waste of time or tax money, (6) 4 said the survey was "too personal", (7) 5 claimed to be "too busy" and (8) 2 were physically disabled (Farhar-Pilgrim and Unseld, 1982:38).

Other categories of incomplete questionnaires included: (1) 23 invalid or incomplete responses, (2) 18 were late e.g.

past the end of December, 1980, (3) 3 had return address labels removed so were unidentifiable, and (4) 33 blank questionnaires were returned (Farhar-Pilgrim and Unseld, 1982:39).

Data Gathering Methods:

The interviewers for the nonsolar personal interviewing process were trained by Gallup Organization "through the use of written instructional materials, a tape-recorded summary of key information and telephone briefings with each interviewer" (Farhar-Pilgrim and Unseld, 1982:36).

Fieldwork was conducted from October 16, 1980 to November 24, 1980. The work was interrupted from the weekend prior to the national election held on November 4, to the Wednesday after Election Day.

The average interview length was 56 minutes. Gallup reported that during the pretest the survey had created a lot of interest and people had many questions. So the interviewers left pamphlets and information on how to get more information about solar energy with the respondents after the interviews (Farhar-Pilgrim and Unseld, 1982:36).

Thirty percent of the completed interviews were validated with follow-up telephone calls or through the mail. "The level of refusal encountered in the survey was approximately the same as that which Gallup has encountered in similar work" (Farhar-Pilgrim and Unseld, 1982:37).

The potential solar respondents were sent a mailed questionnaire with a cover letter and postage-paid return envelope. After a two week period, a follow-up postcard was sent, then a second postcard after two more weeks. Finally, a second questionnaire and cover letter were sent to all who had not responded two weeks later. This process was completed by October, 1980. The responses were accepted through the end of December.

Marketing Management Concepts Inc. was subcontracted by SERI to edit and code the questionnaires. The return address labels on the envelopes were destroyed to assure the anonymity of the respondents. The marketing firm then provided SERI with a data tape, codebook and frequency distributions of all the variables (Farhar-Pilgrim and Unseld, 1982:39).

Obtaining the Data Tapes:

After hearing of the SERI study, I decided to investigate its potential as a data base for an analysis of soft path preferences. I met with Dr. Farhar-Pilgrim in the summer of 1981. She assured me that there would be no problems in my using the data and suggested my contacting SERI directly. I then attempted to obtain a copy of the data from SERI, which had undergone reorganization by 1982.

Although the nonsolar homeowners data were readily available, the solar homeowners' data were missing from SERI. Dr. Farhar-Pilgrim was able to provide me with another copy of the data tape with the proviso that I not publish the geographic locations of solar homeowners on a state by state or zip code basis, for that could be an "invasion of respondent privacy" in states where little solar technology existed (Personal communication, December 14, 1982). I agreed to that. Also, the identification numbers were stripped from the data, again assuring anonymity.

When I received the codebooks and data tapes, the nonsolar homeowner data and codebook matched perfectly. However, that was not true of the solar data set. Therefore, I reconstructed the solar codebook from the structure of the data set. The accuracy of the reconstruction was validated with frequency runs compared to those reported in Farhar-Pilgrim and Unseld (1982).

Because I did not have access to the original questionnaires, I was not able to correct the ten cases with miscoded variables in the solar data. These were recoded into "missing variables."

Instrument Design:

Various techniques were used to gather information to design the research instruments. Focused interviews were conducted with solar and nonsolar homeowners, solar leaders and community leaders of four communities known to be pro-solar throughout the U.S. - Davis, California; the San Luis Valley of Colorado; Carbondale, Illinois, and New York City. The tape recorded open-ended interviews were content analyzed for the ideas and concerns of people who had thought about and/or adopted solar energy technologies (Farhar-Pilgrim and Unseld, 1982:33).

A six-month study was conducted of nine solar homeowners in Tucson, Arizona to further explore the relationship between "values and life-style preferences in the solar adoption decision" (Farhar-Pilgrim and Unseld, 1982:34).

Members of the survey design team also met with Department of Energy officials, and "representatives of large and small firms manufacturing solar equipment, builders of solar homes, and public interest groups" (Farhar-Pilgrim and Unseld, 1982:33).

These sources of information were then used to design the nonsolar interview schedule and the survey instrument for the solar homeowners. The survey instrument and "study plan were reviewed and approved by the Energy Information

Administration and the Office of Management and Budget" (Farhar-Pilgrim and Unseld, 1982:34).

The survey instruments used with both samples were identical except for questions which were inappropriate because both did not own solar technologies. The solar survey instrument had many questions about specific experiences with solar technologies including operating, engineering, and economic factors. Attitudinal, behavioral and lifestyle preference questions were basically identical for both samples.

Questions concerning the potential advantages and problems with solar technologies were asked retrospectively of the solar homeowners, e.g. "when you were thinking about using solar energy in your home". . . or "how important this advantage actually was to you in making your decision . . ." They were asked hypothetically of the nonsolar homeowners, e.g. "if you were thinking about using solar energy in your home " and ". . . how important it [possible advantages] would be for you in making . . . a decision."

Copies of the instruments are reproduced in Farhar-Pilgrim and Unseld (1982) Appendixes B and C. Most of the questions were structured but there were a few open-ended questions. As seen in Appendix B of this document, the Likert format was used quite extensively in the questions of particular interest to this project.

SAMPLES' CHARACTERISTICS

The solar and nonsolar samples' characteristics include house and fuel types, household composition, socioeconomic status indicators (household income, occupation of head of household, education of the respondent), and other demographic information such as age, race, gender, and geographic region.

Housing and Fuel Characteristics:

Housing and fuel characteristics summarized in Table 2 indicate current energy type.

Table 2

Both the solar and nonsolar households sampled predominantly live in single dwellings (95% and 90%). Less than 10% live in multiple housing structures or in mobile homes. The greatest difference, but nevertheless a small one, is seen in the percentage of the samples living in multiple housing units (3% solar to 7% nonsolar).

The main fuel types used by the two samples is quite different. Most of the nonsolar households used natural gas as their primary heating fuel (56%). Fuel oil, which was controversial in 1980 due to the oil embargo, was the primary fuel in 19% of the households. Electricity was used in 13% of the households, followed by lesser use of propane, wood and other fuels.

Table 2

HOUSING CHARACTERISTICS AND PRIMARY HEATING FUEL

	Solar		Nonsolar	
	%	(n)	%	(n)
HOUSING TYPE				
Single dwelling	95	(3565)	90	(1819)
Multiple dwelling	3	(98)	7	(136)
Mobile	1	(33)	3	(58)
Other	1	(47)	1	(10)
Missing data*	2	(66)	0	(0)
Total	100	(3809)	101	(2023)
MAIN FUEL TYPE				
Solar	18	(650)	0	(0)
Fuel oil	16	(580)	19	(368)
Electricity	32	(1181)	13	(249)
Propane	2	(81)	4	(72)
Natural gas	12	(426)	56	(1101)
Wood	10	(383)	8	(161)
Other	10	(365)	1	(17)
Missing data*	4	(143)	3	(55)
Total	100	(3809)	101	(2023)

*Non-missing percentages based on those who answered.

On the other hand, the modal solar households used electricity (32%) as primary fuel while the second largest category of households claimed solar (18%) as the main heating source. Fuel oil was used by only three percent fewer solar than nonsolar households (16%). Both samples showed about the same percentage using wood as the primary heating system, though the solar sample has a slightly higher percentage of users (10% compared to 8%). The other point that Table 2 makes is that the solar sample used a more diversified array of fuel types when compared to the nonsolar.

Table 3 presents the average cost of household energy use in the summer and winter of 1980 for the two samples.

Table 3

On the average, the nonsolar households paid $103.00 per month for household heating, cooling, electricity, and hot water. The range varied from $4.00 to $938.00 with some reporting winter heating costs as high as $1,300! However, 75% of the households paid an average of $120.00 or less per month.

The solar sample reported an average monthly expenditure of $93.54 for household energy. The range was $3.00 - $5,000.00 with 75% of the households paying $100.00 or less per month.

Table 3

AVERAGE ENERGY COSTS
(in 1980 dollars)

Quartiles	Summer	Winter	Monthly*
SOLAR			
1st	1 - 35	3 - 45	3 - 43
2nd	36 - 50	46 - 70	44 - 66
3rd	51 - 80	71 - 116	67 - 100
4th	81 - 6,000	117 - 8,000	101 - 5,000
Missing data	9% - (347)	12% - (448)	13% - (477)
Total	(3809)	(3809)	(3809)
X	$82	$109	$94
s.d.	$358	$280	$209
Range	$1 - $6,000	$3 - $8,000	$3 - $5,000
NONSOLAR			
1st	4 - 39	4 - 70	4 - 60
2nd	40 - 60	71 - 100	61 - 85
3rd	61 - 98	104 - 150	86 - 120
4th	100 - 900	151 - 1300	122 - 938
Missing data	2% (45)	3% (62)	3% (68)
Total	(2023)	(2023)	(2023)
X	$77	$129	$103
s.d.	$ 61	$108	$74
Range	$4 - $900	$4 - $1,300	$4 - $938

* Conservative estimate based on averaging summer and winter energy costs.

Not only are the physical demands of the housing structure and energy costs important, but also the social composition and stability of the household. Table 4 describes the household composition of the homeowners.

Table 4

The modal family structure is that of a two parent family with children, in both samples. The next most common household structure is married couples with no children (31% of the solar and 28% of the nonsolar samples).

The greatest difference between the two samples is in the larger percentages of single adults and single parents in the nonsolar sample. Sixteen percent of those respondents were adults living alone, while 10% were single parents with predominantnly one or two children. Less than 10% of the solar sample fit these categories. These patterns may reflect the older age of the solar sample (see Table 8).

The average number of children was very similar for both samples with 1.305 in the solar and 1.137 in the nonsolar households.

Migration plans of households may affect the willingness of the homeowners to invest in renewable energy technologies. These plans were determined with the question, "How likely are you to move within the next three years?"

Table 4

Household Composition

	Solar		Nonsolar	
	%	(n)	%	(n)
FAMILY TYPE				
Two parent family	49	(1865)	42	(852)
Married couple	31	(1168)	28	(569)
Extended family	4	(165)	4	(82)
One adult	1	(45)	16	(326)
Single parent	5	(180)	10	(194)
Other	7	(257)	-	-
Missing data	3	(129)	-	-
Total	100	(3809)	100	(2023)
NUMBER OF CHILDREN				
0	40	(1521)	45	(913)
1	17	(664)	19	(389)
2	23	(876)	20	(409)
3	10	(389)	11	(215)
4	4	(134)	3	(68)
5+	3	(95)	1	(29)
Missing data	3	(130)	-	-
Total	100	(3809)	99	(2023)
X	1.305		1.137	

The nonsolar and solar samples were very similar. About 75% claimed that it was "very unlikely" or "unlikely" that the household would move during that period and about 15% claimed that it was "very likely" or "likely" that they would move (Appendix A, Table 24).

Socioeconomic Characteristics:

The economic, occupational, and educational characteristics of the samples provide indicators of the households' resources for implementing their preferences. The household income provides disposable income for acquiring solar energy technologies. The occupation of the head of household suggests the types of technical skills and knowledge which the householders have, as well as prestige.

Table 5

As expected, the nonsolar sample generally had a lower income level than the solar sample. For example, 12% of the nonsolar sample fell below the 1979 Federal Poverty level guidelines for a family of three (U.S. Dept. of Commerce, 1983) while only 2% of the solar households was in that income category.

Table 5

SOCIOECONOMIC CHARACTERISTICS OF HOMEOWNERS

	Solar %	Solar (n)	Nonsolar %	Nonsolar (n)
EDUCATION				
Graduate school	39	(1451)	9	(172)
College	24	(890)	13	(252)
Some college	19	(688)	18	(369)
Trade or technical	6	(232)	6	(119)
High school	10	(360)	32	(639)
Less that high school	3	(97)	23	(452)
Missing data	2	(91)	1	(20)
OCCUPATIONS				
Professional	40	(1491)	16	(307)
Manager, executive	15	(557)	9	(186)
Business owners	7	(254)	6	(113)
Skilled workers	11	(382)	17	(333)
Retired	14	(523)	19	(383)
Other	4	(156)	0	(1)
Service worker	2	(79)	4	(88)
Manufacturer's rep.	2	(59)	2	(34)
Semi-skilled trade	1	(46)	10	(196)
Sales	.5	(17)	1	(24)
Clerical, office	2	(59)	5	(99)
Farm owner, mngr.	1	(41)	4	(70)
Laborers	.6	(21)	5	(98)
Homemaker, Student	.6	(19)	3	(52)
Missing data	3	(105)	2	(39)
INCOME				
Greater than $55,000	12	(423)	4	(74)
$45,000 - $54,999	10	(341)	4	(75)
$35,000 - $44,999	17	(617)	10	(186)
$25,000 - $34,999	24	(853)	16	(302)
$20,000 - $24,999	14	(510)	16	(287)
$15,000 - $19,999	10	(366)	15	(273)
$12,000 - $14,999	5	(175)	9	(169)
$10,000 - $11,999	3	(102)	7	(125)
$7,000 - $ 9,999	2	(87)	8	(140)
Less than $6,999	2	(86)	12	(217)
Missing data	7	(249)	9	(175)
Total		(3809)		(2023)

When the samples were divided into quartiles by income, the quartile income values were lower for the nonsolar sample. The solar group had about $10,000.00 more in each quartile than the nonsolar sample. For example, the lowest quartile in the nonsolar sample included those making up to $11,999 while in the solar group, the lowest quartile went up to $19,999. The third quartile's upper range was $34,999 among the nonsolar households and $44,999 among the solar homeowners. Thus it is clear that the solar sample has access to greater economic resources.

In this study, professionals are over-represented in the solar sample when compared to the nonsolar sample (40% to 16%). Managers and executives are also somewhat overrepresented in the solar sample with 15% compared to 9%. Business owners are approximately equally represented in the two groups with about 6% of the respondents being in this occupational category.

Table 6

Table 7

Although the skilled trades do not rank in the top income generating groups, they may have more abilities to work with technologies. Although skilled tradespersons represent one of the larger groups within the solar sample, it is underrepresented when compared to the nonsolar sample (11% compared to 17%). This is also true of the semi-skilled

Table 6

INCOME AND OCCUPATIONS - SOLAR

Occupations	Very High ($45,000+)	High ($35,000- 44,999)	Upper Middle ($20,000- 34,999)	Middle ($12,000- 19,999)	Low ($7,000- 11,999	Poverty Row (Under $6,999)	Total
Professional	28 (401)	22 (308)	38 (548)	9 (128)	2 (29)	1 (13)	41 (1427)
Manager/ executive	34 (182)	25 (132)	34 (181)	6 (31)	1 (7)	1 (4)	15 (537)
Own business	21 (51)	15 (37)	37 (89)	17 (41)	7 (17)	3 (6)	7 (241)
Skilled worker	6 (22)	9 (33)	49 (175)	27 (97)	7 (25)	2 (6)	10 (358)
Retired	7 (32)	8 (37)	33 (159)	28 (134)	17 (80)	8 (36)	14 (478)
Other	15 (22)	12 (18)	41 (61)	20 (29)	7 (11)	5 (7)	4 (148)
Service worker	14 (10)	10 (7)	45 (33)	27 (20)	3 (2)	3 (2)	2 (74)
Manufact. rep	29 (17)	14 (8)	48 (28)	7 (4)	2 (1)	0 (0)	2 (58)
Semi-skilled worker	14 (6)	16 (7)	49 (21)	16 (7)	2 (1)	2 (1)	1 (43)
Sales	0 (0)	18 (3)	53 (9)	12 (2)	12 (2)	6 (1)	1 (17)
Clerical/ office	0 (0)	16 (9)	47 (27)	23 (13)	14 (8)	0 (0)	2 (57)
Farm owner/ manager	16 (6)	13 (5)	26 (10)	32 (12)	5 (2)	8 (3)	1 (38)
Farm labor	0 (0)	0 (0)	33 (1)	0 (0)	33 (1)	33 (1)	0 (3)
Laborer	24 (4)	12 (2)	24 (4)	41 (7)	0 (0)	0 (0)	1 (17)
Housewife	23 (3)	8 (1)	16 (2)	31 (4)	8 (1)	16 (2)	0 (13)
Full-time student	0 (0)	50 (1)	0 (0)	0 (0)	0 (0)	50 (1)	0 (2)
Total	22 (756)	17 (608)	38 (1348)	15 (529)	5 (187)	2 (83)	100 (3511)
Missing data							298
Grand Total							3809

Table 7

INCOME AND OCCUPATIONS - NONSOLAR

Occupations	Very High ($45,000+)	High ($35,000-44,999)	Upper Middle ($20,000-34,999)	Middle ($12,000-19,999)	Low ($7,000-11,999	Poverty Row (Under $6,999)	Total
Professional	19 (53)	20 (56)	45 (125)	10 (28)	5 (14)	2 (5)	15 (281)
Manager/ executive	21 (35)	19 (32)	42 (71)	15 (25)	4 (6)	1 (1)	9 (170)
Own business	11 (11)	24 (24)	34 (34)	20 (20)	5 (5)	5 (5)	5 (99)
Skilled worker	4 (11)	10 (32)	45 (141)	28 (89)	8 (26)	5 (14)	17 (313)
Retired	2 (7)	1 (4)	7 (24)	23 (78)	36 (125)	31 (106)	19 (344)
Other	0 (0)	0 (0)	100 (1)	0 (0)	0 (0)	0 (0)	0 (1)
Service worker	2 (2)	4 (3)	39 (33)	26 (22)	8 (7)	20 (17)	5 (84)
Manufact. rep	37 (11)	3 (1)	33 (10)	17 (5)	7 (2)	3 (1)	2 (30)
Semi-skilled worker	1 (2)	4 (7)	35 (63)	36 (65)	15 (26)	9 (16)	10 (179)
Sales	0 (0)	15 (3)	35 (7)	30 (6)	15 (3)	5 (1)	1 (20)
Clerical/ office	2 (2)	5 (5)	35 (32)	40 (37)	13 (12)	4 (4)	5 (92)
Farm owner/ manager	17 (11)	14 (9)	16 (10)	28 (18)	14 (9)	11 (7)	4 (64)
Farm labor	0 (0)	0 (0)	10 (1)	40 (4)	20 (2)	30 (3)	1 (10)
Laborer	0 (0)	8 (7)	33 (28)	35 (30)	17 (15)	7 (6)	5 (86)
Housewife	0 (0)	0 (0)	3 (1)	15 (6)	18 (7)	64 (25)	2 (39)
Full-time student	0 (0)	0 (0)	0 (0)	43 (3)	29 (2)	29 (2)	0 (7)
Refused	0 (0)	11 (2)	26 (5)	21 (4)	21 (4)	21 (4)	1 (19)
No answer	40 (4)	10 (1)	30 (3)	20 (2)	0 (0)	0 (0)	1 (10)
Column Total	8 (149)	10 (186)	32 (589)	24 (442)	14 (265)	12 (217)	100 (1848)
Missing data							175
Total							2023

professions. Although these professions are represented in 10% of the nonsolar sample, they are only 1% of the solar sample.

Other occupations which have low income are not very strongly represented in the solar sample as expected. Examples of these are sales, clerical, farm managers, and laborers. Homemakers and full-time students are also underrepresented in this group when compared to the nonsolar sample.

There is some underrepresentation of retired people who are solar owners when compared to the percentage found in the nonsolar group (14% to 19%). However, the solar retirees have higher incomes than those in the nonsolar sample (Tables 6 and 7).

Education is an important resource, for differing levels of education expose individuals to different types of information and help develop skills in seeking new information. While 55% of the nonsolar sample have a high school education or less, the solar sample is composed predominantly of those with a college level education or higher (63%). In fact almost 40% of the solar sample has graduate level education while the nonsolar homeowners have an equivalent percentage (38%) in trade or technical schools and high school (Table 5).

<u>Other Demographic Characteristics</u>:

Other demographic characteristics include age, race and gender.

Table 8

In these data, 21% of the nonsolar homeowners are below 34 years of age and 20% are 65 or older. The solar sample shows a distribution which is slightly smaller in these age groups - 16% under 34 and 16% are 65 or older. The curvilinear relationship of age and solar system ownership is apparent as 68% of the solar respondents are in the 35 to 64 age groups, while only 59% of the nonsolar respondents are in these categories. The mean age, however, for the two groups is very similar - 43 years for solar and 44 for the nonsolar.

The ethnic and racial composition of the U.S. population was well reflected in the nonsolar sample. The predominant group was Caucasian (88%) as was true in the solar sample (85%).

The second largest group was Blacks, representing 8% of the sample. This ethnic group is significantly underrepresented among solar homeowners (.4%). This is also an underrepresentation of the Blacks in the U.S. population

Table 8

DEMOGRAPHIC CHARACTERISTICS OF HOMEOWNERS

	Solar %	Solar (n)	Nonsolar %	Nonsolar (n)
AGE				
24 or less	.4	(14)	4	(76)
25 - 34	16	(608)	17	(345)
35 - 44	26	(970)	20	(403)
45 - 54	22	(799)	21	(414)
55 - 64	20	(716)	18	(364)
65 - 74	13	(467)	14	(270)
75 or more	3	(94)	6	(127)
Missing data	4	(141)	1	(24)
Total	100.4	(3809)	100	(2023)
RACE				
Caucasian	85	(3110)	88	(1761)
Asian	13	(467)	1	(16)
Black	.4	(16)	8	(165)
Hispanic	1	(40)	2	(44)
American Indian	1	(22)	1	(11)
Missing data	4	(154)	1	(26)
Total	100.4	(3809)	100	(2023)
GENDER				
Male	not	available	54	(1072)
Female	---	------	46	(910)
Missing data	---	------	2	(41)
Total			100	(2023)

(U.S. Dept. of Commerce, 1983). The geographic distribution of the two samples does not explain this for both have about 27% from the South. The high socioeconomic level of the solar homeowners is a better explanation.

This is probably the reason why the Hispanic and American Indian populations were underrepresented. Many of these ethnic groups have a high percentage of their members in poverty and are renters rather than homeowners.

The Asian/Pacific Islanders (12%), however, are overrepresented. This may reflect the overrepresentation of the Western region (39%) in the solar sample - especially since it includes Hawaii and California, two states which have both a high percentage of people of Asian descent as well as a preponderance of solar technologies.

Although the gender of the respondents is important in influencing attitudes towards energy and environment, this information is not available for the solar respondents. The nonsolar sample, however, is composed of 53% males and 45% females.

Women have been identified as having more favorable environmental attitudes, stronger energy conservation behavior (Farhar et al., 1980), and as being more strongly against nuclear power and pro-solar than men

(McStay and Dunlap, 1983; Stout-Wiegand and Trent, 1983; Reed and Wilkes, 1980; and Brody, 1984).
Brody (1984) examines two hypotheses in his work - one which suggests that the reason for women's lack of support for nuclear power is due to their marginality in the social structure, and the other, that it is due to their perception of the safety risks associated with the systems. Brody concluded that although men and women viewed the energy crisis as serious, women were less supportive of nuclear power as a way of resolving the crisis because of their concerns with the risks.

Reed and Wilkes (1980) also concluded that women were more strongly against nuclear power development than men because of their marginality in the social structure. This is somewhat supported by Stout-Wiegand and Trent's (1983) findings that women were more strongly against economic and energy developments than men because of the negative social impacts of boomtown conditions.

Women have engaged "in behaviors such as cutting down on driving, saving newspapers for recycling, and avoiding environmentally damaging products (of all types) more often than do men . . . reflecting a genuinely stronger commitment to a 'pro-environmental' lifestyle" (McStay and Dunlap, 1983:297). Men on the other hand, do engage in more political actions.

These findings suggest that women will be more favorable to the development of solar energy technologies than men. However, Farhar-Pilgrim and Unseld (1982) found that men were more favorably inclined toward solar energy systems than women. They also found that women are more likely to perceive the energy situation as getting worse in the future.

Unfortunately this issue cannot be pursued further with these data.

<u>Regional Characteristics</u>:

Garrett-Price et al. (1980) report that the West shows the most immediate promise for solar space heating as an economic option. This may be reflected in the larger percent of the solar sample in the West (39%) compared to the nonsolar sample (14%) (Table 9).

Table 9

Compared to the nonsolar sample, there is an under-representation of the solar respondents in the Midwest (8% to 31%). Surprisingly, there is an equivalent representation of solar and nonsolar households in the East (27%) and very similar representation in the South (26% solar to 28% nonsolar).

Table 9

REGIONAL DISTRIBUTION OF HOMEOWNERS

	Solar*		Nonsolar**	
	%	(n)	%	(n)
EAST (ME,NH,VT,MA,RI,CT,DE, NY,NJ,PA,MD,WV,DC)	27	(1014)	27	(554)
MIDWEST (OH,MI,IN,IL,WI,MN,ND, IA,MO,SD,NE,KS)	8	(317)	31	(622)
SOUTH (VA,NC,SC,GA,FL,KT,TN, AL,MS,AR,LA,OK,TX,PR)	26	(980)	28	(570)
WEST (AZ,CO,ID,UT,NM,CA,NV, OR,WA,HW,AK,MT,WY)	39	(1492)	14	(277)
Missing data	0	(6)	0	(0)
Total	100	(3809)	100	(2023)

* States not represented for solar: Louisiana, Nevada, South Dakota.

** States not represented for nonsolar: North Dakota, Delaware, Hawaii, Alaska, Montana, Wyoming, Nevada, Puerto Rico.

CHAPTER VI

SPP DEVELOPMENT MODEL:

OPERATIONALIZATION AND MEASUREMENT ISSUES

The theoretical model is the framework used to empirically examine the influence of solar energy technologies on the development of soft path preferences (SPP). A critical aspect of testing theoretical thought is to translate the abstract concepts into measureable indicators. In this chapter I discuss the indicators chosen to empirically examine the SPP development model. Findings from previous research and the logic used in choosing particular indicators are specified. Issues of index construction, scale development, and other measurement topics are addressed.

OPERATIONALIZING THE SPP DEVELOPMENT MODEL

In Table 10, the indicators used to operationalize the SPP development model are specified. The items used for the indexes are listed in Appendix B.

Table 10

Table 10

SPP DEVELOPMENT MODEL INDICATORS

ENERGY VULNERABILITY NEEDS: (solar - nonsolar samples)

1. Dwelling type (both) - HOUSE
2. Monthly energy costs (both) - AVCOST
3. Number of children in the household (both) - NUMCHIL
4. Household characteristics (both) - FAMTYP
5. Age of respondent (both) - AGE
6. Perceptions of the "national energy crisis" (both) - LADDER
7. Life style impacts of the "energy crisis" (both) - IMPACT

CONTEXTUAL RESOURCES: (solar - nonsolar)

1. Educational level of respondent (both) - EDUC
2. Gross household income (both) - INCOME
3. Personal network support index (both) - PERSUP
4. Institutional support index (both) - INSTSUP
5. Perceived governmental support index (both) - GOVSUP
6. Federal support (nonsolar) (index - solar) - FEDERAL
7. State support (nonsolar) (index - solar) - STATE

-- additionally, for solar only --

8. Local support index - LOCAL
9. Experiences of personal support index - GRMEMBR
10. Problems of increased cost index - PRCOST
11. Problems of local policies index - PRLCL
12. Problems with people index - PRPEOP
13. Problems acquiring the system - PRBLD

TECHNOLOGY CHARACTERISTICS: (solar: active - passive)

1. Years of ownership (both) - OWNLNGTH
2. Problems experienced operating the system (both) - PROPNG
3. Date of system installation (both) - ACTYR, PASSYR
4. Building methods index (both) - ACTBLDMTD, PASBLDMTD
5. Sources of materials and parts (both) - LCLAPRT, LCLPPRT
6. Average number of down periods (both) - ADOWN, PDOWN
7. Cost of solar energy systems (both) - COSTTECH

EVALUATION OF SYSTEMS: (solar - nonsolar)

1. General evaluation of systems index (both) - GENERAL
2. Technical capabilities index (both) - TECEVAL
3. Expected energy savings (both) - EXPSAVE
4. Intentions about adding systems (both) - ADDTECH
5. Technical systems support index (both) - TECHSUP

-- also, for solar only (active - passive) --

6. Average evaluation of systems' condition (both) - ACTCOND PASSCOND
7. Recommended solar to others - RECMEN

SOFT PATH PREFERENCES: (solar - nonsolar)

1. Energy self-reliance index (both) - EYSLFREL
2. Local self-reliance index (both) - LCLSLFREL
3. Resources conservation attitudes index (both) - CNRBLF
4. Resources conservation behavior index (both) - CNRBHVR
5. Energy conservation behavior (both) - EYCONS
6. Personal comfort and prestige index (both) - STATUS
7. Personal economic gains index (both) - ECON

Energy Vulnerability Needs:

Energy vulnerability needs is the driving variable of the model identifying the needs the householders perceive which may lead to a change in the energy base of society. Needs is operationalized in three ways: (1) physical structure of the home, (2) household composition and size, and (3) perceptions of the "energy crisis" and its impacts.

One of the important sources of energy needs of a household is determined by the size of its dwelling. Sackett (1984) notes that from 1950 to 1979, the size of the houses in the U.S. increased from 983 square feet to 1,750 square feet. Therefore the heating space actually was higher in 1980 than thirty years earlier.

While the sizes of the buildings were growing, there was a decrease in the rate at which energy use grew both in the residential and commercial sectors. Between 1950 and 1973, buildings' energy use grew at about 4.5% per year while between 1973 and 1980, the growth occurred at only .4% a year (Hirst et al., 1981:11). The residential energy use per household declined at an average rate of 1.7% per year between 1973 and 1980. Most of the decline was due to conservation measures such as setting the thermostat lower (40%) and about 20% was due to increased technical efficiencies such as adding attic insulation to homes (Hirst et al., 1981:8).

While size of dwelling is the ideal indicator, this is only approximated in these data by the type of housing owned by the respondents. Single-family dwellings use more energy than other types of housing, including multifamily dwellings and mobile homes (Morrison and Gladhart, 1976; Newman, 1982). In these data, housing types are: (1) single-family dwelling, (2) multifamily dwelling, (3) mobile home, and (4) other.

The average energy cost of the household is computed from average monthly energy bills in winter and in summer. This indicator is only an approximation, for the reported average monthly costs of electricity, heating, hot water and cooling for winter and summer are added together and divided by two. Many solar and nonsolar homeowners verified their costs with bills or with other documents so the responses are fairly reliable approximate measures of actual energy costs (Farhar-Pilgrim and Unseld, 1982:417).

Ideally, the energy cost information would be available for the solar homeowners from before the time they acquired the solar technologies. It is a less useful indicator of energy need for the homeowners who already own the solar technologies.

As seen previously (Table 3, p.117) the differences in average reported energy costs between the solar and nonsolar homeowners is minimal (e.g. $93.54 to $103.00). Those households living in larger dwellings and paying higher energy costs, will experience greater energy vulnerability needs.

The size and social structure of the household also affect the amount of energy used. This is operationalized using number of children, type of household composition, and the age of the respondent as indicators.

Several researchers (Morrison and Gladhart, 1976;Newman, 1982) found that larger families and the families in the child-rearing stages use more energy than families without children or at earlier or later family stages. "Teenage children are the biggest drain on energy resources" (Newman, 1982:3). The greater the number of children in the household, the more energy is needed. This indicator and that describing the household composition are proxies for the actual number of people living in a house . . . which is the ideal size indicator.

The size and estimated energy use of the household are used to rank order the family types. Two parent families are assumed to be the largest, and the multigenerational families the second largest households. Married couples are also great users of energy, especially if both work outside the home. Finally, single parents and single adults use less energy than other household types for they have fewer people.

Age has been associated with consumption of energy. Newman (1982) found that age was important because of its association with size of household. There is a sharp increase in energy use in the thirty-five to forty-four age categories. Most energy is expended in the 44 to 59 age categories with a slow decline after this. Energy expenditure and consumption slopes increase steeply in the early phases and decrease less sharply after the 44-59 age period. Therefore the age indicator is ordered based on energy consumption, from the most energy consuming ages to the least as follows: (1) 35-44 years, (2) 45-54, (3) 55-64, (4) 25-34, (5) 65 and older and (6) 24 or less.

Finally, the respondent's perceptions of the national "energy crisis" and of its impacts on the household's lifestyle are used as indicators of perceived national energy vulnerability. National vulnerability perception is computed from the respondents' perceptions of how good or bad the national energy situation would be in 1985 minus the perceptions of what it was like in 1980. The perceptions are based on a ten point scale with 0 = the worst possible situation and 10 being the best. The responses are ranked from perceptions of a worst situation in 1985 than in 1980 to a better situation at that time.

Finally, the energy vulnerability needs concept also includes an indicator of perceived impacts of the energy crisis on the household's life style. Greater perceived impacts are associated with greater vulnerability needs (Appendix A, Table 25).

The solar and nonsolar homeowners' perceptions reflect different behavioral experiences with energy. The solar homeowners have already "done" something about their perceptions by having acquired solar energy technologies. Obviously it would be preferable to have an indicator directly measuring the perceived need to change the energy base of the household and society, but this is available only indirectly in this data set.

<u>Contextual Resources</u>:

The second major construct of the model is contextual resources. These resources affect the household's ability to resolve the perceived need for energy by providing barriers or assistance for the resolution of the "needs".

Resources are composed of three parts: (1) the individual's or household's characteristics which serve as resources, (2) resources available in the household's social context, and (3) problems which the solar households have with the solar technologies as described below.

The individual and household's resources include: (1) the education of the respondent, and (2) the gross annual household income. The external resources available in the household's social context include: (1) perceived personal network support, (2) perceived institutional support, and (3) types of governmental support. These indicators are shared by both solar and nonsolar homeowners.

Both education and income are ordered from highest to lowest values indicating greater to fewer access to resources. Education is measured in this study as the respondents' having completed: (1) graduate studies, (2) college, (3) some college, (4) trade or technical college, (5) high school, and (6) less than high school.

Higher education is associated with a higher degree of ability in seeking new knowledge and in using public resources. It has also been associated with a greater awareness of the finiteness of natural resources. Those with higher education (e.g. some college or more) have tended to be more aware of and use federal tax credits for conservation and solar energy technologies (Farhar-Pilgrim and Unseld, 1982; Warkov, 1979; Carpenter and Chester, 1982).

However, Warkov (1979) found that although educational level was important in recruiting to the HUD program he examined, it made "little difference as to which households do or do not actually acquire solar" (Warkov, 1979:50). This was similar to Carpenter and Chester's (1982) findings which indicated a strong interaction of income with education.

> Among homeowners with less than $20,000 income, as education increases so does the percent that filed a tax credit. For homeowners in the $20,000 to $30,000 bracket the effect of education on filing a tax credit is so slight as to be negligible. Among homeowner that have more than $30,000 income, as education increases there is a modest increase in filing for a tax credit.
>
> (Carpenter and Chester, 1982:8)

Thus the tax credit incentives seem most significant to the middle income persons with higher education and to a lesser extent to those with high income and high education. Education has usually been positively associated with concerns about energy conservation and environmental issues (Olsen, 1983; Farhar-Pilgrim et al., 1979; Farhar et al., 1980; Farhar-Pilgrim and Unseld, 1982; Hamm et al., 1982).

Dunlap and Olsen (1984) found that high education was a characteristic of activists of both the hard and soft path ideologies. Many studies have documented the higher educational level of pro-environmentalists (Morrison and Dunlap, 1985; Vine, 1980; Mitchell, 1980; Van Liere and Dunlap, 1980; Farhar-Pilgrim et al, 1979; Farhar-Pilgrim and Unseld, 1982).

Education is also related to concerns about energy. Hamm et al. (1982) found a positive relationship between energy-related attitudes and practies and to beliefs in technological solutions. Farhar-Pilgrim and Unseld (1982) found a positive relationship between education and favorability toward solar energy technologies. However, they also report that those with college degrees and above are more likely to see that solar energy technologies are not a good investment. Farhar et al. (1980; Farhar-Pilgrim et al., 1979) found in their review of the literature that increased education was not associated with favorability toward solar energy technologies. So the role of education as a resource for the use of solar energy technologies is still unclear.

Income also is associated with having more resources for acquiring the renewable energy technologies. In this study, household's annual gross income is measured from over $55,000 to under $6,999 a year (Appendix B, p.283).

Warkov (1979) found that households which participated in the HUD solar technology programs had higher income than the average household in Connecticut. That pattern was also true of Carpenter and Chester's (1982) findings that those employed part time had the highest percentage of people filing claims for tax credits for solar energy technologies, while those who were fully employed were second and the retired, third.

Farhar-Pilgrim and Unseld (1982) found a positive association between income and conservation actions, while Hamm et al. (1982) found only a weak relationship between income and energy conservation attitudes and actions.

Income has an interesting relationship to environmental concerns. Dunlap and Olsen (1984) clearly indicate that "hard path activists report far higher incomes than do the soft-path activists" (Dunlap and Olsen, 1984:425). Morrison and Dunlap (1985) examined this issue further finding that the modal income of members of environmental organizations was above average. Van Liere and Dunlap (1980) report that income is often negligible or sometimes negatively related to environmental concerns.

They also report that favorability to solar energy technologies increases with income, including the probability of investing in a solar technology (Farhar-Pilgrim and Unseld, 1982; Farhar-Pilgrim et al., 1979; Farhar et al., 1980).

The majority of the findings suggests that income is positively associated with favorability toward and use of solar energy technologies. Therefore, I expect income to have a positive relationship to the contextual resources variable, to use of solar energy technologies and to the development of soft path preferences.

The contextual resources for the solar energy technologies variable also indicates some of the conflicts occurring when households change energy base. This variable is the primary one with indicators to capture some of the societal conflicts suggested by soft path critics.

Personal network support is indicated through the respondent's perceptions that friends, neighbors, job associates, and spouse or housemates are in favor of solar energy technologies (Appendix B,p.283). This is an additive 17 point index which is weighed making the spouse or housemate's answer most important, neighbors and friends intermediate, and that of the colleagues less important - see Farhar-Pilgrim and Unseld (1982:179).

Technology support institutions may directly assist or create barriers to the acquisition of solar energy technologies. The additive 20 point index of institutional support provides a measure of how well institutions support alternative energy systems: (1) utility companies, (2) homeowners' insurance companies, (3) technology sellers through warranty coverage of systems, and (4) solar energy companies' dependability (Appendix B,p.284).

The third contextual resource examined is governmental support. The nonsolar and solar respondents were asked whether or not they perceived the three levels of government (local, state and federal), as "favorable", "mixed" or "opposed" to the use of solar energy technologies. The responses were weighed providing stronger influence to local governmental support, reflecting Lovins' emphasis on community based action. The additive 18 point index of general governmental support is another indicator of contextual resources support for solar systems (Appendix B,p.284).

The nonsolar homeowners reported whether or not they knew if there was a federal or state income tax credit for the purchase of solar water and home heating technologies. The solar homeowners indicated their participation in federal demonstration programs, and whether or not they received local and state property and sales tax credits or exemptions (Appendix B, p.285). The number of grants, credits, or exemptions received is summed creating a four point index of state and federal support, but only a three item index was possible for local support.

Carpenter and Chester (1982:5) found that the most important variable in determining whether homeowners had solar water or space heating technologies were tax credits. Respondents claimed that these technologies would not have been installed without the tax credits.

Additional indicators are available for the solar sample. A three point personal membership in solar voluntary associations or professions is used (Appendix B, p.288). It is assumed that people who participate in groups focused on solar energy technologies are linked into a network providing more resources for changing to renewable energy technologies, so this is expected to provide additional resources for the use of solar energy technologies and the development of soft path preferences.

Actual problems experienced with the solar technologies are indicators of contextual barriers for the solar homeowners. Problems in choosing between solar systems, lack of information, difficulty in choosing contractors, builders, or architects, increased costs, policy problems and people problems and installation issues are specified. A five point index is also created for increased costs due to difficulties in obtaining financing, increased property taxes, and utility rates, and decreased resale value of the home (Appendix B, p.286). When homeowners experience negative economic factors because institutions in their communities increase charges, they will perceive greater barriers and fewer resources available for ownership of alternative energy technologies.

Problems with solar access rights and local building codes create an additive three point scale indicating local policy barriers. A four point additive scale of people problems is created from reported experiences with vandalism, neighbors' opposition, and obstruction of solar technologies. The greater the policy and neighborhood problems experienced, the fewer the perceived resources in the community. Finally, an additive five point index is created from problems experienced in attempting to acquire alternative energy systems (Appendix B, p.288).

The contextual resources variable therefore is composed of indicators which both facilitate and detract from the ability and favorability of the householders to acquire solar energy technologies and develop soft path preferences. The homeowners may find that the resources available in the community are not sufficient to adequately support their need for renewable energy systems. The more problems they encounter, the fewer the resources in their locale. The fewer the problems, the greater the resources. If the resources are perceived as being adequate for the resolution of the perceived energy vulnerability needs, then the homeowners may acquire solar energy systems. The use of solar energy technologies is expected to be positively associated with the development of soft path preferences.

<u>Technology Type</u>:

Technology type is a very important variable in the development of SEP according to Lovins. Information is provided only by solar homeowners for this concept. The years of solar technology ownership is computed from the number of months of ownership divided by 12. The date of acquisition is also reported separately for the active and passive systems (Appendix B, p.289). The date the technology was installed or constructed reflects different cohorts' experiences with social contextual influences on the development of SPP and with the operation of the solar technologies. The length of ownership indicates how long energy has been visible to the owner or that the homeowner has been associated with a solar network. Due to cognitive dissonance, she/he may become more committed to the values and attitudes of the soft path changes reflected in soft path preferences. Thus, the longer the ownership length, the greater the commitment to soft path preferences.

Length of ownership also is associated with the experiences of the homeowners with the operation of the solar energy technologies. The longer the ownership length, the greater the possibility for having problems operating the solar technologies. The problems experienced operating the solar energy technologies form a five point summated index measured with indicators of: (1) maintenance problems, (2) difficulty finding paths or equipment for repair,

(3) problems with overheating, and (4) problems from poor system design (Appendix B, p.289).

As indicated previously, Lovins (1976) claims that those who obtain solar technologies are interested in taking control of their own energy systems. Therefore important characteristics of the solar technologies include whether the owners make them from local resources. A ten point additive index was developed from indicators about how the energy systems were manufactured or designed, built and installed. The indicators are weighed according to whether or not the technology was created by the respondent locally or by a foreign firm or hired professional (Appendix B,p.290).

Because of soft path's emphasis on self-reliance and control of one's own energy systems, the following characteristics of the manufacturing or building process are more consistent with the soft path: (1) being manufactured by small local firms instead of national and foreign firms; (2) being built on site rather than as complete packaged systems and then assembled, and (3) being installed by the owner as opposed to a hired contractor (Appendix B, p.291). These characteristics reflect how solar energy systems can be installed using processes congruent with either soft path or hard path orientations.

The sources of the parts and materials for the solar systems also form part of the technologies' implementation process. The following is the ranking and rationale given for the ordering of an eight point variable: (1) local solar companies are specifically committed to renewable energy systems, so they are identified as being most consistent with the development of the soft path changes; (2) local hardware, lumber or supply companies are general purpose stores supporting "do-it-yourselfers" and technical self-reliance; (3) local heating, plumbing stores are more dependent on items manufactured elsewhere, so they are a little less consistent with soft path developments; (4) the use of local building contractors and architects sources is another step away from direct control and participation by the owner of the solar technology; (5) local outlets of chain stores, mail ordering from nonlocal solar companies and getting materials and parts from non-local solar companies are all steps away from local self-reliance. These indicators of the acquisition process are reported separately for active and passive systems (Appendix B, p.291).

The total installed cost of the solar energy technologies is also an important characteristic of the solar technologies (Appendix B, p.289). The technology type as measured by the implementation process, the length of ownership, operating problems and cost of the technologies will affect the evaluation which the owner makes of the alternative energy systems and will influence SPP development.

Evaluation of Solar Systems:

Evaluation is the third construct in the nonsolar model and fourth for the solar model. It is a combination of general and specific evaluation indicators, and measures of the intentions of the homeowners about future use of solar energy technologies. These questions were asked retrospectively of the solar homeowners, and hypothetically of the nonsolar sample.

A ten point additive index reflecting general evaluation of solar systems is created from overall reactions and specific experiences as solar system owners. The more positive the homeowners' assessment, the more inclined they will be to continue using renewable energy technologies and the greater their soft path preferences.

A thirty five point additive scale is developed from items about the technical capacities of solar energy technologies in the following categories: (1) technical and economic performance, (2) climatic adaptation to sunny and cold climates, (3) longevity, (4) technical obsolescence, (5) safety of the system and (6) operating reliability (Appendix B, p.292).

An assessment of solar energy technologies as a good investment is computed as the difference between expected and actual savings from the solar system. A higher percentage being saved compared to what was expected is associated with a more positive evaluation of renewable technology ownership supporting longer use and stronger SPP development (Appendix B, p.293).

The intentions of the respondent were directly addressed with the question "To what extent, if any, have you considered investing in solar energy technologies in the next 2-3 years?" or " adding more solar." Four values were given as possible responses from "will definitely invest" to "have not considered." Solar homeowners have an additional four point indicator of whether or not they have recommended solar technologies to others. The nonsolar homeowners' indicator describes their perceived ease of using solar technologies on their home (Appendix B, p.295).

Finally, only solar homeowners are asked to evaluate the: (1) helpfulness of maintenance and operating instructions for the solar system, (2) warranty coverage, and (3) quality of repair service. This creates a 15 point additive index from the Likert-like five point satisfaction scale for each item (Appendix B, p.296).

Separate evaluations were made by the solar homeowners of the overall conditions of their active and passive solar systems. These indicators were computed as an average of a five point assessment scale from "excellent" condition with no problems to "poor systems" with chronic problems (Appendix B, p.297).

A positive evaluation of the solar energy technologies is associated with greater soft path preferences development.

Soft Path Preferences:

Soft Path Preferences is composed of five basic dimensions: (1) self reliance preferences, (2) natural resources conservation preferences, (3) personal gains preferences, (4) equity and (5) social diversity preferences. The last two are not operationalized in this data set and are social impacts of a changed energy base.

Self reliance is central to the Lovins' theory of social change. It is through self-reliant attitudes and behaviors that households and communities are able to become independent from the centralized dominant social structures of the national and international levels which control the hard energy path. It is through the process of self-reliance that individuals working in communities can recapture some of the energy resources which are being siphoned away.

In these data, self reliance preferences is measured in two ways: (a) attitudes about energy self-reliance, and about (b) local community and personal self-reliance.

An additive 20 point index was created from beliefs in the importance of:(1) increasing overall self-reliance, (2) having a more reliable energy supply, (3) reducing the need for large power plants, and (4) increasing independence from utility companies (Appendix B, p.297).

A twenty point additive local self-reliance index was created from variables measuring attitudes about whether local communities or the federal government would be able to resolve the energy crisis, about the importance of being independent from national policies, and about whether or not the respondents were developing self-reliance skills (Appendix B, p.298).

The second dimension of soft path preferences, natural resources conservation preferences, is important to Lovins' ideas of equity. It is only as energy and other natural resources are conserved by the present generation that there will be some left for future generations and other nations. Energy conservation also provides additional resources for the transition from the hard energy path to the soft energy path.

Natural resources conservation preferences uses measures of: (1) general attitudes towards natural resources conservation, and (2) perceptions about the importance of easing energy shortages, and (3) of decreasing personal use of energy resources. These items form a 15 point additive index of the perceived importance of conserving natural resources (Appendix B, p.299).

Natural resources conservation behavior will lead the transition to the soft path independently of belief systems, claims Lovins (1976). The behaviors release additional natural resources, not the attitudes. Therefore, a 15 point additive natural resources conservation behavior index is created composed of the reported activities of: (1) recycling household materials, (2) recycling clothes, and (3) contributing to ecological organizations (Appendix B, p.300).

Another index of natural resource conservation behavior is created by the number of energy conservation behaviors out of 15 performed by the respondents (Appendix B, p.300). The greater number of such activities is positively associated with SPP development.

A strong dimension of the Lovins' argument is that the soft path will be developed as people discover that it is to their personal economic and noneconomic advantage to change their energy base. Economically, solar energy is cheaper than nonrenewable energy, except for the fact that government subsidies make the nonrenewable energy appear to be cheaper. The noneconomic gains include the satisfaction of self-reliance and the attendant self-esteem.

In these data, the dimension of personal gain is measured by the importance of: (1) increased comfort and prestige, and (2) increased personal economic gains. Increased personal prestige, and home comfort are measured with a ten point additive index (Appendix B, p.301).

Both the hard path and the soft path advocates claim that personal economic self interest is served by "their" energy base. Personal economic gains are measured on an additive 20 point index of perceptions that: (a) solar is a good investment, (b) it saves money, (c) it is a protection against rising energy costs, (d) it decreases utility bills, and (e) increases the resale value of the home.

Several of the dimensions of soft path preferences are inadequately measured in these data. The dimension of self-reliance preference could have more directly measured the attitudes about national energy self-reliance. Community energy self-reliance as opposed to dependence on the federal government was adequately measured with three indicators.

Personal and household self-reliance aspects were inadequately tapped with only one indicator.

The second dimension of natural resources conservation only had one indicator which did not focus on energy conservation attitudes. A broader use of indicators of other aspects of natural resources conservation, such as water conservation, air quality, throwaway packaging, etc., would have strengthened the attitudinal measure.

The behavioral indicators include behaviors which are upper middle class oriented (e.g., contributing to ecologically oriented organizations) as well as lower class oriented (e.g., buying clothing at a garage sale or at a second-hand store). Other behaviors could have been tapped such as the sharing of neighborhood tools, garden composting, reusing aluminum foil, using the bicycle or public transporation, etc.

Finally, the energy conservation indicators inadequately measure the bahaviors of serious energy conservers. For example, walking to work, living downtown to prevent the urban sprawl, <u>not</u> using appliances or fireplaces, and so on are not measured.

The third dimension, of noneconomic personal gain, was measured with only two indicators. One indicator mixed self-esteem with increased status and prestige. Indicators of satisfaction with increased diversity, equity, self-reliance and local control would have strengthened the variable. Measures of the respondents' perceptions of personal and household gains of the soft path, such as increased neighborhood cohesion, would have been useful, also.

While offering these criticisms and suggestions for the development of stronger indicators for measuring SPP, I acknowledge that this is not an uncommon problem with secondary analysis. These data were gathered for a diffusion and marketing study of solar energy technologies. They were quite appropriate for that purpose in 1980.

MEASUREMENT ISSUES

In preparing the data for analysis, the attributes and values of each of the variables were ranked in relation to theoretical and empirical knowledge about the relationship of the variables to the soft path preferences development model's concepts. The lowest rank was assigned to those attributes and values which were most closely related to the development of soft path preferences.

In most cases the variables have at least four attributes or values although in a couple of cases it was necessary to retain only three attributes/values. Dichotomous variables were used to develop indexes. Variables which were measured on scales quite different from the 3-50 point range used most frequently, were transformed into scales more compatible with the other variables by dividing through by 10, usually.

Indexes were created with as much similarity as possible between the solar and nonsolar samples. The items within the indexes were chosen primarily through face validity though that was empirically verified by examining their inter-correlations and Cronbach split-half reliability scores (Cronbach, 1951). The variables which displayed no correlation with the other variables were deleted from their indexes. The construction of the indexes is specified in Appendix B and in Table 11.

Table 11

The primary difference between the solar and nonsolar indexes is that the solar homeowners specified actual experiences with the technologies while the nonsolar homeowners had to respond more abstractly. The table indicates the correlation between the items and their indexes without the item.

Table 11

INDEXES OF THE SPP DEVELOPMENT MODEL

	Correlation Item to Index S*	Correlation Item to Index N*	Alpha w/o Item S	Alpha w/o Item N	Scale Variance
RESOURCES:					
1. Personal Network support					
Spouse	.153	.397	.482	.387	
Friends & neighbors (X2)	.469	.487	.133	.301	S: .007
Friends (X2.5) (CRFRNDS)	.016	.006	.575	.707	N: .001
Colleagues (X3)	.462	.470	.150	.336	
alpha	S:	.575	N:	.707	
2. Institutional support					
Utility company	.606	.298	.814	.704	
Warranty coverage	.708	.524	.769	.506	S: .133
Insurance coverage	.698	.518	.774	.479	N: .730
Firm's dependability	.644	.409	.798	.563	
alpha	S:	.833	N:	.627	
3. General governmental support					
Federal support (X3)	.429	.390	.350	.224	
State support (X2)	.488	.444	.319	.179	S: .006
Local support	.416	.358	.369	.246	N: .594
Local laws (X1.5) (CRLAWS)	.052	.016	.727	.800	
alpha	S:	.727	N:	.800	
4. Federal support received					
Federal tax crdit	.223	----	-.027	----	
HUD - 1	.003	----	.364	----	S: .010
HUD - 2	.212	----	.022	----	
alpha	S:	.263			
5. State support received					
Sales tax exemption	.076	----	.020	----	
Property tax exemption	.136	----	.004	----	S: .011
Low income loan	.089	----	.051	----	
Income tax credit(TAXSTA)	-.023	----	.359	----	
alpha	S:	.359			

S* = solar, N* = nonsolar

Table 11 (cont.)

	Correlation Item to Index S	N	Alpha w/o Item S	N	Scale Variance
6. Local support received					
Sales tax exemption	.193	----	----	----	
Property tax exemption	.193	----	----	----	S:.002
alpha	S:	.239			
7. Personal support					
Member solar groups	.352	----	----	----	
Solar professional	.423	----	----	----	S:.003
alpha	S:	.756			
PROBLEMS:					
1. Increased cost					
Financing difficulties	.265	----	.405	----	
Utility rates up	.320	----	.348	----	S:.0004
Property tax up	.257	----	.423	----	
House resale values down	.322	----	.410	----	
alpha	S:	.466			
2. Local policy problems					
Solar access rights	.226	----	----	----	
Local building codes	.226	----	----	----	S:.001
alpha	S:	.266			
3. Problems from people					
Vandalism	.264	----	.215	----	
Neighbors' opposition	.241	----	.234	----	S:.0007
Obstruction of system	.201	----	.438	----	
alpha	S:	.348			
4. Acquisition problems					
Installation	.252	----	.473	----	
Choosing a system	.261	----	.463	----	S:.0007
Inadequate information	.342	----	.384	----	
Inadequate professionals	.344	----	.401	----	
alpha	S:	.502			

Table 11 (cont.)

	Correlation Item to Index P**	A**	Alpha w/o Item P	A	Scale Variance
TECHNOLOGY TYPE		(solar)			
1. Building methods used					
Manufacturer/designer 1	.852	.576	.929	.826	
Manufacturer/designer 2	.981	.707	.902	.872	A:21.322
Construction method 1	.845	.708	.941	.809	P:15.909
Construction method 2	.975	.852	.893	.754	
Installation method 1	.869	.591	.926	.818	
Installation method 2	.987	.851	.891	.755	
alpha	A:	.831	P:	.930	
2. Problems operating the systems		(solar)			
Maintenance problems	.308	----	.315	----	
Repair parts	.246	----	.382	----	S:.0008
Overheating	.126	----	.479	----	
Improper system design	.333	----	.292	----	
alpha	S:	.446			
EVALUATION:					
1. General evaluation					
Favorability to solar	.245	.574	----	----	S:.041
Satisfaction with solar	.245	.574	----	----	N: .101
alpha	S:	.389	N:	.718	
2. Technical capabilities					
Economic and technical	.251	.225	.618	.559	
Warm climates only	.240	.211	.623	.565	S:.226
All climates good	.309	.359	.604	.509	N:.154
Longevity	.316	.258	.605	.549	
Obsolescence	.402	.306	.571	.531	
Safety	.406	.338	.569	.518	
alpha	S:	.629	N:	.573	
3. Technical support					
Helpfulness instructions	.092	----	-.244	----	
Warranty satisfaction	.084	----	-.255	----	S:3.275
Repair satisfaction	-.155	----	.569	----	
alpha	S:-.037				

P** = passive, A** = active

Table 11 (cont.)

	Correlation Item to Index S	N	Alpha w/o Item S	N	Scale Variance
SOFT PATH PREFERENCES					
1. Energy self-reliance					
Increased overall	.636	.629	.661	.705	Var.
Reliable energy supply	.575	.640	.688	.705	S: .063
Independence of utilities	.573	.564	.689	.741	N: .044
Fewer large power plants	.446	.526	.757	.758	
alpha	S:	.756		N: .780	
2. Local self-reliance					
Use community resources	.095	.067	.286	.238	Var.
Independence of federal	.203	.131	.150	.166	S: .242
Trust federal policies	.148	.124	.232	.176	N: .535
Self-reliance skills	.141	.146	.241	.144	
alpha	S:	.289	N:	.235	
3. Resource conservation beliefs					
Ease energy shortage	.655	.465	.440	.328	Var.
Conserve natural resources	.642	.469	.463	.331	S: .313
Reduce consumption	.356	.231	.799	.665	N: .041
alpha	S:	.709	N:	.572	
4. Resource conservation behavior					
Recycling paper, glass.	.250	.202	.208	.144	Var.
Contribute to ecological organizations	.268	.178	.172	.192	S: .681 N: .484
Buy second hand goods	.164	.136	.386	.277	
alpha	S:	.371	N:	.295	
5. Personal comfort and prestige					
Greater home comfort	.167	.206	----	----	Var.
Increased status and prestige	.167	.206	----	----	S: .378 N: .055
alpha	S:	.277	N:	.340	
6. Personal economic gains					
Protection from increased energy costs	.511	.563	.619	.711	Var.
Reduced energy bills	.608	.625	.544	.678	S: .102
Long-term savings	.623	.668	.544	.661	N: .105
Increased home resale	.254	.458	.791	.791	
alpha	S:	.695	N:	.764	

Because of the low correlation with their indexes, and because of the way they depressed the reliability of the index, some of the items were dropped. This was true for the "personal network support index" (dropped "concerned about what friends and neighbors would say"); for the "general governmental support index" (dropped "concerned that codes or covenants might prohibit use of solar energy technologies in your home"), and "state support received index" (dropped "received state tax credit"). Items were deleted only if they were weak in <u>both</u> the solar and nonsolar samples and if they were not central to the construct. Those items which were theoretically central for construct validity were retained even though this reduced the reliability of the index as a whole. See, for example, the index "technical support".

In developing the indexes and preparing the data for modeling, the missing values were included as such if they were under 5% of the answers. If 5-20% of the answers were missing, the mean value of the variable was substituted for the missing values. If the indicator had a higher percentage of missing values, it was deleted from the analysis. Pairwise deletion of missing values was used in the principal components and Pearson correlation analyses.

The "don't knows" were sometimes coded as a "neutral" value in the ranking of the attributes or as "missing values" depending on the particular variable. This can be examined in the frequency tables of Appendix A.

Sometimes the frequencies were highly skewed because of a few outliers. The distributions were capped at three standard deviations from the mean if there were few respondents in those categories. These can also be examined in Appendix A.

In order to compare the degree of soft path preferences which developed among the various samples -- solar, nonsolar homeowners; passive - active solar owners; those who had owned solar technologies for different periods of time -- a soft path preference scale was created.

The variables of the soft path preferences were factor analyzed using principal components extraction with orthogonal varimax rotations. The communality values were used as weights in developing scores for each respondent. Each indicator of the soft path preference was multiplied by the weight of the variable and then standardized by using the sum of weights as the denominator.

Table 12

SPP SCALE WEIGHTS: SOLAR AND NONSOLAR

Variable:	Solar	Nonsolar
Energy self reliance	.77772	.81407
Local self reliance	.61171	.44332
Resource conservation beliefs	.77289	.63946
Resource conservation behavior	.65177	.43049
Energy conservation behavior	.35973	.55338
Personal comfort and prestige	.62019	.53421
Personal economic gains	.74135	.75970

In order to prepare the SPP development model, preliminary examination of the data was performed by factor analyzing the theoretically defined indicators of the energy vulnerability needs and the contextual resources concepts to determine if the variables were empirically associated with those two concepts. The same process was followed with the concepts of technology type, evaluation, and soft path preferences.

The results of the orthogonal and oblique rotations were identical in loading the variables on similar factors with very similar weights. This clearly identified the factors adding confidence to the use of the partial least squares modeling procedure which uses principal components extraction.

As a result of the analysis, "respondent's age" was found to be more closely associated with variables of the energy vulnerability needs concept than with the contextual resources variables where it had been originally placed. It therefore became an indicator associated with energy vulnerability needs. The "behavioral intention" variables were strongly associated with the evaluation variables, so they were also used as indicators of this construct as argued in the theoretical section. "Problems of increased cost" and the "real savings" from solar technology use were more closely associated with evaluation concept variables than with soft path preferences variables, so they were moved to that concept.

The following variables were dropped from further analysis because they did not correlate very strongly with other variables. "Moving plans" and "type of primary heating fuel" were both dropped from the energy vulnerability needs concept. Other variables which were dropped due to large missing values or lack of clear construct validity were: (1) "types of solar technologies known to the respondents" (Farhar-Pilgrim and Unseld, 1982), (2) "willingness to take out a loan to pay for solar technologies", and (3) "participation in local community activities".

Finally, results from Pearson correlation analysis were used to enter the variables into the partial least squares (PLS) modeling program (Appendix C, Tables 38 and 39).

CHAPTER VII

ANALYSIS

In this chapter, I describe the partial least squares (PLS) covariance structure model which I used as a method for examining the interrelationships of the indicators with the concepts of the SPP development model and to describe the relationships among the model's concepts. These relationships will be described for four major subgroups. The solar and nonsolar samples will be compared; then the active and passive solar system owners will be compared. This will help determine if the process of soft path development is similar or different for the four groups.

After the theoretical model has been examined using indicators which are as similar as possible for each subset being compared, then the model is trimmed to express the relationships more parsimoniously.

In order to facilitate the discussion of the method of analysis, I will use the terms used most often by structural equation modelers. PLS is one of that class of methods. The theoretical concepts which form the primary variables of the model are called "latent variables" because they are not measured directly. The measureable items which I have called indicators are labelled "manifest variables" by structural equation modelers.

INTRODUCTION TO PLS

Partial least squares structural equation modeling was developed by Herman Wold (1980) in response to some of the situations researchers find themseleves in - searching to analyze relationships between variables when theoretical knowledge is scarce and when the researcher is not sure of the theoretical distribution of the population being studied. This method was developed as an alternative to the "hard modeling" approaches (Falk and Stuber, 1984) which are primarily aimed at accuracy and model testing. PLS soft modeling is "intermediate between data analysis and the (hard) assumptions of the ML [sic. maximum likelihood] mainstream of contemporary statistics" (Wold, 1982:5).

PLS is designed as a complimentary tool which maximizes consistency, or patterns, rather than accuracy (Wold, 1982:53). The model standardizes the latent variables to unit variance. Using least squares, PLS also minimizes all residual variances jointly without optimizing total residual variance or using other criterion of optimization (Wold, 1980:67). This is a major difference between partial least squares operations and maximum likelihood operations whereby all of the residuals are minimized simultaneously. PLS does it iteratively by block of manifest variables (Lohmoller, 1984).

The PLS method also does not face identification problems because it explicitly estimates the latent variables from the weighted aggregates of their manifest variables with weights determined by the weight relations mode (Wold, 1980, 1982; Lohmoller, 1984).

The manifest variables are therefore quite critical to determining characteristics of the latent variables. In PLS, the noise from random variability is reduced when the loadings of the manifest variables are large. The residuals from one latent variable ". . . are the data input for PLS estimation . . ." of the next latent variable as the program goes through the various iterations (Apel and Wold, 1982:222).

Apel and Wold explain:

> Designed primarily for research contexts that are simultaneously data rich and theory-primitive, soft modeling has to cope with noise that is inevitable in the indirect observation of latent variables by manifest indicators, plenty of noises when only some few indicators are available, each of which carries noise of its own.
>
> (Apel and Wold, 1982:237).

Apel and Wold (1982) recommend using loadings of between 0.5 and 0.6 though they also use 0.3 (Apel and Wold, 1982:229).

There are three weight relation modes which determine the manifest variables' relations to the latent variables. Through Mode A, the relationship arrows connecting the manifest and latent variables are pointed outwardly from the latent variable. This mode is consistent with principal component analysis for the first latent variable. Although the PLS estimates are more stable with Mode A, which is basically a sequence of simple OLS regressions (Apel and Wold, 1982:228), this mode tends to reduce the beta values between the latent variables by creating minimum residual variances in the block structures of the latent variables (Wold, 1980:70).

Using Mode A, the PLS procedure minimizes, in its first stage, each residual variance to estimate the loading on each manifest variables one by one (Wold, 1980:67). This can be interpreted as the contribution of each manifest variable separately to the latent variable.

Mode B is the second mode and is less stable for it is more like multiple regression or canonical correlation for the first latent variable or canonical variate (Levine, 1977). Thus it provides the best possible prediction of the latent variable without regard for residual variance on the manifest variables (Falk, 1986). Mode B is usually indicated by arrows coming into the latent variable from the manifest variables. Therefore, the manifest variables' weights are the amount which each variable contributes jointly with the other manifest variables to the latent variable. This mode tends to increase the beta values and the correlation between the latent variables that are connected with the arrow scheme (Wold, 1980:71).

Wold (1980) recommends using Mode B for exogenous latent variables, but using Mode A for the other latent variables.

Bielby and Hauser (1977) suggest that the Mode A should be used when the manifest variables "appear as indicators (reflections or effects) of latent variables . . ." while the Mode B is used when ". . . observables appear as causes of latent variables" (Bielby and Hauser, 1977:147). Mode C is a combination of A and B. In the PLS program (Lohmoller, 1984) only one mode can be specified for each block of variables.

One of the advantages of using PLS modeling is that it can be used to analyze: (1) dichotomous variables, (2) categorical variables, (3) aggregated categorical variables, and (4) internal or ratio variables. Since these can be included together in an analysis (Lohmoller, 1984; Falk, 1986), there are no restrictive assumptions about the measurement level of the data.

PLS assumes linear relationships between the manifest and latent variables, and between latent variables. It also assumes that the manifest variables' residuals are independent of each other and of the residuals of the latent variables. An advantage of the PLS program is that it actually examines the correlations between the residuals and the various other parts of the model. The data used in this analysis meet the assumptions of the modeling program.

A criticism often made of PLS is that it provides a biased estimate of the relationships of the model. In fact Apel and Wold (1982) developed an experiment indicating that PLS estimates are indeed biased . . . "the tendency being on the one hand to underestimate the LV [sic. latent variable] correlations and path coefficients" while overestimating the relationships between the manifest variables and the latent variables (Apel and Wold, 1982:223; Dijkstra, 1983).

Areskoug (1982) examined the impact of the bias and concluded that "the loadings preserve their relative magnitudes within blocks, and the estimated correlation between the latent variables is the highest possible among linear forms of indicators" (Areskoug, 1982:106).

The manifest variables are fed into a PLS computer program in block order, sequentially reflecting the model. These blocks of manifest variables create the latent variables and are the theoretical relationships of the model. The direction of the relationships between the latent variables is also specified. The influence of the manifest variables operates solely through the latent variables (Lohmoller, 1984; Wold, 1982).

Comparing PLS and ML:

Areskoug compared the performance of PLS and maximum likelihood estimation of factor models (ML) which is the dominant mode in structural equation modeling.

One of the disadvantages of ML is that it is based on heavy iterative procedures and thus may be very expensive for large samples. ML is " . . . especially designed for situations with detailed knowledge of the data and the model structure" found in experimental fields (Areskoug, 1982:107). PLS, however, "attempts to derive robust estimates under a minimum of assumptions about the stochastic properties of the model . . ." by focusing on the relations between the latent variables (Areskoug, 1982:96).

Bentler and Weeks (1980) claim that the greatest advantage which PLS has over ML is that estimates can be obtained where they cannot with ML because of the assumptions of normality and of the costly iterative computer processes of ML.

Joreskog and Wold (1982) compared the two analytic processes, concluding that they are complimentary. "ML is theory-oriented, and emphasizes the transition from exploratory to confirmatory analysis. PLS is primarily intended for causal-predictive analysis in situation, of high complexity but low theoretical information" (Joreskog and Wold, 1982:270). Through a dialogue with the computer, PLS helps consolidate, improve and further develop the model. The focus in ML estimation is simply on whether or not the model fits the data.

Rationale for Selecting PLS Rather than ML Modeling:

One of the assumptions which "hard modeling" makes is that one has a closed theoretical system with all of the concepts correctly specified and with no important ones omitted (Falk and Stuber, 1984; Falk, 1986). As indicated previously, the model which I have specified about soft path preference development does omit the important theoretical variable of social structural changes and its feedback to soft path preferences, perceptions of energy vulnerability needs and contextual resources. Clearly I am not meeting the first criterion of hard modeling.

Furthermore, even within the portion of the theoretical model which I am proposing to examine, there are ommissions - specifically, equity and social diversity values and attitudes were left out due to data limitations.

Other limitations include the poor construct validity of some manifest variables, such as using number of children and type of family for size of the household. Other problems with the manifest variables have been discussed in the operationalization and measurement chapter.

As mentioned in the operationalization chapter, some of the additive indexes have poor split-half reliability scores. Although this is not fatal in additive indexes, it does present another measure of how well the individual items making up the indexes are related (Cronbach, 1951). They do not meet the criterion of being well tested empirical measures of theoretical concepts. Also, the data are primarily ordinal and not interval as required by maximum likelihood estimators.

Furthermore, the solar sample was a snowball sample. Although it is very large, it was not randomly selected and many of the variables are not normally distributed as required in "hard modeling". Although large samples provide many advantages, they are also very expensive when all manifest and latent coefficients are estimated simultaneously (ML), particularly if the model has any complexity.

Although accuracy is a strong contribution of maximum likelihood estimations, this is not the primary purpose of my current research. Since the manifest variables are only approximate measures, it seems foolish to provide a highly accurate estimate of their relationships! I am more interested in examining the comparative strengths of the different relationships in the model to discover if the strength of those relationships is consistent with what is predicted by the theory of soft path development.

I have proposed a model of theoretical relationships which combines well developed research traditions with one having little empirical research. There are still many questions about how the manifest variables are related to the latent variables of the soft energy path. Thus the proposed system of relationships needs to be explored and refined.

PLS allows exploration of nested models using chi-square for comparing the relative fit of different models rather than as a probability test of "goodness of fit". This is especially true with very large samples (Bentler and Bonett, 1980; Falk, 1986).

This exploration is conducted conservatively when compared to ML estimations for PLS tends to overestimate the measurement model's (e.g. manifest to latent variables) relationships and to underestimate the relationships among the latent variables.

These are the primary reasons why I have chosen to use the partial least squares process for examining the theoretical model. Although ML is ideal for comparing well developed models since its mathematical properties are better understood and it is more precise, I do not believe it is appropriate for this project.

PLS SPECIFICATIONS OF THE SPP DEVELOPMENT MODEL

The model describing the theoretical process of soft path preferences development was examined by comparing the solar and nonsolar samples using similar manifest variables. Then the model was respecified for the solar homeowners to include the additional latent variable "technology type" and some manifest variables specific to the experiences of the solar system owners.

The second model comparison was made between two subsets of solar owners, the active and the passive solar system owners. Equivalent manifest variables specified to their particular types of solar systems were used in the modeling process.

In every comparison, a measurement model was first run. This specified the number of latent variables in the model, but put all variables into one block so that the manifest variables were free to associate with any latent variables.

Measurement Model for Solar and Nonsolar Homeowners:
Originally, 29 manifest variables were entered into the measurement model for the nonsolar homeowners and 43 into the solar homeowners model in the sequence specified in Tables 17 and 18.

In order to keep the models comparable, the only manifest variables which were deleted were weak for both samples. The very conservative criteria used were: (1) Were the loadings (Mode A) of the manifest variable under .300? (2) Did the manifest variable have a low score on both the weights and the loadings (Mode B and A)? (3) How theoretically central was the manifest variable to the latent variable?

There were two manifest variables which fit all the criteria and therefore were deleted from further consideration: (1) "perceived governmental support" (solar=.214; nonsolar=.164) and (2) "institutional support" (solar=.048 and nonsolar=.098).

Two additional manifest variables were deleted from each of the separate sample's models. For the nonsolar sample, the "estimated acquisition and installation cost of a solar water heater" (.229) and the estimate for a solar home heating system (.281) were deleted because they had very high missing values.

Although the manifest variables indicating the methods used in building or acquiring the active or passive solar systems had low values (.178;.226), their theoretical centrality served to retain them in the solar models.

For the solar sample, "expected payback" (-.009) was deleted from the model due to its low association with the latent variable. The "expected payback" variable was computed from the respondents' estimates of the cost of solar systems divided by their average yearly energy costs. It simply was not a sufficiently strong indicator being primarily composed of "noise".

After these deletions, the nonsolar sample's model was composed of 25 manifest variables and the solar sample had 40 manifest variables. These formed the foundation for exploring the process of SPP development.

<u>Measurement Model for Active and Passive Technology Owners:</u> Forty two manifest variables were placed in the active and passive measurement models. Several were removed because they had extremely high missing values and were therefore not considered further. The first indicating the "source of parts for passive and active systems" (missing data = 47%), the "number of times the passive solar systems had been unoperative" (missing data = 99%), and finally "how long the

respondents felt the solar systems would last" (missing data =87%). "Institutional support" and "perceived governmental support" were dropped for consistency with the solar and nonsolar samples.

As a result of the measurement model run, two more manifest variables were dropped - "personal network support" (solar = -.041; nonsolar =-.099) and "problems operating the system" (solar =-.020; nonsolar =-.047). Therefore, the passive and active solar SPP development models were completed with 35 manifest variables.

Specification of the Theoretical Model:

An important influence on the path relationships between the latent variables is the mode used in relating the manifest variables to them. The mode specifications of the manifest variables are indicated in Table 13.

Although it is possible to use one manifest variable per latent variable, it is better to use at least three (Falk and Stuber, 1984; Falk, 1986; Kim and Mueller, 1978). This criterion has been met.

Table 13

Table 13

MODE SPECIFICATIONS FOR THE SPP DEVELOPMENT MODEL

Latent Variable	Mode*	Minimum no. Indicators
Energy vulnerability needs	B	7
Contextual resources	B	5
Technology type (solar)	A	4
Problems (solar)	A	5
Evaluation of systems	A	6
Soft path preferences	A	7
Model type	C	25**

*Mode: A = outward directed
B = inward directed
C = mixed mode

**The minimum number of indicators is associated with the nonsolar model.

Since the smallest sample size used in the analysis is that of the passive solar technology owners (n=326) this is still well within the criterion of 5 respondents per manifest variable. The largest number of variables analyzed using the passive subgroup is 37.

The soft path preferences development model allows me to examine the influence which the manifest and latent variables have on the development of attitudes and behaviors consistent with social structural changes labelled the soft energy path.

There are three measures which summarize how completely the model captures the data:(1) chi-square without taking into consideration the effects of the model; chi-square with the model, (2) the multiple correlation (R-square) for each endogenous latent variable, and (3) the Bentler - Bonett reliability measure (BB). The number of iterations necessary to extract the values is another indication of whether or not the model capitalized on chance (Dijkstra, 1983). Each one of these measures gives slightly different information about the model as it reflects a "better" or "worse" fit of the model with the data as described below.

The R-square indicates how much of the variable is influenced by the information in the model. The chi-square should go down with each trimmed model indicating better fit between the data and model. The difference in the measure without and with the model should also be examined for a large decrease in in value when the model is specified (Bentler and Bonett, 1980). On the other hand, the BB reliability measure should go up with each new model if the model is showing a better fit with the data.

Finally, the number of iterations is reported simply as a measure of the difficulty which the program had in extracting the values. So, I will examine the number of iterations across the models to see if they are consistent with each other, being aware that a large number of iterations could indicate instability of the estimates.

The information on each of these measures will be provided for each model's versions to assess the improved or decreased fit with the data.

CHAPTER VIII

FINDINGS

I will begin by examining the results of the soft path preferences scale analysis. First the solar and nonsolar samples' scores will be compared to examine the first hypothesis of this project. Then the passive and active technology owners will be compared to determine if there are differences associated with the types of solar energy technologies. Finally, I will examine the results for subgroups of four different ownership lengths.

In the second part of this chapter, the results of the modeling effort are presented and discussed.

SOFT PATH PREFERENCES SCALE

Soft path preferences scales were developed based on principal components analysis of the samples as presented in Chapter VI.

<u>SPP Scales: Solar - Nonsolar Homeowners</u>:

The first hypothesis explored with the SPP scale is

> H1:There is a greater amount of SPP among solar homeowners than among nonsolar homeowners.

The SPP scale scores for the two groups are presented in Table 14 and Figure 5.

Table 14

SPP SCALE COMPARISON: SOLAR - NONSOLAR

SPP Dimensions	Solar Mean	Solar s.d.	Nonsolar Mean	Nonsolar s.d.
	(n = 3809)		(n = 2033)	
Self-reliance				
1. Energy	2.198	.706	2.964	.748
2. Local community	1.895	.379	1.512	.291
Natural resources conservation				
3. Attitudes	1.904	.468	1.826	.356
4. Behaviors	.990	.361	.542	.217
5. Energy conservation	.492	.272	.745	.324
Personal gain				
6. Noneconomic	.623	.292	.729	.237
7. Economic	2.418	.539	2.936	.653
Total SPP Score	10.520	1.820	11.276	1.960

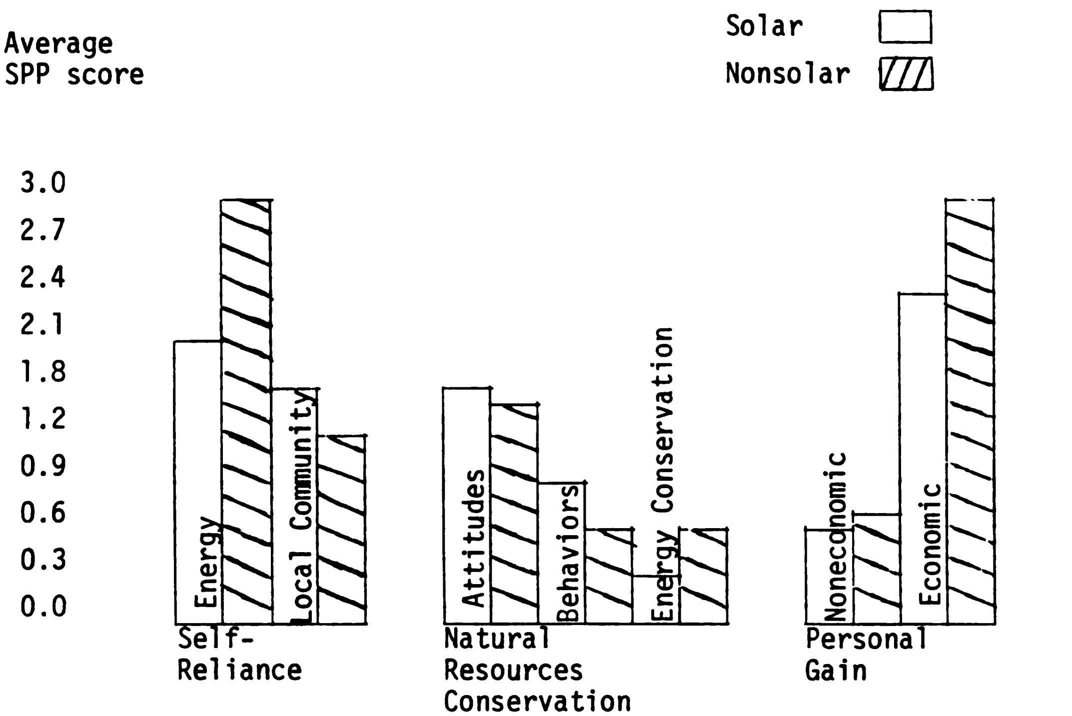


Figure 5: SPP SCALE COMPARISON: SOLAR - NONSOLAR

No test of significance of difference between means was conducted, because the solar sample was not randomly selected and because the sample sizes are so large. However the comparative differences in the means and standard deviations of the two samples will be discussed in an attempt to understand the soft path preferences of solar and conventional energy homeowners.

An examinination of Table 14, indicates that in general the nonsolar homeowners have greater degree of soft path preferences than do the solar homeowners. The nonsolar homeowners have a mean score of 11.276, .756 points higher than the total score of 10.520 of the solar homeowners. This is contrary to hypothesis one that solar homeowners would have greater soft path preferences overall.

The dimensions of the soft path preferences provide additional information about areas of agreement and disagreement between the two samples. The dimension of self-reliance indicates that the nonsolar homeowners show greater preferences for energy self reliance, but the solar homeowners have greater preferences for the local community's being the primary one responsible for decisions affecting its own development. The standard deviations of the two samples are fairly similar, although solar homeowners show more variation regarding local community self reliance.

Larger differences are shown in the attitudes and behaviors about natural resources conservation. The solar homeowners show greater natural resources conservation attitudes (1.904 vs. 1.826) and behaviors (.990 vs. .542) while the nonsolar homeowners indicate having greater energy conservation behaviors (.745 vs. .492). There is a smaller difference in the expressed attitudes (.078) than in the natural resource conservation behaviors (.448 vs. .253).

Issues of personal gain are clearly more important for the nonsolar homeowners than for the solar homeowners probably understandable, given the higher socioeconomic level of the solars. They placed more importance on the economic and on the status and comfort advantages than did the solar homeowners.

The pattern which appears among the dimensions of soft path preferences suggests the nonsolar homeowners have greater preferences for energy self-reliance and economic personal gains. These are the dimensions showing the greatest differences between the samples. On the other hand, these are dimensions in which the solar homeowners experience less vulnerability since they have already implemented measures which make them more energy self-reliant. They also have greater income resources than do the nonsolar respondents.

The next two areas of greatest differences between the two samples indicate higher scores for the solar homeowners. They show greater preferences for local community self-reliance and broader natural resources conservation behaviors. These are perhaps linked to their greater involvement with community issues (Appendix C, Table 41).

The natural resources conservation attitudes and preferences for noneconomic personal gains are practically identical for both groups; the energy conservation behaviors also show only small differences.

SPP Scales: Active - Passive Technology Owners:

As discussed previously, passive technologies have characteristics more consistent with the Lovins' soft energy technology notion than do the active solar systems. Therefore a second hypothesis is

> H3: Passive solar energy technology owners have more soft path preferences than active solar energy technology owners.

To examine this hypothesis, the solar homeowners were divided into three types of solar technology owners: (1) owners of mixed active and passive systems (32%, n=1205), (2) active technology owners (60%, n=2278) and (3) passive system owners (9%, n=326).

To keep the influence of the type of technology as clear as possible, the weights used in computing the SPP scales were taken from principal components analysis of the separate groups rather than using the loadings developed for solar homeowners (Appendix C, Table 40). The results of the soft path preferences scale for active and passive solar technology owners are presented in Table 15 and Figure 6.

Table 15

Figure 6

Consistent with the hypothesis, passive solar technology owners have a higher degree of overall soft path preferences (10.682) than do the active solar technology owners (10.109). The difference in the mean scores of .573 is in fact smaller than that found between the solar and nonsolar homeowners.

Examining the separate dimensions of the scale more closely, there is a great difference (.762) in the active and passive preferences for local community self-reliance. The differences in preferences for energy self-reliance is smaller (.200) with the passive solar technology owners showing a slightly greater preference than the active technology owners.

The natural resources conservation attitudes and behaviors are similar except for energy conservation behaviors. The active solar technology owners have higher scores on general

Table 15

SPP SCALE COMPARISON: ACTIVE AND PASSIVE OWNERS

SPP Dimensions	Active Mean	Active s.d.	Passive Mean	Passive s.d.
	(n = 2278)		(n = 326)	
Self-reliance				
1. Energy	2.122	.702	2.399	.656
2. Local community	1.774	.357	1.012	.173
Natural resources conservation				
3. Attitudes	1.832	.451	1.616	.389
4. Behaviors	.922	.333	1.163	.394
5. Energy conservation	.467	.283	1.565	.512
Personal gain				
6. Nonecomic	.625	.314	.727	.257
7. Economic	2.367	.519	2.201	.494
Total SPP Score	10.109	1.748	10.682	1.649

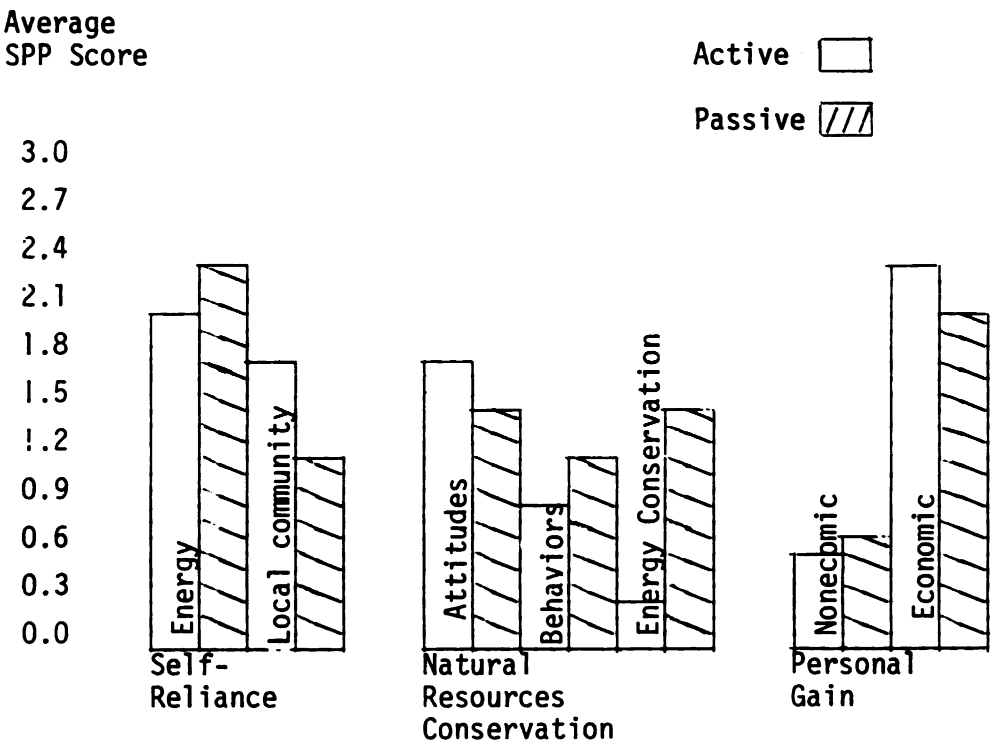


Figure 6: SPP SCALE COMPARISON: ACTIVE - PASSIVE

attitudes toward natural resources conservation, and fewer natural resources conservation behaviors. However, the passive solar technology owners report a greater number and variation in their energy conserving behaviors than do the active (difference = 1.098).

Both the passive and active technology owners are similar in their personal gains dimensions. The economic advantages aspects of solar energy technologies are important issues to both solar samples, but less important for either of these groups than for the nonsolar homeowners.

Solar Homeowners - Effects of Length of Ownership:

Only a very small percentage of the American population owned solar energy technologies in 1980. In Chapter IV, I proposed that with increased length of ownership, solar homeowners will develop a network supportive of soft path preferences through association with others who own the technologies. Thus the hypothesis:

> H4: Length of ownership of solar technologies is positively associated with degree of soft path preferences.

In order to examine this hypothesis, the solar homeowners were divided into four subgroups based on the number of years of technology ownership in 1980: (1) ten years or more (n=116); (2) 5-9.99 years (n=285), (3) 1-4.99 years (n=2728), and (4) less than one year (n=680).

Rogers (1983) claims that many new technologies fail within four years. It is clear that the majority of the solar homeowners (90%) were still very new adopters and hadn't passed this critical point. On the other hand, 116 claimed to have owned solar systems for a "long" time period - e.g. before the "energy crisis" became very salient. About 8% (n=285) could be considered "old timers", having acquired the systems during the early part of the "energy crisis" decade of 1970's. Table 16 and Figure 7 present the soft path preference scores of the major subgroups.

Table 16

Figure 7

The lowest soft path preferences score is 9.553 associated with those who have owned solar technologies for ten years or longer. The highest total score is associated with those who have owned the technologies for a year or less. There is more homogeneity in that subgroup while the subsample which has owned the technologies for the longest period has the greatest diversity of opinion as indicated by the standard deviations of 2.032 compared to 1.731. The relationship between SPP and ownership length is monotonic but in the <u>opposite</u> direction from the expectation of hypothesis four.

Although the greatest difference in the SPP scale scores exists between those who have the technologies for less than a year and those who have owned them for more than 10 years

Table 16

SPP SCALE COMPARISON: LENGTH OF OWNERSHIP

	10 + yrs.		5-9 yrs.		1-4 yrs.		Less than 1 yr.	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
	(n = 116)		(n = 285)		(n - 2728)		(n = 680)	
Self-reliance								
1. Energy	1.975	.736	2.214	.708	2.714	.883	2.257	.666
2. Local community	1.789	.319	1.411	.283	1.524	.304	1.865	.376
Natural resources conservation								
3. Attitudes	1.520	.457	1.624	.417	1.369	.337	2.010	.452
4. Behavior	1.378	.492	1.318	.488	1.161	.419	1.087	.405
5. Energy conserv.	.673	.451	.705	.359	.683	.379	.626	.342
Personal gain								
6. Noneconomic	.757	.337	.798	.334	.344	.163	.445	.214
7. Economic	1.461	.422	2.003	.476	2.928	.648	2.445	.496
Total SPP Score	9.553	2.032	10.075	1.786	10.723	1.927	10.746	1.731

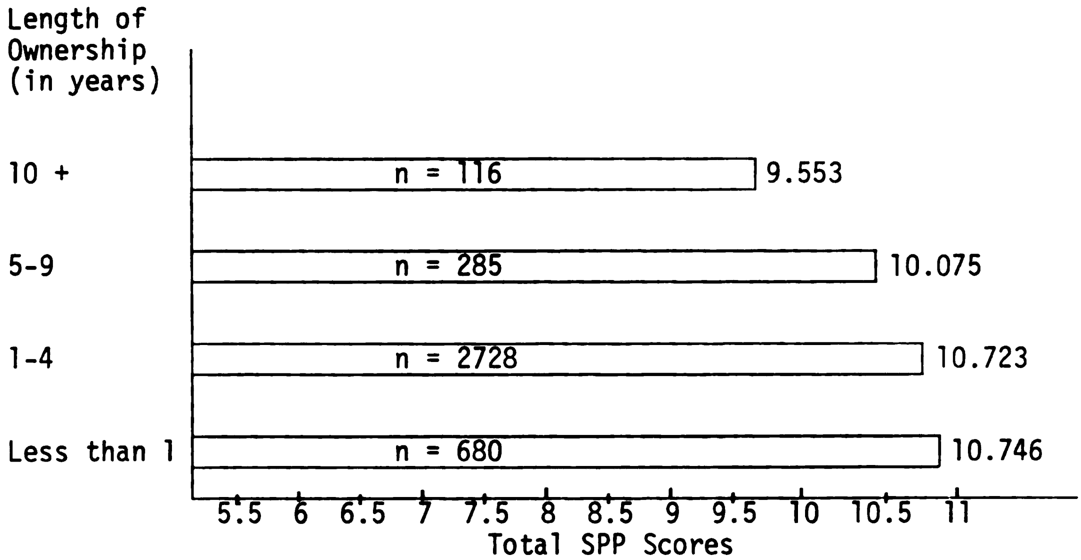


Figure 7: TOTAL SPP SCORES COMPARISON: LENGTH OF OWNERSHIP

(1.193), there are also differences among those who have owned them for a shorter time period. The threshold seems to be five years of ownership for there is little difference between the new owners and the 1-4 years owners (.023). The larger difference is between the 1-4 years and the 5-9 years owners (.648).

As seen in the previous comparisons, the greatest differences between the groups are in their preferences for energy self-reliance (.739) and for economic personal gain (1.467).

The dimensions of soft path preferences show some interesting patterns. Preference for energy self-reliance is greatest for the 1-4 years group while the concern for local community self-reliance is strongest among the "old-timers."

The natural resources conservation dimension shows less variation over time than was seen in the previous comparison. The energy conservation behaviors are similar for all groups and the natural resources conservation behaviors show a slow increase with those having owned the technologies for longer than five years performing more conservation behaviors. Interestingly, the lowest scores for natural resources conservation attitudes are held by those owning the technologies for 1-4 years. This is also the group which has the highest scores on preferences for economic personal gains.

The personal gains dimension suggests that economic personal gains are more important to those owning the technologies for less than five years while the noneconomic personal gains were much more important to those who have owned them for more than five years. This is consistent with the speculation that the economic payback of the solar energy technologies is a more salient issue to those who have "recently" (5 years or less) invested capital in acquiring the technologies.

Therefore, overall the hypothesis that length of ownership is positively associated with SPP is not supported. The results suggest that the "new owners" (five years or less) have gone from great enthusiasm for their acquisition to the more sobering reality of working with their solar energy technologies. This interpretation is supported by previous findings that often solar system owners report positive results from their systems even when the solar technology is not working very well (Eastman, 1982).

The salience of economic gains may be in conflict with the strong energy self reliance preferences expressed by the "new owners" during the threshold period. This conflict may be expressed in their lower attitudinal support for natural resources conservation. The "new owners" continue to strongly prefer energy self-reliance, but this may be contrary to their strong preference for economic personal gains. Theirs is the lowest of the four groups. Further research is necessary to examine this possible conflict more closely.

Once having passed the five year watershed, the noneconomic personal gains become more important as well as the natural resources conservation behaviors. These are the households which may provide the stronger support for the development of the soft energy path social changes for their behaviors are the most consistent with soft energy path transformation using Lovins' behavioral criteria.

SOFT PATH PREFERENCES DEVELOPMENT MODEL

The soft preferences development model allows an examination of the influences of the latent variables on the development of SPP. With the PLS program, the manifest and latent variables can be reordered, dropped, constrained, etc. as appropriate to theoretically refine the original model.

I will first examine the theoretical model for the solar and nonsolar samples. The model will then be trimmed, guided by the sizes of the beta values between the latent variables. This procedure will also be followed to compare the passive and active solar system owners.

The solar samples will then be examined more closely. The theoretical model will be respecified in response to the values obtained for the manifest and latent variables. The new models will then be trimmed to explore a more parsimonious model. This process will be followed for the total solar sample as well as the passive and active solar subsamples.

The modeling is conducted to empirically examine the hypothesis

> H2:The solar technologies are more strongly associated with soft path preferences than the perception of energy vulnerability and the availability of contextual resources.

If this hypothesis is supported, then there is some indication that the experience with changing the energy base of the household has a greater effect on the development of the soft path restructuring of society than do perceptions of resource vulnerability and the availability of resources to support solar energy technologies use.

Theoretical Model - Manifest Variable Relationships:

In order to make the solar and nonsolar models as comparable as possible, they were first compared without allowing for the influence of the technologies in the solar sample. Then the full theoretical model of the solar sample was developed and compared with the nonsolar sample. The manifest variables and their values are presented in Table 17 and Table 18.

Table 17

Table 18

As seen in the baseline and theoretical models, the primary influences on the perceptions of energy vulnerability needs for both the solar and the nonsolar samples, are the age of the respondent and the type of household. Contrary to expectations, the number of children in the household does not contribute to perceptions of energy vulnerability needs. Average cost of heating water and of heating and cooling the home, does have a moderate (.457, .400) influence <u>on the solar</u> in both the baseline and theoretical models. It has a low (.135) influence on <u>nonsolar</u> homeowners' perceptions of energy vulnerability needs.

The perceived impacts of the "energy crisis" is negligible for both samples. The perceptions about the future energy vulnerability of the country have a weak effect on the perceptions of energy vulnerabilities in the theoretical models.

Income is the dominant resource of both the solar and nonsolar homeowners. A very surprising finding is that education has a weak but negative influence on the contextual resources variable for the solar (baseline =

Table 17

BASELINE AND THEORETICAL MODELS' MANIFEST VARIABLES: SOLAR AND NONSOLAR HOMEOWNERS

Variables	Theoretical Nonsolar (Weights)	Baseline Solar (Weights)
NEEDS		
Household Type	.625	.491
No. Children	.019	-.048
Respondent's Age	.514	.524
House	.069	.181
Energy Cost	.135	.457
Impact of Crisis	.093	-.147
Energy Crisis	-.179	.053
RESOURCES		
Income	.807	.937
Education	-.028	-.158
Federal Support	.192	.270
State Support	.037	.030
Personal Support	.386	-.102
EVALUATION		
General	.828	.705
Technical	.364	.056
Expected Energy Savings	.539	-.379
Cost Energy System	.641	-.075
Adding Technologies	.648	.759
Recommend Solar	.572	.703
SPP		
Energy Self Reliance	.788	.832
Local Self Reliance	.642	.674
Conservation Attitudes	.738	.583
Resource Behavior	.379	.456
Energy Conservation	.490	-.256
Economic Gains	.652	.457
Noneconomic Gains	.433	.626

*The values for the reduced models are in Appendix C, Table 43.

Table 18

THEORETICAL MODELS' MANIFEST VARIABLES: SOLAR

Variables	(Weights)
NEEDS	
Household Type	.520
No. Children	.016
Respondent's Age	.492
House	.214
Energy Cost	.400
Impact of Energy Crisis	.066
Energy Crisis	-.105
RESOURCES	
Income	.671
Education	-.145
Federal Support	.575
State Support	.096
Personal Support	-.060
Group Member	-.156
Local Support	-.029
Problems Cost Up	.038
Problems with Local Policies	.028
Problems with People	.115
Problems Building Technologies	.091
EVALUATION	
General	.691
Technical	.059
Expected Energy Savings	.377
Cost Energy Savings	----
Adding Technologies	.626
Recommend Solar	.654
Condition of Active Systems	.383
Condition of Passive Systems	.634
Technical Support	.219
TECHNOLOGY TYPE	
Ownership Length	.685
Year Passive Installed	.209
Year Active Installed	.677
Cost of Technology	.086
Operating Costs	-.432
SPP	
Energy Self Reliance	.826
Local Self Reliance	.699
Conservation Attitudes	.568
Resource Behavior	.454
Energy Behavior	-.226
Economic Gains	.441
Noneconomic Gains	.630

*The values for the reduced models are in Appendix C, Table 40.

-.158, theoretical = -.145) and nonsolar (-.028) homeowners. Another surprise was that the personal network was moderately important (.386) to the nonsolar homeowners while having negligible effect (-.060) on solar owners' resources.

As expected, federal support for the solar system has a stronger influence on the resources of the solar (baseline = .270, theoretical = .575) than the nonsolar (.192) homeowners. The state resources are negligible for both samples. Perhaps this is true because few states provided resources for solar systems in 1980 (Farhar-Pilgrim and Unseld, 1982).

There were several suprises in the solar theoretical model relationships. There is a small but negative (-.156) effect on perceptions of available resources of having memberships in groups associated with solar energy interests, perhaps due to their higher expectations of support. Also, local support for solar systems had no influence on the contextual resources. The various problems associated with acquiring the solar systems had very little influence on the perceived contextual resources available to the solar homeowners except for a small influence (.115) associated with people's opposition (e.g. vandalism, neighbors' opposition, obstruction to the solar system).

The latent variable, evaluation of the solar systems, also has some interesting manifest variable relationships. The general evaluation of the systems has a very strong influence for both solar (baseline = .705, theoretical = .691) and nonsolar (.828) homeowners. The evaluation of the specific characteristics of the technology is more significant for the nonsolar (.364) homeowners than for the solar (baseline = .056, theoretical = .059) homeowners.

The influence of the cost of the technology (.641) and the amount expected to be saved (.539) is quite strong for the nonsolar homeowners in the expected direction. The surprise for the solar homeowners, is that although the cost of the technology has a negligible influence on evaluation (-.075) or on technology type (.086) in the theoretical model, the difference between expected and actual savings has a negative moderate (baseline = -.379, theoretical = -.377) influence on the evaluation of the systems suggesting that the solar technologies owners saved less money than they expected to. This provides a negative effect on the evaluation of the technologies.

For both the solar and nonsolar homeowners, their willingness to acquire solar systems (baseline = .759; theoretical = .626) or to recommend them to others (baseline = .703; theoretical = .654) strongly reflects their evaluation of the systems. The strength of the influence is somewhat stronger for the solar than for the nonsolar (acquisition = .648; recommendation =.572) homeowners.

Other manifest variables available to the solar homeowners include an assessment of the condition of their personal solar systems and an assessment of the technical support which they received for their renewable technologies. The condition of the passive technologies contributes strongly (.634) to the evaluation of the technology, while only moderately (.383) to the active solar systems. This relationship reflects the fact that active solar technologies owners report having more problems with their systems than the passive technologies owners (Appendix C, Table 42). The assessment of experiences with technical support contributes a low (.219) influence on the evaluation of the systems.

For the solar system owners, the technology type latent variable has interesting relationships with its manifest variables. The years of ownership (.685) has the greatest influence on defining the technology type. This influence is dominated by the active system owners (.677). Length of ownership is similar for active and passive solar technology owners (Table 29). However, 90% of the solar homeowners are active or mixed solar technology owners. As expected the cost of the technology (.086) has a negligible influence. The problems which the solar homeowners experienced in operating the systems have a moderate and negative (-.432) relation to the technology type.

Finally, both the solar (baseline = .832, theoretical = .826) and nonsolar (.788) homeowner's soft path preferences are dominated by the influence of the preference for energy self reliance. The contribution of local self reliance preferences is very similar for both the solar and nonsolar homeowners. As also indicated previously, the natural resources conservation attitudes are stronger among the nonsolar (.738 vs. baseline = .583, theoritical = .571), but the actual behavior is more prevalent among solar homeowners (.379: baseline = .456, theoretical = .453). On the other hand, although energy conservation practices are moderately influential (.490) with the nonsolar homeowners, their influence is weaker and negative (baseline = -.256, theoretical = -.226) among the solar homeowners. This suggests that possibly the solar homeowners are no longer performing as many energy conservation practices because acquisition of the solar systems may be perceived as sufficient.

Finally, economic personal gains were more influential (.652) for nonsolar homeowners' SPP, though only moderately strong (baseline = .457, theoretical = .441) for the solar homeowners. Comfort and prestige are more important personal gains for the solar homeowners (baseline = .626, theoretical

= .629) while being only a moderately important (.433) reflection of the nonsolar homeowners' SPP.

The contributions of the manifest variables to the latent variables remain fairly stable as the models are trimmed for further fit (Appendix C, Table 43). The design of the solar and nonsolar theoretical models with the PLS specifications have been presented in Figures 8 and 9.

Figure 8

Figure 9

<u>Theoretical Model: Solar and Nonsolar Homeowners</u>:
The next important questions are: (1) how do the latent variables influence each other? and (2) how well does the theoretical model describe the nonsolar and solar homeowners' data? The data for these are presented in Table 19.

Table 19

The strongest relationship in the model is between needs and resources showing a moderately strong relationship (nonsolar= .461, solar=.415) in the baseline models, and a slightly less strong one in the solar theoretical model (.386).

The relationship between needs and evaluation is negligible in all of the models as is the relationship between needs and soft path preferences for the solar models. Needs is

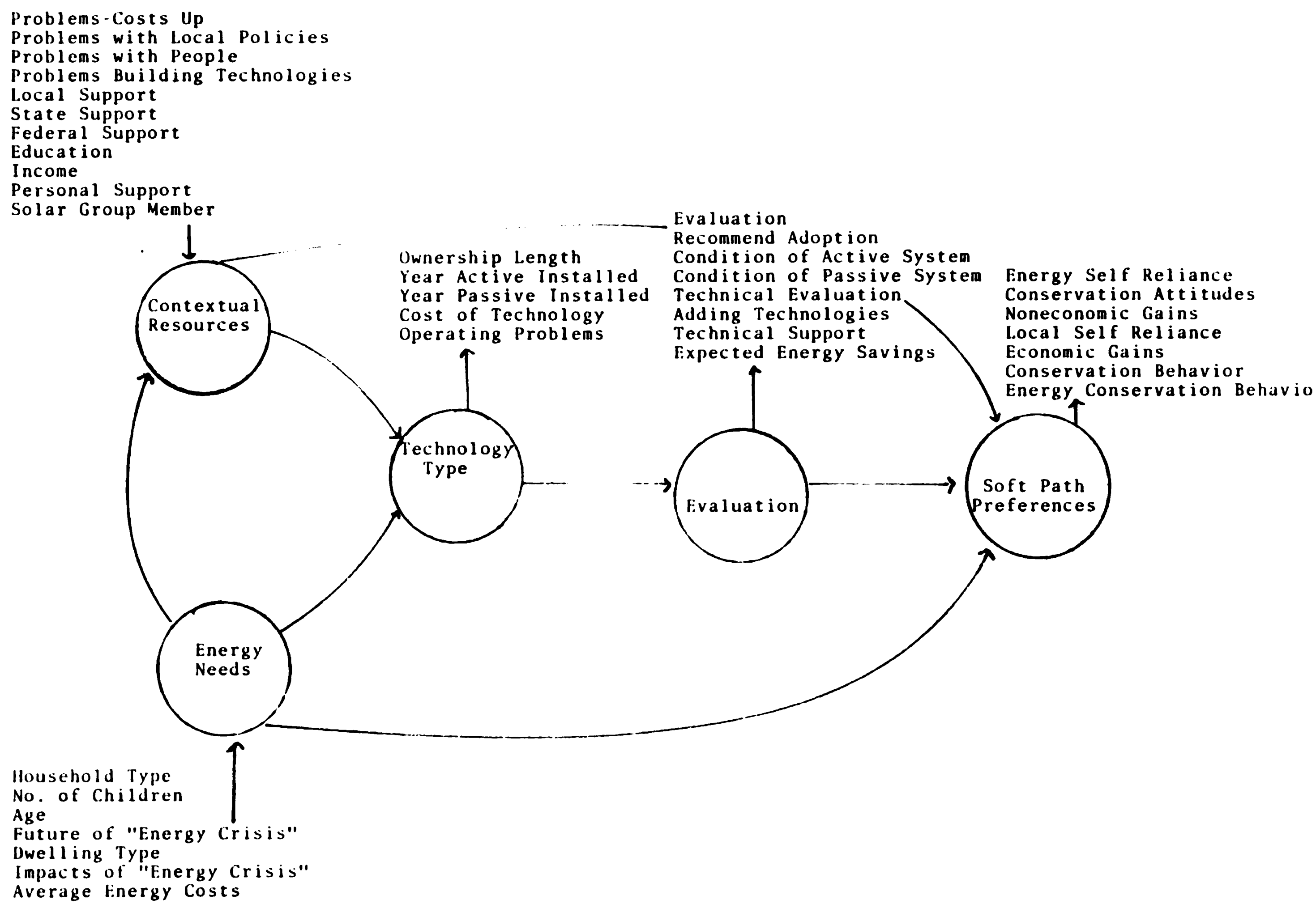


Figure 8: SOLAR THEORETICAL MODEL WITH PLS SPECIFICATIONS

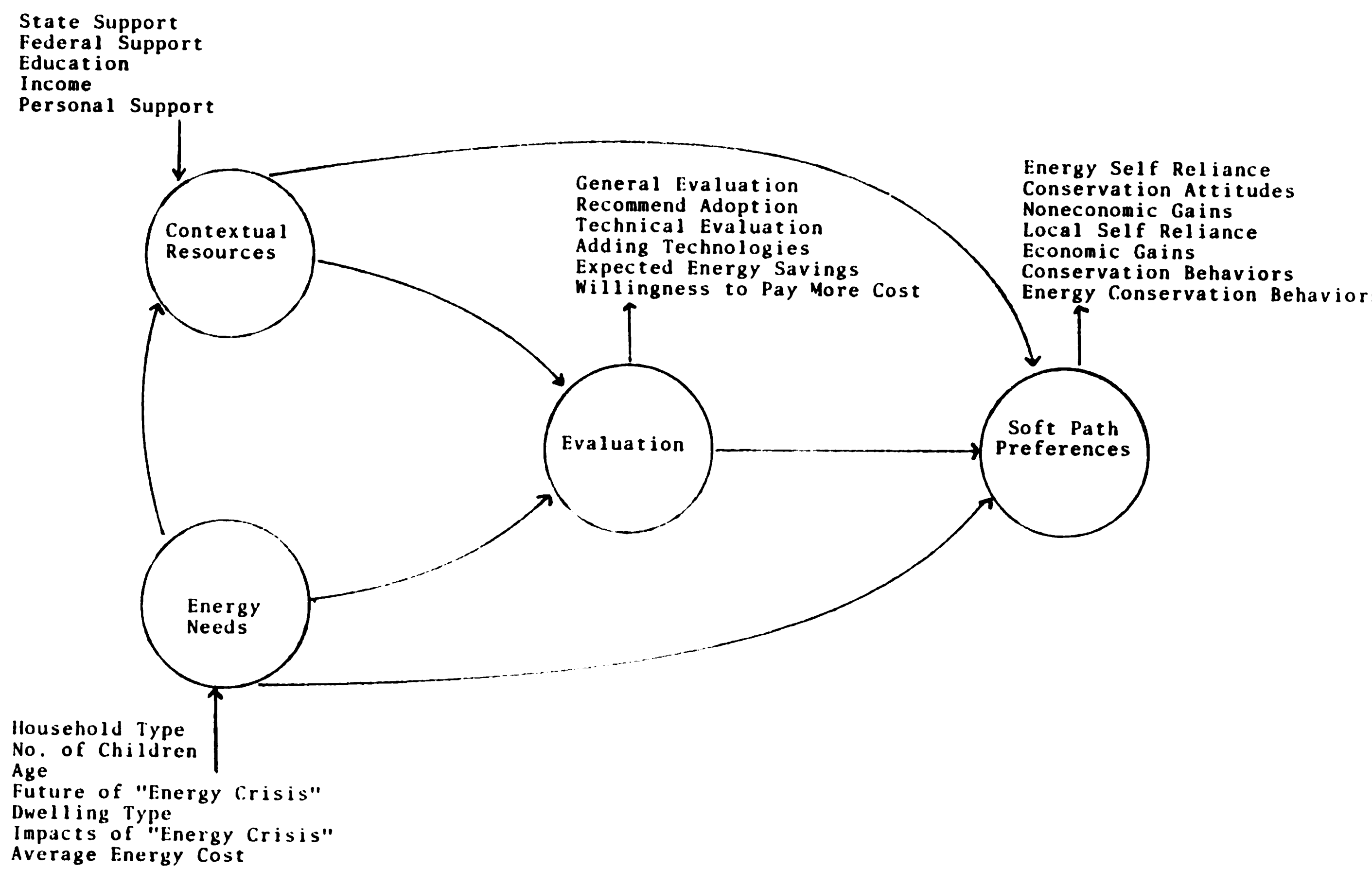


Figure 9: NONSOLAR THEORETICAL MODEL WITH PLS SPECIFICATIONS

Table 19

THEORETICAL MODEL'S RELATIONSHIPS and GOODNESS OF FIT: SOLAR AND NONSOLAR HOMEOWNERS

Latent Variables:	Baseline Nonsolar	Model Solar	Theoretical Model Solar	
		BETAS		
Needs - Resources	.461	.415	Needs - Resources	.386
Needs - Evaluation	.010	.073	Needs - Tech Type	-.067
Needs - Spp	.160	.029	Needs - Spp	.019
Resources - Eval	.450	-.081	Resources - Tech	-.391
Resources - Spp	.065	-.153	Resources - Spp	-.157
			Tech - Evaluation	-.122
Evaluation - Spp	.335	.349	Evaluation - Spp	.368
		R-SQUARE		
Resources	.213	.172	.149	
Evaluation	.207	.007	.015	
Tech Type	----	----	.177	
Spp	.195	.149	.161	
No. parameters	31	31	45	
No. iterations	9	18	86	
Chi-square (no model)	5.141	3.628	6.725	
(d.f)	300	300	703	
Chi-square (with model)	2.309	2.013	4.909	
(d.f.)	269	269	655	
Bentler-Bonnett	.551	.445	.265	

also not related to the type of solar system (-.067) in the theoretical solar model. The nonsolar model indicates a small relationship between needs and SPP (.160).

The contextual resources latent variable has a moderate (.450) relationship to the evaluation of the solar systems for the nonsolar sample, indicating that those with more resources tend to have a more positive assessment of solar systems. This relationship does not hold for the solar baseline model (-.081). The solar theoretical model shows a moderate negative relationship between resources and technology type (-.391) suggesting that those who have more resources tend to have solar systems which have been more recently acquired, cost more, and have fewer operating problems.

Both solar models indicate a weak but negative relationship between resources and soft path preferences suggesting that those with fewer contextual resources will have preferences more consistent with soft path changes. This finding is consistent with Lovins' interest in having the general populace rather than the elites change the energy base of society. The nonsolar homeowners' model shows no relationship (.065) between resources and soft path preferences. The evaluation of solar systems is moderate in its association with the development of soft path preferences in all of the models.

The model is not very good at capturing the R-square values for any of the variables. The variances of resources (.213; baseline = .172, theoretical = .142) and soft path preferences (.195; baseline = .149, theoretical = .161) are influenced to a low degree by the model. The evaluation latent variable is better explained for the nonsolar (.207) than the solar sample (baseline = .007, theoretical = .015).

The R-square is highest for the technology type latent variable (.177) in the solar theoretical model. This and the negative and low (-.122) beta value between technology type and evaluation suggest that the use of solar energy technologies has a negative influence on the development of SPP. However, the evaluation latent variable is sufficiently strong to translate this negative input into a positive influence on SPP development. Therefore, SPP receives a stronger negative direct influence (-.157) from contextual resources than from technology type, contrary to expectations. But the technology influence is stronger than the negligible (.019) energy vulnerability needs influence as expected.

Evaluation of the solar technologies, however, does have a moderate (.335; baseline = .349, theoretical = .368) influence on the development of the soft path preferences. This is further explored through trimming the original theoretical models.

The models were trimmed by dropping one of the latent variable relationships at a time based on the theoretical model's beta values until a linear relationship was portrayed. First the relationship between needs --> evaluation or needs --> technology type was dropped for all three models; then the relationship between needs and soft path preferences was constrained to 0; finally, the relationship between resources and SPP was constrained leaving a straight linear relationship from needs --> resources --> technology type or evaluation (with technology type --> evaluation included only in the solar theoretical model) --> SPP.

With each additional constrained latent variable relationship, there was a slight improvement in the fit of the models until the best fit was shown with the linear form of all models (Appendix C, Table 45). The strongest fit appeared with the nonsolar model going from BB=.570 (dropping needs --> evaluation) to BB=.582 (straight linear model). The solar theoretical model goes from BB=.258 (dropping needs --> tech type) to BB = .270. Both show only the most trivial minimal improvements in BB score of .018 (solar) and .012 (nonsolar). The nonsolar model extracted its values in only 8 or 9 iterations, while the solar theoretical model required 64 to 93 iterations. The other criteria for indicating better fit of the model with the data did not improve to any important degree.

Theoretical Model: Active and Passive Technology Owners: Given the better fit which is shown by the nonsolar than the solar model, the next attempt was to model the relationships among the passive and active solar technology owners in order to see if the relationships among the latent variables were different for those subgroups.

The manifest variables relationships to the latent variables are indicated in Table 20.

Table 20

Although the relationships between the manifest and latent variables for the passive and active technology owners were very similar to those of the solar sample, there are some differences.

Age continues to have a moderate influence on perceptions of energy vulnerability and needs for both the passive (.426) and active (.575) solar system owners. Number of children has a low negative influence on the passive owners (-.203) and no influence on the pure active owners. On the other hand, the type of household has a moderate influence (.506) on the active solar system owners' perceptions of energy vulnerability needs while it has no (.060) influence on the passive homeowners.

The physical characteristics of the house (.267 vs. .097) and

Table 20

THEORETICAL MODELS' MANIFEST VARIABLES:
ACTIVE AND PASSIVE TECHNOLOGY OWNERS

Variables:	Active (Weights)	Passive
ENERGY VULNERABILITY NEEDS		
Household Type	.506	.060
Number of Children	-.024	-.203
Age	.575	.426
Dwelling Type	.097	.267
Energy Costs	.312	.784
Impacts of "Energy Crisis"	.035	-.217
Future of "Energy Crisis"	.088	.066
CONTEXTUAL RESOURCES		
Income	.638	.932
Education	.005	-.073
Federal Support	.569	-.052
State Support	.146	-.035
Local Support	-.037	-.101
Solar Group Member	-.027	-.310
Problems - Costs Up	-.026	.112
Problems With Local Policies	-.018	.106
Problems With People	.109	-.087
Problems Building Technologies	-.178	-.026
TECHNOLOGY TYPE		
Ownership Length	.874	.307
Year Active Installed	.767	----
Year Passive Installed	----	.119
Cost of Technologies	.388	.680
Active Building Method	.418	----
Passive Building Method	----	.848
EVALUATION		
General Evaluation	.742	.726
Technical Evaluation	-.041	.124
Expected Energy Savings	-.451	-.070
Adding Technologies	.685	.598
Recommend Adoption	.723	.752
Condition of Active System	.404	----
Condition of Passive System	----	.320
Technical Support	.357	.180
SOFT PATH PREFERENCES		
Energy Self Reliance	.856	.829
Local Self Reliance	.614	.648
Conservation Attitudes	.636	.576
Conservation Behavior	.338	.455
Energy Conservation Behaviors	-.195	-.325
Economic Gains	.586	.561
Noneconomic Gains	.576	.506

the cost of energy seem to be stronger influences on passive technology owners' perceptions of energy vulnerability needs. The average cost of heating the water and heating and cooling the home has about twice as strong an influence on the passive owners' needs perceptions (.784) as compared to the active owners (.312).

The future of the energy situation in the nation has no impact on either type of system owner, while the perception of impacts on household's life style is negatively related to the passive owners' needs perception (-.217).

As before, income is the manifest variable which dominates (active = .638, passive = .932) the resources latent variable. Again, education (active = .005, passive = -.073) does not influence the perception of contextual resources. Another variable which is a moderately strong (.569) resource for active solar homeowners is federal subsidies. State support also provides some resources to the active solar homeowners (.146). Local support was noninfluential (-.037) with active owners and had a small negative influence (-.101) on the passive homeowners' resources.

The second largest influence on the passive homeowners' contextual resources is participation in groups which support solar energy, although the influence is negative and moderate (-.310).

The various problems in acquiring solar systems play a negligible influence on the perception of contextual resources. Problems experienced with people's reactions to the technologies and with acquiring the solar systems were stronger influences on the active latent variable while cost factors and problems with local building codes and access rights were greater issues for passive solar owners.

The length of ownership is more influential on defining technology type for the active system owners than for the passive system owners. Both manifest variables which measure this have very strong loadings on the technology type latent variable (.876, .767). On the other hand, the cost of the technology (.680) and the method used to build it (.848) were stronger influences on the technology type of the passive owners.

As seen previously, the general evaluation variable (active = .742, passive = .726), the plan to add solar systems (active = .685, passive = .598) and the recommendation to others for adoption (active = .723, passive = .752) have the strongest influences on the evaluation latent variable. The evaluation of the specific technical capabilities of the solar systems has practically no influence on the active solar homeowners, while it does have a small (.124) effect on the passive solar systems' evaluation.

There is a great difference in the influence of the expectations of savings on the solar active and passive system owners. These expectations have no influence on the passive solar technology owners' evaluation while they have a moderately strong (-.451) negative influence on the active technology owners. Perhaps the passive owners did not have expectations for great savings, or they were more accurate in their estimation of what they would save than the active solar homeowners.

The technology support structures are more influential on the active system owners (.357) than the passive (.180). The assessment of the condition of their technologies has approximately the same effect on the evaluation latent variable for both active (.404) and passive (.320) system owners.

Finally, the subsamples' soft path preferences are very similar to each other and to the overall solar sample. Again, the diversity which does occur is in relation to the attitudes and behaviors about natural resources conservation. The active solar homeowners record a stronger influence of natural resources conservation attitudes (active = .636, passive = .576) while the passive solar system owners show greater general conservation behavior (active = .455, passive = .338). The number of energy conserving behaviors which they report has a low moderate negative (-.325) influence on the soft path preferences of passive solar system owners and it has a small, but still negative (-.195) influence on the soft path preferences of the active solar system owners. This is consistent with the solar sample.

The relationships among the latent variables of the model are also important to examine for both the active and the passive solar homeowners.

Table 21

In this model, as in the solar model, the highest beta weights are between needs and resources (passive = .430, active = .435). The relationship between evaluation and soft path preferences is similar, moderately strong. The other sizeable relationship between the latent variables is between resources and technology type showing a moderate negative relationship (active=-.366, passive=-.432) as was found in the total solar sample.

The other relationships are negligible for the active system owners. However the passive owners' model has a positive and small relationship between technology type and evaluation (.214), and between energy needs and technology type (.139)

The models' R-squares indicate that the model influences the

Table 21

THEORETICAL MODELS' RELATIONSHIPS AND GOODNESS OF FIT: ACTIVE AND PASSIVE TECHNOLOGY OWNERS

Latent Variables:	Active	Passive
	BETAS	
Needs - Resources	.435	.430
Needs - Tech Type	-.088	.139
Needs - Spp	.066	-.129
Resources - Tech	-.366	-.432
Resources - Spp	-.056	-.155
Tech - Evaluation	.040	.214
Evaluation - Spp	.319	.330
	R-SQUARE	
Resources	.189	.185
Tech Type	.170	.154
Evaluation	.002	.042
Spp	.107	.195
No. parameters	42	42
No. iterations	12	13
Chi-square (no model)	6.142	7.198
(d.f.)	595	595
Chi-square (with model)	3.525	6.057
(d.f.)	550	550
Benter-Bonnett	.426	.159

greatest percentage of the variance of the soft path preferences for the passive system owners (.195) while it captures less of the actives' SPP (.107). The strongest latent variables are resources (passive=.185, active=.189) and technology type (passive = .154:active = .170). The models capture very little of the variance of evaluation for either the passive (.046) or the active (.002) system owners.

Comparing all three models - solar, active and passive system owners - evaluation is the latent variable least affected by the model. The passive solar technology owners experiences with their technologies positively affect (.214) their evaluation of the solar technologies. The technologies also show a postive relationship with the development (.330) of their soft path preferences. This is not true for the active solar energy technology owners. Therefore hypothesis two, that technology will have a greater effect on the development of soft path preferences than contextual resources and energy vulnerability needs is supported for the passive solar technology owners but not for the active owners.

The theoretical models were further trimmed to see if a better fit could be obtained between the models and the data. In order to do this, the relationship between needs --> technology type was constrained to zero. Next, resources --> SPP was dropped, then needs --> SPP was constrained making the models completely linear (Appendix C, Table 45).

The linear relationship provided the best improvement in goodness of fit for the passive model (BB=.162 to BB=.171) while the active model remained very similar (BB=.422 to BB=.423) with the non-trimmed model capturing slightly more of the active (.426) data patterns. The number of iterations were very similar for both models. Trimming strengthened all the latent variable relationships' in the passive model, while the active model remained basically the same (Appendix C, Table 46).

Modified Model:

Since the technology problems variables contributed so little to the contextual resources latent variable I decided to create a latent variable composed only of five technology problems. I then placed it between technology type and evaluation in the model therefore modifying the original theoretical relationships. This is shown in Figure 10.

Figure 10

As indicated in Table 22, the modified SPP development models are composed of 33 manifest variables for the solar sample and for the passive subsample; the active subsample

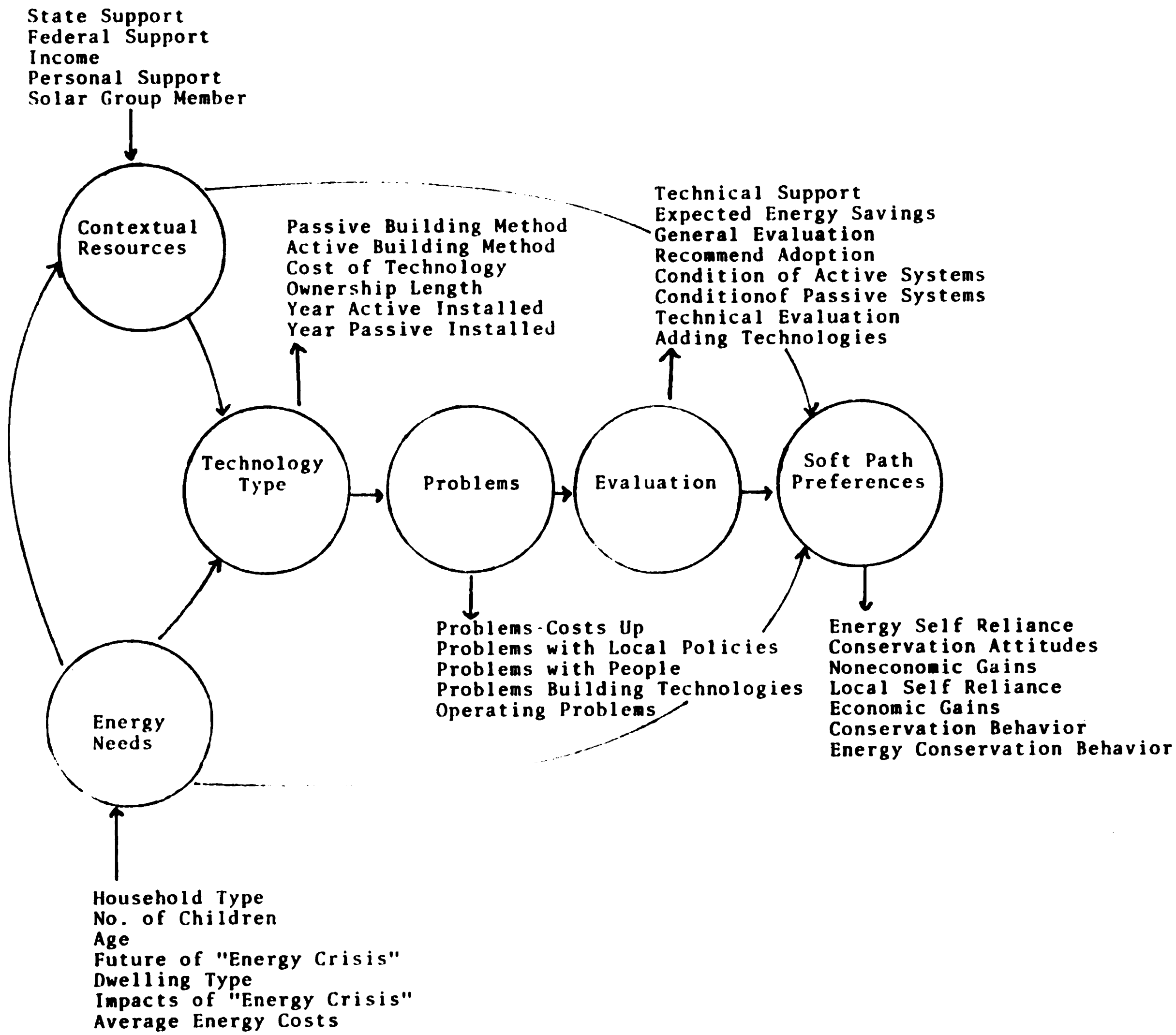


Figure 10: MODIFIED MODEL WITH PLS SPECIFICATIONS

uses 30 manifest variables in its modified model. The six latent variables follow the same modes as specified previously in Table 13.

Table 22

The manifest variables which were omitted from the complete solar sample and the active samples due to their having low values were: number of children, future of the "energy crisis", impacts of the "energy crisis", local support, personal support, solar group member, and education. The passive sample model ommitted the following: household type, local support, state support, and education.

As seen previously, the active technology owners and solar samples are very similar. The values of the manifest variables are also similar to those of the theoretical models. The primary difference is in the problems latent variable. Its manifest variables have a positive and much stronger relationship with the latent variable indicating that they are better represented as a separate variable.

The influence which the manifest variables have on the problems latent variable is similar for all three samples. The strongest influence is created by the problems which the solar system owner has in operating the solar system (solar=.920, active=.915, and passive=.513). The second major effect is created by problems encountered while trying

Table 22

MODIFIED MODELS' MANIFEST VARIABLES:
SOLAR, ACTIVE AND PASSIVE HOMEOWNERS

Variables:	Solar	Active (weights)	Passive
ENERGY VULNERABILITY NEEDS			
Household Type	.508	.494	----
No. of Children	----	----	-.143
Age	.513	.595	.469
Dwelling Type	.190	.102	.285
Energy Costs	.399	.312	.761
Impacts of "Energy Crisis"	----	----	-.198
Future "Energy Crisis"	----	----	.109
CONTEXTUAL RESOURCES			
Income	.706	.666	.903
Education	----	----	----
Federal Support	.543	.578	.018
State Support	.093	.138	----
Local Support	----	----	----
Solar Group Member	----	----	-.313
TECHNOLOGY TYPE			
Ownership Length	.698	.881	.220
Year Active Installed	.661	.776	----
Year Passive Installed	.267	----	.083
Cost of Technologies	.308	.380	.478
Active Building Method	.449	.397	----
Passive Building Method	-.114	----	.701
PROBLEMS			
Problems - Costs Up	.332	.385	-.075
Problems With Local Policies	.259	.334	.133
Problems With People	.332	.387	.285
Problems Building Technologies	.685	.632	.498
Operating Problems	.920	.915	.513
EVALUATION			
General Evaluation	.832	.834	.430
Recommend Adoption	.758	.766	.382
Condition of Active System	.620	.714	----
Condition of Passive System	.337	----	.321
Technical Evaluation	.268	.232	.089
Adding Technologies	.355	.286	.185
Technical Support	.378	.382	.162
Expected Energy Savings	-.507	-.554	-.131
SOFT PATH PREFERENCES			
Energy Self Reliance	.850	.860	.358
Conservation Attitudes	.582	.590	.154
Noneconomic Gains	.596	.524	.244
Local Self Reliance	.679	.599	.335
Economic Gains	.536	.712	.251
Conservation Behavior	.382	.179	.218
Energy Conservation Behavior	-.231	-.142	-.104

to build the system (solar=.685, active=.632, passive=.498). The other problems have a low moderate influence on the solar and active owners. Problems with increased costs have no influence on the passive owners' latent variable (-.075), problems with local codes and solar access were also a minimal issue (.133) for the passive solar owners.

The six latent variables model shows an improvement in fit for the subsamples but not for the solar sample as seen in Table 23.

Table 23

The full solar sample goes from BB=.215 with the full modified model, to .214 with the linear trimmed six latent variable model (Appendix C, Tables 47 and 48). This is a worse fit than the BB=.270 of the theoretical model for the solar sample. The active solar technology owners, however, show an improvement in fit with BB=.469 with the full modified model to .480 with the linear trimmed one. This is better than the .426 value of the full theoretical model.

Again the passive owners' subsample shows a different pattern than the active and solar samples. Its best fit is with the linear modified model showing BB=.293 compared to .240 with the full modified model. This shows a much better fit than the BB=.159 of the full theoretical model.

Table 23

MODIFIED MODELS' RELATIONSHIPS AND GOODNESS OF FIT:
SOLAR, ACTIVE AND PASSIVE HOMEOWNERS

Variables:	Solar	Active	Passive
		BETA's	
Needs - Resources	.434	.427	.434
Needs - Tech Type	-.178	-.102	.117
Needs - Spp	-.099	.117	-.099
Resources - Tech	-.472	-.347	-.474
Resources - Spp	-.196	-.079	-.190
Tech Type - Problems	.002	.043	-.002
Problems - Evaluation	.259	.373	.259
Evaluation - Spp	.203	.187	.206
		R-SQUARE	
Resources	.188	.182	.188
Tech Type	.182	.161	.183
Problems	.000	.002	.000
Evaluation	.067	.139	.067
Spp	.129	.045	.126
No. parameters	45	38	41
No. iterations	15	11	16
Chi-square			
(no model)	7.737	5.096	6.494
(d.f)	666	435	528
Chi-square			
(with model)	6.078	2.705	4.937
(d.f.)	614	390	480
Bentler-Bonnett	.215	.469	.240

In every sample, the R-square is nonexistent for the problems and very low for evaluation, while the best values for the latent variable soft path preferences is with the passive solar system owners modified model. This reflects the fact that few of the solar technology owners had problems with their technologies (see Table 42).

The beta values have a familiar pattern. The strongest relationship continues to be between the needs and resources latent variables. The relationship between resources and technology type are also moderate for every sample (solars= .472, active=-.347) and for the passive owners, -.474.

The relationship between technology type and problems are non-existent, yet the relationship between problems experienced and evaluation of the solar system is similarly low for all the samples, the solar and passive samples = .259 and active samples = .373.

While the relationships between evaluation and soft path preferences is low for the active solar (.187), it is again more similar for the solar sample (.203) and for the passive owners (.206).

Even with a better fit between the model and the data for the modified model, the patterns of relationships continue to be stable. The latent indicator of contextual resources has a weak relationship to the development of soft path preferences for the passive sample and has no effect for the active sample. Energy vulnerability needs also does not have much of an effect at this historical period. Evaluation of the technology has a moderate influence on SPP development for all three samples although the type of technology has a low influence on evaluation.

CHAPTER IX

DISCUSSION AND CONCLUSIONS

Since 1980 when the data were gathered for this project, there have been many changes in the national policy support for the development of renewable energy technologies. Concerns about economic development and growth have become more salient and concerns with energy scarcity have receded.

Although the public does not now have the high awareness of energy resources as was present in 1980, there are other aspects of the environment which continue to capture concern about natural resources and their developments (Morrison, 1986). There are also those who warn that natural resources scarcity is still a relevant issue.

Therefore lessons which we can learn from the "energy crisis" are still relevant to policymakers, planners, and activists of the future. Are there indications that there has been a change in lifestyle preferences which are more compatible with a renewable resources energy base?

Many researchers have suggested that there has been a qualitative change in the core values of the American society during the 1970's (Mitchell, 1984; Yankelovich and Lefkowitz, 1980; Buss and Craik, 1983; Milbrath, 1984).

Are the worldviews (Buss and Craik, 1983) supportive of soft path structural changes associated with changes to a renewable energy base for society? More specifically, is the use of solar energy technologies associated with soft path preferences? Is the general population of society supporting this change, or is such a change dependent on political and economic elites?

For theorists interested in understanding the interaction of energy, technology and society, these questions are also important. Although Amory Lovins is primarily an energy activist, his thinking has provided one of the clearer, though very limited, recent theories of social change created through the societal energy base. This has been the foundation for my exploration of the interaction of solar energy technologies with soft path compatible attitudes and behaviors of the American population in 1980.

THEORETICAL IMPLICATIONS

Theoretical Implications of the SPP Scale:

Lovins has suggested that currently the societal values in the United States and other European countries are supportive of the development of the soft energy path. He suggests that the population is interested in: (1) self-reliance, to gain independence from energy utility companies and from other forms of centralized energy control in order to take control over the energy aspects of their lives.

(2) energy conservation, so that there will be more available energy resources for future generations and for other nations; (3) personal gains of more community cohesion, self-esteem (e.g. lack of alienation), and satisfaction with life. He suggests that these preferences can be accomplished through maximizing economic and noneconomic benefits for individuals and communitites.

As households, individuals and communities accomplish these goals, they will be restructuring society into a more benign system with a more resilient, less catastrophic, and equitable form. Because he is concerned that this be accomplished through a changed energy base, his primary focus has been on encouraging people who use traditional energy forms to switch to renewable energies and to conserve energy resources.

Although Lovins is clear that he expects the values which are supportive of the soft energy path to already be in place, he is not clear about what the specific impacts of the implementation of those values through renewable energy technologies and conservation will be, except through a restructured social system. He has argued that the criteria used in choosing an energy technology should be its end use. Therefore he suggests that it is appropriate to use "soft" as well as "hard" energy technologies during the transition period before the social system is restructured to be more compatible with the "soft" energy technologies.

I have suggested that the development of the soft energy path social changes will not occurr simply through the use of renewable energy technologies and energy conservation. These must reinforce and be guided by values, attitudes and behaviors which are compatible with a "soft" restructuring of society. Otherwise there will be a continuation of the current hard energy path with those in control using the surplus natural resources created through conservation and a change in energy base for their own purposes (e.g. centralized political control and economic production). Therefore, I have proposed that the change in energy base must be associated with compatible attitudes and behaviors.

The Lovinses have increasingly stressed the economic advantages to individuals and communities of changing their energy base. I suggest that economic gains are not a sufficient reason for using soft technologies. A stress on economic gains will further reinforce the hard energy path. Noneconomic concerns for self-reliance and more equitable distribution and control of natural and socioeconomic resources must occur.

Furthermore, I have argued that it is necessary for compatible attitudes and behaviors to persist over time among the renewable energy technology owners. Otherwise the soft path will not overcome the resistance of the hard energy path.

Those who change their solar energy base will lead the change to the soft path if the technologies reinforce and increase the values, attitudes and behaviors which are compatible with such social change. This should be true if renewable energy technologies serve as mode of expressing those values.

The soft path preferences scale was developed to measure the attitudes and behaviors of those who changed their energy base compared to those who had not done so. The soft path preferences scale is composed of dimensions which are compatible with a soft path restructuring of society. These dimensions include: (1) self-reliance, (2) natural resources conservation, and (3) personal gains. The scale has ommitted the important dimensions of (4) equity and (5) social diversity due to limitations of the data available for the present study. The scale was then used to examine the relationship between the ownership of solar energy technologies and attitudes and behaviors compatible with soft path social changes.

The results of this examination are the following: (1) Nonsolar homeowners have more attitudes and behaviors which are compatible with the development of the soft path social changes than solar homeowners. (2) Solar homeowners who have owned the technologies for a shorter period of time express more attitudes and behaviors which are compatible with the development of soft path social change than do those who have owned the technologies for a longer period of time. (3) The passive solar technologies owners have more attitudes and behaviors which are compatible with the development of the soft path social change than do the active solar technologies owners. Only the last of these findings supports the Lovins' notion as developed in my hypotheses.

The fact that the soft path preferences scores are higher for the nonsolar homeowners than for the solar homeowners does, however, indicate that Lovins is correct in proposing that the attitudes and behaviors held by Americans are supportive of aspects of the development of the soft energy path social change. There is broad based support for the decentralized, self-reliant, energy conserving behaviors which he has proposed. It is not clear that such support extends to using solar energy technologies thus changing the energy base.

The lower SPP scale scores of the solar technology owners suggest that those who have the greatest attitudinal and behavioral support for the soft energy path (the nonsolars) are not changing the energy base of their household.

This finding was explored through a comparison of active and passive solar technology owners. In this comparison, the passive solar technology owners have a higher soft path preference score than the active owners. Since the solar sample is dominated by the active solar technology owners (60%), it is clear that their preferences overshadow the attitudes and behaviors expressed by the passive solar technology owners (9% of the solar sample).

The passive solar energy technology owners' attitudes and behaviors are more compatible with the development of the soft energy path social change as seen in examining the dimensions of SPP.

The passive solar technology owners were the main implementers of soft path social change in 1980. They perform far greater energy conserving and other natural resources conserving behaviors than do either the active solar technology owners or the nonsolar homeowners. As argued previously, their solar energy technologies are more "soft" than the active technologies. They do express, however, the lowest attitudinal support for natural resources conservation of any of the samples.

Their preferences are higher for noneconomic personal gains but lower for economic gains than those expressed by the active technology owners. These SPP scores plus their strong concern about energy self-reliance suggest that the passive solar technology owners view a change in energy base as desirable based on concerns for resource conservation (Stern and Aronson, 1984) and self-reliance. This leads to the speculation that these technologies owners may have stronger concerns for greater equity across generations. They, however, do not show as many preferences for community self-reliance as the other samples do. Therefore this may indicate a preference for an individual approach to resource conservation rather than the cohesive community approach advocated by the Lovinses. This issue, of course, can only be examined with additional data.

Another pattern is reflected in the SPP scale scores of the active technology owners and the nonsolar sample. The active owners' expressed natural resources conservation attitudes are similar to those of the nonsolar homeowners (1.832:1.826), while showing higher natural resources conservation behaviors (.922:.542) and lower energy conservation behaviors (.467:.745) than the nonsolar homeowners. They also showed a stronger preference for economic gains than the passive sample (2.367:2.201), yet lower scores than the nonsolar sample did (2.367:2.936). Their noneconomic personal gains preferences were also the lowest of the three samples, as was their concern with energy self-reliance.

These dimension scores suggest that energy is a commodity for the active solar technology owners rather than a tool congruent with soft path social change (also see Stern and Aronson, 1984).

This orientation and the dominance of active solar technology owners may be the reason for the pattern of SPP dimensions which was observed over time among the solar owners.

There is a negative relationship between time and the SPP scale scores among solar technology owners. As seen previously, those who have owned the solar energy technologies for five years or less seem to meet a watershed period close to the fifth year. At that time both the economic gains and the energy self-reliance concerns of the householders become stronger. Five years may be the time when the idea that the solar energy technologies are a commodity generating economic gains is challenged. This challenge is in conflict with the strong concern for energy self-reliance which appeared at this time in the sample. Those who have owned the solar technologies for five years or more begin to express preferences for more noneconomic gains from the technologies.

The nonsolar homeowners' SPP scale is dominated by concerns for energy self-reliance and economic personal gains. They show a preference for community self-reliance which is closer (1.512) to the stronger concern of the active solar onwers (1.774) than the weaker preferences of the passive solar technology owners (1.012).

These findings suggest that the Lovinses' emphasis on economic personal and community gains of changing the energy base of society may be sufficient for nonsolar homeowners to change their energy base. However, if this course is followed, energy will be perceived primarily as a commodity to be incorporated by the current social structures. There will be no change to the soft energy path because the elites of the hard path will simply control this resource as they have other resources (Reece, 1979; Purdy, 1985; Schnaiberg, 1980).

Furthermore, those who perceive energy as a commodity are also not strong energy conservers. These findings suggest that the Lovinses' current emphasis on energy as an economic gain and the emphasis on using both hard and soft technologies during the transition will not support a change to the soft energy path.

These findings indicate that there is a continuation of the two technologies pattern first identified by Mumford (1967) within solar energy technologies. One is a "democratic technology" (e.g. passive solar energy technologies) and one a "totalitarian technology" (e.g. active solar energy technologies) more dependent on elite dominated systems. Therefore, even with a society based on a renewable energy base, the separation of the technocratic elites and the populace can continue though perhaps not quite as strongly as the separation which exists within the current hard path.

Once these differences between the nonsolar and solar samples, active and passive samples were discovered, then I further investigated the processes which support the development of the soft path preferences through the use of the SPP development model.

Theoretical Implications of the Soft Path Preferences Model:

Lovins has proposed that the implementation of the solar energy technologies will create more satisfaction, diversity, equity, and soft path structural changes. I have suggested that in order for these changes to occur, the solar energy technologies must reinforce attitudes and values which are compatible with the soft path.

Lovins also suggests that the only reason that more people are currently not using solar energy technologies is because there are so many institutional barriers preventing the renewable energy base technologies from being economically competitive. He suggests that the primary task of energy activists is to reduce those barriers. This issue is explored through the modeling process.

The main finding is that although perceived energy vulnerability needs and contextual resources were able to moderately influence the solar energy technologies' characteristics, the technologies had little association with the problems which the solar technology owners encountered or with their evaluation of the technologies. Therefore the technologies had little influence on the development of the SPP. This was true for every sample examined except for the passive sample. The type of technology which is used by the passive solar technology owners has a stronger and positive influence on evaluation of the technology and on the development of the SPP.

Since there was no relationship between technology type and problems and since the model did not explain any of the variance in the problems encountered by the solar energy technology owners, this finding casts doubt on the need to reduce barriers for early adopters (e.g. less than five years ownership length). The early adopters reported few barriers. Perhaps barriers will be encountered by later adopters, but those were not the concerns of these affluent early adopters.

At this early stage in the adoption process, the primary influence on the development of preferences compatible with soft path social changes was the evaluation of the solar energy technologies. Therefore, the symbolic value of the solar energy technologies dominated. The evaluations were generally positive irrespective of experiences with the technologies. This is seen in the nonsolar as well as in the solar samples. This, however, is different for the passive solar technology owners. The experiences which this sample had with the solar energy technologies did serve to more strongly reinforce the positive evaluation of the solar energy technologies and strengthened its effect on the development of the SPP.

Only the nonsolar sample's model captured some of the variance (.221) of the evaluation variable suggesting that contextual resources do influence positive evaluation of solar energy technologies for nonsolar homeowners. The model does not capture any of the evaluation variable's variance in the solar samples. Therefore this needs further exploration.

The symbolic nature of the solar energy technologies' influence in the development of SPP suggests why the solar sample's SPP scores are reduced over time. During five years of working with the solar energy technologies the owners are able to move past their symbolic nature and experience their realities as well. Therefore, the technologies are not reinforcing the development of SPP but reducing it. Broader natural resources conservation behaviors slowly increase over time, however. Unfortunately, the historical natural resources conservation behaviors of the nonsolar sample is not available in these data to form a comparison group. Therefore these behaviors may simply reflect the preferences of a different historical cohort.

Besides indicating the lack of influence of the solar technologies on the development of SPP, another result of the modeling indicates that income is the dominant resource for all the samples. Federal subsidies are a second resource for the active solar technology owners. Belonging to a solar profession or voluntary solar energy group has a negative influence (-.310) on the passive technologies owners resources. The resources are negatively related to soft energy technologies for all three samples. This suggests that those with many resources will select the "harder" solar energy technologies (e.g. active).

Resources are positively related to evaluation of the solar energy technologies for the nonsolar homeowners. The evaluation variable of the nonsolar homeowners captures the symbolic nature of solar energy technologies since those homeowners report their perceptions without owning the technologies. The dominant manifest variable is general favorability to solar energy technologies, although technical characteristics are also important. The second strongest manifest variables are the economic ones, as expected. Also, the personal networks have a greater influence on the nonsolar homeowners suggesting that this is a potentially important resource for the introduction of solar energy technologies to nonadopters.

These findings support the possibility of there being a bifurcation in the renewable energy base of society. Those with more resources prefer the harder solar energy technologies while those households with fewer resources prefer softer renewable technologies. This relationship holds true across all solar samples.

The solar samples are primarily composed of socioeconomic elites, and although they have adopted the solar energy technologies thus changing the energy base of their households, their greater resources are not supportive of soft solar energy technologies. On the other hand, the nonsolar sample which represents a cross-section of the population, does show a positive association between access to resources and greater SPP development.

The models for the nonsolar homeowners and the passive technology owners capture about 15% of the SPP variable's variance while the active sample's model contributes only about 10%. This leaves room for considerable theoretical exploration of other models of SPP development.

The models do, however, gives some indication that the change in energy base proposed by Lovins through the use of solar energy technologies has little direct influence on the development of attitudes and behaviors compatible with soft energy path social changes in the short run (e.g. 1-5 years). Because of the early adopter nature of the solar samples, the long term direct effects cannot be measured with these data.

Due to the household nature of the data, the indirect effects through social structural changes are also not measured. Therefore Lovins' claim that the changes to an alternative energy base will create social structural changes to the soft energy path is not supported here, but is not definitively tested.

These findings further indicate that Lovins' theory of social change must be refined to include diversity in the impacts of the change in energy base of society depending on whether the change is based on hard or soft renewable energy technologies. The active solar energy technologies change in energy base will be incorporated into the hard energy path providing no challenge to the current social system. A change in energy base which is produced through the use of soft renewable energy technologies does have an influence on the development of attitudes and behaviors which are more compatible with the development of social structural transformation to the soft energy path. Although Lovins has allowed for the use of many different types of renewable energy technologies, he prefers passive energy technologies for households. This is also the type which the Lovinses use in their home.

POLICY AND PROGRAMMATIC IMPLICATIONS

The SPP development model indicates some leverage points for those seeking to develop policies and programs supportive of a change in the energy base of society and for those seeking soft energy path social changes. One of the first decisions the policy-makers or energy activist must make is whether their focus will be simply on a change in the energy base or a change which is more compatible with attitudes and behaviors consistent with soft energy path changes. I will assume that the policy-maker is more interested in changing the energy base of society, while the energy activist is interest in restructuring society along the soft energy path.

Policy Implications:

Since the primary purpose of the policy-maker is to change the energy base of society, the primary focus will be on how to encourage nonsolar homeowners to conserve energy and to use active solar energy technologies.

As indicated in the energy vulnerability needs relationships of the nonsolar homeonwers, the policy-makers should focus primarily on single family homeowners composed of middle aged (35-45 years old), two parent or multigenerational families with children, who earn high incomes. The types of nonsolar people who would be most amenable to solar energy technology adoption have already been thoroughly identified by Farhar-Pilgrim and Unseld (1982).

Past policies supportive of solar adoptiont at the federal and state levels have little impact on the nonsolar homeowners. But the nonsolar respondents are concerned about the cost of the solar technologies as indicated by the .641 weight of their evaluation latent variable. Business incentives to solar energy technology companies for dependable and knowledgeable support for acquiring and operating the solar energy technologies would respond to another concern about use of solar technologies. Specific technical support such as warranty and insurance coverage which will reduce the risks of adopting the solar energy technologies are also important to the nonsolar homeowners (.364 on the evaluation variable; also see Table 27).

The approach used in encouraging the use of solar energy technologies should stress that the technologies will increase energy supply, providing greater independence from a need for big power plants and utilities as well as independence from national policies. Furthermore, the image should be one of self-reliant personal capabilities (see Table 34). Little mention should be made of the "energy crisis" and the need to decrease personal use of energy to help resolve the energy crisis. As seen in the energy vulnerability variables, this had little influence on household's energy vulnerability needs perceptions.

The personal economic gains of solar energy systems should also be stressed. The suggestion that solar energy technologies will decrease utility bills and increase the home resale value are important to the nonsolar sample. However, it is critical not to stress great savings compared to current utility bills. As seen in the evaluation variables, when expectations of savings are too high, the experience of not meeting those expectations reduces the positive assessment of the technologies (-.451) for active solar owners.

Finally, the SPP model provides some suggestions about the process to be followed in diffusing solar energy technologies. (This has been closely examined in Farhar-Pilgrim and Unseld, 1982). The emphasis should be placed on reaching nonsolar homeonwers through their personal networks, for this is the manifest variables that showed the second largest weight (.386) on the contextual resources latent variable.

These approaches will encourage a change in the energy base of society to hard renewable energy technologies, the active solar technologies. There will be no social structural transformation, but the social system will continue on its hard energy path. These approaches treat energy as a commodity.

Implications for Energy Programs:

Energy activists seeking to transform the social structure to the soft energy path will need to emphasize the soft solar energy technologies (e.g. the passive technologies) and energy conservation.

The people approached should be similar to those of interest to the policy-makers. However, the energy activist should primarily emphasize an approach to those owning single family dwellings who have larger families, rather than emphasizing the two parent families.

Time spent emphasizing policies supportive of solar energy technologies, at the national or state levels, will have little effect on the households interested in passive solar energy technologies. However, this was true in 1980 when the policy incentives generally were not extended to passive technologies[10]. Perhaps the influence is greater since the policies have become more favorable. This question needs further research.

Greater emphasis should be placed on changing local building codes and in protecting solar access rights (.106 weight on the contextual resources) as well as on reducing the cost of using passive technologies due to increased difficulty in getting financing (9%, n=29 had this problem) or increased property taxes (8%, n=25).

The potential passive solar energy adopters will be interested in having adequate technical support (.180 on the evaluation variable) and will want to know about the technical capabilities of the passive solar energy technologies (.124 on evaluation). They will also be interested in monitoring the performance of their solar energy technologies (.320).

The process used to encourage passive solar technology use should emphasize the importance of the technical capacities of the passive solar energy systems to help the household become more energy self-reliant. It should also emphasize the positive aspects of being involved with the construction of the technology (.848 on technology latent variable) and on the technologies' capacities to further increase natural resources conservation. The passive technology owners practice many energy conservation behaviors, as mentioned previously.

Although the nonsolar homeowners are concerned with economic personal gains, those who are amenable to passive technologies are less concerned prefering a realistic approach to economic gains. Expected bills savings and economic preferences were <u>not</u> very important to them. The passive solar technology owners had the lowest scores on economic gains. Energy is perceived as a natural resource which must be conserved (Stern and Aronson, 1984).

The passive energy technologies owners were negatively influenced by their participation in voluntary solar energy groups or as solar professionals (-.310). This suggests that those groups were not the best ones to use in informing the nonsolar homeowners about passive solar technologies in 1980.

Since 30% (n=100) of the passive technology owners in the sample were professionally involved with solar energy, this indicates that energy activists seeking a soft energy path transformation should meet with such groups. Perhaps they had higher expectations of support and were discontent with the amount provided for passive solar energy technologies compared to active systems' support. For example, they would know that federal policies supported active but not passive solar technology acquisition in 1980 (Axelrod, 1984). Only 12% (n=262) of the active solar technology owners were professionally involved with solar energy technologies so these groups have a smaller influence on perceptions of contextual resources as indicated by its (-.027) weight on the contextual resources variable. This is further reinforced by the finding that contextual resources is negatively, though weakly related directly to SPP in most of the solar models.

LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Due to the limited development of Lovins' theory of energy based social change and of the measurement problems inherent in secondary research, there are many criticisms which can be made of this study. Therefore, my focus in reviewing this work is on how this study could have been improved given the limitations of data and theory.

Limitations of the Study:

There are several ways in which the design of the study can be improved. The primary focus of this study was on comparing the solar and nonsolar homeowners. This is consistent with Lovins' concerns for changing the energy base of society.

There are two variables, income and geographic region, which influence the amount of resources available for solar energy technologies adoption for both the solar and nonsolar samples. Their influence in biasing the results must be more clearly addressed.

I discussed the great differences which exist between the solar and nonsolar samples in their access and control of the income resource. The solar sample represents an elite group which controls many socioeconomic resources while the nonsolar sample represents a cross-section of all social classes. Therefore the results may be presenting the ideological orientation of a high socioeconomic class of people rather than primarily attitudes and behaviors of solar energy technology users. This bias can be mitigated by weighing the nonsolar sample to be equivalent to the income groups of the solar sample. This is most important to do for the income variable since it has such a strong influence on the contextual resources latent variable.

The geographic region may also bias the nonsolar sample to underrepresent its contextual resources. I have already indicated how there are great regional variations in support for solar energy technologies through policy and physical elements. Garrett-Price et al. (1980) have indicated that in the short run, solar energy technologies will be most economically competitive in the western geographic region of the U.S. As shown earlier, the solar sample overrepresents the West compared to the nonsolar sample and underrepresents the Midwest. To remove the potential regional bias, the nonsolar sample can be weighted to be more similar to the solar sample.

Such regional weighting may further strengthen the differences between the solar and the nonsolar homeowners for the nonsolar homeowners will show even further support for the use of solar energy technologies than when they are randomly spread throughout the country. The bias which currently exists in the analysis due to geographic influence, tends to reduce the SPP scale scores of the nonsolar homeowners rather than increase them. However, to more accurately examine the differences in SPP the weighting should be used.

Another element which is contaminating some of the responses of the solar technologies owners is the difference in the length of time which they have owned their technologies. As shown in the SPP development model, the length of ownership has a stronger influence on the active solar owners than the passive. I have argued that different historical experiences may be accounting for some of the recorded differences in the SPP scores. For example, the cohort which experienced the Depression will tend to be more natural resources conserving than younger cohorts.

One way to reduce the influence of history is to eliminate those who have owned the solar technologies for ten years or more from the analysis. This will also more cleanly capture the influence of the "energy crisis" decade (1970-1980). As mentioned previously, longitudinal data on the nonsolar homeowners is not available.

A more refined analysis can also be done of the different solar technology types. I have argued that it was important to closely examine the active and passive solar owners as examples of two different forms of flow energy base changes. Although these data are biased to the active solar energy technology owners, there may be more passive or mixed technology users in the country. If this is true, then these owners will have greater numerical influence on societal changes. Therefore it is also important to examine the SPP scale scores of the "mixed" solar technology owners.

Further effort could also be made to identify the combination of solar energy technology owners which composed the national population in 1980. The SPP scale scores could be weighted appropriately for these data to be more generalizeable to the U.S. population of solar energy technology users of that historical period.

In Chapter VI, I have identified some of the measurement problems of using the data. Clearly the SPP scale must be further developed. Additional dimensions need to be added to the scale to more fully capture the notions of the soft energy path changes: (1) equity, (2) social diversity, (3) community economic development, (4) grassroots democracy, (5) community cohesion, (6) less personal alienation and (7) greater resilience (e.g. less risk).

I have already discusses dimensions 1 and 2. Dimensions 3, 4, and 5 focus more strongly on using the local community as the unit of change rather than the household. The Lovinses have proposed that the community is the best unit for creating social changes as discussed in chapters II and III.

Although they don't present a minimum size of population required for such changes in their written work, Hunter Lovins has verbally expressed that about 2,000 people are the minimum number necessary to make the use of conservation and renewable energy technologies a useful economic development strategy for a community (Roundtable discussion, May, 1986). The dimension of energy as a tool for local community economic development is therefore another dimension to be incorporated in the SPP scale.

Grassroots democracy is the process to be used at the local community level for the decision-making necessary for soft energy path social changes. Although the current study examines preferences for community self-reliance and the participation of homeowners in community activities, it does not examine preferences for grassroots democratic decision-making as opposed to policy-makers' and community leaders' decision-making processes. This dimension should include indicators of the process of decision-making as well as of control over the outcome of the decisions. As argued previously, the democractic process may simply be another method of coopting participation without power. This is an important dimension to be included in the SPP scale.

The SPP scale also does not include the dimension of community cohesion. This is an outcome of the grassroots democracy process according to Lovins. Clearly this dimension should be measured with indicators of cohesion as well as of conflict since both are probable outcomes. It should also differentiate among the groups of the community who may be the winners (the populace?) and the losers (the elites?) of the social changes.

The alienation dimension is presented at the individual level by Lovins. This dimension should be measured at both the individual and the community level since more or less alienation is an outcome of participation with power. It may be that the passive solar energy technology owners, for example, have behaviors which are most congruent with changes to the soft energy path but are the most alienated from the local community. There are hints of this in their low scores on community self reliance and in the negative relationships of their participation in solar energy groups with the contextual resources variable.

The dimension of greater resilience and less risk should have a number of indicators measuring various forms of risk. The Lovinses have proposed two major areas of greater resilience with renewable energy technologies: (1) greater energy system resilience free from widespread simultaneous "down times" as experienced with "brown outs" using the current centralized energy system; (2) greater resilience from the threat of sabotage such as that provided by terrorist control of nuclear power plants or bombs created with the by-products of power plants.

Although not specifically mentioned by the Lovinses, another area which this dimension should measure is freedom from catastrophic accidents which are a potential of the centralized, nuclear power driven energy system. The inclusion of these additional dimensions in the SPP scale will strengthen its ability to measure preferences which are compatible with the development of soft energy path social changes.

Other latent variables of the SPP development model need better indicators. The energy vulnerability needs variable would be improved by stronger measures of perceived household energy vulnerability. Indicators of the salience of energy vulnerability and measures of actual energy use would strengthen this variable. Size of dwelling and of the household are also important to measure directly as opposed to indirectly.

The technology type latent variable also needs stronger indicators. As mentioned previously, some were weak due to lack of adequate responses from the nonsolar homeowners. More indicators of participation in the operation of the technologies would strengthen this variable.

So few problems were experienced by the solar technology owners that there was little variance to be interpreted by the SPP development model. Perhaps more variance will occurr when people have owned the technologies for a greater time period. This could be examined through a panel study.

Finally, the model of SPP development itself should be examined in respecified form. Since there is little relationship between the use of the technologies and the development of soft path preferences, the relationship between energy vulnerability needs --> contextual resources --> SPP --> evaluation --> type of solar energy technologies could be analyzed for the different solar energy technology owner samples. This would more clearly differentiate between the "hard" and "soft" streams of changing the energy base of society. Within this model, solar energy technologies are a direct expression of values.

However, to examine the impacts of the implementation of these technologies on social structure and the feedback from those changes on further development of the preferences, the study must be conducted at the community level rather than at the household level as possible with these data.

These are the primary criticisms and refinements suggested for this study. Obviously there are many other research questions which could also be developed.

<u>Future Research Implications</u>:

Some of the criticisms of the current study presented above can be developed into future research strategies. Obviously the development of the SPP scale requires further research.

Through the suggested respecification of the model for example, a closer examination can also be made of the variables which create the positive evaluation of solar energy technologies. This research would investigate more closely the symbolic meaning of a changed energy base as expressed through solar energy and other renewable technologies (e.g. wood stoves, wind, etc.). The influence of the symbolism of the change can be compared with the behaviors supportive of the ideology. Questions such as what social classes are supportive of the ideology and what social classes perform the behaviors of the ideology can be further investigated.

The question of whether the population is able to withdraw from the control of the elites of society through obtaining control of energy and community processes provides a fertile ground for further research. Is it more efficient and equitable to obtain a changed energy base through the processes of policy, program and codes developed by the elites or through individual households' decisions made in marketplace competition? This research could also examine the impacts of policies, specifically the support currently provided for passive solar system acquisition. Has this reinforced the development of the soft energy path along soft lines?

The conflicts between elites and the population potentially created by a change in the energy base have been inadequately examined. Is such a change really threatening to the production forces of society or are those forces simply extending their dominance over the new energy resource? Is the hard energy path resisting a movement to the soft energy path or has this remained a dormant issue?

The differences between energy conservation practices and other natural resources conservation and attitudes could also be pursued more closely. Are the conservers also the ones changing the energy base of society? Clearly this is true in the case of passive solar technology owners, but it does not hold for the active sample.

Finally, other theoretical frameworks could be used to address questions about changing the energy base of society. Diffusion research could be used to further analyze the differences between those owning solar energy technologies for five years or more and less than that time period. I have suggested that five years is a critical ownership length. These owners could be compared to the persons who have chosen to no longer own solar energy technologies. These people may have become disenchanted with the soft energy path or found that they were not saving enough money by using the solar energy technologies.

These would be important contributions to building knowledge about conservation and the dynamics of changing the energy base of society. They would provide more information which could then be built into a more systematic theory about the relationship between the energy base, technologies, and social structures. This theoretical work is critically needed to provide guidance to further empirical research.

CONCLUSIONS

I began this study with the expectation of finding some relationships between soft path preferences with the behavior needed to change the energy base of society arguing that both the attitudes and the renewable technology change were necessary to implement the soft path social structural changes proposed by Amory Lovins.

The findings indicate that there was general attitudinal support for Lovins' notions of changing the energy base in 1980. The behavioral support, though energy conservation, solar energy technology ownership, and other natural resources conservation behaviors were not as widespread. The solar, active and passive samples performed more of these than did the nonsolar sample.

It is suggested that the renewable energy base implemented by the solar homeowners is proceeding along two lines, the hard energy path direction being developed by the active solar technology owners and the soft energy path line, by the passive technology owners. It is proposed that the active solar technology owners view energy as a commodity while the passive owners perceive it as a natural resource to be conserved. Therefore, the active solar technology owners are continuing to reinforce the current hard energy path while the passive technology owners may be part of the vanguard of the soft energy path. This perspective is reinforced by the finding that the passive solar energy technologies influence the evaluation of the technologies and the development of attitudes and behaviors compatible with the soft energy path while the solar technologies have no influence on the evaluation and soft path preferences of the active solar technologies owners.

Further research is called for to more closely examine this proposed bifurcation of soft energy path developments.

ENDNOTES

1 Olsen (1983) first used this phrase to indicate individuals' preferences for policies based on renewable energy sources and conservation rather than on nonrenewable sources such as oil, coal and nuclear.

2 I will use "Lovins" to refer to the original ideas developed by Amory Lovins. The "Lovinses" is used with the more recent developments since Amory's partner, Hunter Lovins, has been jointly involved in the evolution of the SEP notion since 1980.

3 Hunter is a lawyer and has undergraduate sociology training.

4 The goal of the Fishbein model is to predict a person's behavioral intention to do something based on the person's attitudes and norms towards the behavior (Keating, 1982; Fishbein and Ajzen, 1975).

5 Schnaiberg does not present any data supporting the advocates' role in the diffusion of the technologies. The diffusion could be simply attributed to market behavior.

6 They are both small-scaled, decentralized, based on local and renewable resources, and under the control of the user (Lodwick and Morrison, 1982; Lovins, 1978; Morrison and Lodwick, 1981; Morrison, 1980; Schumacher, 1973).

7 This theme has been more strongly developed in the Lovinses' recent work. See especially Lovins and Lovins (1982).

8 See also various issues of the Rocky Mountain Institute (RMI) Newsletter.

9 The renewable energy technology owners often will also have nonrenewable systems as back-up while the nonrenewable owners do not have renewable system supplements (Farhar-Pilgrim and Unseld, 1982).

10 In 1984, two years after the Solar Energy and Energy Conservation Bank was put into operation under a federal district court order, bank funds were limited to conservation measures and passive solar technologies. No longer was support for active solar systems allowed (Axelrod, 1984:212).

APPENDIX A: SELECTED DESCRIPTIONS OF THE SAMPLES

Table 24

MOVING PLANS: SOLAR AND NONSOLAR HOMEOWNERS

	Solar		Nonsolar	
	%	(n)	%	(n)
MOVING PLANS				
Very unlikely	45	(1672)	57	(1157)
Unlikely	28	(1042)	20	(397)
Unsure	11	(425)	7	(142)
Likely	5	(189)	6	(124)
Very likely	11	(414)	10	(197)
Missing data	2	(67)	0	(6)
Total		3809		2023

Table 25

PERCEPTIONS OF THE "ENERGY CRISIS"

		Nonsolar %	(n)	Solar %	(n)
LIFE STYLE IMPACTS:					
Serious changes		9	(179)	5	(205)
Less comfort		30	(610)	27	(1032)
Some effects		.5	(10)	4	(148)
No effects		47	(942)	52	(1975)
Don't know		14	(279)	12	(449)
Missing Data		.1	(3)	--	----
Total		100	(2023)	100	(3809)
		$\bar{X}$ = 3.263		$\bar{X}$ = 3.376	
		s.d. = 1.268		s.d. = 1.156	
U.S. ENERGY FUTURE:					
Worst:	1	0	(2)	.1	(3)
	2	.2	(5)	.1	(6)
	3	3	(57)	1	(48)
	4	16	(298)	13	(474)
	5	8	(140)	9	(322)
Same:	0	15	(305)	12	(424)
	6	13	(267)	19	(674)
	7	33	(621)	38	(1355)
	8	8	(156)	8	(274)
	9	.5	(10)	.6	(21)
Better:	10	0	(1)	.1	(4)
Missing data:		8	(161)	5	(204)
Total			(2023)		(3809)

Table 26

CONTEXTUAL RESOURCES: PERSONAL NETWORK SUPPORT FOR SET

	Favorable	Mixed	Opposed	Missing
Spouse				
Solar	93 (3273)	6 (213)	1 (21)	8 (302)
Nonsolar	72 (1063)	18 (272)	10 (144)	27 (544)
Job associates				
Solar	52 (1614)	47 (1485)	1 (34)	18 (676)
Nonsolar	66 (828)	26 (329)	8 (98)	38 (768)
Friends/neighbors				
Solar	47 (1558)	52 (1734)	1 (47)	12 (470)
Nonsolar	60 (849)	30 (423)	10 (133)	31 (618)

	Not Importnt.	Slightly Imprtnt.	Somewhat Imprtnt.	Important	Very Imprtnt	Miss. Data
Importance of friends/neighbors opinions:						
Solar	88 (3119)	7 (255)	3 (94)	1 (51)	1 (16)	7 (274)
Nonsolar	73 (1391)	14 (267)	5 (103)	6 (105)	3 (49)	5 (108)

Solar network member:	Yes	No	Missing data
Solar professional	17 (633)	83 (3071)	3 (105)
Solar group member	15 (555)	85 (3108)	4 (146)

Table 27

CONTEXTUAL RESOURCES: TECHNOLOGICAL SUPPORT

	Not Importnt.	Slightly Imprtnt.	Somewhat Imprtnt.	Important	Very Imprtnt	Miss. Data
POTENTIAL PROBLEMS:						
Utility company						
Solar	82 (2901)	8 (279)	4 (156)	3 (119)	2 (78)	7 (276)
Nonsolar	33 (625)	16 (301)	15 (277)	21 (405)	15 (282)	7 (133)
Warranty coverage						
Solar	22 (785)	8 (289)	13 (453)	27 (968)	30 (1050)	7 (264)
Nonsolar	2 (43)	3 (50)	5 (100)	30 (568)	60 (1162)	5 (100)
Insurance coverage						
Solar	56 (1943)	16 (559)	12 (419)	11 (396)	5 (174)	8 (318)
Nonsolar	5 (92)	5 (90)	9 (173)	34 (632)	47 (889)	7 (147)
Dependable solar firms						
Solar	15 (538)	6 (225)	10 (342)	31(1090)	39 (1372)	6 (242)
Nonsolar	3 (66)	3 (56)	6 (121)	26 (501)	61 (1176)	5 (103)

Table 28

CONTEXTUAL RESOURCES: GOVERNMENT SUPPORT FOR SOLAR ENERGY TECHNOLOGIES

Perceived general support:	SOLAR			NONSOLAR		
	Federal	State	Local	Federal	State	Local
Favorable	67 (2349)	71 (2465)	50 (1572)	81 (1388)	75 (1187)	66 (979)
Mixed	28 (964)	26 (888)	46 (1429)	9 (155)	15 (229)	24 (353)
Opposed	5 (172)	3 (101)	4 (138)	10 (166)	11 (168)	11 (162)
D.k./missing	9 (324)	9 (355)	18 (670)	15 (314)	22 (439)	26 (529)

	Solar received	Nonsolar perceived			
FEDERAL SUPPORT:	Yes	Yes	No	D.k.	Miss.
Income tax credit	69 (2627)	46 (934)	17 (341)	37 (745)	0 (3)
HUD solar heating grant	2 (74)				
HUD solar hot water grant	16 (608)				
STATE SUPPORT:					
Income tax credit	37 (1426)	14 (276)	30 (597)	57(1148)	0 (2)
State sales tax credit	7 (261)				
State property tax exemption	2 (88)				
State low income loan	2 (58)				
LOCAL SUPPORT:		---	---	---	---
Local sales tax credit	1 (48)				
Local property tax exemption	8 (304)				

	Not Importnt.	Slightly Imprtnt.	Somewhat Imprtnt.	Important	Very Imprtnt	Miss. Data
Concerned about building codes						
Solar	60 (2119)	13 (448)	10 (362)	10 (347)	7 (234)	8 (299)
Nonsolar	14 (263)	8 (152)	13 (238)	33 (606)	31 (563)	10 (201)

Table 29

TECH TYPE: SOLAR TECHNOLOGY OWNERSHIP LENGTH

	Earlier to 1970	1971 to 1975	1976 to 1980	Total
Active system 1	2 (66)	7 (234)	91 (2883)	100 (3183)
Active system 2	2 (8)	10 (50)	88 (428)	100 (486)
Passive system 1	9 (91)	11 (112)	81 (840)	101 (1043)
Passive system 2	5 (14)	6 (16)	89 (233)	100 (263)
Year Discontinued	7 (8)	4 (4)	89 (100)	100 (112)
Missing data	-	-	-	(94)
Total	(122)	(317)	(3276)	

Ownership length (in years)	10 plus 2% (71)	5-9 8% (285)	3-4 24% (907)	1-2 48% (1821)	less 1 18% (680)

Quartiles 1.2 (25%) 2.3 (50%) 3.3 (75%)

$\bar{X}$ = 3.10 s.d. = 4.67 range = 1 month to 54 yrs.

Missing data 1% (45)

Table 30

SOURCES OF PARTS AND MATERIALS FOR SELF MADE SYSTEMS
(Solar)

	Active		Passive	
	%	(n)	%	(n)
Local solar co.	67	(1752)	17	(113)
Local heating, air conditioning store	10	(264)	1	(19)
Local building contractor	5	(130)	23	(155)
Local hardware store	9	(223)	38	(254)
Local architect	1	(27)	4	(27)
Local chain store outlet	2	(43)	3	(20)
Non-local solar manuf.(mailorder)	7	(188)	12	(81)
Non-local solar company	0	(6)	0	(3)
TOTAL transactions no.		(2633)		(672)
No. of self installed systems*		1133		626

* See Table 1

Table 31

PROBLEMS EXPERIENCED WITH SOLAR TECHNOLOGIES

n = 3809	Experienced	Not Experienced
ACQUIRING SOLAR TECHNOLOGIES		
Getting information	15 (563)	85 (3246)
Choosing a system	16 (610)	84 (3199)
Getting good builder	9 (327)	85 (3245)
Installing a system	16 (620)	84 (3189)
WITH LOCAL POLICIES		
Building codes	7 (250)	93 (3559)
Solar access rights	1 (36)	99 (3773)
WITH PEOPLE'S RESPONSES		
Vandalism	1 (52)	99 (3757)
Neighbors opposition	2 (58)	99 (3751)
System obstruction	7 (246)	94 (3563)
WITH INCREASED COSTS		
Financing	5 (187)	95 (3622)
Utility rates up	3 (119)	97 (3690)
Property tax up	6 (210)	95 (3599)
Resale value down	1 (35)	99 (3774)
OPERATING SOLAR TECHNOLOGIES		
Maintenance	17 (628)	84 (3181)
Finding parts	10 (382)	90 (3427)
Overheating	8 (289)	92 (3520)
Improper design	11 (425)	89 (3384)

Table 32

EVALUATION OF SOLAR TECHNOLOGIES

	Strongly Positive		Positive		Unsure/ Neutral		Negative		Strongly Negative		Miss. Data	
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)
General assessment												
Solar	76	(2800)	20	(746)	3	(110)	0	(9)	0	(10)	4	(234)
Nonsolar	32	(644)	45	(905)	18	(370)	4	(81)	1	(14)	0	(9)
Technical and economic performance												
Solar	42	(1580)	37	(1369)	11	(399)	9	(352)	1	(45)	2	(64)
Nonsolar	10	(199)	35	(704)	35	(711)	18	(360)	2	(40)	0	(9)
Safety of system												
Solar	50	(1766)	13	(459)	10	(356)	16	(559)	11	(390)	7	(279)
Nonsolar	6	(123)	5	(93)	7	(127)	26	(504)	56	(1062)	6	(114)
Operating reliability												
Solar	16	(554)	12	(409)	15	(523)	29	(1040)	29	(1042)	6	(241)
Nonsolar	3	(49)	2	(46)	6	(106)	30	(577)	59	(1127)	6	(118)
Longevity												
Solar	33	(1243)	50	(1880)	15	(550)	2	(65)	0	(12)	2	(59)
Nonsolar	9	(187)	43	(869)	43	(860)	4	(89)	0	(8)	1	(10)
Technical obsolescence												
Solar	28	(984)	22	(783)	24	(860)	18	(631)	9	(322)	6	(229)
Nonsolar	6	(117)	8	(158)	16	(311)	34	(646)	35	(662)	6	(129)
Only for sunny climates												
Solar	24	(892)	45	(1684)	11	(392)	16	(580)	5	(196)	2	(65)
Nonsolar	5	(97)	29	(590)	22	(451)	39	(779)	5	(96)	1	(10)
For cold or cloudy climates												
Solar	63	(2251)	10	(344)	9	(311)	10	(393)	7	(242)	8	(304)
Nonsolar	14	(250)	10	(184)	12	(209)	28	(510)	36	(659)	10	(211)
Adequacy of knowledge												
Solar	47	(1761)	46	(1718)	—	—	7	(267)	1	(17)	1	(46)
Nonsolar	11	(212)	17	(335)	9	(179)	33	(672)	31	(624)	0	(1)
For personal use (nonsolar)	21	(419)	37	(754)	22	(448)	16	(318)	4	(78)	0	(6)
Ease of use (nonsolar)	15	(306)	17	(349)	19	(374)	39	(783)	10	(204)	0	(7)
EXPERIENCE BASED EVALUATION: (Solar only)												
Experience solar homeowner	59	(2264)	30	(1136)	5	(188)	5	(172)	1	(49)	0	(0)
Warranty cov.	30	(696)	41	(959)	20	(471)	4	(101)	4	(83)	5	(180)
Repair service	31	(772)	23	(575)	31	(782)	8	(200)	7	(165)	21	(798)*
Instructions	24	(474)	57	(1105)	13	(247)	6	(108)	0	(5)	3	(130)
CONDITION OF THE TECHNOLOGIES:												
Active 1	31	(1062)	43	(1446)	15	(496)	3	(97)	3	(91)	5	(185)
Active 2	5	(155)	6	(210)	3	(88)	1	(25)	0	(12)	76	(2887)
Passive 1	43	(473)	32	(352)	21	(228)	3	(28)	1	(15)	7	(278)
Passive 2	44	(127)	32	(90)	21	(59)	2	(7)	1	(3)	28	(1088)

* This question is translated from "Relative to the repair service for conventional heating or hot water systems, how would you rate the quality of your solar repair service?" The respondants' choices included "I do my own repair". The 569 (15%) who answered affirmatively to this are not included in the answers reported above.

Table 33

EVALUATION: INTENTIONS AND RECOMMENDATIONS

	Strongly Positive %	(n)	Positive %	(n)	Unsure/ Neutral %	(n)	Negative %	(n)	Strongly Negative %	(n)	Miss. Data %	(n)
ADD/GET SOLAR TECHNOLOGIES												
Solar	28	(1049)	20	(748)	20	(732)	19	(707)	12	(454)	3	(119)
Nonsolar	4	(71)	14	(283)	1	(24)	13	(258)	69	(1381)	0	(6)
RECOMMEND SOLAR:												
Solar	72	(2695)	23	(852)	4	(167)	1	(45)	--	---	1	(50)
EASE OF USE:												
Nonsolar	15	(306)	17	(349)	19	(374)	39	(783)	10	(204)	0	(7)

Table 34

SPP: SELF RELIANCE PREFERENCES

	Very Imprtnt.	Important	Somewhat Imprtnt.	Slightly Imprtnt	Not Imprtnt.	Missng Data
General self reliance						
Solar	38 (1351)	31 (1077)	15 (527)	8 (275)	9 (299)	7 (280)
Nonsolar	34 (640)	39 (726)	15 (272)	7 (138)	5 (92)	8 (155)
ENERGY SELF RELIANCE						
Fewer big power plants						
Solar	16 (550)	17 (588)	20 (689)	20 (685)	28 (980)	8 (317)
Nonsolar	31 (587)	38 (710)	16 (296)	8 (149)	7 (139)	6 (142)
Independence of utilities						
Solar	26 (916)	23 (807)	17 (582)	14 (479)	21 (749)	7 (276)
Nonsolar	39 (747)	30 (566)	14 (272)	10 (183)	7 (134)	6 (121)
Reliable energy supply						
Solar	23 (817)	26 (897)	19 (658)	14 (486)	19 (651)	8 (300)
Nonsolar	45 (860)	38 (720)	9 (168)	5 (85)	4 (69)	6 (121)
LOCAL SELF RELIANCE						
Inc. self reliance skills*						
Solar	50 (1867)	12 (444)	14 (534)	19 (708)	4 (152)	3 (104)
Nonsolar	42 (849)	12 (235)	15 (299)	18 (360)	13 (270)	1 (10)
Community resolutions						
Solar	34 (1282)	52 (1962)	8 (295)	4 (156)	1 (51)	2 (63)
Nonsolar	19 (378)	66 (1336)	10 (199)	5 (98)	1 (10)	0 (2)
Independence from national policies						
Solar	16 (542)	12 (421)	12 (415)	13(445)	47(1636)	9 (350)
Nonsolar	38 (700)	31 (569)	14 (252)	9(172)	8 (149)	9 (181)
Not federal resolution **						
Solar	29 (1084)	33 (1239)	16 (606)	15(542)	7 (275)	2 (63)
Nonsolar	11 (224)	32 (641)	20 (395)	28(574)	9 (187)	0 (2)

* Translated from 5-point frequency of behavior responses

** Translated from 5-point "agreement" responses

Table 35

SPP: RESOURCES CONSERVATION PREFERENCES

	Very Imprtnt.	Imprtant	Somewhat Imprtnt.	Slightly Imprtant	Not Imprtnt.	Missng Data
General conservation						
Solar	28 (990)	28 (986)	19 (674)	13 (464)	12 (408)	8 (287)
Nonsolar	44 (850)	36 (694)	11 (218)	5 (100)	3 (53)	5 (108)
Ease energy shortage						
Solar	26 (925)	30 (1064)	22 (768)	13 (468)	9 (333)	7 (251)
Nonsolar	34 (662)	39 (749)	15 (285)	8 (151)	5 (89)	5 (87)
Decrease personal use **						
Solar	50 (1861)	43 (1627)	3 (111)	3 (112)	1 (44)	1 (54)
Nonsolar	29 (594)	58 (1162)	5 (105)	7 (134)	1 (23)	0 (5)
CONSERVATION BEHAVIORS *						
Recycle home materials						
Solar	14 (537)	22 (831)	13 (470)	35 (1292)	16 (592)	2 (87)
Nonsolar	12 (236)	11 (212)	9 (179)	24 (478)	45 (908)	1 (10)
Recycle clothes						
Solar	1 (22)	2 (70)	5 (194)	36 (1335)	56(2080)	3 (108)
Nonsolar	1 (22)	2 (42)	6 (117)	33 (661)	58(1164)	1 (17)
Contribute to ecological organization						
Solar	14 (527)	7 (268)	25 (934)	6 (213)	47(1734)	4 (133)
Nonsolar	3 (51)	3 (65)	13 (263)	3 (64)	78(1552)	1 (28)

* Translated from 5-point frequency responses
** Translated from 5-point "agreement" responses

Table 36

SPP: ENERGY CONSERVATION ACTIVITIES

	SOLAR				NONSOLAR			
	Performed		na*	mv**	Performed		na*	mv**
	%	(n)	%	%	%	(n)	%	%
Thermostat at 65 in winter	13	(1842)	25	7	64	(1284)	7	1
Thermostat at 78 in summer	34	(1304)	48	8	35	(716)	36	3
Carpool	26	(964)	26	12	22	(436)	30	3
Small car owner	65	(2475)	7	9	45	(919)	9	2
Window covers	52	(1995)	14	10	48	(979)	5	3
Caulking	61	(2306)	18	9	76	(1539)	3	2
Storm windows	53	(2005)	21	10	60	(1204)	7	2
Hot water temp. control	63	(2406)	11	10	59	(1189)	2	3
Fireplace device	32	(1207)	36	11	22	(434)	38	4
Efficient appliances	52	(1949)	12	10	37	(739)	8	5
Insulated	54	(2084)	19	10	61	(1242)	4	2
Heat pump	11	(409)	31	3	4	(78)	12	5
Furnace timer	16	(612)	30	12	12	(248)	4	10
Wood stove	30	(1148)	23	11	18	(356)	7	3

na* = not applicable
mv** = missing data

Table 37

SPP: PERSONAL GAINS PREFERENCES

	Very Imprtnt.		Imprtant		Somewhat Imprtnt.		Slightly Imprtant		Not Imprtnt.		Missng Data	
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)
ECONOMIC												
Rising cost protection												
Solar	57	(2038)	30	(1090)	7	(256)	3	(94)	3	(123)	6	(208)
Nonsolar	48	(919)	38	(731)	9	(165)	3	(60)	3	(48)	5	(100)
Decreased utility bills												
Solar	47	(1674)	29	(1044)	12	(443)	7	(240)	6	(197)	6	(211)
Nonsolar	57	(1090)	30	(568)	8	(144)	3	(60)	3	(56)	5	(105)
Increased home resale value												
Solar	8	(281)	16	(567)	20	(695)	21	(749)	35	(1252)	7	(265)
Nonsolar	30	(568)	35	(665)	16	(300)	11	(215)	8	(160)	6	(115)
NONECONOMIC												
Increased home comfort												
Solar	14	(479)	20	(701)	17	(594)	13	(459)	36	(1266)	8	(310)
Nonsolar	32	(591)	43	(794)	13	(231)	7	(123)	6	(112)	9	(172)
Increased personal prestige												
Solar	4	(133)	6	(211)	10	(335)	13	(461)	67	(2356)	8	(313)
Nonsolar	5	(102)	10	(185)	10	(182)	13	(253)	62	(1183)	6	(118)
(Nonsolar only) Good investment*	11	(230)	22	(445)	33	(670)	22	(443)	11	(223)	1	(12)
Long term money savings												
Solar	51	(1843)	30	(1095)	10	(352)	5	(177)	4	(139)	5	(203)
Nonsolar	56	(1067)	32	(612)	7	(137)	2	(43)	3	(50)	6	(114)

* Translated from 5-point money saved assessment

APPENDIX B: OPERATIONALIZING THE SPP MODEL

APPENDIX B

OPERATIONALIZING THE SPP MODEL

SOLAR:	NONSOLAR:
ENERGY VULNERABILITY NEEDS	
A. <u>Needs created by family and housing structures:</u>	
XHOUSE What type of structure do you live in? [1] - one family house [2] - attached house (duplex,townhouse,etc.) [3] - mobile home [4] - other [5] - no response	HOUSE
*XAVCOSTV = Average monthly energy cost	*AVCOSTV
(XWNCOST + XSUMCOST / 2)/10 [5000-0000]	same
XWNCOST During this past winter - say during December, January, and February - what were your average monthly energy costs for electricity, heating, and hot water?	WINCOST
[0000-8000] - number of dollars	[0000-1300]
XSUMCOST During this past summer - say June, July, and August - what were your average monthly energy costs for electricity, heating, hot water, and cooling?	SUMCOST
[0000-6000] - number of dollars	[000-900]
XNUMCHIL number of children	NUMCHIL
[20-00] - number of children	same
XFAMTYP household structure	FAMTYPE
[1] - two parent family [2] - extended family (e.g.multigenerational) [3] - married couple [4] - single parent [5] - one adult	same

SOLAR | NONSOLAR

XRAGE | RAGE

Resource ordered age of respondent:
[1] - 35 - 44
[2] - 45 - 54
[3] - 55 - 64
[4] - 25 - 34
[5] - 65 and older
[6] - 24 or less

B. Needs related to perceptions of the "energy crisis":

*XLADDRV = | LADDRV =

Expected energy situation in our country in five years.

XLADDR1 - XLADDR2 | LADDR1 - LADDR2

[0-10] - estimate of whether the energy situation will be better or worst

---

XLADDR1 | LADDR1

Here is a picture of a ladder. Let's suppose the top of the ladder represents the best possible energy situation for our country and the bottom, the worst possible energy situation for our country. Please show me on which step of the ladder you think the United States is at the present time.

XLADDR2 | LADDR2

Just as your best guess, if things go pretty much as you now expect, where do you think the U.S. will be on the ladder, let us say, about five years from now?
[0 - 10] - 0 = worst
10 = best

XIMPACT | IMPACT

In different parts of the nation, people have reported a variety of effects of the energy situation on their daily lives. How has the energy situation affected your family (household)? Would you say...? | same

[1] - We have had to make serious changes in our daily habits.
[2] - Our life has been less comfortable and convenient, but it is not serious.
[3] - Don't know.
[4] - We have had to make a few adjustments, but our lifestyle has not been affected.
[5] - It really has had no effect on us.

SOLAR	NONSOLAR
RESOURCES	
A. <u>Personal Support:</u>	
XEDUC	REDUC
What is the highest level of education you have completed?	
[1] - graduate work or more	
[2] - college graduate	same
[3] - some college	
[4] - trade or technical school	
[5] - high school graduate	
[6] - less than high school	
XINCOME	INCOME
Please check off which category best represents the total annual income, before taxes, of your immediate family living in your household?	Which category best represents the total annual income of all persons living in your household?
[1] - over $55,000 a year	
[2] - $45,000 - 54,999 a year	
[3] - $35,000 - 44,999 a year	
[4] - $25,000 - 34,999 a year	same
[5] - $20,000 - 24,999 a year	
[6] - $15,000 - 19,999 a year	
[7] - $12,000 - 14,999 a year	
[8] - $10,000 - 11,999 a year	
[9] - $7000 - 9999 a year	
[10]- under $5000 - 6999 a year	

SOLAR	NONSOLAR
*XPERSUP =	*PERSUPV =
Perceived personal network support	
(XFOSPOU + FOFRND*2 + FOWORK*3)	same
[1] - support	
[2] - neutral	
[3] - no support	

Please indicate whether each of the following is favorable to, or opposed to, using solar energy for homes.
[1] - favorable
[2] - unsure
[3] - opposed

SOLAR	NONSOLAR
XFOSPOU	FOSPOUS
Your spouse/housemate	
XFOFRND	FOFRNDS
Your neighbors and friends	
XFOWORK	FOWORK
People you work with	

SOLAR	NONSOLAR

B. Institutional Support:

---

*XNSTSUP Perceived institutional support -	*INSTSUP
(XCRUTIL + XCRWARR + XCRINSU + XCRFIRM) [1] - great support [2] - support [3] - some support [4] - little support [5] - no support	same same

---

..which of these were concerns to you when you were thinking about using solar energy in your home... show how important that concern was to you. [1] - not at all important [2] - slightly important [3] - somewhat important [4] - important [5] - very important	..how important a concern it would be for you, if you were thinking about using solar energy in your home. same
XCRUTIL Possible problems with utility company	CRUTIL
XCRWARR Warranty coverage for solar energy system	CRWARR
XCRINSU Cost and difficulty of getting solar energy systems covered by homeowners insurance	CRINSU
XCRFIRM Problems with dependability of firm	CRFIRM

C. Governmental Support:

---

*XGOVSUPV = Perceived governmental support for solar energy technologies.	*GOVSUPV =
(XFOFED*3 + XFOSTAT*2 + XFOLOCAL)	same

SOLAR	NONSOLAR
Please indicate whether each of the following is favorable to, or opposed to, using solar energy for homes. [1] - favorable [2] - unsure [3] - opposed	
XFOFED The federal government	FOFED
XFOSTAT Your state government	FOSTATE
XFOLOCAL Your local government	FOLOCAL

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*XFEDSUP =
Received federal support

(XTAXFED + XHUD1 + XHUD2) [1] - great support [2] - support [3] - some support [4] - no support	---

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Types of federal support received:

XTAXFED Federal tax credit [1] - applies [0] - does not apply XHUD1 HUD Solar Heating and Cooling Demonstration Program Grant XHUD2 HUD Solar Hot Water Demonstration Program	FTAXINC Do you happen to know if there is a federal credit available on your income tax for those who purchase solar energy systems for the home? [1] - yes [2] - unsure [3] - no

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*XSTASUP =
Received state support

(XTAXST + XTAXPRO + XLOAN) [1] - great support [2] - support [3] - some support [4] - no support	---

---

SOLAR	NONSOLAR
Type of state support received: [1] - applies [0] - does not apply XTAXST State Sales tax credit or exemption XTAXPRO State Property tax exemption XLOAN State low income loan	STAXINC As far as you know does your state have an income tax credit for the purchase of solar energy systems for the home? [1] yes [2] unsure [3] no
*XLCLSUP = Received local support (XTAXLCL + XTAXPLC) [1] - support [2] - some support [3] - no support	---
XTAXLCL Local Sales tax credit or exemption [1] - applies [0] - does not apply XTAXPLC Local Property tax exemption	--- ---

D. <u>Problems Experienced:</u>

*XPRCOSTV = Problems with increased costs (XPRFIN + XPRUTIL + XPRTAX + XPRVALU) [0] - no problems [1] - slight problems [2] - some problems [3] - problems [4] - many problems	---

As a solar owner, which of the following problems have you actually experienced?
[0] - Does not apply
[1] - Applies

SOLAR	NONSOLAR
XPRFIN Difficulty in obtaining financing	---
XPRUTIL Utility raised rates for solar owners	---
XPRTAX Increased property tax	---
XPRVALU Resale value of house has decreased	---

---

*XPRLCLSV =
Local policy problems

(XPRSAR + XPRCODE)
[0] - no problems ---
[1] - some problems
[2] - several problems

As a solar owner, which of the following
problems have you actually experienced?
[1] - does not apply
[0] - applies

XPRSAR
Difficulty obtaining solar access rights ---

XPRCODE
Conflicts with local building codes ---

---

*XPRPEOPV= ---
Problems from people

(XPRVAND + XPRNEBR + XPROBST)
[0] - no problems
[1] - some problems
[2] - problems
[3] - many problems

As a solar owner, which of the following
problems have you actually experienced?
[0] - does not apply
[1] - applies

SOLAR	NONSOLAR
XPRVAND Vandalism to the solar energy system	---
XPRNEBR Opposition of the neighbors	---
XPROBST Obstruction of your solar energy system by vegetation, new buildings, etc.	---

---

---

*XPRBLDV =
Problems acquiring the solar system ---

(XPRINST + XPREVAL + XPRINFO + XPRQUAL)
[0] - no problems
[1] - slight problems
[2] - some problems
[3] - problems
[4] - many problems

As a solar owner, which of the following problems have you actually experienced? ---
[0] - does not apply
[1] - applies

XPRINST
Installation problems ---

XPREVAL
Difficulty in evaluating and choosing among competing systems ---

XPRINFO
Lack of clear, reliable information ---

XPRQUAL
Finding a qualified contractor, architect, or builder ---

SOLAR ONLY

---

*XPRFRNDV =
Experience with personal support

(XMEMBER + XPROINV) ---
[1] - great support
[2] - support
[3] - little support

XMEMBER ---
Are you a member of a solar energy groups, such as a local solar energy association or a chapter of the International Solar Energy Society?
[1] - yes
[0] - no

XPROINV ---
Are you professionally involved with solar energy?
[1] - yes
[0] - no

****

ACTIVE SYSTEMS (solar only) TYPE OF SOLAR TECHNOLOGY	PASSIVE SYSTEMS
XOWNTIMV Number of years the solar technology is owned [000-652] - number of months/12	same
XDATIN1V Year active system 1 was installed in 10 [1 - 80] - year/10	XPYR1V Year passive system 1 was constructed in 10 [1 - 80] - year/10
XCOSTSEV What was the total installed cost of your energy system(s)? [0000-9996] - number of dollars/1000	same

---

*XPROPTNV= same
Problems operating the solar technologies

(XPRMAIN + XPRPART + XPRHEAT + XPRDESN)
[0] - no problems
[1] - slight problems
[2] - some problems
[3] - problems
[4] - many problems

As a solar owner, which of the following problems have you actually experienced?
[0] - Does not apply
[1] - Applies

XPRMAIN ---
Maintenance problems

ACTIVE SYSTEMS (soLar only)	PASSIVE SYSTEMS
XPRPART Difficulty finding parts and equipment for initial purchase or repair	---
XPRHEAT Overheating	---
XPRDESN Difficulties arising from improper system design	---
*XABLDMTD Method used in building active system	*XPBLDMTD Method used in building passive system
(XABLD1 * .5) + (XABLD2) + (XABLD3 * 1.5)	same - with XPBLD1, 2, 3.
XABLD1 - sum of values = 1 XABLD2 - sum of values = 2 XABLD3 - sum of values = 3	same with passive variables
(XAMANU1 + XAMANU2 + XACBUIL1 + XACBUIL2 + XAINST1 + AINST2)	same with passive variables
XAMANU1 Active System 1 was manufactured by [1] - small local firm + myself (volunteered) [2] - national firm [3] - foreign firm (+ other)	XPDESI1 Passive System 1 designed by [1] - yourself [2] - acquired plans [3] - a contractor, an architect, other
XAMANU2 Active System 2 was manufactured by	XPDESI2 Passive System 2 designed by
XACBUIL1 Active System 1 built [1] - systems built on site [2] - systems bought as components and assembled on site [3] - systems bought as a complete "packaged" system and assembled on site (+ other)	XPBUIL1 Passive System 1 built same
XACBUIL2 Active System 2 built	XPBUIL2 Passive System 2 built

ACTIVE SYSTEMS (solar only)	PASSIVE SYSTEMS
XAINST1 Active System 1 installed [1] - by yourself [2] - by both self and contractor [3] - by a contractor (+other)	XPINST1 Passive System 1 installed by same
XAINST2 Active System 2 installed by	XPINST2 Passive System 2 installed by

---

From whom did you purchase your system(s) or parts and materials for it?
[1] - applies
[0] - does not apply

*XLCLAPRT *XLCLPPRT
Sources of parts and materials for either of the solar systems:

	Active	Passive
[1]	XASOCO1 or XASOCO2 Local solar company	XPSOCO1 or XPSOCO2
[2]	XAHARD1 or XAHARD2 Local hardware, lumber, etc. supply house	XPHARD1 or XPHARD2
[3]	XAHVACI1 or XAHVACI2 Local heating, plumbing, ventilating, air conditioning store	XPHVAC1 or XPHVAC2
[4]	XABLDR1 or XABLDR2 Local building contractor	XPBLDR1 or XPBLDR2
[5]	XAARCHI1 or XAARCHI2 Local architect	XPARCH1 or XPARCH2
[6]	XACHAI1 or XACHAI2 Local outlet of chain store	XPCHAI1 or XPCHAI2
[7]	XAMAIL1 or XAMAIL2 Mail order from a non-local solar manufacturer	XPMAIL1 or XPMAIL2
[8]	XANLSC1 or XANLSC2 Non-local solar company	XPNLSC1 or XPNLSC2

---

*XADOWNV = Average active systems incidents of failure	*XPDOWNV = Average passive incidents of failure
(XADOWN1 + XADOWN2)/2	(XPDOWN1 + XPDOWN2)/2

XADOWN1 Active system 1 incidents of failure [000-995] - number of incidents	XPDOWN1 Passive system 1 same
XADOWN2 Active system 2 incidents of failure	XPDOWN2 Passive system 2 same

SOLAR	NONSOLAR
EVALUATION:	

---

*XGENEVAL =	*GENEVAL =
General evaluation of solar systems	
(XOVEVAL + XSATEXP)	(SPEVAL + OVEVAL)

XSATEXP Altogether, how satisfied are you with your experiences as a solar owner? [1] - very satisfied [2] - satisfied [3] - unsure, no opinion yet [4] - dissatisfied [5] - very dissatisfied	SPEVAL Given what you know about solar energy right now, do you strongly favor, favor, oppose or strongly oppose the idea of using it in <u>your</u> home? [1] - strongly favor [2] - favor [3] - unsure [4] - oppose [5] - strongly oppose
XOVEVAL Based on your understanding of solar energy for homes, how do you feel about it? [1] - strongly favor [2] - favor [3] - unsure/neutral [4] - oppose [5] - strongly oppose	OVEVAL same

---

---

*XTECEVAL =	*TECEVAL =
Specific evaluation of technological capabilities	
(XBEFF1 + XBEFF2 + XBEFF3 + XCRCLIM + XCRSAFE + XCRRELI + XCROBS)	same

---

XBEFF1 In general, solar energy systems are technically and economically practical today for homes. [1] - strongly agree [2] - agree [3] - unsure [4] - disagree [5] - strongly disagree	BEFF1 same

SOLAR	NONSOLAR
XBEFF2 If they are practical at all, solar energy systems are only practical for homes in warm, sunny climates (reversed order of responses)	BEFF2
XBEFF3 Solar energy systems in general will perform satisfactorily over a long period of time.	BEFF3
XCROBS Possibility that solar energy systems now on the market will soon be obsolete and better systems will be available later.	CROBS
..which of these were concerns to you when you were thinking about using solar energy in your home... show how important that concern was to you. [1] - not at all important [2] - slightly important [3] - somewhat important [4] - important [5] - very important	..how important a concern it would be for you, if you were thinking about using solar energy in your home. same
XCRSAFE Safety of solar energy systems	CRSAFE
XCRRELI Operating reliability of solar energy system	CRRELI
XCRCLIM Climate too cold or cloudy or not enough wind.	CRCLIM

---

*XXSAV1 =
Difference between expected savings
and actual savings

(XEXPSAV - XSAVING)

SOLAR | NONSOLAR

XEXPSAV | ---

When you bought or built your solar energy system(s), approximately what percent of your total monthly utility cost did you <u>expect</u> to save?

[1] - over 85%
[2] - 75%
[3] - 65%
[4] - 55%
[5] - 45%
[6] - 35%
[7] - 25%
[8] - 15%
[9] - 5%
[10]- Did not expect to save at all

XSAVING | ---

Since you acquired your solar energy system, what percent of your total monthly utility costs do you think you have actually saved?

[1] - over 85%
[2] - 75%
[3] - 65%
[4] - 55%
[5] - 45%
[6] - 35%
[7] - 25%
[8] - 15%
[9] - 5%
[10]- Did not expect to save at all

--- | INVEST

At present costs, do you think that owning a solar energy system will result in sufficient utility savings to make it a good investment?

[1] - definitely
[2] - I think so
[3] - don't know
[4] - probably not
[5] - definitely not

SOLAR	NONSOLAR
XADSOL How likely is it that you will add other solar applications to your present home? [1] - very likely [2] - likely [3] - unsure [4] - unlikely [5] - very unlikely	BI To what extent, if any, have you considered investing in a solar system for your house in the next 2-3 years? [1] - plan to invest [2] - may invest [3] - don't know [4] - will not invest [5] - not considered
XRECMEN On the basis of your experience, have you reccommended solar energy to others or not? [1] - yes have reccommended it highly [2] - yes, with some reservations [3] - have not reccommended for or against it [4] - no, have reccommended against it	---
---	EASE ...would you say your house could easily use solar energy...or could not use it? [1] - could use easily [2] - could use with some difficulty [3] - don't know [4] - ...only with major renovation [5] - could not use

SOLAR	NONSOLAR
---	WILLPAY How much more than your present total monthly bill for utilities would you be willing to pay per month for your own solar energy system in your home? [1] - more than $85 [2] - $85 per month [3] - $40/month [4] - $25/month [5] - $8/month [6] - no more [7] - don't want
*XTECSUPV = Evaluation of technical support (XWARSAT + XREPAIR + XINHELP)	
XINHELP How helpful were the [sic. operation and maintenance] instructions to you? [1] - extremely helpful [2] - helpful [3] - don't know [4] - not helpful [5] - harmful XWARSAT How satisfied are you with your warranty coverage? [1] - very satisfied [2] - satisfied [3] - don't know [4] - dissatisfied [5] - very dissatisfied XREPAIR Relative to the repair service for conventional heating or hot water systems, how would you rate the quality of your solar repair service? [1] - never needed repairs [2] - better [3] - about the same [4] - less reliable but adequate [5] - inadequate	---

ACTIVE SYSTEMS (solar only)	PASSIVE SYSTEMS
*XACONDV = Overall condition of both systems	*XPCONOV =
(XACOND1 + XACOND2)/2	(XPCONO1 + XPCONO2)/2
XACOND1 What overall condition describes your (active) solar energy systems 1 and 2 right now? [1] excellent condition, never were any problems [2] very good, the few problems have been solved [3] good, some minor problems remain [4] fair, system problems difficult to resolve [5] poor, system has chronic problems	XPCONO1 same
XACOND2	XPCONO2

SOLAR	NONSOLAR

****

SOFT PATH PREFERENCES

*XEYNDPV = Energy self reliance	*EYNDPV= same
(XRASELF + XRARELI + XRAUTIL + XRAPLNT)	(EYSUP + UTLIND + EAPLNTS + EASREL)
...list of factors that might have influenced your decision to adopt solar energy...how important [was] this advantage to you in making your decision to use solar energy. [1] - very important [2] - important [3] - somewhat important [4] - slightly important [5] - not at all important	...advantages that could enter into your decision about using solar energy in your home. ...how important it would be for you in making such a decision
XRASELF Increasing overall self-reliance	EASREL
XRARELI Having a more reliable supply of energy	EYSUP
XRAUTIL Increasing independence from utility company	UTLIND

SOLAR | NONSOLAR
XRAPLNT | EAPLNTS
Reducing need for more large power plants

---

*XLCLNDPV = | *LCLNDPV=
Local self reliance

(XLOCAL + XTRUST + XRAFEDS + XSKILLS) | (LOCAL + TRUST + GOVIND + SKILLS)

...list of factors that might have influenced your decision to adopt solar energy...how important [was] this advantage to you in making your decision to use solar energy.
[1] - very important
[2] - important
[3] - somewhat important
[4] - slightly important
[5] - not at all important

...advantages that could enter into your decision about using solar energy in your home. ...how important it would be for you in making such a decision

XLOCAL | LOCAL
We should pay more attention to the particular energy needs of each city or town - and to meeting those needs through local resouces wherever possible.
[1] - strongly agree
[2] - agree
[3] - unsure
[4] - disagree
[5] - strongly disagree

same

XTRUST | TRUST
People like me should trust the federal government to find a solution to the energy crisis.
[1] - strongly disagree
[2] - disagree
[3] - unsure
[4] - agree
[5] - strongly agree

same

XRAFEDS | GOVIND
Increasing independence from federal government policies

SOLAR	NONSOLAR
Please indicate whether and how much you or members of your household engage in these activities:	
XSKILLS	SKILLS
Developing and using skills to increase self-reliance, such as in carpentry, car repair, food preservation.	
[1] - regularly [2] - usually [3] - frequently [4] - sometimes [5] - never	same

---

---

*XCNSBLFV = Resource conservation beliefs (XCUTCON + XRASHOR + XRACONS)	*CNSBLFV = (CUTCON + EASHORT + EASRES)
...list of factors that might have influenced your decision to adopt solar energy...how important [was] this advantage to you in making your decision to use solar energy. [1] - very important [2] - important [3] - somewhat important [4] - slightly important [5] - not at all important	...advantages that could enter into your decision about using solar energy in your home. ...how important it would be for you in making such a decision
XRASHOR Easing the energy shortage	EASHORT
XRACONS Conserving natural resources; protecting the environment	EASRES
XCUTCON People like me have a responsibility to help resolve our country's energy problems by cutting back on consumption, even if this means making some sacrifices in the way I live. [1] - strongly agree [2] - agree [3] - unsure [4] - disagree [5] - strongly disagree	CUTCON same

---

SOLAR	NONSOLAR
*XCNSBHRV = Conservation behavior (XRECYCL + XECOORG + XBUYCLO)	*CNSBHRV (RECYCL + ECOORG + BUYCLO)

Please indicate whether and how much you or members of your household engage in these activities:

XRECYCL Recycle the newspapers, glass or cans used at home. [1] - recycle all this material [2] - recycle most of this material [3] - about half of this material [4] - some of this material [5] - never recycle	RECYCL same
XECOORG Contribute to ecologically oriented organizations (such as the Sierra Club, etc.) [1] - contribute regularly to 2 or more organizations [2] - contribute regularly to 1 organization [3] - occasionally contribute [4] - used to contribute but no longer do [5] - never have contributed	ECOORG same
XBUYCLO Buying clothing at a garage sale or a second-hand store. [1] - all of the household clothing [2] - most items [3] - about half of the household's clothes [4] - a few items [5] - none of the household clothing	BUYCLO same

*XECCONSV = number of energy conservation behaviors which are performed by the household	*ECCONSV = same
[XECTH65 + XECTH78 + XECPOOL + XECCAR + XECSHUT + XECCALK + XECWIND + XECHWH + XECFIRE + XECAPPL + XECINSU + XECPUMP + XECTIMR + XECSTOV]	same
XECTH65 Set thermostat at 65 or lower in winter	ECTH65
XECTH78 Set thermostat at 78 or higher in summer	ECTH78

SOLAR	NONSOLAR
XECPOOL Carpool	ECPOOL
XECCAR Drive a small car	ECCAR
XECSHUT Install shutters or shades on windows	ECSHUT
XECCALK Install weatherstripping or caulk around doors or windows	ECCAULK
XECWIND Install storm or doublepane windows	ECWINDO
XECHWH Install temperature setting on hot water heater	ECHWH
XECFIRE Install glass doors, heatilator, or other energy saving device on fireplace	ECFIRE
XECAPPL Buy energy-efficient appliances	ECAPPL
XECINSU Add insulation	ECINSU
XECPUMP Install a heat pump	ECPUM
XECTIMR Install timer on heating system or furnace	ECTIMER
XECSTOVE Install wood stove	ECSTOVE

---

*XCMFRTV = SET as comfort and prestige (XRACOMF + XRAPRES)	*COMFRTV = (CMFRT + STATUS)
XRACOMF Increasing comfort of home	CMFRT
XRAPRES Increasing status, prestige, and self-esteem	STATUS

SOLAR	NONSOLAR
*XINVESTV = SET as financial investment (XRACOST + XRABILL + XRASAVE + XRAVALU)	*INVESTV = (EACOSTS + UTLBLS + SAVMNY + RESALE)
...list of factors that might have influenced your decision to adopt solar energy...how important [was] this advantage to you in making your decision to use solar energy. [1] - very important [2] - important [3] - somewhat important [4] - slightly important [5] - not at all important	...advantages that could enter into your decision about using solar energy in your home. ...how important it would be for you in making such a decision
XRACOST Protecting against rising energy costs	EACOSTS
XRABILL Reducing utility bills now	UTLBLS
XRASAVE Saving money over the long term	SAVMNY
XRAVALU Increasing resale value of home	RESALE

APPENDIX C: MODELS' CHARACTERISTICS

Table 38

PEARSON CORRELATIONS: SOLAR HOMEOWNERS

Variable	1	2	3	4	5	6	7	8	9
1.FAMTYPE									
2.NUMCHIL	.542								
3.AGE	.396	.392							
4.LADDER	.096	.060	.106						
5.HOUSE	.097	.068	.078	.049					
6.IMPACT	.068	.060	.077	.064	.024				
7.AVCOST	.059	.097	.050	-.007	-.004	.049			
8.LOCAL	.070	.056	.072	.011	.029	.095	.057		
9.STATE	.114	.068	.059	.023	.028	.076	.060	.517	
10.FEDERAL	.199	.139	.186	.025	.080	.097	.104	.352	.299
11.EDUCATION	.060	.008	.088	.142	.024	.072	.041	.059	.064
12.INCOME	.265	.166	.283	.085	.095	-.039	.198	.056	.049
13.PERSUP	.023	-.005	.015	.002	.007	.011	-.022	-.014	-.007
14.GRMEMBR	.030	-.010	.019	.092	.004	.026	-.031	.010	.031
15.OWNLENGTH	-.191	-.131	-.176	-.022	-.062	-.056	-.022	-.108	-.123
16.PASSYR	-.076	-.039	-.062	-.018	-.004	.019	.200	.069	.020
17.ACTYR	-.117	-.107	-.096	.005	-.042	-.046	-.069	-.110	-.098
18.COSTTECH	-.036	-.074	-.094	-.054	-.010	.015	-.035	.004	.003
19.ACTBLDMTD	-.021	-.017	-.027	.030	-.028	.001	-.077	-.044	-.034
20.PASBLDMTD	.078	.066	.031	-.032	.020	.015	.037	.002	.019
21.PRCOST	-.041	-.056	-.008	-.054	.017	-.066	.017	-.028	-.036
22.PRLCL	-.037	-.027	-.033	-.067	.019	-.084	.031	-.072	-.054
23.PRPEOP	.005	-.012	.023	-.068	.044	-.048	-.019	-.084	-.074
24.PRBLD	-.050	-.047	-.073	-.088	.004	-.087	-.029	-.129	-.102
25.PROPNG	-.005	-.010	-.027	-.115	.004	-.081	-.017	-.016	-.005
26.GENEVAL	.004	-.012	-.006	-.030	.012	-.018	-.103	.013	.026
27.RECMEN	.024	.008	.015	-.065	.031	-.004	-.096	.017	.029
28.ACTCOND	.055	.009	.027	-.035	.033	-.062	-.019	.048	.038
29.PASSCOND	.125	.061	.093	.126	.085	.018	-.028	.091	.091
30.TECEVAL	-.069	-.069	-.084	.026	-.002	-.098	-.060	-.096	-.061
31.ADDTECH	.071	.046	.082	.026	.028	.097	.020	.069	.085
32.TECHSUP	.009	.000	.014	-.033	.019	.019	.024	-.011	-.011
33.EXPSAVE	.015	.029	.010	-.001	-.016	-.001	.053	-.013	-.030
34.EYSLFREL	.022	.005	.048	-.014	-.005	.071	-.066	.056	.057
35.CNRBLF	-.019	-.021	-.005	-.057	-.003	.050	-.030	.048	.035
36.STATUS	-.013	-.051	-.013	-.018	-.022	.013	-.013	.025	.021
37.LCLSLFREL	.040	-.005	.049	.079	.036	.070	-.065	.035	.038
38.ECON	.096	.099	.119	-.059	.011	.056	-.043	.040	.042
39.CNRBHVR	-.037	-.040	-.037	.040	-.007	.049	-.042	.065	.070
40.EYCONS	.053	.045	.073	.031	.054	-.011	.073	.001	.001

Table 38 (cont.)

	10	11	12	13	14	15	16	17	18
11.EDUCATION	.095								
12.INCOME	.212	.310							
13.PERSUP	-.007	.062	.018						
14.GRMEMBR	-.049	.140	-.030	.066					
15.OWNLENGTH	-.304	-.065	-.156	.021	.088				
16.PASSYR	-.028	.012	.045	.035	-.008	.445			
17.ACTYR	-.261	-.012	-.156	.039	.050	.129	-.017		
18.COSTTECH	.007	-.087	-.166	.002	-.125	.071	.133	-.027	
19.ACTBLDMTD	-.101	-.070	-.157	.000	.029	.063	.004	.127	.087
20.PASBLDMTD	.056	-.145	-.017	-.041	-.149	-.035	-.014	-.260	.268
21.PRCOST	.006	.006	.056	.009	-.110	-.004	.065	-.029	.086
22.PRLCL	-.013	-.047	.007	.019	-.130	.009	.072	-.015	.093
23.PRPEOP	-.033	-.047	.016	.019	-.104	-.037	-.063	.013	.006
24.PRBLD	-.091	-.123	-.055	.049	-.024	.057	.074	.059	.128
25.PROPNG	.094	-.126	.020	.025	-.122	-.066	.031	.010	.166
26.GENEVAL	.043	.078	-.044	.139	.124	.051	.030	.035	.073
27.RECMEN	.042	.046	-.050	.107	.107	.059	.022	.052	.084
28.ACTCOND	.144	-.012	.058	.047	-.002	-.038	.060	-.017	.106
29.PASSCOND	.098	.274	.069	.076	.171	.015	.049	-.399	-.137
30.TECEVAL	-.108	.084	-.031	.096	.130	.130	.038	.072	.044
31.ADDTECH	.006	.067	-.054	.065	.241	.029	-.022	.098	-.015
32.TECHSUP	.016	-.054	-.025	.024	.032	-.025	.018	.020	.042
33.EXPSAVE	-.018	-.075	-.014	-.067	-.071	-.051	.011	-.038	-.058
34.EYSLFREL	.044	-.041	-.141	.081	.133	-.032	-.129	.078	-.070
35.CNRBLF	.059	.034	-.032	.056	.091	-.059	-.053	.030	-.049
36.STATUS	-.059	-.027	-.125	.061	.205	.036	-.094	.160	-.084
37.LCLSLFREL	-.021	.065	-.119	.087	.221	.033	-.103	.064	-.061
38.ECON	.110	-.107	-.062	.038	-.037	-.115	-.096	-.023	.026
39.CNRBHVR	.021	.175	-.059	.068	.197	.046	.027	.055	-.030
40.EYCONS	.027	.033	.083	-.024	-.023	.007	.083	-.072	.051

Table 38 (cont.)

	19	20	21	22	23	24	25	26
20.PASBLDMTD	.083							
21.PRCOST	-.017	.026						
22.PRLCL	-.002	.045	.346					
23.PRPEOP	-.022	.017	.322	.344				
24.PRBLD	.035	.080	.226	.246	.178			
25.PROPNG	-.032	.102	.228	.201	.231	.361		
26.GENEVAL	-.023	-.030	.037	-.020	.035	.133	.255	
27.RECMEN	-.001	-.042	.040	.001	.035	.107	.207	.596
28.ACTCOND	-.109	.038	.035	.022	.039	.155	.334	.374
29.PASSCOND	-.072	-.159	-.046	-.056	-.005	-.086	-.015	.198
30.TECEVAL	.009	-.073	.058	.018	.012	.151	.068	.219
31.ADDTECH	.039	-.114	-.078	-.084	-.039	-.088	-.054	.213
32.TECHSUP	.039	.035	-.017	.004	.004	.119	.184	.160
33.EXPSAVE	.028	.056	-.035	.005	-.033	-.080	-.130	-.386
34.EYSLFREL	.021	-.136	-.059	-.064	.003	-.045	-.015	.173
35.CNRBLF	-.002	-.116	.030	-.004	.022	-.009	.007	.132
36.STATUS	.059	-.198	-.069	-.034	-.029	-.043	-.055	.095
37.LCLSLFREL	.072	-.107	-.096	-.092	-.023	-.092	-.100	.129
38.ECON	-.010	.015	-.013	.016	.047	.007	.081	.135
39.CNRBHVR	.019	-.185	-.024	-.063	-.020	-.048	-.070	.104
40.EYCONS	.013	.082	.031	.016	-.020	-.011	-.009	-.031

	27	28	29	30	31	32	33	34	35
28.ACTCOND	.285								
29.PASSCOND	.163	.192							
30.TECEVAL	.186	.112	.078						
31.ADDTECH	.212	.021	.207	.029					
32.TECHSUP	.117	.155	-.061	.056	.068				
33.EXPSAVE	-.281	-.208	-.104	-.136	-.121	-.088			
34.EYSLFREL	.169	.028	.174	-.104	.233	.071	-.030		
35.CNRBLF	.126	.034	.078	-.024	.106	.044	-.016	.531	
36.STATUS	.104	-.047	.152	-.073	.212	.001	-.002	.401	.189
37.LCLSLFREL	.131	.002	.236	.018	.290	.061	-.082	.428	.158
38.ECON	.158	.085	.051	-.131	.046	.070	.010	.441	.198
39.CNRBHVR	.091	-.054	.125	.040	.187	-.004	-.068	.214	.306
40.EYCONS	-.051	.026	.021	.012	-.045	-.049	.012	-.141	-.146

Table 38 (cont.)

	36	37	38	39	40
37.LCLSLFREL	.272				
38.ECON	.246	.159			
39.CNRBHVR	.148	.189	-.093		
40.EYCONS	-.076	-.075	-.054	-.139	

Table 39

PEARSON CORRELATIONS: NONSOLAR HOMEOWNERS

Variables	1	2	3	4	5	6	7	8	9
1.FAMTYPE									
2.NUMCHIL	.561								
3.AGE	.288	.364							
4.LADDER	.021	.033	.001						
5.HOUSE	.068	.039	.032	.025					
6.IMPACT	.068	.136	.095	.041	.002				
7.AVCOST	.148	.182	.173	-.011	.005	.101			
8.STATE	.038	.053	.013	-.033	.014	.021	-.023		
9.FEDERAL	.122	.077	.128	-.063	.097	.053	.056	.191	
10.EDUCATION	.093	.071	.122	-.034	.091	.015	.104	.035	.266
11.INCOME	.382	.263	.394	-.036	.090	-.012	.223	.019	.294
12.PERSUP	.084	.095	.054	-.038	.001	.032	.013	.029	.081
13.GENEVAL	.182	.135	.130	-.064	.002	.090	.041	.040	.235
14.EASE	.116	.068	.075	-.007	-.006	-.006	.014	.041	.132
15.TECEVAL	-.001	.025	-.033	-.033	-.032	-.040	-.052	-.015	.143
16.BI	.089	.084	.064	-.031	-.040	.069	.023	.050	.242
17.INVEST	.086	.098	.053	-.068	-.008	.068	.017	.060	.018
18.WILLPAY	.155	.098	.105	-.011	.024	.020	.024	.014	.144
19.EYSLFREL	.102	.068	.109	-.051	-.020	.102	.053	.003	.019
20.CNRBLF	.075	.086	.097	-.058	.010	.098	.023	.009	.053
21.STATUS	.042	.024	.003	-.019	-.005	.056	.025	.077	-.093
22.LCLSFREL	.230	.115	.173	-.015	.006	.124	.013	.005	.139
23.ECON	.101	.090	.110	-.008	.037	.111	.088	.045	-.062
24.CNRBHVR	.097	.124	.079	-.013	.058	.012	-.063	.038	.113
25.EYCONS	.198	.116	.103	-.057	.002	.123	.073	-.013	.170

Table 38 (cont.)

	10	11	12	13	14	15	16	17	18
11.INCOME	.461								
12.PERSUP	.111	.127							
13.GENEVAL	.259	.295	.382						
14.EASE	.139	.201	.161	.312					
15.TECEVAL	.104	.058	.144	.309	.167				
16.BI	.227	.244	.170	.369	.342	.211			
17.INVEST	-.027	.046	.185	.395	.179	.218	.205		
18.WILLPAY	.179	.250	.201	.382	.199	.165	.230	.233	
19.EYSLFREL	-.008	.122	.122	.284	.122	-.142	.128	.207	.174
20.CNRBLF	.101	.149	.172	.329	.121	-.070	.133	.208	.214
21.STATUS	-.196	-.074	.037	.097	.050	-.152	.008	.193	.073
22.LCLSFREL	.096	.254	.103	.267	.130	.011	.186	.074	.172
23.ECON	-.060	.038	.063	.174	.092	-.224	.045	.181	.093
24.CNRBHVR	.113	.127	.088	.176	.099	.120	.140	.095	.158
25.EYCONS	.190	.271	.041	.223	.095	.040	.166	.054	.147

	19	20	21	22	23	24	25
20.CNRBLF	.636						
21.STATUS	.466	.280					
22.LCLSFREL	.359	.252	.140				
23.ECON	.683	.502	.546	.243			
24.CNRBHVR	.088	.133	.006	.149	.019		
25.EYCONS	.133	.182	-.009	.243	.055	.201	

Table 40

SPP SCALE WEIGHTS: ACTIVE AND PASSIVE TECHNOLOGY OWNERS

Variable:	Active	Passive
Energy self reliance	.77439	.74226
Local self reliance	.58445	.29312
Resource conservation attitudess	.74819	.62470
Resource conservation behavior	.62811	.67378
Energy conservation behavior	.37323	.86689
Personal noneconomic gains	.67064	.59034
Personal economic gains	.71391	.66532

Table 41

COMMUNITY PARTICIPATION: SOLAR AND NONSOLAR HOMEOWNERS

	SOLAR		NONSOLAR	
	%	Number Answered	%	Number Answered
Worked on community problems	39	(1477)	23	(464)
Contacted politicians	37	(1419)	16	(316)
Ran for a political office	3	(96)	1	(18)
Wrote letters to editors	18	(689)	7	(146)
Worked for a campaign	11	(416)	7	(132)
Officer of a community organization	25	(956)	11	(229)
Signed a petitian	52	(1964)	39	(789)
Gave neighbors advice	49	(1860)	41	(816)
None of these	16	(594)	36	(723)

Table 42

UNOPERATIVE PERIODS OF SOLAR SYSTEMS

	System - 1	System - 2	System - 1	System - 2
No. "down" times				
25% of samples	1	1	1	1
50% " "	2	2	2	2
75% " "	3	7	3	5
100% " "	400+	400+	100+	100+
$\bar{X}$	60	140	6	20
s.d.	222	329	18	38
Median	2	2	2	2
Range	1 - 400+	1 - 400+	1 - 100+	1 - 100+
Respondents	1284	122	162	34
Missing data	111	2397	198	847
No. years expected to last				
25% of samples	10	10	19	19
50% " "	20	20	25	29
75% " "	20	25	80	100
100% " "	400+	300+	600	600
$\bar{X}$	36	42	134	150
s.d.	79	74	219	228
Median	20	20	25	30
Range	1 - 400+	1 - 300+	1 - 600+	1 - 600+
Respondents	2534	354	836	224
Missing data	273	2422	228	835

Operating problems:	none	few	some	several	many	missing
Number of problems	69 2627)	20 (761	8 (293)	3 (97)	1 (31)	3% (101)

Table 43

THEORETICAL TRIMMED MODELS MANIFEST VARIABLES:
SOLAR AND NONSOLAR HOMEOWNERS

Variables:	NONSOLAR 1*	1,3** (weights)	1,2,3***	SOLAR 4#	4,5## (weights)	4,5,6!
ENERGY VULNERABILITY NEEDS						
Household Type	.607	.571	.570	.495	.501	.522
No. of Children	-.002	-.004	-.007	-.030	-.037	-.045
Age	.543	.564	.565	.493	.503	.509
Future "Energy Crisis"	-.159	-.125	-.125	-.101	-.096	-.005
Dwelling Type	.097	.135	.137	.226	.225	.208
Impacts of Energy Crisis	.058	-.086	-.086	-.150	-.131	-.039
Energy Costs	.170	.234	.236	.475	.462	.429
RESOURCES						
Problems-Costs Up	----	----	----	.075	.072	.011
Problems With Local Policies	----	----	----	.055	.051	.001
Problems With People	----	----	----	.117	.117	.141
Problems Building Technologies	----	----	----	.174	.166	.028
Local Support	----	----	----	-.029	-.028	-.015
State Support	.034	.027	.029	.088	.089	.117
Federal Support	.189	.182	.187	.552	.556	.621
Education	-.027	-.022	-.011	-.169	-.166	-.113
Income	.813	.822	.823	.657	.658	.642
Personal Support	.377	.364	.347	-.063	-.062	-.019
Solar Group Member	----	----	----	.190	-.186	-.039
TECHNOLOGY TYPE						
Ownership Length	----	----	----	.599	.522	-.703
Year Active Installed	----	----	----	.635	.578	-.690
Year Passive Installed	----	----	----	.136	-.072	-.241
Cost of Technology	----	----	----	-.023	-.067	-.135
Operating Problems	----	----	----	-.592	-.560	.370
EVALUATION						
General Evaluation	.828	.828	.828	.718	.309	.690
Recommended Adoption	.572	.572	.572	.671	.288	.655
Condition of Active system	----	----	----	.439	.119	.379
Condition of Passive system	----	----	----	.624	.431	.633
Technical Evaluation	.364	.366	.359	.080	-.120	.048
Adding Technologies	.648	.649	.647	.581	.350	.626
Technical Support	----	----	----	.246	.143	.218
Expected Energy Savings	.538	.537	.541	-.397	-.087	-.371
Willingness to Pay More Cost	.641	.642	.642	----	----	----
SOFT PATH PREFERENCES						
Energy Self Reliance	.788	.781	.810	.824	.339	.841
Conservation Attitudes	.738	.748	.763	.566	.168	.592
Noneconomic Gains	.432	.410	.468	.629	.285	.609
Local Self Reliance	.642	.637	.607	.701	.381	.681
Economic gains	.651	.630	.675	.436	.138	.482
Conservation Behaviors	.380	.396	.376	.457	.225	.440
Energy Conservation Behaviors	.490	.497	.447	-.228	-.070	-.210

1* = Drop Needs - Evaluation
1,3** = Drop Needs - Evaluation, Resources-SPP
1,2,3*** = Drop Needs - Evaluation, Resources-SPP, Needs-SPP
4# = Drop Needs - Tech Type
4,5## = Needs Tech Type, Needs-SPP
4,5,6! = Drop Needs - Tech Type, Needs-SPP, Resources-SPP

Table 44

THEORETICAL TRIMMED MODELS' - MANIFEST VARIABLES: ACTIVE AND PASSIVE TECHNOLOGY OWNERS

Variables:	Active 1*	Active 1,2# (weights)	Active 1,2,3!	Passive 1*	Passive 1,2# (weights)	Passive 1,2,3!
ENERGY VULNERABILITY NEEDS						
Household Type	.490	.484	.485	.063	.139	.064
No. of Children	-.074	-.062	-.061	-.205	-.331	-.243
Age	.605	.592	.591	.415	.519	.551
Future "Energy Crisis"	.135	.154	.154	.087	.107	.146
Dwelling Type	.118	.125	.124	.268	.278	.319
Impacts of Energy Crisis	.010	-.029	-.025	-.219	-.130	-.033
Energy Costs	.319	.340	.338	.787	.714	.695
CONTEXTUAL RESOURCES						
Problems-Costs Up	-.020	-.018	-.019	.121	.117	-.025
Problems With Local Policies	-.016	-.011	-.012	.115	.086	-.030
Problems With People	.109	.105	.108	-.099	-.085	.041
Problems Building Technologies	-.174	-.173	-.176	-.021	-.016	-.063
Local Support	-.036	-.039	-.038	-.105	-.111	-.077
State Support	.138	.137	.139	-.032	-.030	.033
Federal Support	.563	.558	.564	.042	.048	.138
Education	.012	.009	.009	-.060	-.062	-.039
Income	.645	.653	.646	.933	.941	.912
Solar Group Member	-.026	-.027	-.018	-.303	-.289	-.330
TECHNOLOGY TYPE						
Ownership Length	.869	.868	.868	.207	.213	.315
Year Active Installed	.762	.761	.762	----	----	----
Year Passive Installed	----	----	----	-.006	.001	.110
Cost of Technology	.383	.385	.385	.664	.670	.684
Active Building Method	.441	.442	.440	----	----	----
Passive Building Method	----	----	----	.880	.876	.843
EVALUATION						
General Evaluation	.741	.742	.744	.728	.726	.732
Recommend Adoption	.722	.723	.724	.752	.751	.759
Condition of Active System	.402	.401	.402	----	----	----
Condition of Passive System	----	----	----	.314	.317	.343
Technical Evaluation	-.041	-.038	-.036	.115	.110	.118
Adding Technologies	.686	.687	.686	.594	.594	.582
Technical Support	.357	.356	.355	.179	.174	.179
Expected Energy Savings	-.451	-.452	-.453	-.058	-.052	-.074
SOFT PATH PREFERENCES						
Energy Self Reliance	.856	.852	.851	.829	.823	.821
Conservation Attitudes	.636	.650	.655	.576	.556	.570
Noneconomic Gains	.576	.573	.566	.507	.524	.558
Local Self Reliance	.615	.608	.605	.649	.669	.610
Economic Gains	.584	.567	.568	.562	.563	.619
Conservation Behavior	.340	.362	.369	.453	.432	.392
Energy Conservation Behavior	-.195	-.218	-.212	-.324	-.300	-.311

1* = Drop Needs - Tech Type
1,2# = Drop Needs - Tech Type, SPP
1,2,3! = Drop Needs - Tech Type, SPP, Resources-SPP

Table 45

THEORETICAL TRIMMED MODELS - GOODNESS OF FIT:
SOLAR AND NONSOLAR HOMEOWNERS

Trimmed relationships	NONSOLAR 1*	1,3**	1,2,3	SOLAR 4#	4,5##	4,5,6!
			BETAS			
LATENT VARIABLES:						
Needs - Resources	.389	.387	.396	.369	.371	.401
Needs - Evaluation	----	----	----	----	----	----
Needs - Tech Type	----	----	----	----	----	----
Needs - Spp	.165	.175	----	.017	----	----
Resources - Evaluation	.473	.472	.470	-.422	-.422	.412
Resources - Tech Type	----	----	----	----	----	----
Resources - Spp	.042	----	----	-.175	-.166	----
Tech Type - Evaluation	----	----	----	-.159	-.156	.115
Evaluation - Spp	.342	.357	.393	.352	.355	.371
			R-SQUARE			
Resources	.152	.150	.157	.136	.138	.161
Evaluation	.224	.223	.221	.025	.024	.013
Tech Type	----	----	----	.178	.178	.170
Spp	.188	.184	.157	.156	.156	.138
No. parameters	30	29	28	44	43	42
No. iterations	7	7	6	93	90	64
Chi-square (no model)	5.141	5.143	5.141	6.725	6.725	6.725
(d.f.)	300	300	300	703	703	703
Chi-square (with model)	2.212	2.178	2.151	4.992	4.981	4.912
(d.f.)	269	269	269	655	655	655
Bentler-Bonnett	.570	.576	.582	.258	.259	.270

1* = Drop Needs - Evaluation
1,3** = Drop Needs - Evaluation, Resources-SPP
1,2,3*** = Drop Needs - Evaluation, Resources-SPP, Needs-SPP
4# = Drop Needs = Tech Type
4,5## = Drop Needs - Tech Type, Needs-SPP
4,5,6! = Drop Needs - Tech Type, Needs-SPP, Resources-SPP

Table 46

TRIMMED MODELS - GOODNESS OF FIT:
ACTIVE AND PASSIVE TECHNOLOGY OWNERS

Trimmed relationships	Active 1*	Active 1,2#	Active 1,2,3!	Passive 1*	Passive 1,2#	Passive 1,2,3!
			BETAS			
LATENT VARIABLES:						
Needs - Resources	.437	.438	.438	.429	.436	.446
Needs - Tech Type	----	----	----	----	----	----
Needs - Spp(2)	.064	----	----	-.127	----	----
Resources - Tech Type	-.404	-.403	-.403	-.380	-.381	-.386
Resources - Spp	-.058	-.031	----	-.159	-.216	----
Tech Type - Evaluation	.040	.041	.042	.212	.213	.221
Evaluation - Spp	.320	.321	.320	.331	.331	.375
			R-SQUARE			
Resources	.191	.192	.192	.184	.190	.199
Tech Type	.163	.162	.163	.144	.145	.149
Evaluation	.002	.002	.002	.045	.045	.045
Spp	.107	.103	.102	.197	.188	.141
No. parameters	41	40	39	41	40	39
No. iterations	12	13	12	12	13	13
Chi-square (no model)	6.142	6.142	6.142	7.198	7.198	7.198
(d.f)	435	435	435	595	595	595
Chi-square(with model)	3.551	3.557	3.546	6.033	6.026	5.965
(d.f.)	395	395	395	550	550	550
Bentler-Bonnett	.422	.421	.423	.162	.163	.171

1* = Drop Needs - Tech Type
1,2# = Drop Needs - Tech Type and Needs-SPP
1,2,3! = Drop Needs - Tech Type, Needs-SPP, Resources-SPP

Table 47

MODIFIED TRIMMED MODELS - MANIFEST VARIABLES:
SOLAR HOMEOWNERS

Variables:	SOLAR 1* (weights)	1,2#	1,2,3!
ENERGY VULNERABILITY NEEDS			
Household Type	.493	.493	.498
No. of Children	----	----	----
Age	.509	.508	.504
Future "Energy Crisis"	----	----	----
Dwelling Type	.187	.187	.188
Impacts of "Energy Crisis"	----	----	----
Energy Costs	.431	.433	.431
CONTEXTUAL RESOURCES			
State Support	.092	.092	.111
Federal Support	.536	.536	.569
Income	.712	.712	.675
Personal Support	----	----	----
Solar Group Member	----	----	----
TECHNOLOGY TYPE			
Ownership Length	.680	.680	.689
Year Active Installed	.660	.660	.666
Year Passive Installed	.259	.259	.263
Cost of Technologies	.321	.321	.299
Active Building Method	.474	.474	.466
Passive Building Method	-.077	-.077	-.093
PROBLEMS			
Problems - Costs Up	.332	.333	.336
Problems With Local Policies	.260	.261	.264
Problems With People	.331	.331	.334
Problems Building Technologies	.687	.688	.687
Operating Problems	.919	.918	.919
EVALUATION			
General Evaluation	.832	.832	.833
Recommend Adoption	.759	.759	.759
Condition of Active System	.620	.619	.625
Condition of Passive System	.337	.335	.329
Technical Evaluation	.268	.272	.271
Adding Technologies	.355	.354	.343
Technical Support	.378	.379	.381
Expected Energy Savings	-.507	-.508	-.507
SOFT PATH PREFERENCES			
Energy Self Reliance	.850	.847	.856
Conservation Attitudes	.583	.599	.632
Noneconomic Gains	.597	.593	.549
Local Self Reliance	.679	.670	.649
Economic Gains	.535	.511	.549
Conservation Behavior	.384	.411	.407
Energy Conservation Behavior	-.233	-.263	-.229

1* = Drop Needs - SPP
1,2# = Drop Needs - SPP and Needs - Tech Type
1,2,3! = Drop Needs - SPP, Needs - Tech Type, and Resources-SPP

Table 48

MODIFIED TRIMMED MODELS - MANIFEST VARIABLES:
ACTIVE AND PASSIVE TECHNOLOGY OWNERS

Variables:	Active 1*	Active 1,2#	Active 1,2,3! (weights)	Passive 1*	Passive 1,2#
ENERGY VULNERABILITY NEEDS					
Household Type	.495	.495	.453	----	----
No. of Children	----	----	----	-.226	-.226
Age	.594	.579	.606	.579	.574
Future "Energy Crisis"	----	----	----	.126	.144
Dwelling Type	.103	.110	.135	.302	.307
Impacts of "Energy Crisis"	----	----	----	-.112	-.109
Energy Costs	.311	.341	.353	.697	.697
CONTEXTUAL RESOURCES					
State Support	.141	.143	.139	----	----
Federal Support	.585	.583	.583	.018	.010
Income	.658	.659	.661	.907	.914
Personal Support	----	----	----	-.288	-.280
Solar Group Member	----	----	----	-.306	-.297
TECHNOLOGY TYPE					
Ownership Length	.882	.882	.878	.319	.226
Year Active Installed	.776	.776	.773	----	----
Year Passive Installed	----	----	----	.159	.040
Cost of Technologies	.378	.378	.367	.701	.697
Active Building Method	.397	.398	.422	----	----
Passive Building Method	----	----	----	.830	.859
PROBLEMS					
Problems - Costs Up	.385	.384	.384	.276	.277
Problems With Local Policies	.333	.333	.332	.530	.530
Problems With People	.387	.387	.387	.549	.549
Problems Building Technologies	.632	.632	.630	.764	.763
Operating Problems	.915	.915	.916	.804	.806
EVALUATION					
General Evaluation	.835	.835	.835	.826	.826
Recommend Adoption	.768	.768	.767	.765	.765
Condition of Active System	.712	.711	.711	----	----
Condition of Passive System	----	----	----	.573	.573
Technical Evaluation	.231	.233	.232	.252	.252
Adding Technologies	.289	.291	.291	.279	.279
Technical Support	.381	.381	.381	.285	.285
Expected Energy Savings	-.554	-.554	-.554	-.369	-.369
SOFT PATH PREFERENCES					
Energy Self Reliance	.857	.854	.854	.828	.829
Conservation Attitudes	.641	.686	.686	.553	.554
Noneconomic Gains	.480	.484	.484	.533	.531
Local Self Reliance	.574	.568	.568	.658	.658
Economic Gains	.705	.646	.646	.573	.573
Conservation Behavior	.245	.310	.310	.429	.429
Energy Conservation Behavior	-.136	-.232	-.232	-.283	-.282

1* = Drop Needs - SPP
1,2# = Drop Needs - SPP and Needs - Tech Type
1,2,3! = Drop Needs - SPP, Needs - Tech Type, and Resources-SPP

Table 49

MODIFIED TRIMMED MODELS - GOODNESS OF FIT:
ACTIVE AND PASSIVE TECHNOLOGY OWNERS

Variables:	Active 1*	1,2#	1,2,3!	Passive 1*	1,2#	1,2,3!
			BETAS			
Needs - Resources	.426	.427	.427	.439	.440	.431
Needs - Tech Type	-.102	-.101	----	.178	----	----
Needs - Spp	.083	----	----	----	----	-.204
Resources - Tech Type	-.348	-.348	-.392	-.477	-.405	-.405
Resources - Spp	----	----	----	-.236	-.238	-.262
Tech Type Problems	.042	.042	.037	-.003	-.007	----
Problems - Evaluation	.372	.372	.373	.256	.256	.266
Evaluation - Spp	.188	.187	.187	.219	.219	.139
			R-SQUARE			
Resources	.181	.182	.182	.193	.194	.186
Tech Type	.162	.162	.154	.185	.164	.164
Problems	.002	.002	.001	.000	.000	.000
Evaluation	.139	.139	.139	.066	.066	.125
Spp	.042	.035	.035	.124	.124	.101
No. parameters	37	36	35	40	39	39
No. iterations	11	9	9	16	17	22
Chi-square (no model)	5.096	5.096	5.096	6.494	6.494	6.494
(d.f)	435	435	435	528	528	528
Chi-square (with model)	2.686	2.655	2.650	4.962	4.955	4.957
(d.f.)	390	390	390	480	480	480
Bentler-Bonnett	.473	.479	.480	.236	.237	.237

1* = Drop Needs - Tech Type
1,2# = Drop Needs - Tech Type and Needs-SPP
1,2,3! = Drop Needs - Tech Type, Needs-SPP, Resources-SPP

Table 50

MODIFIED TRIMMED MODELS - GOODNESS OF FIT:
SOLAR HOMEOWNERS

Variables:	1*	Solar 1,2#	1,2,3!
		BETAS	
Needs - Resources	.440	.441	.445
Needs - Tech Type	-.177	----	----
Needs - Spp	----	----	----
Resources - Tech Type	.475	.403	.407
Resources - Spp	-.242	-.243	----
Tech Type Problems	.003	.008	.011
Problems - Evaluation	.257	.257	.261
Evaluation - Spp	.215	.216	.272
		R-SQUARE	
Resources	.194	.195	.198
Tech Type	.183	.163	.165
Problems	.000	.000	.000
Evaluation	.066	.066	.068
Spp	.126	.126	.074
No. parameters	44	43	42
No. iterations	15	15	15
Chi-square (no model)	7.737	7.737	7.737
(d.f)	666	666	666
Chi-square (with model)	6.085	6.075	6.082
(d.f.)	614	614	614
Bentler-Bonnett	.214	.215	.214

1* = Drop Needs - SPP
1,2# = Drop Needs - SPP and Needs - Tech Type
1,2,3! = Drop Needs - SPP, Needs - Tech Type, and Resources - SPP

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