AN ABSTRACT OF THE THESIS OF

Martin Marganus for the degree of Doctor of Philosophy

in Family Resource Management presented on August 29, 1983

Title: A Market Oriented Approach to Energy Conservation Identifying Disadvantaged Families as Target Groups for Energy Assistance Programs

Abstract approved: Redacted for Privacy
(Dr. Suzanne Badenhop)

Energy expenditures, perceived family well being, and energy conservation actions were analyzed by family composition and level of income. Data were from a three state subsample (Arizona, Colorado, and Oregon; N = 2,633) of a larger stratified random sample of households in the Western United States. Data were collected in the spring of 1981 by mail survey.

Self-reported total annual energy expenditures were correlated with scores on an Index of Well Being, a measure of the perceived level of cut-backs in areas of consumption other than energy, due to rising fuel prices. No significant ($p \leq .05$) correlation was found between energy expenditures and scores on the Index of Well Being. The proportion of income spent on residential energy (energy budget share), however, was significantly ($p = .001$) correlated with the Index of Well Being ($r = -.247$).

Families were classified according to the age and marital status of the head of household, and the number of dependents in the family. One-way analysis of variance was used to test differences in energy expenditures, the energy budget share, and scores on the Index of Well Being between family types and families at different income levels. All

variables differed significantly ($p \leq .001$) between groups. Families past retirement age had an average energy budget share of almost twice the amount of other families. The form of relationship was tested by fitting linear, quadratic, and cubic contrasts to the group means. Energy expenditures varied across stages in the family-life-cycle in the form of an inverted U. Interactions between the two grouping factors, family composition and income, were tested in a two-way analysis of variance. Only in the case of the energy budget share a significant ($p \leq .05$) interaction was found. There was no significant effect of climate on energy expenditures.

Log-linear analysis was used to find differences in the probability with which families at different stages in the family-life-cycle and at different income levels had taken various energy conservation actions. Models were fitted to five-way frequency tables of energy conservation actions by age and marital status of the head of household, family size, and income. Conservation actions were classified as energy efficiency improvements or curtailments. The probability of efficiency improvements generally increased with age and income, while no clear trend existed for curtailments. A stepwise logistic regression procedure was employed to find socioeconomic and housing factors associated with the differences in conservation actions between family types and income groups. Interfamily differences in energy conservation actions were largely determined by differences in the built environment. The probability for having taken conservation actions was lowest in rented multi-family dwellings, built before 1975. Weatherization programs should, therefore, be targeted to these dwellings. Since loans were equally used by all income groups, but tax credits more often by high income families, a loan program would be a more equitable way to encourage energy conservation than tax credits.

A Market Oriented Approach to Energy Conservation
Identifying Disadvantaged Families as Target
Groups for Energy Assistance Programs

by

Martin Marganus

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Doctor of Philosophy

Completed August 29, 1983

Commencement June 1984

APPROVED:

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Date thesis is presented August 29, 1983

typed by: Martin Marganus

Acknowledgements

I am greatly endebted to Dr. Suzanne Badenhop and Dr. Geraldine Olson for their encouragement and guidance in completing my doctoral program and the dissertation in particular. Their comments and constructive critizism have contributed greatly to the quality of this dissertation.

Dr. Fred Ramsey, Dr. Carvel Wood, and Dr. Floyd McFarland served on my doctoral committee and I want to thank them for their suggestions and their help.

A big THANK YOU goes to my friend Toni Remmele who not only provided moral support during difficult times but who also shared the late night hours with me creating the illustrations and tables in this dissertation.

Finally I would like to say thank you to all faculty members and students in the Family Resource Management Department. They made the more than three years here at Oregon State University an interesting, exciting, and enjoyable experience.

Data for this study were provided by the Western Regional Agricultural Experiment Station Project (W-159) "Consequences of Energy Conservation Policies for Western Regional Households", which was partly funded by a grant from the U.S. Department of Agriculture.

Funds for the computer analysis were provided by an unsponsored research grant from the Milne Computer Center at Oregon State University.

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CHAPTER I

INTRODUCTION

Statement of the Problem

Assuring an adequate supply of energy at affordable prices remains a serious problem in the minds of Americans despite a recent oil glut on world markets (Honeywell Study, 1982). A 1981 national opinion poll found that cutting back on heating and air conditioning were the two most frequently cited areas were Americans had made sacrifices in response to inflation; 91 percent of the respondents had made sacrifices of some sort (Alderman and Begans, 1981). A recent nationwide study by Honeywell (1982) found that 62 percent of the respondents felt energy costs were a very serious threat to the American standard of living and that this feeling was even more pronounced among low-income families (Honeywell Study, 1982). Increasing fuel prices and dwindling supplies of energy have spurred research in two directions - development of new energy resources and more efficient energy use. This study focuses on the latter strategy.

Energy conservation not only involves technological advances but also the personal commitment of consumers to change their behavior. Federal energy policies and regulations such as the 55 mph speed limit, mandatory fuel efficiency standards for automobiles (CAFE), efficiency ratings of home appliances, and tax credits for energy saving home improvements are directed toward forced energy conservation. While these regulations have been effective in reducing energy demand to some extent in a relatively short time, an approach to energy conservation based on market principles, where rising energy prices induce energy conservation, has been advocated by several authors (i.e. International Energy Agency, 1976; Russell, 1979; Ross and Williams, 1981; Feiveson and Rabl, 1982; Hirst et al. 1982). It is also the energy policy of the Reagan Administration. The concept of a market approach to energy conservation rests on the conviction that current energy prices are kept artificially low. Thus, when prices were allowed to rise to a level where they would represent their true cost, investing in energy conservation would have much greater appeal than it presently has. There is evidence that rising fuel prices had a strong impact on reducing energy demand during the past decade (U.S. Bureau of the Census, 1981; Monthly Labor Review).

The market approach has been criticized not only of being an "insufficient base for resource management policy" (Winkler and Winett, 1982, p. 434), but more importantly, of being inequitable. Morell (1981) in a paper on energy conservation and public policy pointed out:

> Contrasts between the economical behavior of those who can afford to conserve energy and those who cannot is another area worthy of sensitive new research. Equity concerns dominate the discourse about energy pricing (...), but such equity considerations normally remain unstated in the conservation debates (p. 27).

Dillman et al. (1982), reporting on the effects of rising energy prices on lifestyle, concluded that the poor were forced to accept a lower standard of living, while the rich invested in energy conservation.

Realizing the problems of low-income families dealing with soaring energy prices, three types of energy assistance programs were started by the federal government and utility companies in the winter of 1976-77. First, low-income fuel assistance programs were intended to help poor families pay their fuel bills and assist them in emergencies. These programs were initiated by the federal government but now are entirely administered by the states. Second, an inverted rate structure of utility companies granting a basic supply of energy at a low rate to all families, a policy also referred to as life-line utility rates. And third, low-income weatherization programs were offered as a more permanent solution to the problem of high energy costs. Designing programs for maximum efficiency was a difficult task and it was not made easier by the scarcity of relevant data. Hirst and Goeltz (1982) noted:

> (There are) large variations among households in their recent conservation actions. These variations suggest the importance of carefully examining the factors that account for differences among households. Program managers and policy analysts cannot assume that households are homogeneous (...). These differences among households must be taken into account in the design and implementation of conservation programs, their subsequent evaluation, and in the development of energy use models that project future levels of energy use (pp. 146 f).

Therefore, information is needed on energy consumption for different family types at different income levels. Furthermore, a measure for the adverse effects of rising energy prices is needed to identify families in need of energy assistance programs. And, finally, an analysis of the differences between low-income and other families in their energy conservation efforts is needed.

Purpose of the Study

This study provides information relevant for designing programs that help low-income families deal with rising energy cost. Families are classified into family types according to the age and marital status of the head of household, and the number of dependents. The classification is an extension of the family-life-cycle concept since it incorporates middle-aged and older unmarried individuals, as well as single-parent families. Disaggregate data for different family types are used throughout the analysis so that family-specific conclusions can be drawn.

Different family types at different income levels are analyzed as to how they vary in the highest educational level of the household, occupation of the head of household, and how the characteristics of the home in which they live differ. Mean overall energy expenditures are computed for different family types and at different income levels to provide guidlines for determining benefits. Eligibility criteria for energy assistance programs establish who should receive benefits. The current practice in the majority of states makes eligible only those families who have incomes at or below 125 percent of the official poverty level. This procedure, based strictly on money, was considered insufficient and was therefore supplemented by a more psychological measure, the perceived well being of a family. To that purpose an index was created that summarizes the extent of cut-backs a family reportedly had to make in several areas of consumption due to rising energy cost. The Index of Well Being is a psychological measure since only perceived cuts are considered.

In order to help low-income families make ends meet new utility rate structures have been proposed. The first specified amount of energy (kwh or therms) used thereby would be sold at a low per unit rate and higher rates would be charged beyond that. It has been argued that these life-line utility rates indiscriminately benefit all thrifty energy users and not just the poor. Finding the right amount of subsidized life-line energy that best serves poor families is, therefore, a matter of judgement.

Low-income weatherization programs are an attempt to provide a more permanent solution to the problems of poor families experiencing rising fuel prices. Differences between low-income and other families regarding the extent to which they have taken selected conservation actions are analyzed so that weatherization programs can be targeted to those conservation measures that are not yet widely used among poor families. In addition the extent to which other personal and housing characteristics influence the adoption of these conservation measures are examined. This provides guidelines for developing an effective low-income weatherization program. Home improvement loans and tax credits have been used as incentives for investing in energy efficiency. Yet it is unclear whether low-income families have taken advantage of these programs. Therefore, the extent to which loans have been utilized and tax credits have been claimed by families at different income levels is analyzed.

Limitations

The study is limited in the following ways:

It focuses on energy conservation rather than development of new energy resources as a way to solve the energy problem.

It deals exclusively with residential energy consumption which accounts for about one fifth of all direct energy use. Thus, it leaves out aspects of energy use in public and private transportation, the industrial, and the commercial sector where four fifth of the energy are consumed.

The study emphasizes market oriented policy strategies and offers guidelines as to how their undesirable effects on low-income families could be mitigated. It does not concern itself explicitly with mandatory government policies aimed at industry and consumers, or with policies directed at increasing energy supplies.

The sample was drawn from telephone directories which may have introduced some bias. It was also stratified to yield an equal number of urban (SMSA) and rural (non-SMSA) households and thus oversampled rural households.

List of Variables

Family composition has been conceptualized in a family-life-cycle framework in marketing research, studies on family relations and financial management, and other areas where it was found useful. The family-life-cycle concept has evolved over time into a more and more complex framework for classifying families. Murphy and Staples (1979) identified as a major shortcoming of all family-life-cycle classifications that they ignore that family patterns have changed dramatically. During the past decades, the traditional family-life-cycle concept has become inadequate since too many families could no longer be classified by it. In order to take into account the high incidence of divorce, Murphy and Staples devised a modernized family-life-cycle as shown in Figure 1.

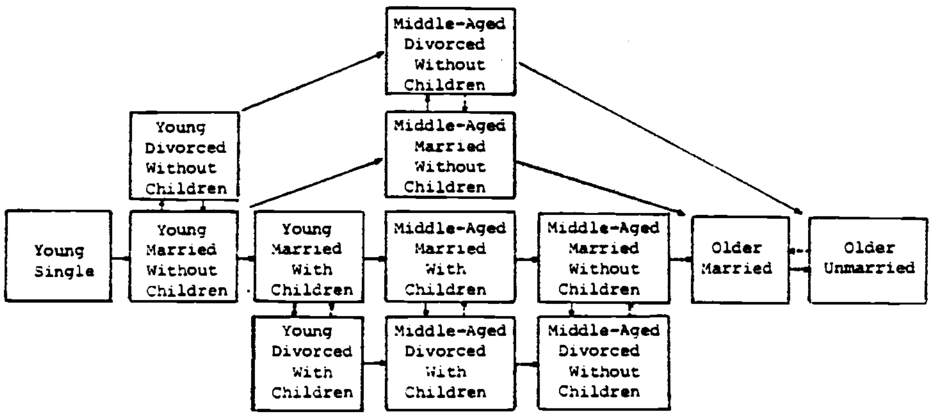


Figure 1. The Family Life Cycle as Devised by Murphy and Staples.
(Murphy and Staples, 1979, p.16)

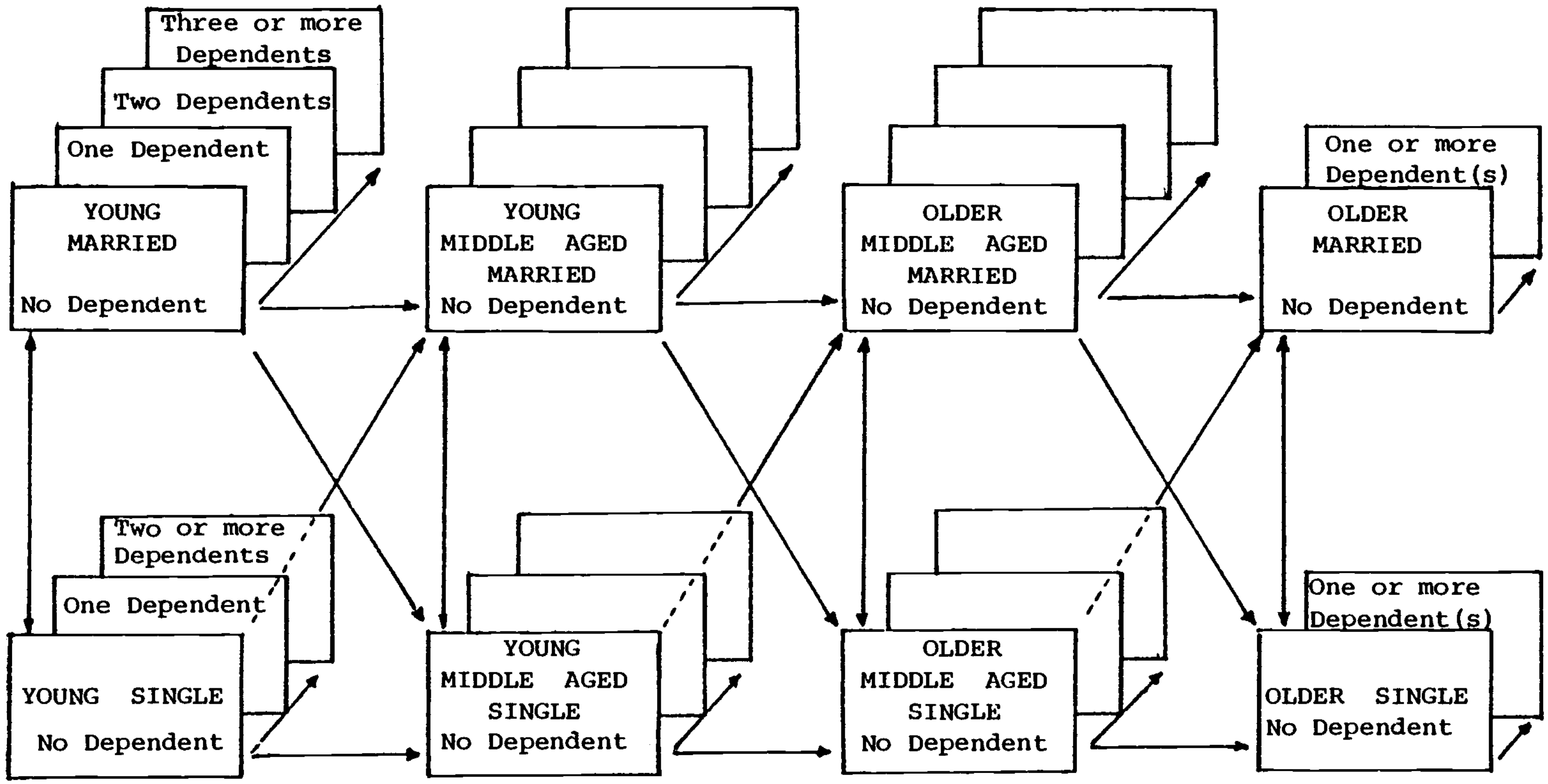
Building on Murphy and Staples' classification, families were distinguished in this study according to the age of the head of household. There were four groups, young (under 35 years of age), young middle-aged (35 to 49 years of age), older middle-aged (50 to 64 years of age), and older (65 and over) families. A further distinction was made depending on whether the head of household was married or not (i.e. never married, separated, divorced, or widowed). To assure comparability, the male head of household was chosen for reference, except in families where no male was present. Finally, families were distinguished according to the number of dependents (0, 1, 2, 3 or more) who live in the household. For this analysis children as well as adults other than the spouse (i.e. grandparent) were considered dependents. In ninety percent of the cases, however, these were actually children. In its final form there is a traditional (i.e. married) life-cycle, and a non-traditional (i.e. single) life-cycle. Movement between the two are possible through events like marriage, divorce, or widowhood. Figure 2 is an attempt to visualize family composition in its three dimensions.

Total family income was a categorical variable measured at nine levels. It was the gross yearly family income before taxes in 1980.

Low-income families were those families with an income of less than $ 15,000 a year. For most low-income energy assistance programs in the western region, however, the eligibility criterion has been set to 125 percent of the official poverty level. This official poverty level varies according to the number of household members and whether the household is part of a farm or not. It is also adjusted for inflation each year by the Consumer Price Index. For a one-person household, for instance, an income equivalent to 125 percent of the poverty level was $ 5,230 a year in 1980. And a family of five would not have qualified for energy assistance unless it had an income of no more than $ 12,404 per year. The definition adopted for this study therefore covered a wider range of income than is the current practice in most states.

The energy budget share has been found to be a better predictor of energy conservation activities than either income or energy expenditures (Winkler and Winett, 1982). It was the percentage of total family income spent for all types of energy, excluding gasoline.

Figure 2. Proposed Model of the Family-Life-Cycle



The Index of Well Being was computed from a set of twelve statements asking families to indicate the extent to which they were forced to make cut-backs in different consumption areas and how well-off they felt overall. Individual responses were transformed and added up to an index score ranging between 12, meaning that many cut-backs had been made, and 49, meaning that no cut-backs had been made. An almost identical measure called "lifestyle cut-backs" was developed and proved useful in a study by Dillman et al. (1982).

Climate was operationalized using two variables, heating and cooling degree days in a given locale. Heating degree days are the number of degrees Fahrenheit the average daily temperature is below 65 ^{o}F summed over an entire year. Similarly, cooling degree days are the number of degrees Fahrenheit the average daily temperature is above 65 ^{o}F, again summed over the year. Degree days are a concise statement about the thermal harshness of a given geographic area and thus are a useful figure to determine the energy demand for heating and cooling equipment. A map of average heating and cooling degree days for the Western United States is given in Figure 3.

Personal characteristics were the occupation of the head of household, the highest level of education in the family (either the head of household or spouse), total family income, and the type of family as previously defined.

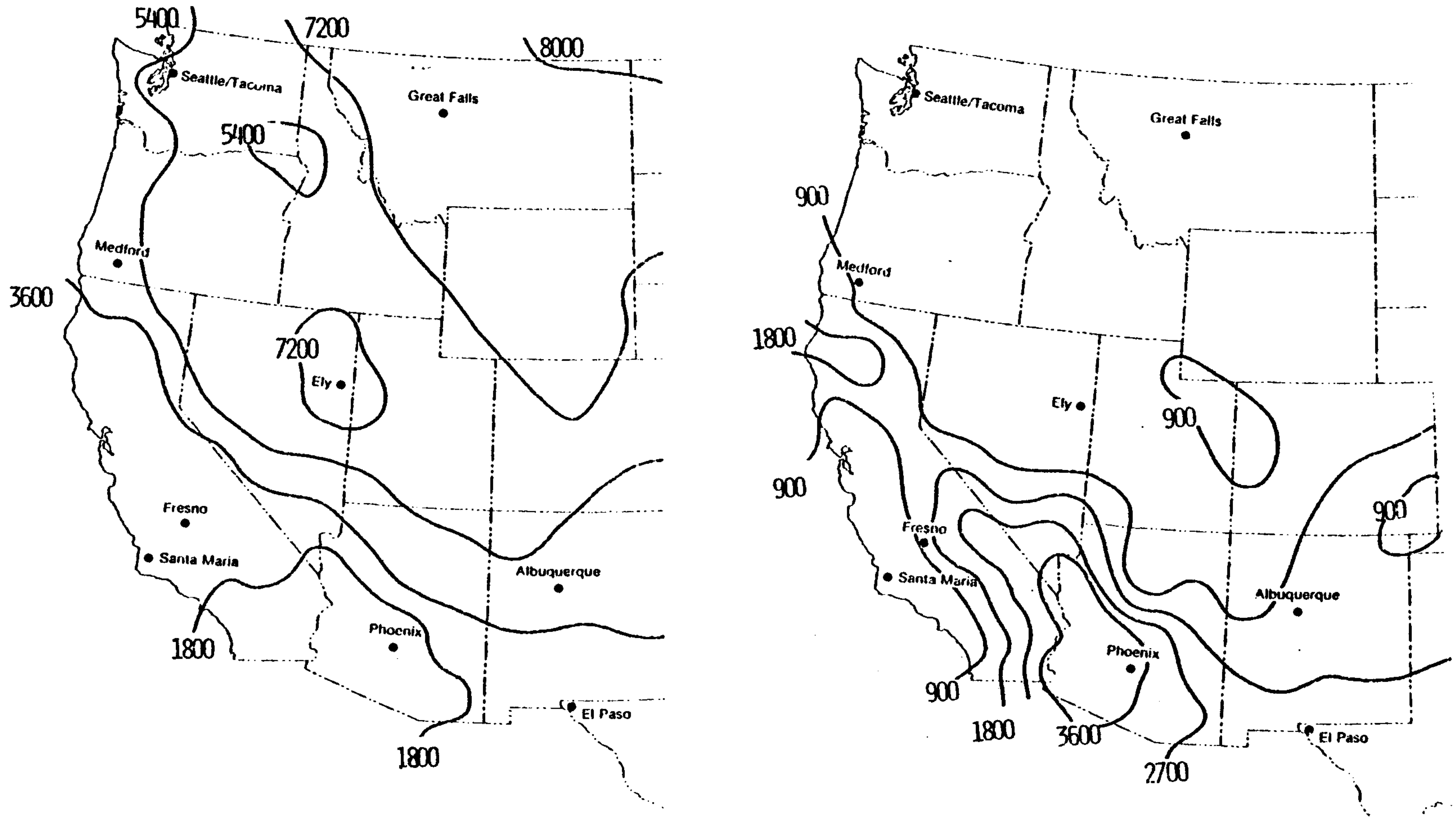
Housing characteristics were the type of house (single-family detached, multi-family unit, mobile home), the size of a house in square feet, the year of construction, the number of years a family has lived in a house, tenure (rented vs. owned), and the main fuel used for home heating (natural gas, electricity, wood, oil, others).

A complete list of the original variables that were used in the analysis is given in Appendix E.

Figure 3. Map of Average Heating and Cooling Degree Days for the Western United States

(Solar Energy Research Institute (SERI). Solar Radiation Energy Resource Atlas of the Unites States. Washington D.C.: U.S. Government Printing Office, 1981.)

HEATING DEGREE DAYS COOLING DEGREE DAYS



List of Hypotheses

In order to determine whether differences in personal and housing characteristics existed between families at different stages in the family-life-cycle and at different income levels the following hypotheses were tested:

H_o1 There is no difference between families at different stages in the family-life-cycle (according to marital status, age of the head of household, and family size) and at different income levels as to the:

H_o1 a Occupation of head of household.

H_o1 b Highest education in the family.

H_o1 c Type of house.

H_o1 d Size of house (in sq. ft.).

H_o1 e Year of construction.

H_o1 f Years in present home.

H_o1 g Tenure (rent vs. own).

H_o1 h Main fuel used for heating.

H_o1 i Location (rural vs. urban).

H_o1 j State.

Test statistic: Fitting of log-linear model to five-way frequency table using chi-square goodness-of-fit test.

In order to find differences in energy expenditures between families at different stages in the family-life-cycle and at different income levels the following hypotheses were tested:

H_o2 a There is no significant difference in energy expenditures at different income levels.

H_o2 b There is no significant difference in energy expenditures across stages in the family-life-cycle (i.e. marital status, age of head of household, and family size).

H_o2 c There is no significant interaction between income and the stage of the family-life-cycle.

In order to find differences in the percentage of income spent for residential energy between families at different stages in the family-life-cycle and at different income levels the following hypotheses were tested:

H_o3 a There is no significant difference in the percentage of income spent for residential energy between families at different levels of income.

H_o3 b There is no significant difference in the percentage of income spent for residential energy between families at different stages in the family-life-cycle (i.e. marital status, age of the head of household, and family size).

H_o3 c There is no significant interaction between income and stage of the family-life-cycle.

In order to find differences in perceived family well being between families at different stages in the family-life-cycle and at different income levels the following hypotheses were tested:

H_o4 a There is no significant difference in perceived family well being between families at different income levels.

H_o4 b There is no significant difference in perceived family well being between families at different stages in the family-life-cycle (i.e. marital status, age of the head of household, and family size.

H_o4 c There is no significant interaction between income and stage in the family-life-cycle.

Test statistic: One- and two-way analysis of variance.

In order to find the overall relationships between family well being and energy expenditures, percentage of income spent on energy and income, and the relationships between income and energy expenditures, as well as the percentage of income spent on energy, the following hypotheses were tested:

H_o5 a There is no significant linear relationship between energy expenditures and family well being.

H_o5 b There is no significant linear relationship between the percentage of income spent on energy and family well being.

H_o5 c There is no significant linear relationship between income and family well being.

H_o5 d There is no significant linear relationship between income and energy expenditures.

H_o5 e There is no significant linear relationship between income and the percentage of income spent on energy.

Test statistic: Significance of the Pearson product-moment correlation coefficient is tested with a t-test.

In order to determine the likelihood with which families at different stages in the family -life-cycle and at different income levels had taken a variety of conservation actions the following hypotheses were tested:

H_o6 There is no significant difference between families at different stages of the family-life-cycle (according to marital status, age of the head of household, and family size) and at different income levels as to the likelihood that they have taken the following conservation actions:

H_o6 a Outside wall insulation.

H_o6 b Four inches of ceiling insulation.

H_o6 c Good caulking and weatherstripping.

H_o6 d Double pane or storm windows.

H_o6 e Evaporative cooler.

H_o6 f Outdoor window shades.

H_o6 g Wood burning stove.

H_o6 h Close-off rooms not in use.

H_o6 i Water heater temp. below 120 ^oF.

H_o6 j Room temp. below 65 ^oF in winter.

Test statistic: Fitting of log-linear models to five-way frequency tables using chi-square goodness-of-fit test.

In order to find underlying factors determining the differences between families at different stages in the family-life-cycle the following hypotheses were tested:

H_o7 There is no significant difference in socioeconomic factors (income, education, occupation) and physical/structural factors (type of house, year of construction, size of house, tenure, location, heating degree days, and cooling degree days) as to the likelihood of the following conservation actions:

H_o7 a Outside wall insulation.

H_o7 b Good caulking and weatherstripping.

H_o7 c Double pane or storm windows.

H_o7 d Outdoor window shades.

H_o7 e Evaporative coolers.

H_o7 f Close-off rooms not in use.

H_o7 g Water heater temp. below 120 ^oF.

H_o7 h Room temp. below 65 ^oF in winter.

Test statistic: Stepwise logistic regression procedure eliminates non-significant terms based on an approximate F-test using a variance-covariance matrix.

In order to determine whether there is a difference between families at different stages in the family-life-cycle (i.e. marital status, age of head of household, and family size) and at different income levels regarding the use of loans to finance energy efficiency investments and claiming state and federal tax credits for doing so, the following hypotheses were tested:

H_o8 a There is no significant difference between families at different stages in the family-life-cycle and at different income levels in their use of loans to finance energy efficiency investments.

H_o8 b There is no significant difference between families at different stages in the family-life-cycle and at different income levels regarding claiming federal tax credits for energy efficiency investments.

H_o8 c There is no significant difference between families at different stages in the family-life-cycle and at different income levels regarding claiming state tax credits for energy efficiency investments.

Test statistic: Fitting of log-linear models to five-way frequency tables using chi-square goodness-of-fit test.

CHAPTER II

REVIEW OF LITERATURE

The Emergence of an Energy Problem

Energy consumption in the industrialized world grew over 50 percent each decade between the 1930's and 1960's. Since 1970 the growth has slowed considerably (Lovins, 1977; Patton, 1981; Ross and Williams, 1981). In 1973 and again in 1979 disruptions in the supply of oil from the Middle East, along with steep price increases, commanded attention from leaders in industrialized countries to their overdependence on imported oil. But oil shortages only served to magnify the advent of an even greater and much more fundamental problem, the world industry's heavy reliance on finite energy resources, estimated to be depleted within the next 25 to 50 years if historical growth patterns were maintained (Lovins, 1977; Bartlett, 1978; Ross and Williams, 1981). The 1970's marked a turning point from cheap and abundant energy sources to an era of scarcity and rising inflation adjusted energy prices. The problems were still further aggravated by the concurrent rise in world population to about 4.5 billion. It has been estimated that per capita energy production peaked in the mid 70's (Patton, 1981).

A Changing View of Energy

Treating energy just as an ordinary commodity is no longer adequate. Rather it has been suggested that, depending on the problem being investigated, energy be viewed as a depletable resource, a necessity, or a strategic material in addition to being a commodity (National Science Foundation, NSF, 1982). The depletable resource view is especially fruitful for longterm projections of energy supplies, or environmental impact studies of energy production and consumption technologies. The necessity aspect is useful when dealing with the hardships created by rising energy prices and when determining minimum energy requirements for households. And the strategic view is best applied to problems of import securement and strategic energy reserves, as well as international politics (NSF, 1982).

A further revision of the ways in which we conceptualize energy is aimed at redefining energy use in terms of energy services provided rather than fuel consumed (Ross and Williams, 1981). Improving the efficiency with which energy is used can readily be expressed in units of fuel saved. Thus, energy conservation becomes an energy source in its own right (Lovins, 1977; Stobaugh and Yergin, 1979; Ross and Williams, 1981).

The Nature of Energy Conservation

Under the impact of two major oil crises research efforts were directed toward the development of alternative energy resources such as bio-fuels, solar and wind energy, oil from tar sands and offshore drilling rigs, as well as nuclear fission and breeder reactor technology. Parallel to this production strategy advances were made in the efficient use of energy more commonly referred to as energy conservation. In order to be effective, an energy conservation strategy must rely not only on technological advances but on literally millions of decisions by individual consumers. This sets it apart from a large scale centralized energy production strategy and explains the need for sociopsychological research in the area of energy conservation. This is particularly true for energy efficiency improvements in the residential sector where twenty percent of all primary energy is consumed directly (Stern and Gardner, 1981; Ross and Williams, 1981). Some 19 million households are involved in the western region of the U.S. alone.

Psychological research suggested that efficiency improvements be distinguished from curtailments although both strategies conserve energy (Stobaugh and Yergin, 1979). Curtailments, such as lowering the room thermostat setting in winter, or closing off rooms not in use carry a negative connotation and affect the perceived level of health and comfort (Morell, 1981). Efficiency improvements such as wall and ceiling insulation, or double pane windows may actually increase the comfort level. Furthermore, efficiency improvements are usually "one shot" actions whereas curtailments involve a sustained commitment and are easily reversed (Stern and Gardner, 1981). More importantly, adoption of energy efficient technology in general offers more potential for energy conservation than curtailments (Stern and Gardner, 1981).

The Potential of Residential Energy Conservation

Energy consumption forecasts over the past decade consistently overestimated the demand for energy by as much as thirty to fifty percent (Landsberg, 1979). As a consequence electric power plants have been built at a rate that has now led to overcapacities in the northwestern United States. Lower actual demand has been attributed to slower than expected economic growth as well as improved energy efficiency in many areas as indicated in Figure 4 (Marlay, 1982).

In addition Ross and Williams (1981) noted that demographic trends such as slower population growth in the U.S. and saturation effects for durable consumer goods were in part responsible for reductions in actual energy demand. But as impressive as recent achievements in energy saving may seem, there remains a large untapped potential for further improvements in energy efficiency. There is wide agreement that one third of the energy presently consumed could be saved without impairing the health of the U.S. economy (Russell, 1979). About one fifth of all energy is consumed directly in the residential sector. By far the largest portion (60 %) is used for heating and air conditioning as shown in Figure 5 (Ross and Williams,

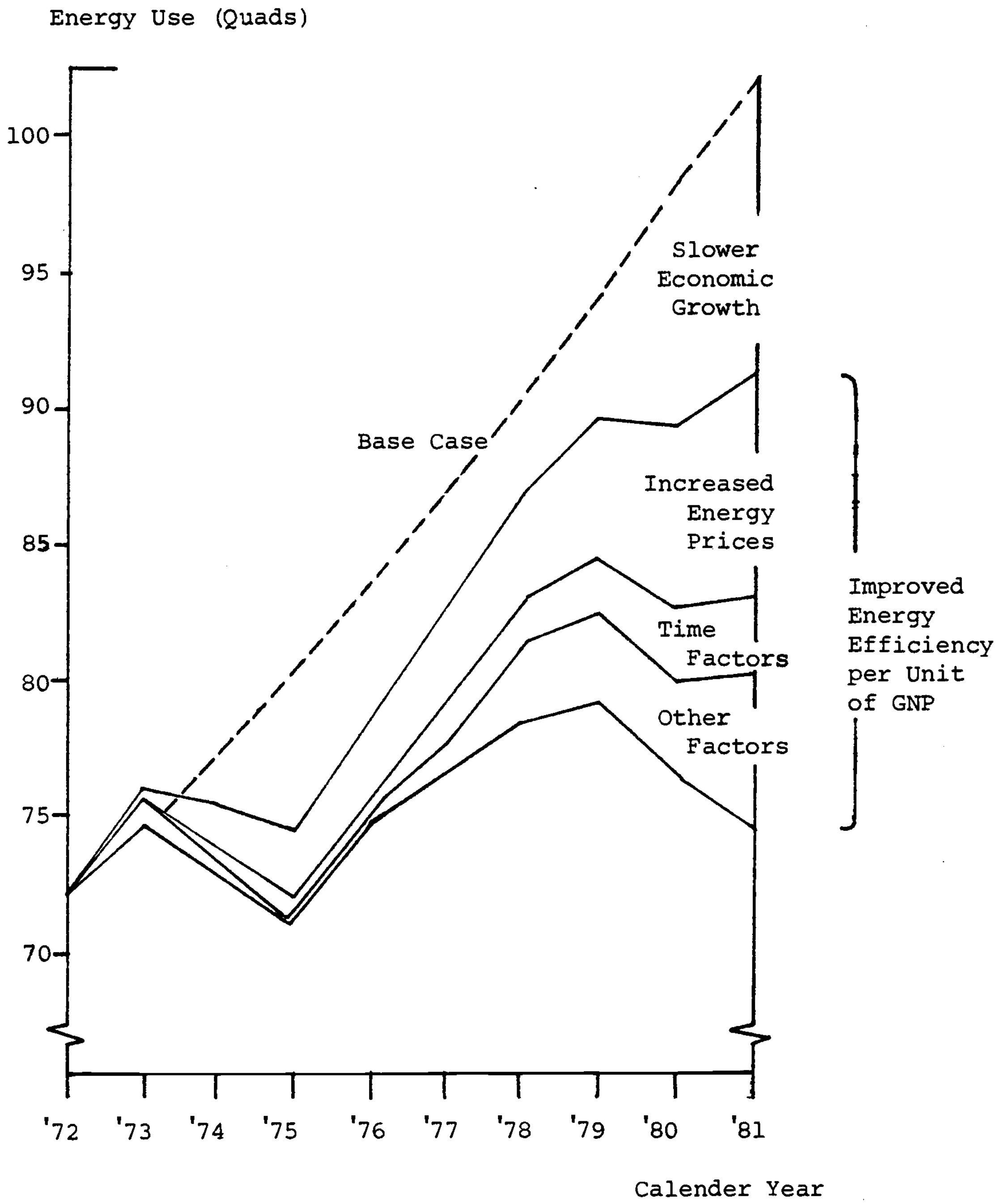


Figure 4. Energy Trends in the U.S. Economy
(R. Marlay, Office of Policy , Planning and Analysis, U.S. Department of Energy)

1981). This is where the largest potential for residential energy conservation lies.

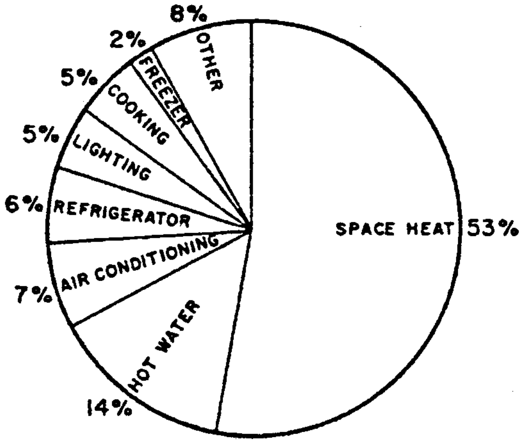


Figure 5. Distribution of Residential Energy Use (1975)
(Ross and Williams, 1981, p. 100)

Ross and Williams (1981) presented calculations explaining that eighty percent of the energy used in a typical home could be saved with "off-the-shelf" efficiency improvements. Their estimates are presented in Table 1 below.

A comparison of several high efficiency heating and cooling systems to a regular all electric house in Knoxville, Tennessee indicated potential savings of 60 percent over the all electric house by an advanced heatpump system with interseasonal energy storage tank (Hirst et al., 1982).

Table 1

Conservation Measures Considered for an Uninsulated House in Oakland, California

Conservation Measure	Investment Required (1976 $)	Annual Fuel Savings (10^6 BTU)	Cumulative Percentage of Fuel Saved
Night Setback Thermostat	100	46	26
6 Inches of Ceiling Insulation	360	43	51
3.5 Inches of Wall Insulation	610	38	72
Storm Windows	490	13	80

Measuring Energy Efficiency

A first, but rather crude, approach to measure energy conservation would establish a baseline energy consumption level against which achieved energy savings could be measured. This method was widely used in empirical social research on energy conservation (i.e. Jackson, 1976; Winkler and Winett, 1982). The greatest disadvantage of this method was its failure to make any reference to potential energy efficiency improvements. Its use was justified on grounds of simplicity and relative ease of measurement. However, "we need to introduce a technological efficiency measure for energy-consuming processes which can be used to point up the possibilities for efficiency improvements" (Ross and Williams, 1981, p. 92). Household furnaces, for example, typically provide 60 percent of the energy contained in the fuel as usable heat. This efficiency measure is based on the first law of thermodynamics (conservation of energy) and may therefore be called first-law efficiency (Ross and Williams, 1981). It can be expressed as:

$$\frac{\text{Energy Transferred to the Purpose of the System}}{\text{Energy Input to the System}}$$

"Unfortunately, the efficiency concept commonly used (i.e. first-law efficiency) is an inadequate indicator of the long-term potential for fuel savings" (Ross and Williams, 1981, p. 92). First-law efficiency does not take the quality of energy, or entropy level into account. A heatpump, for instance, extracts heat from the surrounding environment and delivers this heat plus the energy needed to run the heatpump as usable heat. Thus a heatpump can deliver more than 100 percent of the energy it uses. Along this line of reasoning a theoretical minimum fuel requirement for any given task can be calculated which is determined by the second law of thermodynamics (increase in entropy). A second-law efficiency can therefore be defined as (Ross and Williams, 1981):

$$\frac{\text{Theoretical Minimum Fuel Consumption for a Particular Task}}{\text{Actual Fuel Consumption for a Particular Task}}$$

The following example demonstrates the advantage of using the second-law efficiency concept.

> Consider space heating, in which heat is delivered to a building at 86 ^{o}F by a gas furnace with a 60 percent first-law efficiency. For this application the second-law efficiency is 5 percent when the ambient temperature is 40 ^{o}F. Thus while the first-law efficiency for a gas furnace (60%) gives the misleading impression that only a modest improvement is possible, the second-law efficiency (5%) correctly indicates a 20-fold maximum potential gain in theory (Ross and Williams, 1981, p. 94).

Efficiency standards that compare achieved energy efficiency to an ideal level of efficiency would have the potential to direct attention to those conservation actions that offered the highest theoretical potential for saving energy.

Advantages of Energy Conservation

International Balance of Payments

A penny saved is a penny earned, and with respect to the oil market a ten percent reduction in oil imports translated into some six billion dollars saved every year based on 1980 figures (U.S. DOE, 1981). As oil prices increased rapidly in the wake of two major disruptions of energy imports in 1973 and again in 1979 the U.S. merchandise trade balance slipped into a large deficit as shown in Figure 6.

At a time when the United States expects her largest deficit in her international balance of payments, reducing the bill for foreign oil has considerable appeal.

Less Dependence on Imported Energy

Oil imports into the United States have grown rather than declined since the first Arab oil embargo in 1973 and only during 1981-82 has there been a reversal of this trend (U.S. DOE, 1981) see Figure 7.

A decisive energy conservation policy would cut dependence on foreign energy supplies and ease the upward pressure on oil prices and give, as Ross and Williams (1981) have put it, more control to Americans over their energy future.

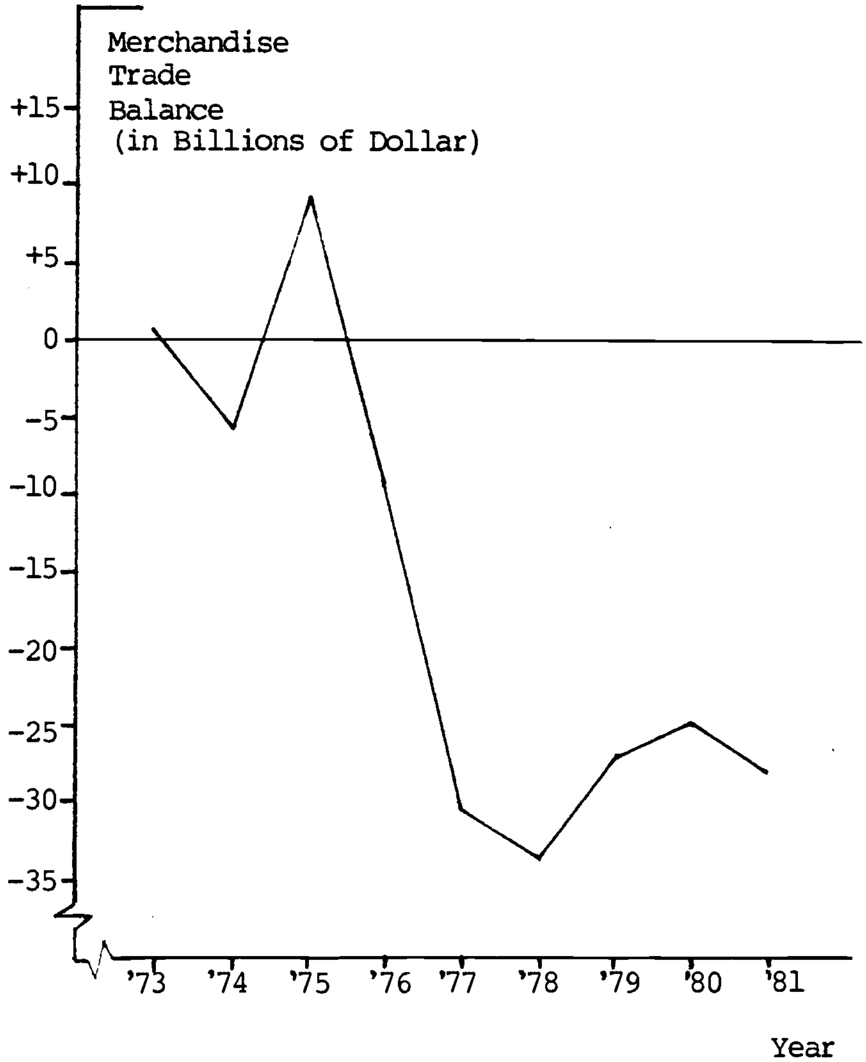


Figure 6. Merchandise Trade Balance Between 1973 and 1981

(Statistical Abstract of the United States 1982/83, U.S. Bureau of the Census, 1982, p. 822 .)

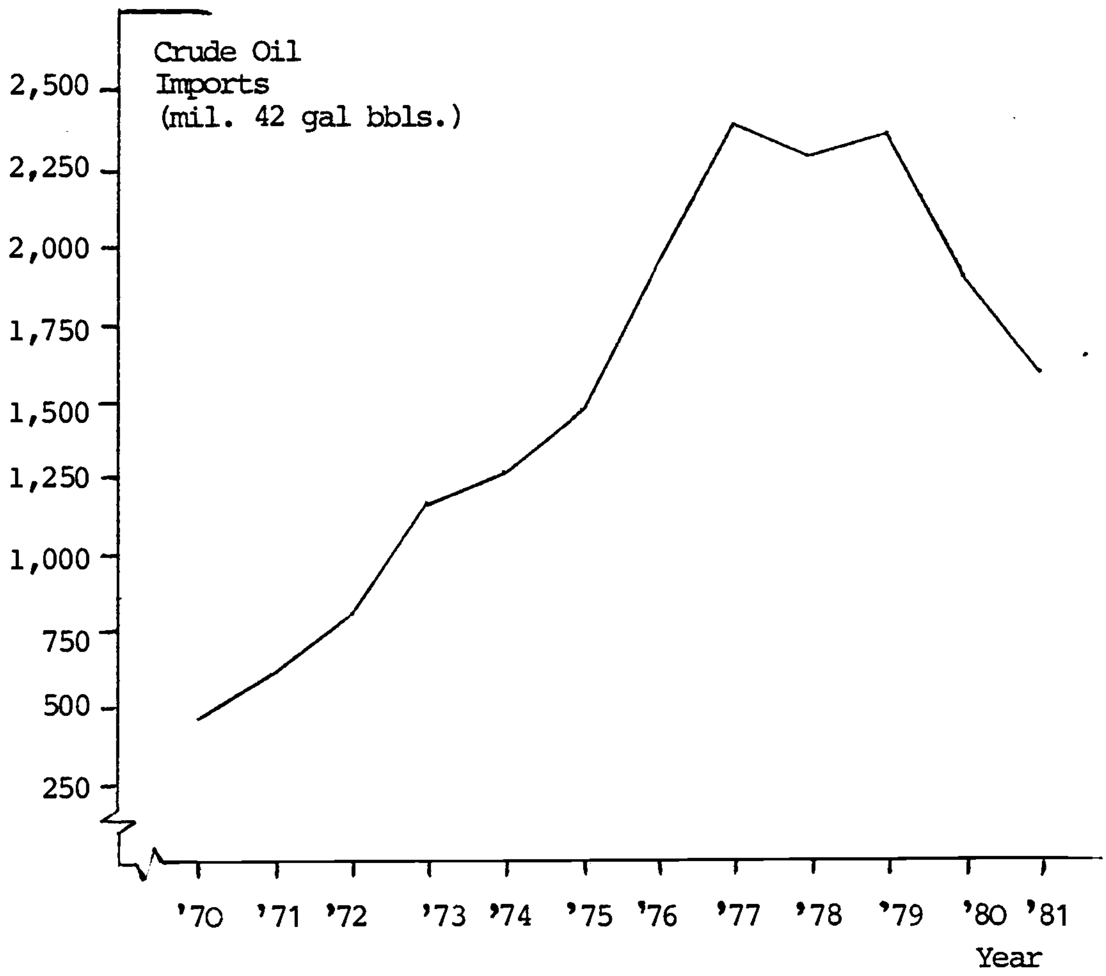


Figure 7. Crude Oil Imports into the United States from 1970 to 1981

(Statistical Abstract of the United States 1982-83, U.S. Bureau of the Census, 1982, p. 578.)

Inflation

Sharply rising energy prices especially for fuel oil have contributed directly to high rates of inflation and indirectly through the rollover of rising energy cost incorporated in other goods and services. Figure 8 shows the Consumer Price Index (CPI) for energy compared to the overall CPI over the past decade.

The impact of soaring energy prices in 1973-74 and again in 1979-80 can clearly be seen. By the same token the recent drop in oil prices has slowed down the rate of inflation almost to its pre 1973 level.

Scarcity of Capital

Energy resources that can be produced cheaply and with little capital investment are virtually exhausted. New sources, such as oil from the arctic north slope of Alaska, from drilling platforms in the ocean, or from tar sands, electricity from nuclear power plants, large coal-fired units, or photovoltaic cells, or fuel alcohol from plant residues are all many times more expensive than the energy resources they are replacing. In order to provide energy using costly new technologies, energy development projects, for instance, accounted for 43 percent of all expenditures for new plants and equipment in 1977 up from an average of 24 percent in the 1960's (Ross and Williams, 1981). As a consequence, capital shortages have occurred in other sectors of the industry pushing up interest rates and delaying much needed modernization efforts. Ironically this has also hampered investment in more energy efficient plants, equipment, and production technologies. Competition for scarce capital resources is the main reason why an energy production strategy, or as Lovins (1977) calls it, hard energy paths, and an energy conservation strategy, or soft energy paths are mutually exclusive.

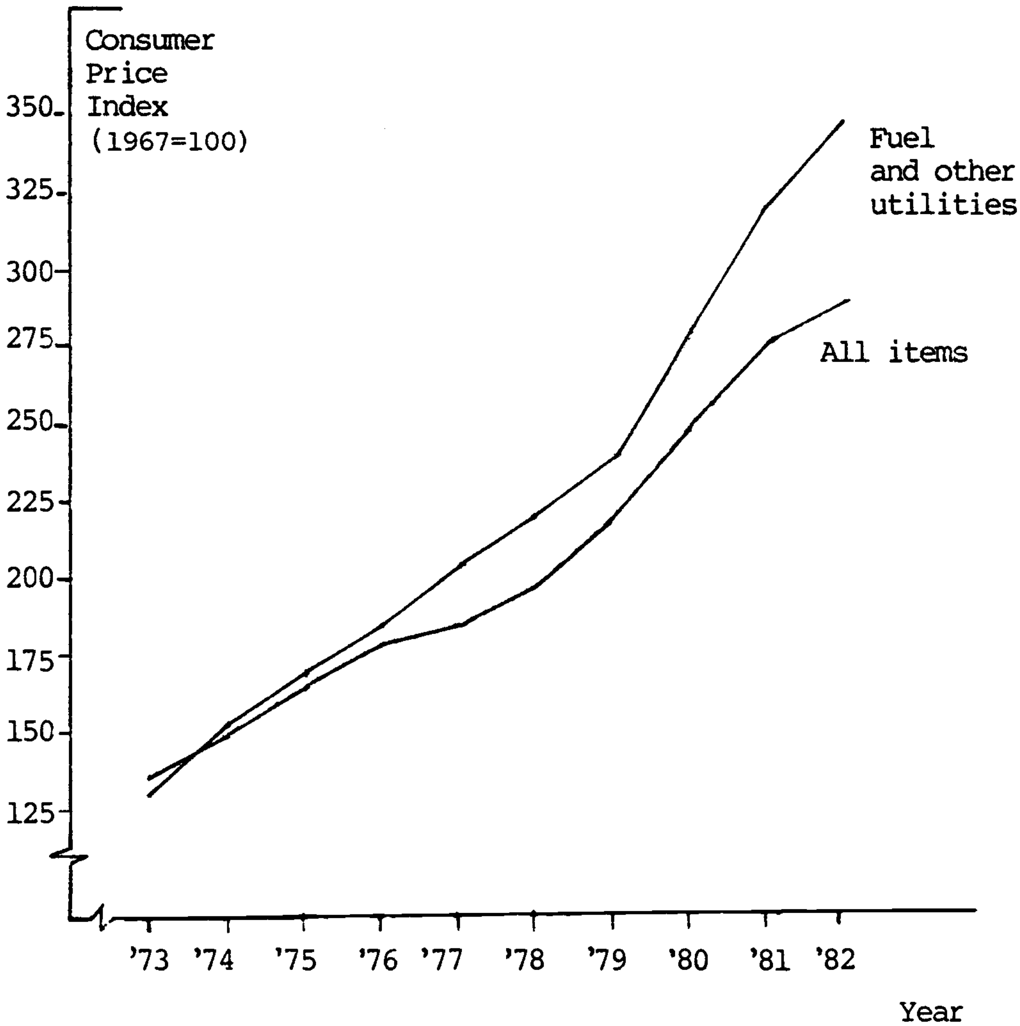


Figure 8. Overall Consumer Price Index and Consumer Price Index for Residential Energy Between 1973 and 1982.

(Statistical Abstract of the United States 1982-83, U.S. Bureau of the Census, 1982, p. 462.)

Environment

Yet another advantage of energy conservation, and maybe the most compelling in the future, is the low environmental impact of most conservation technologies. Ashley et al. (1976) have approached this concern in terms of a risk-benefit analysis. For example, a risk-benefit analysis has been applied to a decision about whether to generate electricity with a conventional lightwater nuclear reactor or an advanced breeder reactor (Evans and Hope, 1982). With the same method one could compare risks and benefits from producing additional units of energy to those from saving these units of energy through conservation. The critical part of a risk-benefit analysis seems to lie in the estimation of risks and their value in dollars. The two risks most often referred to and associated with high levels of energy use are atmospheric changes stemming from a high concentration of carbon dioxide, also called the 'greenhouse effect', and the dangers of nuclear proliferation once breeder reactor technology becomes widely available (Ross and Williams, 1981). Risks associated with energy conservation include sub-normal body temperature or hypothermia especially with older people, and indoor air pollution in super airtight houses with radon and formaldehyde fumes from building material.

Implementing Energy Conservation

Although energy conservation offers a great potential, especially in the residential sector, implementing energy conservation by no means will occur all by itself. "The fact that a device, a procedure, or a technique is demonstrably effective in ideal settings does not guarantee its adoption by real people in the real world" (Darley, 1978, p. 11). As a matter of fact, there are quite a number of obstacles in the way of energy conservation.

Economic Obstacles

Energy services are traded in a far from perfect market. "Decades of subsidies for conventional supply options distort market signals about the economic attractiveness of conservation options" (Hirst et al., 1982, p. 132). Many of these market imperfections either benefit conventional energy supply strategies or hamper energy efficiency improvements. Fuel prices do not reflect the full cost of production and thus have an unjustified advantage over fuel saving, capital intensive investments. In particular these shortcomings are (see Feiveson and Rabl, 1982, pp. 323f):

Regulation of oil and natural gas prices keeping these prices below their replacement cost (i.e. the cost of new discovered gas is almost four times higher than the average price charged today).

The use of average rather than marginal cost pricing by electric utilities which does not reflect the considerably higher cost of electricity from new generating capacity (i.e. nuclear or coal fired power plants). "The 1978 National Energy Act began the process of deregulating natural gas prices and modifying electric utility rate structures. President Reagan's early 1981 order to hasten decontrol of oil prices also helped to align prices with costs. However, even with these actions, fuel prices still do not reflect their full social costs" (Hirst et al., 1982, p. 132).

Direct subsidies to conventional fuels in the form of tax write-offs and accelerated depreciation schedules for energy exploration were estimated to be equal to about ten percent of all new energy investments (Feiveson and Rabl, 1982).

The failure to internalize external social cost mainly in the form of environmental pollution and safety hazards by power generating facilities. But also the cost of securing vital oil imports into the U.S.

and its allies and the cost of maintaining a strategic oil reserve which is born by the tax payer rather than the primary oil consumer.

Federal income tax provisions allow fuel expenditures to be defrayed immediately, whereas efficiency investments can be written off only over an extended period of time under present tax laws.

Risk and uncertainty. The decision to invest in energy efficiency depends on the future development of fuel prices, the performance of energy saving equipment, and interest rates. All three factors are predicted with uncertainty. The recent drop in oil prices was rather unexpected and might have led to different investment decisions if correctly anticipated. There also seems to be a rather wide range of actual performance of energy saving equipment which may be due to factors such as climate, quality of installation, and what other equipment is already present. Since energy efficiency improvements are relatively capital intensive they are sensitive to variations in interest rates. Lower interest rates should encourage investments in energy conservation.

Initial cost. In addition, many low income consumers cannot afford the oftentimes high initial cost of energy saving investments. This limits the option of conserving energy through investments in energy efficiency to middle and high income groups (Morell, 1981; Ross and Williams, 1981; Dillman et al., 1982).

Technical Obstacles

Research and development in energy conservation technology has had to take a backseat to large scale energy production technologies in terms of available funding. It is difficult to predict how far energy conservation technology would have progressed had it received comparable funding as, for instance, the development of breeder reactor technology, but it is safe to assume that it would be more advanced than it is now. Improvements could be made in the reliability of heat pumps and in the efficiency of home appliances.

A further obstacle to the swift introduction of efficiency improvements is the relatively slow turnover rate of the building stock. In addition, building codes are also slow to change. Improved energy efficiency standards for new houses and incorporation of passive solar design principles are prime targets of energy conservation strategies. Little has been done, however, to bring the existing building stock up to higher standards. In the automobile sector the new car average fuel economy of 24 mpg compares to an average fleet fuel economy of maybe 16 to 18 mpg, due to slow turnover of vehicles.

Psychological Barriers

Energy conservation techniques can be viewed as innovations and their adoption by consumers as the diffusion of an innovation. According to Darley (1978, pp. 341-342) four principles can be drawn from diffusion theory that will determine the rate and extent to which an innovation will spread.

> Principle 1: Only a subset of the target population initially will feel the need for any particular innovation (awareness).
>
> Principle 2: Not only is it necessary to feel a negative state, it is necessary to feel that, in general, it is possible to change the negative state (motivation).
>
> Principle 3: To "complete the circuit", a person must believe that a specific, durable, usable, innovation is available that will actually make a significant dent in his problem (information).
>
> Principle 4: If an individual adopts an innovation, certain conditions are necessary for him to regard it as successful (positive feedback).

Individual differences in problem awareness, information about potential solutions to the problem and resources to implement these changes lead to individual differences in the adoption of an innovation. Looking at adoption over time leads to an adoption curve as shown in Figure 9:

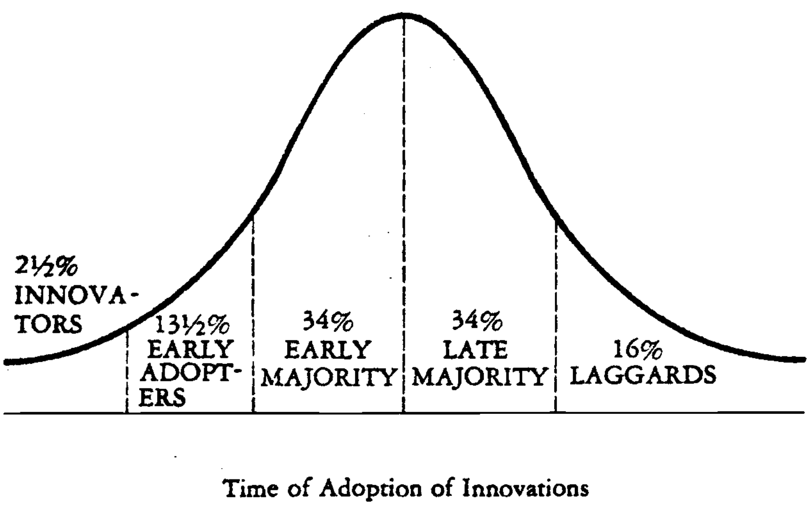


Figure 9. Distribution of Adoption Categories
(Everett M. Rodgers. Diffusion of Innovation
New York: The Free Press, 1962)

According to the point in time at which a household adopts an innovation it is labeled an innovator, early adopter, part of an early or late majority, or a non-adopter. Innovators and early adopters have been found to differ in their socio-demographic characteristics from the majority. They tend to be younger, better educated, and have higher incomes (Assael, 1981). Those are the risk takers who are willing to act under greater uncertainty as to the benefits of an innovation. It should be noted, however, that those who resist an innovation, when in fact it is beneficial, incur a loss just as those who try an unsuccessful innovation.

Changing attitudes toward energy consumption has been the goal of numerous information campaigns. The percentage of people who believed that providing sufficient energy was a serious problem increased to over 70 percent in 1981 (Makela et. al, 1982). Unfortunately there seems to be only a weak relationship between believing in an energy problem and conserving energy (Gottlieb and Matre, 1975; Cunningham and Lopreato, 1977; Perlman and Warren, 1977; Morrison and Zuiches, 1978; Olsen, 1981; Marganus, Olson, and Badenhop, 1982). A positive relationship was found between favoring energy conservation and practicing energy conservation that does not involve money, whereas no such relationship could be established between attitudes and investments in energy efficiency (Marganus, Olson, and Badenhop, 1982). This is an indication of the overriding effect of economic factors in the decision to invest in energy conservation.

Persuasive messages have been used with varying results in socio-psychological experiments (Cook and Berrenberg, 1981). The critical factors determining the success of persuasive information appeared to be how well targeted the messages were and how credible the source of information was perceived (Stern and Gardner, 1981).

Knowledge. Oftentimes people have inaccurate knowledge about how energy can be saved. Harris et al. (1980), for example, found in a survey of 400 Michigan families that reducing lighting was believed to save more money than using less hot water (reported in NSF, 1982, p 18).

Feedback on energy use has been shown to produce short-term energy savings in the order of 10 to 20 percent (Winett, Kagel, Battalio, Winkler, 1978; Stern and Gardner, 1981). The efficacy of feedback about energy use has been accredited to the otherwise invisibility of energy. This problem has been referred to as the "legacy of energy invisibility" (NSF, 1982). Utilities are master metered, and heating oil is bought infrequently in large quantities so that the consumer has little actual information on energy using processes in his home. As a result it becomes impossible to accurately judge the effectiveness of a particular energy conserving measure. Moreover, energy saving equipment, such as efficient furnaces, good wall insulation, or passive solar design features are themselves invisible and thus are received with scepticism. Yet, individual metering of appliances may be far too cumbersome and expensive to gain wide acceptance.

First steps in the direction of better energy use information have been taken. In-house monitors are now available that give an instantaneous readout on current electricity use. Lifetime cost of major appliances which do not only take initial cost into account but also operating cost over the expected lifetime of the appliance, are starting to be publicized. Another example is taken from utility companies that provide a monthly statement which not only indicates the amount of kwh used per day, but also contains information on electricity use in the previous year and degree days for the time period in the present year and the year before so that actual comparisons can be made by the utility customer.

Comfort and convenience was identified by Seligman and Darley (1979) as the most important and the only consistent predictor of electricity use for air conditioning and natural gas use for heating. Convenience also appeard to be the reason for the failure of many car pooling programs (Morell, 1981). Winkler and Winett (1982), however, concluded from their experiments on thermal comfort that there was a rather wide range of what was judged as a comfortable temperature and that factors such as social norms played an important role in defining an acceptable comfort level (Winkler and Winett, 1982).

A Market Approach to Energy Conservation

Energy policy has taken a considerable shift since President Reagan took office in 1981. "The Carter administration, in particular, emphasized the importance of government action in overcoming barriers to efficient energy use. The Reagan administration, however, views these programs as largely irrelevant and prefers to leave energy-efficiency decisions in the hands of private decision makers in each sector" (Hirst et al. 1982, p. 131). An approach to encourage energy conservation that relies on market forces rests on two assumptions. First, it assumes that demand for energy drops in response to rising energy prices, and second, it assumes that current fuel prices are artificially low. Consequently, if fuel prices were free to rise to a level which represents their full cost, investments in energy efficiency would be more attractive. That energy is traded in a far from perfect market has been pointed out in the previous section on economic obstacles to conservation. Market oriented energy policies would try to eliminate the unjustified advantages of a fuel production strategy. Deregulation of oil and natural gas prices has been a first step in this direction taken by the federal government. It has prompted sharp increases in the price of natural gas (Monthly Labor Review, April 1982), although it still remains the cheapest fuel for heating in most areas (Edison Electric Institute, 1982).

The biggest advantage of an approach to energy conservation that relies on the principles of a free market is the fact that it can provide compelling and consistent guidelines for everyone making decisions about energy use. A signal in the form of high fuel prices suggests trying out energy saving investments and vice versa. The price signals would lead, at least in theory, to an optimal mix of fuel use and conservation strategies that would minimize the long-term cost of providing energy services (Hirst et al, 1982).

The Relationship between Energy Prices and Demand for Energy

Even the most casual look at the development of aggregate energy prices and energy consumption reveals a consistent pattern. Whenever energy prices accelerated, the demand for energy slowed down during the past decade as shown in Figure 10:

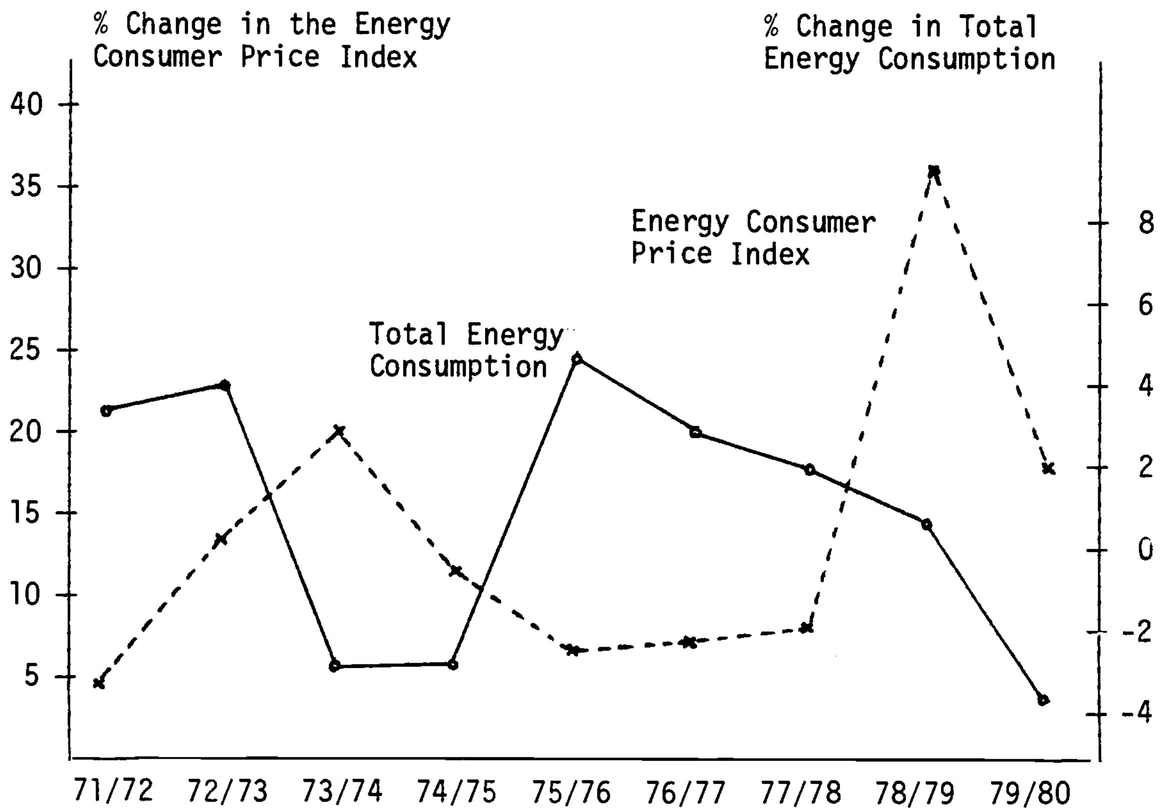


Figure 10. Changes in the Energy Consumer Price Index and Total Demand for Energy Between 1971 and 1980 (Monthly Labor Review; and Statistical Abstract of the United States 1982. U.S. Bureau of the Census, 1981)

Further it can be observed that the full impact of accelerated energy price increases may be felt only after a year or more has passed. This time lag may be explained most appropriately by the technical and psychological barriers that prevent a swift implementation of energy conservation.

Following the second round of massive oil price increases in 1979, for instance, the market share of fuel efficient subcompact cars jumped from 13.0 percent in 1978 to 21.2 percent in the following year at the expense of intermediate-sized cars. It continued to rise until it peaked at 26.8 percent in 1981. Subcompacts remained popular in 1982 (24.3 %) although gasoline prices had actually started to decline in response to an oil glut on the world market. For 1983 the marketshare for subcompacts is estimated to slip to 23.5 percent (Paine Webber Inc., 1983). This suggests that even rather shortlived price fluctuations exert a strong influence on purchase decisions for consumer durables.

In economic theory the reaction of demand upon price variations is analyzed in terms of price elasticities. The coefficient of elasticity (e) is defined as the percentage of change in demand divided by the percentage change in price (Winkler and Winett, 1982). Inelastic demand ($e < 1$) is characteristic of basic goods, while the demand for luxury items is typically elastic ($e > 1$). The coefficient of elasticity may, however, vary between different levels of demand and over time. In the case of energy demand short-term and long-term price elasticities differ considerably. Short-run elasticities are low; they range between 0.1 and 0.2 (Kagel et al. 1979; Stern and Gardner, 1981). The reason for the low elasticity coefficient is that energy is essential and only modest savings can be accomplished through curtailments. Long-run price elasticities for residential energy demand, however, have been estimated much higher, most likely between 0.7 and 1.1 (Pindyck, 1979). This is due to the much larger potential for energy savings of investments in energy efficiency.

An experimental study, which investigated differences in energy consumption between users of bottled gas and natural gas gave evidence that price increases in conjunction with conservation appeals produced significant savings by users of bottled gas, while natural gas users, who faced a less dramatic price increase, failed to reduce their energy use despite comparable conservation appeals (Peck and Doering, 1976).

Evaluating Energy Efficiency Investments

An investment in energy efficiency, just like any other investment, can be evaluated by calculating the rate of return or payback time. This is by no means a simple task and bears a high degree of uncertainty, which makes investment decisions in energy saving equipment a rather speculative issue. Their payoff depends on the rate of inflation, the relative prices of different fuels, equipment cost and performance, government incentives, and interest rates (NSF, 1982). Local factors, such as climate, influence the payoff from an investment in double pane windows, where extreme temperatures will tend to push the rate of return higher. Further considerations involve the presence of other energy saving equipment since they lower the amount of fuel that can be saved by additional investments, the well known law of diminishing returns.

Uncertainty will lead consumers to not take all the energy saving measures that are economically justified had the relevant facts been known (NSF, 1982). An anlysis of implicit rates of return on energy efficiency investments in new homes by O'Neal et al (1981) revealed that electric-resistance-heated homes built in 1976 in Kansas City had an implicit rate of return of 100 percent, or in other words, a one-year payback on the investment. Market rates of interest were 3 percent real (net of inflation) at that time. Had efficiency investments been made up to the point where the marginal rate of return equalled the market rate of 3 percent, new homes would have used an estimated 29 percent less energy than they actually did (O'Neal et al, 1981).

Hirst and Goeltz (1982) estimated the median pay-back time in their nationwide sample of 675 households at 2.1 years. But more than one quarter of the households were using an implicit payback time of less than a year (Hirst and Goeltz, 1982). One reason for the widespread use of unrealistically high expected rates of return may be the popular mistake of calculating the rate of return based on savings in dollars rather than fuel units, which tends to underestimate true rates of return as fuel prices rise (Kempton and Montgomery, 1981).

The implicit rates of return that were found among different families investing in energy saving equipment revealed substantially higher rates among low-income families and rates more in line with market rates among affluent families (Hausman, 1979). The question whether this was due to the limited access to capital for efficiency investments among low-income families remains open.

Determining the Optimal Level of Energy Conservation

While it is useful to determine the maximum potential for energy efficiency improvements it is an altogether different question how much energy should actually be saved through energy conservation. It is reasonable to assume that in most cases this optimal level of efficiency investments will be well below the maximum potential. The decision about the desired level of energy conservation is determined by the objective function that is to be optimized. If the goal is energy independence then many more far reaching energy efficiency investments are justified than if the goal were just maintaining energy consumption at current levels. The objective function proposed here is in line with a market approach and will be called a least-cost strategy (Sant, 1981; Hirst et al, 1982). The least-cost strategy aims at providing energy services with a mix of fuels and capital investments in energy efficiency that minimizes long-run cost. Energy efficiency improvements cost money. These costs typically increase per unit of energy saved as one adds more conservation measures, since ever more sophisticated methods for fuel savings have to be employed. At the same time consecutive energy savings in the same relative magnitude translate into ever smaller amounts of fuel saved in absolute terms, the law of diminishing returns (Hirst et al. 1982). Thus, according to a least-cost strategy, energy efficiency investments should only be undertaken up to a point where the price of a unit of fuel saved is equal to what it cost to buy the unit of fuel today and over the expected lifetime of the efficiency investment.

Calculations by Sant (1981) for the year 1978 indicate that energy services were actually provided with a far from optimal mix of fuels and capital investments. In particular, efficiency improvements were not adopted to the extent at which they would minimize overall long-term cost of energy services, shown in Figure 11.

The calculations also indicated that despite a drop in the share of oil in total energy supply from 43 percent in 1973 prior to the oil embargo to 36 percent in 1978 an optimal share of oil still would have been ten percent lower. Similarly overrated was electricity which had a share almost twice as big as in the least-cost scenario in 1978.

In short, a least-cost strategy for providing energy services, applied within a well functioning energy market, would lead to an optimal mix of fuels used and efficiency investments. The primary conditions for a functioning energy market are the removal of unjustified advantages for energy production strategies and fuel prices that represent their replacement cost as well as those costs that are presently externalized.

Unfortunately, while in theory the market approach has great appeal, it is inflicted with serious problems when it is implemented. Rising prices tend to impose a disproportionate burden on low-income consumers, who most likely would have to bear the brunt of hardships during a transitional phase of price adjustments (Stern and Gardner, 1981; NSF, 1982; Dillman et al., 1982). An energy assistance program of some sort for low-income families is, therefore, indispensable in conjunction with a market oriented approach to energy management (Russell, 1979; Hatch and Whitehead, 1981; Olsen, 1981). After all, energy is a necessity for all members of this society.

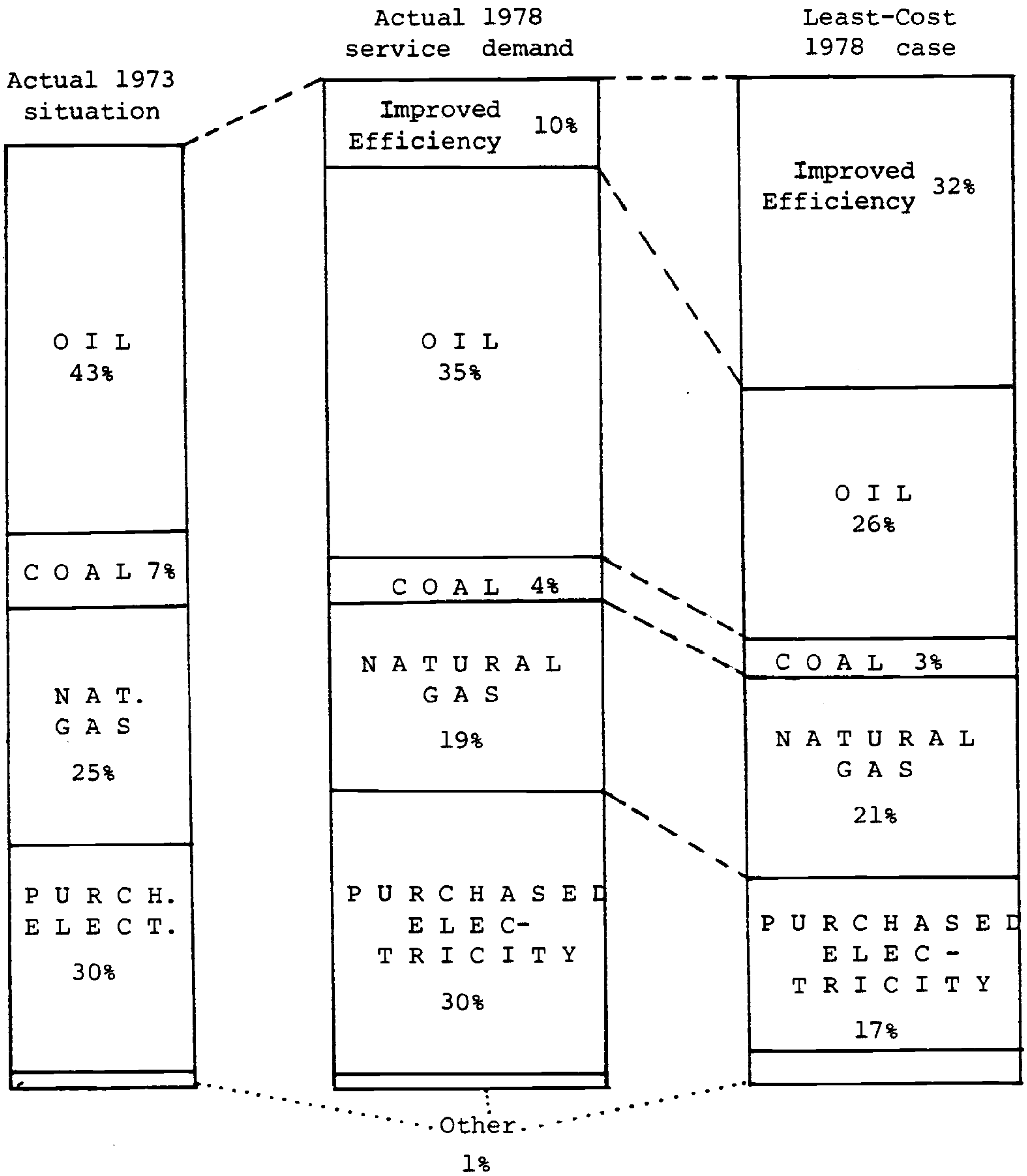


Figure 11. Energy Service Market Shares of Various Technologies

(R.W. Scant, 'Least Cost Energy Strategies', Conference Proceedings, Utilities and Energy Efficiency; New Opportunities and Risks, US DOE, Conf. 08010146, 1981.)

Limitations of a Market Approach to Energy Conservation and the Need for Low-Income Energy Assistance Programs

Most obviously, a market approach fails when consumers are simply priced out of the market. Not only does this produce grave inequities, but in the case of a basic necessity such as energy it will also increase suffering and the likelihood of illegal appropriations. Moreover, the rich may continue to consume at a level of their choice. But, short of minimum survival needs, "to the extent that the appropriate market response to higher energy prices requires investment, the efficient functioning of the market requires that firms and individuals have access to capital. If they do not, market forces alone will not yield an efficient response. This is an overriding problem for low-income individuals who do not have the capital to retrofit their homes and to invest in energy-efficient consumer durables" (Hirst et al., 1982, p. 137).

Low-income families spend a much higher share of their income on energy than middle- or high-income families (Russell, 1979). Worse still, the share of the budget that goes to electricity increased from 8.8 percent to 10.8 percent in the lowest income bracket during the two years following the 1973 oil embargo, as shown in Table 2.

Low-income households did not use much less electricity than more affluent households. As a direct result, price increases for energy present a much more severe problem to low-income families than to those families with higher incomes. A market approach to energy conservation, which aims at increasing fuel prices, is therefore prone to create hardships for low-income families and, thus, is inherently inequitable.

Table 2

Average Annual Electricity Expenditures by Disposable Household Income: 1973 to 1975

	1973	1974	1975
Less than $3,400	$149	$172	$183
$ 3,400 - 6,899	164	183	200
$ 6,900 - 10,499	186	215	228
$10,500 - 15,199	207	240	254
Expenditures as a Percentage of Income			
Less than $3,400	8.8	10.1	10.8
$ 3,400 - 6,899	3.2	3.7	3.9
$ 6,900 - 10,499	2.1	2.5	2.6
$10,500 - 15,199	1.6	1.9	2.0

(Federal Energy Administration (FEA), Household Energy Expenditure Model; and S, Mintz,"An Explanation of Electric Utility Finance and its Effects on the Residential Consumer" Paper Presented at the 22 nd Annual American Council on Consumer Interests Conference, Atlanta, Georgia, April 8, 1976)

A market approach is also inequitable from another point of view. Poor families are less able to afford the typically high initial cost of energy saving investments, such as wall insulation, double pane windows, or storm doors (Dillman, 1982). Furthermore, the poor more often live in "inner-city communities, small towns, and rural areas where the percentage of substandard and dilapidated housing is substantial (...and) maintenance is more likely to be neglected" (Hatch and Whitehead, 1981, p. 51). Finally, the poor are more likely to live in rented dwellings and thus have little control over investment decisions, while landlords have no incentive to invest in energy efficiency (Buck et al, 1982).

Low-Income Fuel Assistance Programs

In response to drastic price increases for energy following the 1973 Arab oil embargo, legistation has been enacted to help poor families pay their fuel bills. A bill was passed by Congress in 1977 creating the Low Income Energy Assistance Program (LIEAP). This program was administered initially by the Community Services Administration (CSA) and is now administered through the Department of Health and Human Services (HHS). Since the Reagan Administration took office, a number of other changes have taken place. Federal funds are now given as a block grant leaving full discretion to the states as to how the money is channeled through to needy families. Also, since 1982, up to 15 percent of Energy Assistance money may be spent on programs improving the energy efficiency of low-income housing rather than direct fuel assistance. Unfortunately, funding has been cut from the \$ 2 billion level in 1982 to a projected \$ 1.3 billion in 1983 (Alliance to Save Energy, 1982). Table 3 summarizes information about the federal energy assistance programs in states of the western region.

The total amount of federal funds available for low income energy assistance programs approached a quarter billion dollars in 1982. A little over ten percent of this money, or \$ 25 million, was committed to low-income weatherization programs. This comes to slightly less than \$ 9.50 for each of the 2.6 million households in the western region with incomes below 125 percent of the poverty level (U.S. Bureau of the Census, 1983c) One should not expect miracles when funding is that low.

For the subsequent analysis a number of factors should be kept in mind. The prevailing eligibility level in the western states for receiving benefits is set at 125 percent of the official poverty level. The variables most often used to adjust benefits are family income, family size, region (as a stand-in for climate), the type of fuel used, and at times the size of house (i.e. number of rooms).

The decision on which variables to base the level of benefits is by no means trivial. Equitability considerations would suggest the use of as many factors as possible from the above list to determine the amount

Table 3

Overview of Energy Assistance Programs in the Western United States in 1982

State	Total Funds (in Dollar)	Weatheriza-tion (in %)	Eligibility	Benefits and Criteria	Emergency Funds
Arizona	6,992,726	10	125% of poverty level 150% if over 60 years	$75-200; $100 average, based on region, income, family size	$490,000 for families receiving cut-off notices
California	85,888,915	10	130% of poverty level	$400 max.; $89 average, based on region, income, fuel type	7.5% set aside for emergencies
Colorado	30,074,454	5.6	125% of poverty level	2 payments: first $92.93 flat; second based on funds avlbl., family size, region, fuel type, and income	7% set aside for emergencies
Idaho	11,639,433	15	125% of poverty level	$270 average, based on region, income, fuel type, and fam. size	$110,000 set aside for emergencies
Montana	11,107,295	15	125% of poverty level	$1,000 max.; $288 average, based on region, family size, fuel type/price,and # of bedrooms	$250,000 set aside for emergencies
Nevada	3,635,182	15	125% of poverty level 150% for elderly and handicapped	$50-500, based on region, fuel type, income, and housing type	small component for households receiving cut-oof notices
Oregon	23,308,973	15	125% of poverty level	$105-300, based on region, fuel type, and income	$250 max. for households with energy budget share of over 25%
Utah	13,537,172	4.5	60% of median income for HHs. up to 6; 150% of poverty level for HHs. of 7 and more	$1,050 max.; $313 average	$160,000 set aside for emergencies
Washington	37,352,107	15	125% of poverty level	$175-225, based on region, income, and family size	$4,000,000 have been spent (late program start)
Wyoming	5,595,550	3.6	150% of poverty level for singles; for each add. person add $2,000	$100-1000, based on region, income, family size, and fuel cost	very few funds spent on emergencies

of money a family should receive. Making the program easy to administer, however, would suggest using as few variables as possible. The problem is to find a model that adequately predicts energy needs with a minimum number of factors.

Life-Line Utility Rates

In order to moderate the effects of rising utility rates on low-income families a new rate structure for utilities providing electricity and natural gas was proposed (Russell, 1979; Ross and Williams, 1981). Rather than charging less per unit of energy consumed for high users, as in the declining block structure, under the new structure a specified amount of energy would be sold at a low rate and energy used beyond this so called life-line block would be sold at higher rates. The life-line rate structure constitutes a reversal of the declining block structure which is still most prevalent. The lost revenue from the initial low cost energy is recovered by charging considerably higher rates for energy used in excess of the life-line block.

It has been argued that life-line utility rates are too unspecific and benefit not only low-income families but all thrifty energy users. In fact, an affluent household may even get the highest benefit from life-line rates by investing in sophisticated energy efficiency equipment (Ross and Williams, 1981). A counter argument is that there is nothing wrong if life-line utility rates would stimulate investments in energy efficiency. What seems critical is to determine an appropriate cut-off level for the life-line block and to examine whether the size of this block should be varied by such factors as family income, family size, or fuel used for heating. This has to be weighed against the loss in ease of administration if no such adjustments had to be made. Determining the right size of the subsidized life-line block is a matter of careful judgement which is not made easier by the lack of relevant information on a family basis.

Low-Income Weatherization Programs

Subsidized utility rates may take away some of the incentive to conserve energy just as fuel assistance programs do (Ross and Williams, 1981). Rather than providing affordable energy for low-income families an alternative strategy could be to help these families consume less energy by weatherizing their homes. An added benefit of this strategy is that it provides a more permanent solution to the problem of high fuel prices and does not come back anew each year. Moreover, the housing stock would be preserved and upgraded at the same time. "The task therefore becomes one of assuring that appropriate investments are indeed made in conservation in low-income housing" (Ross and Williams, 1981, p. 131). The Department of Energy (DOE) currently runs a low-income weatherization program that is funded at a level of $ 25 million in the states of the western region (see Table 3).

For most low-income housing and rented dwellings, it has been argued, incentives such as loan guarantees and interest free loans will have to be offered to assure that something is being done (Ross and Williams, 1981).

An example: In Oregon a utility company may install any energy saving measures recommended by an energy audit in a house. The homeowner does not have to pay until the house is sold. Even then, no interest is charged for the money spent by the utilty company. Moreover, this program is not limited to low-income households. The utility company may even give away energy saving equipment, as long as the cost of saved energy is below the cost of building new power generating capacity. The utility's investments in energy efficiency may be included in its rate base, thus insuring its continued growth (Ross and Williams, 1981). Pacific Power & Light Company, for instance, has given away electric water heater insulative blankets to customers upon request.

An Integrated Low-Income Energy Assistance Program

Fuel assistance programs, life-line rates, and weatherization programs have unique advantages which could best be brought to bear in an integrated program that takes advantage of the strong points of each strategy and carefully balances their weaknesses in order to minimize their undesirable effects.

A weatherization program has the big advantage that it provides a more permanent solution to the energy problems of low-income families. To weatherize all eligible homes at the same time, however, would present insurmountable technical and financial problems. In the meantime people need help to buy the fuel they need to heat their homes. Life-line utility rates may be easy to administer if they do not have to be burdened by administrative decisions about eligibility and varying benefit levels. They are altogether useless for families heating with oil, wood, or liquid petroleum gas. If the right amount of energy is selected, life-line utility rates may not only help poor families but also spur investments in energy efficiency. A fuel assistance program can be targeted more easily and may be handled using different methods like cash assistance, energy vouchers, payment to the energy supplier, and more. They may not be the best solution in the long run, however, since they do not encourage energy conservation.

In 1982 a first step towards an integrated energy assistance program has been taken by the Administration by allowing states to spend up to 15 percent of federal funds for low-income energy assistance on weatherization programs. Many states have taken full advantage of this new provision (see Table 3).

Findings from this study will provide an information base for striking a balance between fuel assistance, life-line rates, and weatherization programs that is best suited to mitigate the effects of rising energy prices in a market oriented approach to energy conservation.

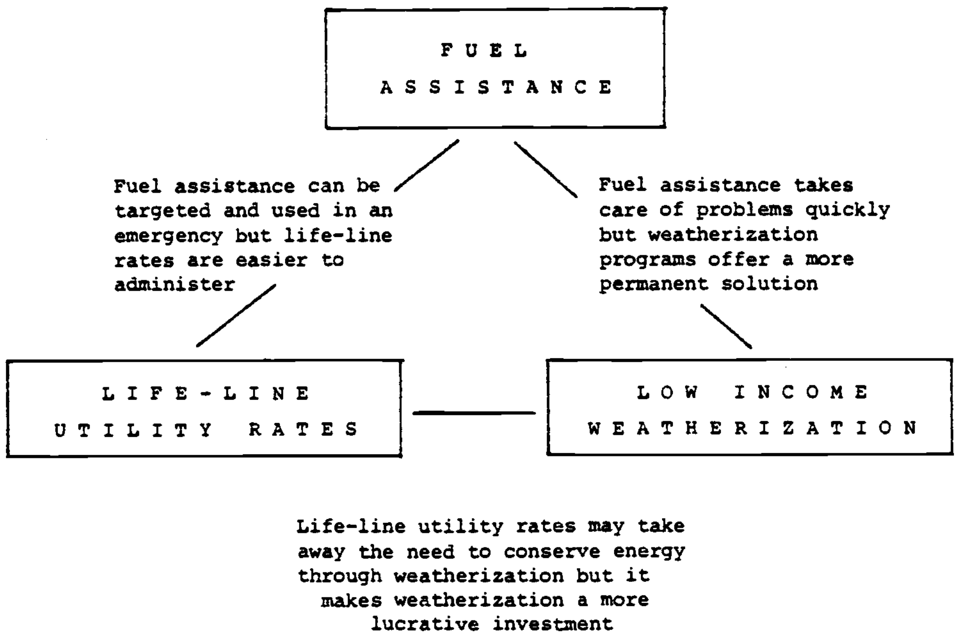


Figure 12. Model of an Integrated Low-Income Energy Assistance Program

CHAPTER III

ENERGY EXPENDITURES AND FAMILY WELL BEING BY INCOME AND STAGE IN THE FAMILY-LIFE-CYCLE

INTRODUCTION

Energy prices rose more than 350 percent between 1973 and 1983 with oil prices leading the way at roughly 450 percent (U.S. Bureau of the Census, 1982). Since the 1973 Arab oil embargo energy price increases outpaced general inflation and reversed a longstanding trend of declining real energy prices. Such dramatic change is bound to cause far reaching social repercussions. Despite a recent decline in oil prices, a majority of Americans remain concerned about assuring an adequate supply of energy at affordable prices (Honeywell Study, 1982). In a recent World Bank statement, inflation adjusted oil prices were predicted to resume their upward movement at an annual rate of 1.6 percent on the average until 1995 (The Wall Street Journal, July 1983). Thus, problems associated with the high cost of energy are likely to be here to stay.

Energy consumption varies considerably among households due to physical/structural and socioeconomic factors. Since heating and cooling account for some 60 percent of all residential energy consumption, housing characteristics play an important role in determining energy use. The size of a house and climatic factors bear on energy needs. Multi-family units may use less energy due to shared walls. Also, a well insulated, weathertight house will require less energy to keep comfortable than an ill-maintained, or uninsulated house. It is by no means uncommon, however, to find energy consumption differ by a factor of two between families occupying comparable homes (Ross and Williams, 1981). Aside from differences in conservation efforts the number of people living in a household will greatly influence energy consumption (Marganus, Olson, and Badenhop, 1982). Also, older people tend to have a narrower comfort range regarding room temperatures due to poorer blood circulation which in turn requires them to use more energy.

It seems most appropriate to analyze residential energy consumption at the family or household level, since decisions about energy use in the home typically involve the entire family. The family-life-cycle concept offers a well established framework for classifying families. Fritzsche (1981) in a study of energy consumption by stages in the family-life-cycle summarized his findings:

> The pattern of total energy consumption (...) is an inverted U distribution (...). Energy consumption increases with each stage of the life cycle through the child raising years. When the children leave home, the consumption level declines but at a slower rate than it grew (p. 230).

He also found that single-parent households consumed much less energy than their married counterparts.

Energy expenditures generally increase as income rises (Newman and Day, 1975; Marganus, Olson, and Badenhop, 1982) but the percentage of income that goes to buying energy usually declines (Olsen, 1981). Thus, low-income families are prone to be affected more strongly by rising energy prices than families who are better off financially. For example, the percentage of income spent for electricity alone rose from 8.8 percent in 1973 to 10.8 percent in 1975 in the lowest income group, while the increase in the highest income group was from 1.6 percent to just 2.0 percent (Russell, 1979). At the same time low-income families spent on average 15 percent of their income for all types of energy.

Worse yet, low-income families find it more difficult to cut their energy use since they already consume close to the minimum needed. They are more likely to live in inefficient substandard housing, but it is difficult for them to improve the energy efficiency of their homes due to lack of access to bank loans or because they are more likely to rent rather than own their home (Morell, 1981). This point has been stressed in a paper by Morell (1981) on energy conservation and public policy where he says:

> Contrasts between the economical behavior of those who can afford to conserve energy and those who cannot is another area worthy of sensitive new research. Equity concerns dominate the discourse about energy pricing (...), but such equity considerations normally remain unstated in the conservation debates (p. 27).

All these factors combine to render low-income families most vulnerable to rapid energy price increases, and previous price increases have already taken their toll and lowered the level of living of the poor (Dillman et al, 1982; Honeywell Study, 1982).

At the same time the Reagan Administration is committed to a market oriented approach to energy conservation, where rising prices for conventional fuels (e.g., through deregulation) make investments in energy efficiency more lucrative (Dillman et al., 1982). In order to mitigate the severest hardships from rising energy prices on low-income families, several steps have been taken by the federal administration.

A low-income energy assistance program was started in 1977 and some version of this program has been approved each year since then. Responsibility to carry out the program was shifted to the states in 1982 and the provision of block grants left considerable discretion to the states as to how they wanted to administer their low-income energy assistance programs. Most states opted for programs that would help poor families pay their utility bills, or help families that received cut-off notices from their utilities. The eligibility criterion to receive benefits was set at 125 percent of the official poverty level in most states. The maximum payment a family may receive varies from state to state and depends on several factors, such as the age of the head of household, climate, number of persons in a family, type of fuel used, and others. There is, however, no uniform formula which is used in all states. Rather, some states consider it too cumbersome to make any of these adjustments (Alliance to Save Energy, 1982).

A second policy to moderate the effects of rising utility rates on low income customers has been a modification of the rate structure. Rather than charging less per unit of energy for heavy users, as in the declining block structure, a specified amount of energy would be sold at a low rate under the new structure. Energy used beyond this socalled life-line block would be sold at higher rates. A life-line rate structure, constitutes a reversal of the declining block structure which remains the most common rate schedule. The lost revenue from the initial low cost energy is recovered by charging considerably higher rates for energy used in excess of the life-line block (Russell, 1979; Ross and Williams, 1981).

Although both policies have the potential to ease the problems low-income families face in dealing with rising energy cost, a more permanent solution to their problem would be an extensive weatherization program for these families. This point is examined in chapter four.

In order to help design an effective low income energy assistance program the following questions were addressed:

- How much money was spent on residential energy by families at different stages of the family-life-cycle and at different income levels?
- What were the differences in the percentage of income that went to energy purchases for these families?
- Was there a relationship between energy expenditures or the energy budget share and the perceived well being in a family?
- Was the effect of income level on energy expenditures and family well being the same at all stages of the family-life-cycle?
- And, finally, was the climate contributing to the severeness of problems families had with rising energy cost?

METHODOLOGY

Sample Design

A stratified random sample of 15,047 households was drawn from telephone directories in ten of the Western United States. Two strata of equal size were formed, one for urban (SMSA) and one for rural (non SMSA) households. This led to an overrepresentation of rural households. From these ten states three were selected for this study on the basis that they represented roughly the same number of households (approx. 1 million each state) and that they covered a wide range of climatic conditions. The states selected, Arizona (hot), Colorado (cold), and Oregon (mild), account for 4,481 households in the sample. While average temperatures vary considerably within these states, they represent the extremes of heating and cooling requirements found in the western region.

Data Collection

Data were collected as part of a Western Regional Agricultural Experiment Station Project (W-159) "Consequences of Energy Conservation Policies for Western Regional Households".

In spring of 1981 questionnaires were mailed to all sample households. The design of the questionnaire, as well as the mailing procedure, followed the Total Design Method (Dillman, 1978). A copy of the questionnaire is included in Appendix F. This method emphasized a personal style in the cover letters and repeated follow-ups on non-respondents. From the 4,481 questionnaires mailed out in the three states, 2,633 usable records were returned, yielding a 58.8 percent response rate. After adjustment for undeliverable questionnaires and ineligible respondents, the response rate rose to 65.6 percent (Makela et al., 1982).

Variable Description

Family composition was conceptualized in a modernized family-life-cycle (FLC) framework similar to that by Murphy and Staples (1979). A distinction was made between traditional, married households, and non-traditional, single households. In 26.5 percent of the families the head of household was not married compared to 36.7 percent in the general population (U.S. Bureau of the Census, 1983a). The age of the male head of household was used to assign families to stages in the FLC. In cases where no male head of household was present, the age of the female was used as a reference. The middle stage in Murphy and Staples' model was subdivided into a younger middle and an older middle stage in order to capture likely differences in the ages of dependents which were not separately assessed. Of all household heads, 29.7 percent were under age 35, 27.4 percent between 35 and 49, 24.5 percent between 50 and 64, and 18.4 percent were age 65 or older. Compared to census data, the middle age groups were overrepresented by about six percent at the expense of young families. A third dimension for family classification was the number of dependents. The term dependents was defined as any person living in a household besides the head of household and spouse. In close to 90 percent of the cases these were children. There were no dependents in 42.8 percent of the families, 22.0 percent had one dependent, 20.8 percent had two, and 14.4 percent had three or more dependents. An overview of the absolute and relative frequencies for each family type is presented in Table 4.

One should keep in mind that a married household is implicitely larger by one person, the spouse, than a comparable single headed household.

Table 4

Classification of Families by Marital Status, Dependents, and Age of Head of Household; Absolute and Adjusted Relative Frequencies.

Marital Status	Number of Dependents	Age of Head of the Household Under 35	35 to 49	50 to 64	Over 64
		n (%)	n (%)	n (%)	n (%)
Not Married	None	95 (3.9)	47 (1.9)	60 (2.4)	117 (4.7)
	One	94 (3.8)	43 (1.7)	26 (1.1)	24 (1.0)*
	2 or more	59 (2.4)	39 (1.6)	21 (0.9)	
Married	None	124 (5.0)	70 (2.8)	281 (11.4)	285 (11.6)
	One	106 (4.3)	109 (4.4)	110 (4.5)	28 (1.1)*
	Two	176 (7.1)	183 (7.4)	63 (2.6)	
	3 or more	79 (3.2)	185 (7.5)	42 (1.7)	

* Categories with less than 10 observations were collapsed.

Income comprised total 1980 family income before taxes as reported. Since responses were measured in nine categories, midpoint estimates were used in place of the original categories. Using this method a mean income for the sample of $ 24,054.63 was found with a standard deviation of 14,281.78. Compared to census data, families with incomes below $ 20,000 were underrepresented in the sample (U.S. Bureau of the Census, 1983a). The average family income in the three state area according to census information was $ 23,315. The absolute and relative frequencies with and without adjustment for missing observations are reported in Table 5.

Table 5

Annual Gross Family Income

Income Range ($)	Absolute Frequency	Relative Frequency %	Adjusted Frequency %
Less than $ 5,000	128	4.9	5.2
$ 5,000 to $ 9,999	287	10.9	11.7
$ 10,000 to $ 14,999	329	12.5	13.4
$ 15,000 to $ 19,999	346	13.1	14.1
$ 20,000 to $ 24,999	374	14.2	15.2
$ 25,000 to $ 29,999	315	12.0	12.8
$ 30,000 to $ 39,999	323	12.3	13.1
$ 40,000 to $ 49,999	160	6.1	6.5
$ 50,000 and more	200	7.6	8.1
No answer	171	6.5	missing
Total	2,633	100.1*	100.1*

* Does not add to 100.0 due to rounding error.

Energy expenditures and energy budget share are two variables based on self reported expenditures for home fuels excluding gasoline for the year 1980. Energy expenditures comprise expenses for electricity, natural gas, heating oil, bottled gas, and wood, as well as a miscellaneous other fuels. In cases where respondents reported average cost per cord of wood as $ 20 or less, a figure of $ 50 which was close to the average cost per cord in the sample, was substituted. This was necessary to account for the fact that a number of respondents did not account for the cost of cutting their own wood. Energy expenditures recorded for less than a year were recalculated to give a full year estimate. Finally, in order to guard against coding errors, families with a yearly energy bill of under $ 120 (= $ 10 per month) or a yearly bill of over \$ 6,000 (= \$ 500 per month) were excluded from the analysis. Mean energy expenditures for all types of fuels in 1980 were \$ 940.35 per household with a standard deviation of 700.28.

The energy budget share was computed by dividing energy expenditures by family income. The measurement of income in nine categories may have caused distortions, especially in the lowest income groups. For the energy budget share a minimum of 0.5 percent and a maximum of 60 percent were set for a family in order to be included in the analysis. The average budget share in the sample was 5.763 percent of income with a standard deviation of 8.627. Both figures, energy expenditures and the energy budget share were subject to large variation among respondents.

The Index of Well Being summarizes the adverse effects of rising energy prices on family well being. The index is based on responses to a general statement about how people felt their quality of life had changed in response to soaring energy prices as shown in Table 6,

Table 6

Perceived Effect of Rising Energy Cost on Quality of Life

Category	Absolute Frequency	Relative Frequency %	Adjusted Frequency %
A lot worse (1)	476	18.1	18.5
A little worse (2)	1,403	53.3	54.4
No effect (3)	598	22.7	23.2
A little better (4)	92	3.5	3.6
A lot better (5)	10	0.4	0.4
No answer	54	2.1	missing
Total	2,633	100.1*	100.1*

Mean response: 2.13 * Does not add to 100.0 due to rounding.

and on eleven statements referring to cut-backs in specific areas of consumption (Table 7). The statements were recoded so that a high score on the Index of Well Being refers to little or no cut-backs, and a low score indicates substantial cuts and a decline in the level of living. The index ranges between 12 and 49 with a midpoint of 30.5. The average score in the sample was 31.06 with a standard deviation of 8.62.

Statistical Analysis

Families were grouped by family composition and by income. Group differences in energy expenditures, the energy budget share, and the Index of Well Being were tested for significance using one-way analysis of variance. The assumption of equal variance within groups, necessary for the ordinary F-test of between group differences, was relaxed by computing Welch and Brown-Forsythe F-statistics, which do not assume equal variances within groups.

The form of relationship between income, age of the head of household, and number of dependents on one hand, and energy expenditures, energy budget share, and Index of Well Being on the other was tested by fitting linear, quadratic, and cubic contrasts to the respective group means.

Two-way analysis of variance was used to test whether an interaction between the grouping factors, family composition and income, existed. Again, energy expenditures, energy budget share, and family well being were analyzed.

The influence of climate on the relationship between family composition, income, and energy expenditures was tested, using a measure of average temperature as a covariate in the one-way analysis of variance.

For some variables winsorized group means, which are less subject to outliers, were computed.

Table 7

Extent of Cuts in Various Areas of Consumption; Absolute and Adjusted Relative Frequencies

Area of Cutbacks	Mean Score	Extent of Cuts Due to Rising Energy Cost A Lot (1)	Some (2)	A Little (3)	None (4)
		n (%)	n (%)	n (%)	n (%)
Money put in Savings	2.07	1096(42.5)	674(26.1)	352(13.6)	459(17.8)
Driving the car (etc.)	2.15	719(27.9)	1071(41.5)	477(18.5)	313(12.1)
Vacations	2.21	922(35.7)	735(28.4)	384(14.8)	545(21.1)
Recreation	2.28	741(28.8)	869(33.8)	460(17.9)	500(19.5)
Meals out	2.31	851(33.2)	686(26.8)	402(15.7)	624(24.3)
Clothes	2.40	635(24.6)	892(34.5)	442(17.1)	615(23.8)
Buying applc. or furnishngs	2.46	726(28.3)	684(26.7)	407(15.9)	747(29.1)
Groceries	2.80	281(11.0)	844(33.1)	523(20.5)	900(35.3)
Housing (rent mortgage, etc)	3.08	300(11.8)	530(20.8)	391(15.3)	1330(52.1)
Health care	3.38	189 (7.4)	369(14.4)	274(10.7)	1725(67.5)
Education	3.57	127 (5.1)	240 (9.6)	222 (8.9)	1915(76.5)

All analyses were performed with the Biomedical Computer Program Package (BMDP) in its 1981 version. Additional information on the statistical methods that were used in this analysis is included in Appendix A.

RESULTS

Relationships between Energy Expenditures, the Energy Budget Share, Index of Family Well Being, and Income

Virtually no correlation was found between energy expenditures and the Index of Well Being ($r = .018$). If at all, one would be led to conclude by the positive sign of the correlation coefficient that the more money families spent on energy, the better off they were. This conclusion, defying common economic reasoning, is due to the strong confounding influence of income. It was found to be positively related to energy expenditures ($r = .173$) and the Index of Well Being ($r = .370$). When the effect of income was removed from energy expenditures by dividing through income, (i.e., the energy budget share), a highly significant ($p \leq .001$) negative correlation ($r = -.247$) was found, as would be expected.

Further, the correlation between energy budget share and index of well being was stronger in the lower income groups (i.e. under $ 20,000) than among higher income groups, where almost no relationship existed. Thus, rising energy prices seemed to have had a stronger impact on families with incomes below the median income, while higher income families were hardly affected. This is further investigated in the following section.

Analysis of Energy Expenditures, Energy Budget Share, and Index of Well Being by Income Level

Income was positively related to energy expenditures (r = .173) and the Index of Well Being (r = .370) but negatively related to the energy budget share (r = -.458). Mean scores for the three variables for each of the nine income groups are reported in Table 8.

Table 8

Energy Expenditures, Energy Budget Share, and Index of Well Being at Different Income Levels

Income Range ($)	Energy[a] Expenditures (in Dollars)	Energy[a] Budget Share (in Percent)	Index of[b] Well Being (unitless)
Less than $ 5,000	760.05	30.402	27.590
$ 5,000 to $ 9,999	698.84	9.318	26.917
$ 10,000 to $ 14,999	750.33	6.003	27.731
$ 15,000 to $ 19,999	981.38	5.608	29.728
$ 20,000 to $ 24,999	892.56	3.967	30.274
$ 25,000 to $ 29,999	973.94	3.542	31.094
$ 30,000 to $ 39,999	925.70	2.645	33.863
$ 40,000 to $ 49,999	1123.05	2.496	35.467
$ 50,000 and more	1231.19	2.239	38.339
All groups combined	921.55	5.360	31.031
Number of valid cases[c]	1,475	1,475	2,203
Between group differences F	7.91	156.53	47.64
Probability of F	$\leq$.001	$\leq$.001	$\leq$.001

a) Third order winsorized means. b) Arithmetic means.
c) Number of cases differ due to missing observations.

The differences in group means were significant ($p \leq .001$) for all three variables (ANOVA-tables I, II, and III are in Appendix C). Variation in income accounted for 46.1 percent of the variance in the energy budget share, for 14.8 percent of variance in the Index of Well Being, and for only 4.1 percent of the variance in energy expenditures.

Energy expenditures ranged from \$ 700 a year in the lower income categories to more than \$ 1,200 in the highest income group. For low-income families, this translates into a monthly fuel bill of 60 to 65 dollars on average. As a consequence, low-income families had to spend a high percentage of their income for home energy. A figure of more than 30 percent in the lowest income group (under \$ 5,000), however, may be inflated. Using \$ 2,500 as a midpoint estimate for this category may not have yielded a good approximation of the true category mean. Yet, it is still clear that energy expenditures belong in the category of basic needs. They tend to take up a large share in the budget of a low-income family, since basic needs tend to be satisfied in spite of rising prices. As a result, low-income families suffered more under price increases, as indicated by the low scores on the Index of Well Being. The lowest income group had a mean score of 27.6 which rose to 38.3 in the highest income category (Table 8). Additional fuel price increases are likely to be felt much more severely by families with incomes below \$ 10,000 per year where the energy budget share was ten percent and more. Families with high incomes, conversely, will be less likely to notice price changes in their two to three percent energy budgets.

For further analyses, the nine income categories were collapsed into four, in order to reduce the risk of outliers distorting the results. Linear, quadratic, and cubic contrasts were fitted to the four group means to decide which form of relationship with income would best describe the data. Arithmetic means for the three variables across the four income levels are reported in Table 9.

Table 9

Energy Expenditures, Energy Budget Share, and Index of Well Being Across Four Income Levels

Group Number	Level of Income	Energy Expenditure (in Dollars)	Energy Budget Share (in Percent)	Index of Well Being (unitless)
1	Under $10,000	754.85	15.910	26.294
2	$10,000 - 19,999	906.36	5.990	28.389
3	$20,000 - 29,999	936.38	3.806	30.673
4	$30,000 or more	1,071.40	2.515	35.757
All groups combined		947.27	5.462	31.062
Number of valid cases		1,336	1,336	1,336
Between group differences F		9.48	141.14	83.22
Probability of F		$\leq .001$	$\leq .001$	$\leq .001$

Energy expenditures were significantly ($p \leq .05$) different between all income levels except the two middle groups ($p = .535$). The relationship between income and energy expenditures was basically linear which was confirmed by a highly significant linear contrast ($t = 5.045$ with 1.322 d.f.; $p \leq .001$). Newman and Day (1975) had found a gradual increase in natural gas consumption with rising income, but a more pronounced increase in electricity consumption. Electricity, however, is more expensive and thus may have prevented a diminishing rate of increase as would be expected.

The energy budget share differed significantly ($p \leq .05$) among all income groups. Testing contrasts did not produce a conclusive result since all three contrasts were highly significant ($p \leq .01$). The budget share dropped sharply from the lowest to the second lowest income category, whereas further drops were less pronounced. Overall, the energy budget share seemed to fall into two categories, high for those earning less than \$ 10,000 a year and moderate for those earning more than that.

The Index of Well Being differed significantly ($p \leq .01$) between all groups. Both the linear ($t = 13.580$ with 1,332 d.f.; $p \leq .001$) and the quadratic ($t = -3.245$ with 1,332 d.f.; $p = .0012$) contrast were significant. As income increased the Index of Well Being rose at an increasing rate. Thus, the highest income group had by far the highest score on the index, while differences in the lower income groups were relatively small.

In summary, families with incomes below \$ 10,000 a year, while spending significantly less on home energy purchases than any other income group, nonetheless were forced to spend over three times more of their income for energy relative to higher income groups. Since energy expenditures tie up such a large share of a low-income family's budget, price increases already had a much more pronounced effect on perceived well being among these families and will likely continue to hurt low-income families as fuel prices rise.

Analysis of Energy Expenditures, Energy Budget Share, and Index of Well Being by Family Composition

Classifying families according to marital status, age of the head of household, and number of dependents led to 25 distinct family types which were placed into the modified family-life-cycle categories, developed for this study. In Table 10, group means are reported for the three variables energy expenditures, budget share, and Index of Well Being.

Overall, there were highly significant ($p \leq .001$) between-group differences for all three variables (ANOVA-tables IV, V, and VI are in

Table 10

Energy Expenditures, Energy Budget Share, and Index of Well Being for Different Family Types

Marital Status	Age of Head of Household	Number of Dependents	Energy Expenditures (in Dollars) [a]	Energy Budget Share (in Percent) [a]	Index of Well Being (unitless) [b]
Not Married	Under 35	None	529.86	4.247	33.614
		One	786.58	5.168	30.911
		2 or more	893.07	7.095	28.088
	35 to 49	None	759.09	5.518	32.953
		One	907.88	6.340	31.421
		2 or more	1,082.21	7.685	28.162
	50 to 64	None	663.01	6.018	31.961
		One	905.56	3.914	31.040
		2 or more	1,212.67	7.482	30.000
	Over 64	None	708.65	10.435	30.538
		1 or more	771.54	11.381	32.706
Married	Under 35	None	758.40	4.630	32.085
		One	904.45	4.595	28.689
		Two	898.44	5.094	29.307
		3 or more	955.60	4.401	28.179
	35 to 49	None	904.37	3.577	32.063
		One	902.35	3.488	30.155
		Two	1,017.56	3.814	31.893
		3 or more	1,081.28	4.265	29.715
	50 to 64	None	885.70	4.670	32.399
		One	1,109.37	4.214	32.762
		Two	1,201.38	4.401	32.036
		3 or more	1,179.93	5.965	28.385
	Over 64	None	804.09	6.542	32.261
		1 or more	1,246.50	6.016	35.762
All groups combined			921.55	5.360	31.107
Number of valid cases [c]			1,449	1,397	2,206
Between group differences F			4.47	4.71	3.42
Probability of F			.001	.001	.001

a) First order winsorized means. b) Arithmetic means

c) Number of cases differs due to missing observations

Appendix C). Young, unmarried individuals had the lowest average energy bills, \$ 530 a year, while the highest group average (\$ 1,246) was found among married families with dependents, headed by a person 65 years of age or older. The energy budget share ranged from a low of 3.5 percent among younger middle-aged married families with one dependent, to a high of 11.4 percent for a single person of retirement age with dependents. Generally, lower scores on the Index of Well Being were found among families with two or more dependents, while families without dependents tended to have higher scores. In order to find out what accounted for differences between families the factors according to which families had been classified were analyzed separately.

Marital status was reduced to a distinction between married and non-married families. Overall, married families spent significantly more money for home energy than non-married families ($t = 2.545$ with 1,423 d.f.; $p = .011$), although this was a significantly smaller portion of their income ($t = -4.663$ with 1,423 d.f.; $p \leq .001$). An overall comparison, however, is flawed for two reasons. First, there was an additional category for large families in the married category, and second, the married category implicitely contains one extra person, the spouse. A pairwise comparison of groups that contain the same number of people revealed that out of fourteen pairs only two differed significantly ($p \leq .05$). There were no significant differences between married and non-married households regarding scores on the Index of Well Being. Hence, a more conservative conclusion was drawn stating that differences on the surface between married and non-married households, as they were found by Fritzsche (1982) did not hold up under closer examination. Instead, where significant differences between married and single families existed they could be attributed to the fact that married families had one additional family member.

The age of the head of household largely determines the stage in the family-life-cycle. The arithmetic means of each age group for variables energy expenditures, energy budget share, and index of well being are reported in Table 11.

Table 11

Energy Expenditures, Energy Budget Share, and Index of Well Being by Age Group

Group Number	Age Category	Energy Expenditure (in Dollars)	Energy Budget Share (in Percent)	Index of Well Being (unitless)
1	Under 35	837.98	4.950	30.064
2	35 to 49	1,006.10	4.723	30.710
3	50 to 64	1,025.08	4.715	32.149
4	over 64	820.41	8.747	31.641
All groups combined		930.82	5.404	30.955
Number of valid cases		1,200	1,200	1,488
Between group differences F		6.70	18.73	4.550
Probability of F		≤.001	≤.001	=.004

Mean energy expenditures did not differ significantly ($p \leq .05$) between the youngest and the oldest age category, and between the two intermediate groups. Families in both intermediate age groups, however, spent significantly ($p \leq .01$) more for residential energy than either young or old families. The relationship between age of the head of household and energy expenditures may thus best be described as an inverted U-curve which was also suggested by a highly significant quadratic contrast fitted to the group means ($t = 4.398$ with 1,196 d.f.; $p \leq .001$). Fritzsche (1982) had found this same general relationship between stages across the FLC and energy consumption.

Analysis of the energy budget share by age groups produced two distinct patterns. No significant differences existed between all age groups under 65 years of age. Families headed by a person of retirement age, however, spent almost twice as much from their income on residential energy, which was a highly significant ($p \leq .001$) difference. Lower energy expenditures in the highest age group were insufficient to offset the even steeper decline in family income forcing the average budget share for energy up to almost nine percent of gross income. Families headed by a person past retirement age were, therefore, much more susceptible to problems arising from fuel price increases.

The average group score on the Index of Well Being differed significantly ($p \leq .05$) between the youngest and the two oldest age groups, as well as between the two intermediate age groups. The relationship between age and well being appeared to be linear as indicated by a highly significant linear contrast ($t = 2.739$ with 1,484 d.f.; $p = .006$). It should be noted, however, that the average score on the index dropped slightly in the highest age group.

In summary it can be concluded that there was not nearly as much variation between age group means as there was between income group means. This was especially pronounced for the Index of Well Being which ranged from 26.3 to 35.8 between income categories, but only from 30.1 to 32.1 between age categories. In short, income had a more decisive effect on energy expenditures and family well being than the age of the head of household or stage in the family-life-cycle.

The number of dependents, again, was measured in four categories ranging from none to three or more dependents. Arithmetic means of the four groups for energy expenditures, energy budget share, and Index of Well Being are given in Table 12.

Table 12

Energy Expenditures, Energy Budget Share, and Index of Well Being for Families with No, One, Two, and Three or more Dependents

Group Number	Number of Dependents	Energy Expenditures (in Dollars)	Energy Budget Share (in Percent)	Index of Well Being (unitless)
1	None	841.45	6.152	32.182
2	One	909.37	4.773	30.794
3	Two	999.74	4.821	30.642
4	Three or more	1078.05	5.297	28.941
All groups combined		930.82	5.404	30.955
Number of valid cases		1,200	1,200	1,488
Between group differences F		6.28	3.44	8.83
Probability of F		≤ .001	= .016	≤ .001

There were significant ($p \leq .05$) differences in mean energy expenditures between families with no dependents and those with two and three or more dependents. Families with only one dependent and those with three or more dependents also differed sifgnificantly. Energy expenditures increased by roughly $ 80 a year for each additional dependent. The fact that each dependent added approximately the same amount to the average energy bill was confirmed by a highly significant linear contrast ($t = 4.203$ with 1,196 d.f.; $p \leq .001$). Hence, there appeared to be no economies of scale with respect to residential energy expenditures.

The energy budget share varied only modestly among families of different size when compared to age or income differences. Highly significant ($p \leq .01$) differences existed only between families without dependents and those with either one or two dependents. The relationship between family size and budget share was U-shaped, also indicated by a significant quadratic contrast fitted to the group means ($t = -2.285$ with 1,196 d.f.; $p = .023$). The largest percentage of income was spent on residential energy by families with no dependents (6.2 %) while the lowest energy budget share was found among families with one dependent (4.8 %). Even the largest families spent less on average (5.3 %) than the families with no dependents.

The average score on the Index of Well Being was found to decline continually with increasing family size and thus followed the reverse pattern of energy expenditures. This was confirmed by a highly significant linear contrast ($t = -4.855$ with 1,484 d.f.; $p \leq .001$). All group means were significantly ($p \leq .05$) different from each other with the exception of the difference between families with one dependent and those with two dependents.

In summary, the larger a family was, the more was spent for residential energy and the larger the decline in family well being. This decline, however, could not be attributed simply to a high proportion of income that had to be spent on energy. Quite contrary, the families with no dependents had the highest energy budget share and also the highest scores on the Index of Well Being.

Testing Interactions between Income and Family Composition

Interactions between income and family composition as they determine energy expenditures, the energy budget share, and the Index of Well Being were tested with two-way analysis of variance (ANOVA-tables VII, VIII, and IX are in Appendix C). The distinction between married and non-married families was dropped since no conclusive differences had been found. Each of the remaining fourteen different family types was assessed at three different income levels, yielding 42 distinct groups. The income groups were low (under $ 15,000), medium ($ 15,000 to $ 30,000), and high income ($ 30,000 and more).

There was no significant ($p \leq .05$) interaction between income and family composition concerning energy expenditures and scores on the Index of Well Being. The relationship between the Index of Well being and income was uniform for all family types. No identifiable pattern existed in the case of energy expenditures.

For the variable energy budget share a significant interaction term was found ($F = 1.68$ with 26;1,360 d.f.; $p = .0178$). Plotting group means for different family types across income levels revealed that differences in the energy budget share between family types were much more pronounced in the low-income category than in the middle and high income categories. In the low-income category, the energy budget share varied between seven and more than fifteen percent from one type of family to another, while in the middle- and high-income categories differences were modest, between two and less than five percentage points. In part, this was a result of the fact that income was used as the denominator in computing the energy budget share. Thus, comparable variability in energy expenditures lead to much less variability in the energy budget share for high-income families than for those with low incomes.

In general, however, income effects were independent of family composition, and a seperate analysis of both effects appears preferable.

The Effect of Climate on Energy Expenditures

A number of states take regional climatic differences into account when they determine how much fuel assistance a family should receive. Average temperatures bear directly on heating and cooling requirements, which account for roughly two thirds of all residential energy use. Adding another factor besides income and family composition to the already complicated formula by which benefits are determined, however, may not be justified if climate had only a negligible impact on energy expenditures.

Climate was operationalized as the number of heating and cooling degree days in a given locale. Heating degree days are the number of degrees the average daily temperature is below 65 ^{o}F, summed over an entire year. Similarly, cooling degree days is the number of degrees the average daily temperature is above 65 ^{o}F, again summed over the year. Degree days are a concise statement about the thermal harshness of a given geographic area and thus are a useful figure to determine the demand on heating and cooling equipment. The average number of heating degree days in the sample was 4,751 with a standard deviation of 2,089 and a range from 1,574 to 9,940 degree days. The respective figures for cooling degree days were a mean of 1,039, standard deviation of 973, and a range from 130 to 2,845 degree days. As might be expected, there was a high negative correlation between heating and cooling degree days ($r = -.787$) meaning that in areas where it gets cold it usually does not get too hot, and vice versa.

An analysis of variance of energy expenditures using degree days as a covariate (i.e., adjusting energy expenditures for climatic differences) resulted in no significant effect of outside temperature on average energy expenditures for different families ($F = 2.262$ with 1; 1,356 d.f. $p = .133$).

There may have been a several reasons for this rather unexpected result. The variation in energy expenditures and degree days was large and only a fairly strong relationship would be significant. A more compelling explanation, however, may be offered by the fact that a relationship existed between heating and cooling degree days, respectively, and the main type of fuel used for home heating. For example, families living in hot climates with relatively mild winters were more likely to use electricity as their main heating source than heating oil or natural gas. The cost of electricity per million BTU, however, was $ 9.40 in 1980, while a million BTU could be purchased for $ 6.25 from oil, or just $ 2.93 from natural gas (U.S. DOE, Residential Energy Consumption Survey 1978/79), as shown in Table 13:

Table 13

Heating Degree Days, Fuel Bill, and Energy Price by Main Fuel Type for Heating

Main Fuel Type	Average Heating D.D.	Average Fuel Bill (in$)	Price per Million BTU (1980)[a)]
Electricity	4,359	$874.07	$ 9.40
Fuel Oil	4,945	1,023.19	$ 6.25
Wood	5,482	842.05	$ 2.77 [b)]
Natural Gas	5,611	971.67	$ 2.93
Propane	5,843	1,158.98	$ 6.15
Total	5,153	929.76	$ 5.26

N = 1,208

a) Source: US EIA Residential Energy Consumption Survey 79/78
b) The estimate of wood is based on 18 Mil. BTU/cord, and $50 per cord.

The major fuel source used for space heating differed substantially between different climatic regions. In those regions that indicated a high heating load, the fuels used tended to be cheaper. This may have partly offset the positive relationship between heating degree days and the amount of fuel needed for heating one would expect. A further levelling of energy expenditures came from the increased need for airconditioning in regions with low heating demand. This should in no way lead to the conclusion that outside temperatures have no effect on the amount of energy that is used in a home, but it should direct attention to the fact that outside temperatures may be related differently to fuel expenditures than to fuel consumption.

DISCUSSION

Interpretation of the Findings Within the Family-Life-Cycle Framework

The results of this study were presented in a form that could readily be translated into the structure of a family-life-cycle such as the one devised by Murphy and Staples (1979). The form was flexible enough to allow exploration of energy expenditures and well being in non-traditional family types, with more precise categorization of family size.

An Example

In order to illustrate how results from the study would fit into a family-life-cycle model, weighted mean scores for energy expenditures, the energy budget share, and the Index of Well Being are presented for each stage in Murphy and Staples' FLC in Figure 13 .

The inverted U-shaped curvilinear relationship between energy consumption and family-life-cycle stage reported by Fritzsche (1982) was confirmed in this study, and found to be linked, mainly, to age of household head. The number of dependents had a more or less constant effect on energy expenditures throughout the family-life-cycle; adding

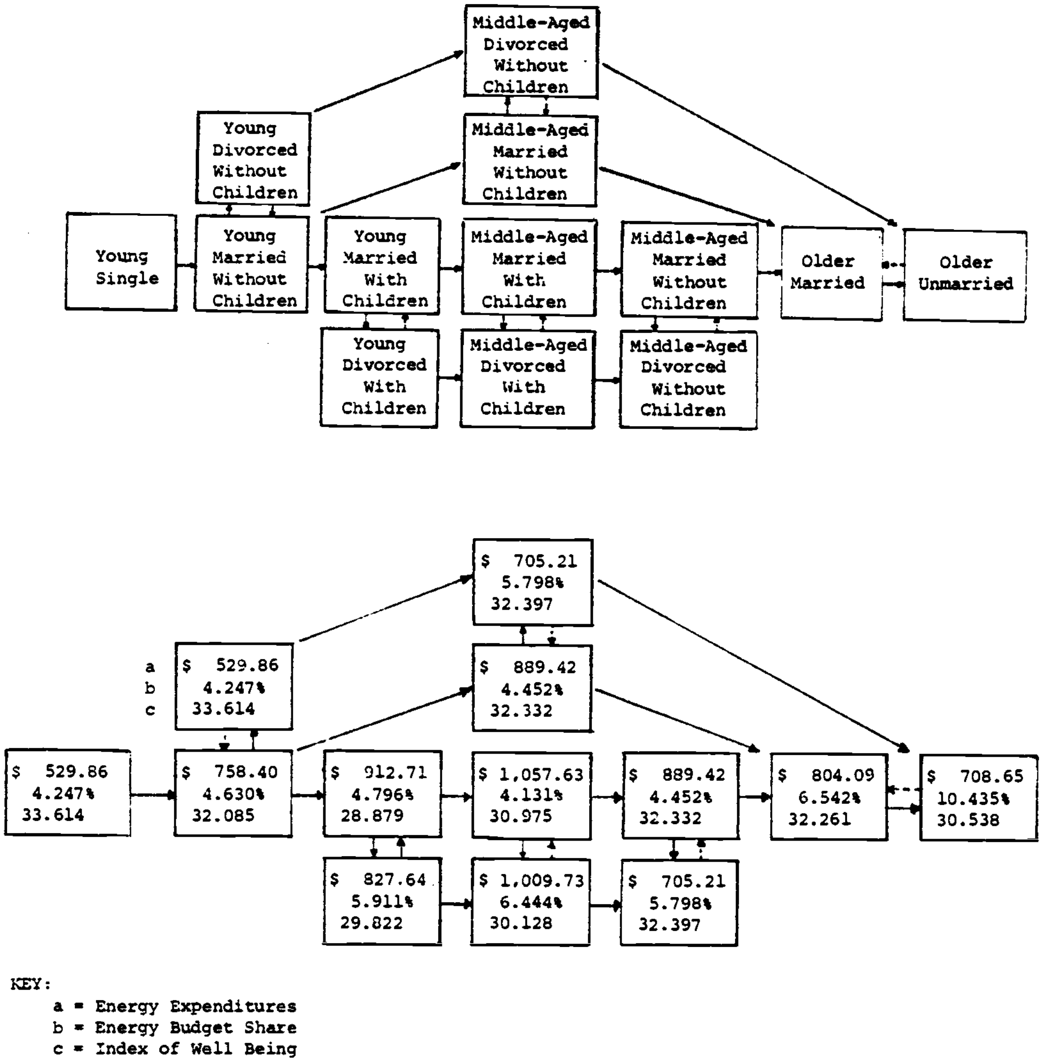


Figure 13. The Family-Life-Cycle Concept by Murphy and Staples, 1979, and an Example of Energy Expenditures, Energy Budget Share, and Index of Well Being Across the Stages in the Family-Life-Cycle

approximately 80 dollars per individual to the average yearly fuel bill. Families in the later stages of the life-cycle were much less likely to have dependents living in their households and, thus, their aggregate energy consumption tended to be lower. But when families of equivalent size were compared to each other, energy consumption increased toward the later stages of the family-life-cycle and only declined past retirement age. This decline, no doubt, was forced by declining income rather than chosen voluntarily, since the energy budget share still doubled in this age group.

Perceived well being, however, was not lower in the last stages of the family-life-cycle. Quite contrary, it increased to its highest level among retirement-age families, even though there were relatively more low-income families in this age group, and low income was strongly related to low scores on the Index of Well Being. The relatively high levels of well being among those age 65 and over may only hold for those who also had a medium to high income. Furthermore, the low-income elderly may have been supported by social security and thus were automatically eligible for low-income fuel assistance, protecting them from the severest impacts of rising fuel prices.

Implications for Low-Income Fuel Assistance Programs

The heaviest cut-backs in areas of consumption other than energy were reported by large families, while families with no dependents reported the fewest cuts, despite the fact that energy bills accounted for the largest budget share among the latter family type. Fuel assistance programs should, therefore, take family size into account.

Energy expenditures varied more extensively across stages in the family-life-cycle than across income levels. The opposite was true for the energy budget share and Index of Well Being. This suggests that energy expenditures tended to be determined by family characteristics whereas budget share and family well being tended to be determined by a family's income. Thus, while it is more important to look at the stage in the family-life-cycle when studying energy consumption, it seems more important to look at income when determining the adverse effects of rapidly rising energy costs. In addition, a significant correlation (r = -.247) existed between the energy budget share and Index of Well Being, but hardly any relationship between the absolute level of energy expenditures and the Index of Well Being (r = .0178). Both findings combined indicate that the percentage of income spent on energy is a superior measure of hardships arising from high energy cost; a finding well in line with previous research (Newman and Day, 1975; Olsen, 1979). Eligibility criteria and benefit levels for low-income fuel assistance programs should therefore be based not just on the fact that a family is poor, but also on a family's expected energy expenditures in relation to their income. Age as well as family size were found to be strong determinants of energy expenditures. A practical method would be to use expected energy expenditures for different stages of the family-life-cycle and adjust benefits to families accordingly.

Adjusting benefits for differences in climate did not appear to be a concern since the number of heating degree days had no significant effect on energy expenditures. The greater use of expensive electricity for heating purposes in mild climates was thought to have offset potential savings from lower consumption of energy.

Implications for the Design of Life-Line Utility Rates

The question whether life-line utility rates actually alleviate the burden of low-income families dealing with high energy cost can not be answered conclusively by the findings in this study. Certainly, they will not render a low-income fuel assistance program obsolete. The difference in energy consumption between the lowest and highest income group was less than \$ 500 a year. Even among families with incomes of less than \$ 10,000 per year, average energy expenditures were around \$ 700 annually. If life-line utility rates were to cover this rather large energy need, chances are, that many families with higher incomes would benefit as much, if not more, since variability in energy expenditures within income groups was found to be very large.

CHAPTER IV

DIFFERENCES IN CONSERVATION ACTIONS AMONG FAMILY TYPES AT DIFFERENT INCOME LEVELS AND SOME EXPLANATORY FACTORS

INTRODUCTION

Energy conservation has been widely advocated as a cornerstone in our efforts to regain control over our future energy supply (Lovins, 1977; Stobaugh and Yergin, 1980; Ross and Williams, 1981). Energy conservation not only saves money, but it reduces inflation, has little impact on the environment, and reduces dependence on imported oil (Hirst et al., 1982). Yet, it has only begun to enter American homes and businesses. Many surveys show that most households have started to conserve energy but much remains to be done (Honeywell Study, 1982). Half the households surveyed in 1979, for example, had taken no action to reduce their fuel bills by investing in energy efficiency (Hirst and Goeltz, 1982). The problem with wider acceptance of energy conservation is, as Dillman et al. (1982) point out, "(...) that it is not something that can be accomplished by simple government decree", but instead "(...) requires decisions by literally millions of home owners" (p. 4). Darley (1981) has likened the process by which people adopt energy conservation actions to the diffusion of an innovation. This process takes time and moves through several phases before a sizable percentage of the population accepts the innovation. Government incentives, such as tax credits for energy saving home improvements, were intended to accelerate this diffusion process.

Rising energy prices were instrumental in motivating people to conserve energy (Marlay, 1982; Honeywell Study, 1982). Cunningham and Lopreato (1977) summarized their extensive literature review: "The major influence on energy conservation behavior is price, especially for low-to-middle income groups" (p. 28). A similar conclusion was drawn by Olsen (1981) in a study of 484 Seattle residents. Several authors have concluded that increasing energy prices further would be an effective way to promote energy conservation (Ross and Williams, 1981; Hirst et al., 1982). This is also the energy policy of the Reagan Administration which has pushed decontrol of oil and natural gas prices.

A pure market approach that relies on high fuel prices to encourage investments in energy efficiency, however, has been criticized not only of being an "insufficient base for resource management policy" (Winkler and Winett, 1982, p. 434), but more importantly, of being inequitable (Morell, 1981). In particular, low-income families are not only hurt directly by rising energy prices because they spend a larger portion of their income on energy (Newman and Day, 1975; Olsen, 1981; Ross and Williams, 1981), but they are also unable to afford the high, up-front cost of energy saving equipment (Morell, 1981, Dillman et al., 1982). Efficiency improvements, such as wall insulation and fuel efficient cars, cost money but may not require giving up convenience and comfort (Stern and Gardner, 1981). While low-income families are less likely to invest in energy efficiency, they may be more likely to cut their energy use through curtailments. Curtailments, such as driving the car less and turning down thermostats, can be done instantly. They do not involve spending money, but they are likely to be perceived negatively. Curtailments require a sustained commitment, constant monitoring, and generally are less effective than efficiency improvements which only require a one-time effort (Stern and Gardner, 1981).

In order to compensate for the difficulties low-income families may face in securing a home improvement loan, government sponsored weatherization programs have been initiated and administered through the Department of Energy. Starting in 1982, fifteen percent of federal low income energy assistance grant money could be spent on weatherization programs by the states (Alliance to Save Energy, 1982). Weatherization programs have the advantage that they offer a more permanent solution to the energy problem of low-income families (Ross and Williams, 1981). Since much capital would be needed to carry out a large-scale weatherization program, not all eligible families could be served in the first years. In the meantime, an effective energy assistance program would be needed for those families.

Low-income families are more likely to live in older, substandard housing, in multi-family units, and they tend to rent rather than own their home (Dillman et al., 1982). An effective weatherization program for tenants is an important ingredient in an effort to improve energy efficiency (Buck and Brandt, 1982; Guthrie and Brandt, 1982). The importance of having some knowledge about the kinds of conservation measures adopted by households, and about the factors that influence these adoption rates was pointed out by Hirst and Goeltz (1982). This information could be used to more carefully target conservation programs to particular groups, such as low-income renters. Hirst and Goeltz (1982) concluded: "(our) data show large variations among households in their recent conservation actions. These variations suggest the importance to carefully examine the factors that account for differences among households" (p.147). This is all the more important since physical/structural characteristics of a familiy's home appear to be more important in determining energy consumption than socioeconomic and family factors (Tienda and Aborampah, 1981). Yet, interrelationships exist between socioeconomic factors and housing characteristics, suggesting that both sets of variables should be considered as they determine energy conservation actions.

METHODOLOGY

Sample Design

A stratified random sample of 15,047 households was drawn from telephone directories in ten of the Western United States. Two strata of equal size were formed, one for urban (SMSA) and one for rural (non SMSA) households. This led to an overrepresentation of rural households. From these ten states three were selected for this study on the basis that they represented roughly the same number of households (approx. 1 million each state) and that they covered a wide range of climatic conditions. The states selected, Arizona (hot), Colorado (cold), and Oregon (mild), account for 4,481 households in the sample. While average temperatures vary considerably within these states, they represent the extremes of heating and cooling requirements found in the western region.

Data Collection

Data were collected as part of a Western Regional Agricultural Experiment Station Project (W-159) "Consequences of Energy Conservation Policies for Western Regional Households".

In spring of 1981 questionnaires were mailed to all sample households. The design of the questionnaire, as well as the mailing procedure, followed the Total Design Method (Dillman, 1978). A copy of the questionnaire is included in Appendix F. This method emphasized a personal style in the cover letters and repeated follow-ups on non-respondents. From the 4,481 questionnaires mailed out in the three states, 2,633 usable records were returned, yielding a 58.8 percent response rate. After adjustment for undeliverable questionnaires and ineligible respondents, the response rate rose to 65.6 percent (Makela et al., 1982).

Variable Description

Sociodemographic characteristics of the sample are summarized in Table 14. Marital status, age of the male head of household, and number of dependents were conceptualized in a modernized and extended family-life-cycle model (Murphy and Staples, 1979). In addition to classic life-cycle models it incorporates non-traditional family types, where the head of household is not married (i.e. single, separated, divorced, or widowed) thus accounting for a growing segment of the population. Of all sample households, 26.5 percent fell into the non-married category, ten percent less than would be expected from 1980 census data (U.S. Bureau of the Census, 1983a). Families in the middle age groups were overrepresented by about six percent at the expense of young families. Dependents were defined as all individuals living in a household other than the head of household and spouse. In nearly 90 percent of the cases, however, the dependents were children. There is indication that families without dependents were underrepresented in the sample.

Income figures reflect the total 1980 family income before taxes. Data were combined into three income levels. Compared to census data there were fewer than expected families in the low-income category, but more than expected in the high-income category. For some parts of the analysis income was dichotomized; 44 percent of the families had incomes below and 56 percent equal to or above $ 20,000 a year. The educational level reported is the highest level found in the household. The average level of education in the sample was, nonetheless, higher than comparable census data. In accordance with both previous findings there were fewer than expected blue-collar workers in the sample.

Housing characteristics of the sample are summarized in Table 15. Compared to 1980 census data there were more families living in single-family homes in the sample, but fewer families living in multi-family units (U.S. Bureau of the Census, 1983b). Renters were underrepresented in the sample which may have been a result of using

Table 14

Sociodemographic Characteristics of Sample
Compared to 1980 Census Data

Variable Categories	Absolute Frequency	Relative Frequency (%)[a]	1980 Census Data (%)
Marital Status			
Married	1,907	73.5	63.3
Not Married	688	26.5	36.7
Age of Head of HOusehold	733	29.7	36.0
Under 35	733	29.7	36.0
35 to 49	676	27.4 } 51.9	46.0
50 to 64	603	24.5 }	
Over 64	454	18.4	18.1
Number of Dependents			
None	1,079	42.8	n.a.[b]
One	556	22.0	n.a.
Two or More	888	35.2	n.a.
Income			
Under $15,000	744	30.2	34.4
$15,000 to 29,999	1,035	42.0	n.a.
$30,000 or more	683	27.7	n.a.
Education			
High School Diploma or less	603	26.3	59.7
Trade School/Some Some College	783	34.1	20.8
College Degree (four year degree or higher)	910	39.6	19.5
Occupation			
Blue Collar	817	37.8	39.8
Clerical	306	14.1	14.7
Professional	869	40.2	43.9

a) Adjusted for missing observations
b) not available

Source: U.S. Bureau of the Census. General Social and Economic Characteristics, Arizona, Colorado, Oregon. Washington D.C.: 1983a

Table 15

Housing Characteristics of Sample
Compared to 1980 Census Data

Variable Category	Absolute Frequency	Relative Frequency (%) [a]	1980 Census Data (%)
Type of House			
Mobile Home	272	10.6	8.8
Single-Family Det.	1,917	74.4	62.7
Multi-Family Housing	387	15.0	28.4
Size of Home			
Under 1,000 sqft.	648	25.6	n.a.
1,000 sqft.-1,999 sqft.	1,409	55.7	n.a.
2,000 sqft. and more	471	18.6	n.a.
Tenure			
Rented	468	18.0	34.1
Owned	2,132	82.0	65.9
Number of Years in Present Home			
Less than 2 years	1,024	44.6	n.a.
2 to 8 years	571	24.9	n.a.
9 years and more	702	30.6	n.a.
Year in Which House was Built			
Before 1960	857	37.5	38.8
1960 to 1974	871	38.1	39.9
1975 or after	556	24.3	21.4
Location			
Rural (Non SMSA)	1,146	49.4	26.6
Urban (SMSA)	1,175	50.6	73.4
Major Fuel Type for Heating			
Electricity	555	29.6	28.6
Heating Oil	113	6.0	6.5
Wood	257	13.7	5.9
Natural Gas	884	47.1	54.3
Propane	65	3.5	3.9
Solar	3	.2	-

a) Relative Frequencies adjusted for missing observations.
b) not applicable
Source: U.S. Bureau of the Census. Detailed Housing Characteristics, Arizona, Colorado, Oregon. Washington D.C.: 1983b.

telephoe books as a sampling frame. The sample deliberately selected an equal number of rural and urban households. Rural households were those outside Standard Metropolitan Statistical Areas (SMSA) and urban households those within. According to census data only 26.6 percent of the households were outside SMSA's in 1980.

Climate was operationalized as the number of heating and cooling degree days. Heating degree days are the number of degrees the average daily temperature is below 65 ^{o}F, summed over the entire year. Similarly, the number of cooling degree days is the sum of the number of degrees the average daily temperature lies above 65 ^{o}F. Degree days are a good indicator of the demand on heating and cooling equipment in a given locale. For the present study both variables were dichotomized, using cutpoints close to the arithmetic means for the two variables (Table 16). There was a high negative correlation between heating and cooling degree days (r = -.787) meaning that areas with cold winters usually do not have very hot summers and vice versa.

Table 16

Climate

Variable Categories	Absolute Frequency	Relative Frequency (%)
Heating Degree Days		
Mild (≤ 4,500)	647	28.5
Cold (> 4,500)	1,623	71.5
Cooling Degree Days		
Cool (≤ 750)	1,573	68.1
Hot (> 750)	737	31.9

Energy conservation actions were comprised of energy efficiency improvements as well as curtailments (Stern and Gardner, 1981). They are reported in Table 17.

Table 17

Absolute and Relative Frequencies of Households Having Taken Energy Conservation Actions

Energy Efficiency Improvements	Absolute Frequency	Relative[a)] Frequency (%)
Good Caulking and Weatherstripping	1673	64.7
More than 4" of Ceiling Insulation	1612	62.3
Insulation in Outside Walls	1399	54.2
Double Pane or Storm Windows	1232	47.9
Wood Stoves	678	26.3
Evaporative Coolers	554	21.3
Outside Window Shades	467	18.4
Curtailment		
Water Heater Set to 120°F or Less	1614	63.5
Close off Rooms Not in Use	1594	62.5
Room Thermostat Set to 65°F or Less in Winter	1359	53.2

a) Relative frequencies adjusted for missing observations.

Efficiency improvements were selected in order to cover a wide range of possible actions and to insure an adequate number of respondents who had taken these actions. The most common conservation measure taken by sample households was caulking and weatherstripping (65 %), whereas only 18 percent had outside window shades.Curtailments had been made in about 60 percent of the households.

Tax credits and home improvement loans. Tax credits are available on the federal and on the state level. Twenty-five percent of the families had claimed federal tax credits, and slightly less than 23 percent had made a claim for state tax credits. Home improvement loans had been taken out by 234 families, or 9.5 percent of the sample, as shown in Table 18.

Table 18

Loans Taken Out and Tax Credits Claimed for Energy Efficiency Improvements

Activity	Absolute Frequency	Relative[a)] Frequency (%)
Taken Out Loan for Efficiency Improvements	234	9.5
Claimed Federal Tax Credit	518	24.9
Claimed State Tax Credit	508	22.7

a) Relative frequencies adjusted for missing observations.

Statistical Analysis

The general structure of the analysis had three major parts. First, it was investigated which conservation actions were likely to be taken by different families at different income levels. Then differences in personal and housing characteristics among families of different composition and with different incomes were identified. Personal and housing characteristics were conceptualized as behavioral constraints or explanatory factors. Finally, an attempt was made to determine what underlying factors explain differences in the likelihood of families taking certain conservation actions. The flow of the general research questions is illustrated in Figure 14.

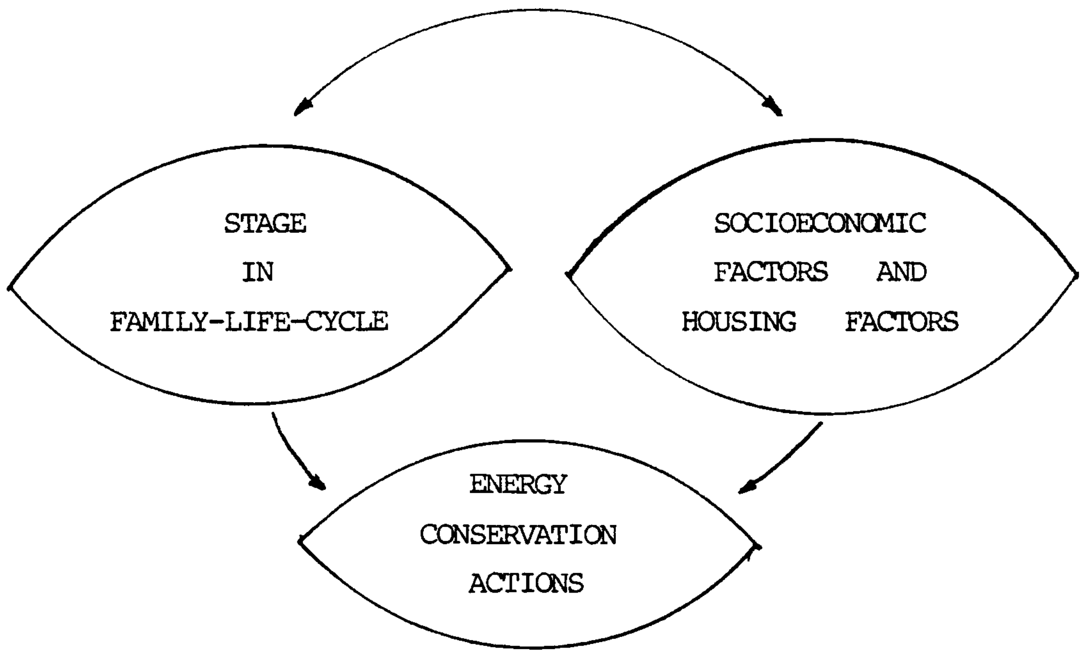


Figure 14. Diagram of General Research Questions

The statistical analysis was based on fitting log-linear models to five-way frequency tables in order to find significant relationships between family composition, income, and conservation actions on one hand, and relationships between family composition, income, and underlying personal and housing factors on the other. Models providing the best fit were selected in a stepwise process by deleting interaction terms from an overspecified model. For each interaction term and main effect in the final model a lambda-parameter was estimated upon which interpretation of the results was based. All relationships were significant at least at the .05-level. A negative lambda-coefficient for a particular category decreases the probability for a case to fall into that category, while a positive lambda-coefficient increases the probability for a case to fall into that category. In instances where the lambda-coefficient is zero, no effect on the probabilities exists and therefore no relationship is assumed. The lambda-coefficients for all categories of a variable are constrained such that they sum to zero. Thus, for a dichotomous variable the lambda-coefficient for one category is the complement of the other category. Therefore, only one lambda-coefficient was reported for dichotomous variables.

Logistic regression (or logit analysis) is a special case of log-linear analysis where one variable is considered the dependent variable, while all the other variables are considered independent variables (Goodman, 1978). This analysis was used to test the relationships between conservation actions and underlying socioeconomic and housing factors. Predictor variables were selected in a stepwise procedure, deleting non-significant terms one at a time. The stepwise logistic regression procedure allowed the testing of more variables than ordinary log-linear analysis. All analyses were performed with the Biomedical Computer Program Package (BMDP) in its 1981 version at Oregon State University's Milne Computer Center.

RESULTS

Results from the Analysis of Energy Conservation Actions by Family Composition and Income

Analytical Procedure

In order to test the relationships between family composition and income and various energy conservation actions, five-way frequency tables were formed for each energy conservation action. The five variables for each model were age of the head of household, marital status, number of dependents, income, and one of the conservation measures. To each five-way table a log-linear model was fitted in a two-stage process. First, all main effects, two-, and three-way interactions were tested as to whether they were significant (none of the four- or five-way interactions were found to be significant). A model was formed containing all potentially significant terms. Then all terms which were not necessary to yield a model with adequate fit (i.e., a probability of the chi-square goodness-of-fit value greater than .05) were deleted in a stepwise procedure to arrive at the most parsimonious model. Thus, the final model included all the main effects and interactions necessary to describe the observed cell frequencies in the five-way table. They were significant at least at the .05-level.

Relationships between Family Composition Variables and Income

All log-linear models testing the relationships between family composition, income, conservation actions, and personal and housing factors contained the same four variables. Three of them represented family composition (i.e. marital status, age of the head of household, and family size) and the fourth variable was income. The models only varied in the fifth variable, for example energy conservation actions. Since relationships between the former four variables were essentially the same for each model they are discussed first.

Findings concerning the relationships between family composition variables and income were as would be expected. Families headed by a person in the middle age categories were more likely to be married, had more dependents, and tended to have higher incomes than either families headed by a young person or by a person past retirement age. There was a strong three-way interaction involving the age of the head of household, the number of dependents, and income. Among young families the likelihood of having many dependents was highest in the low-income bracket, whereas among families in the older age groups, having many dependents was relatively more common in the highest income bracket.

Relationships between Family Composition, Income, and Energy Efficiency Improvements

The interpretation of the relationships between family composition, income, and energy efficiency improvements was based on lambda-coefficients. The lambda-coefficients for all two-way interactions involving energy conservation actions are summarized in Table 19.

Married families were more likely to have invested in energy efficiency then were singles in all but one instance. Outdoor window shades were equally likely to be installed in married and non-married households.

Investments in energy efficiency generally increased with the age of the head of household. For caulking and weatherstripping, and evaporative coolers the likelihood dropped in the highest age group (65 years of age and older). There was no age effect on the probability of having a wood stove. In the case of double pane or storm windows there was a three-way interaction between age, marital status, and the

Table 19

Lambda-Coefficients for Two-Way Interaction Between Family Composition, Income, and Conservation Action

Conservation Action	Age of Head of HH. < 35	35-49	50-64	> 64	Marital Stat. Married	No. of Dependents 0	1	2	Income (in $1,000) < 15	15- < 30	≥ 30
Wall Insulation	-.122	.006	.022	.094	.156	0	0	0	-.238	.020	.218
4" Ceiling Insulat.	-.243	-.047	.101	.190	.166	0	0	0	-.317	.035	.281
Caulking	-.173	-.033	.112	.094	.168	0	0	0	-.217	.036	.181
Storm Windows	-.092	-.031	.039	.084	.090	0	0	0	-.171	.074	.097
Evaporative Cooler	-.106	-.079	.117	.069	.070	0	0	0	.057	-.030	-.026
Window Shades	-.137	-.079	.060	.156	0	0	0	0	0	0	0
Wood Stove	0	0	0	0	.216	-.132	.037	.095	0	0	0
Close-off Rooms	-.006	.042	.032	-.067	.037	.171	.063	-.233	0	0	0
Water Heater 120°F	0	0	0	0	.100	0	0	0	.083	.034	.118
Room Temperat. 65°F	.174	.186	-.067	-.313	-.059	0	0	0	0	0	0

incidence of storm windows (see Table 20 for lambda-coefficients). In non-married families the probability of having storm windows increased with age, whereas it decreased with age in married families.

Table 20

Lambda-Coefficients of Three-Way Interaction for Variables Storm Windows, Marital Status, and Age of Head of Household

Storm Windows	Marital Status	Age of Head of Household <35	35-49	50-64	>64
Present	Married	.146	.044	-.111	-.078

The size of a family (i.e., number of dependents) had no significant effect on the probability of having invested in energy efficiency with the exception of wood stoves. They were more common in larger families than in small ones.

Income was related to conservation measures much in the same way as the age of the head of household. In general, more efficiency improvements had been made as income increased. There was, however, no income effect on window shades and on wood stoves. These conservation measures were taken by the same proportion of families in all income categories. Evaporative coolers, in contrast to all other measures, were more commonly owned by low-income families than by either middle- or high-income families. Evaporative coolers could well be the poor-man's airconditioner. A significant three-way interaction between income, marital status, and having an evaporative cooler indicated that among married families the incidence of an evaporative cooler declined as income increased, while among non-married families evaporative coolers were relatively more common as income rose (see Table 21 for lambda-coefficients).

Table 21

Lambda-Coefficients of Three-Way Interaction for Variables Evaporative Cooler, Marital Status, and Family Income

Evaporative Cooler	Marital Status	Family Income Low	Medium	High
Present	Married	.146	.027	-.173

There was also an interaction between income and marital status in the case of storm windows (see Table 22 for lambda-coefficients). Among high income families, those who were married were reltively less likely to have double pane or storm windows, than non-married families, while the opposite was true for low-income families.

Table 22

Lambda-Coefficients of Three-Way Interaction for Variables Storm Windows, Marital Status, and Family Income

Storm Windows	Marital Status	Family Income Low	Medium	High
Present	Married	.007	-.111	.104

In general, it may be concluded that the likelihood of energy efficiency investments increased over the family-life-cycle, sometimes dropping in the last stage. Married families were consistently more likely to have energy efficient homes than non-traditional families where the head of household was not married.

The number of dependents did not appear to influence the decision and/or ability to invest in energy conservation, while income clearly had a positive effect on investments, with the notable exception of evaporative coolers, window shades, and wood stoves.

Relationships between Family Composition, Income and Curtailments

The relationships between curtailments, family composition variables and income were less clear-cut than in the case of efficiency investments (see Table 19). Married families more likely had closed off rooms they did not use, and turned down the water heater thermostat, but they were less inclined to set the room thermostat to 65 ^{o}F or less in winter. The young and the old were less likely to close off rooms than families in the middle age groups. While there was no effect of age on turning down the water heater thermostat, there was an age effect on turning down the room thermostat. The probability of setting the room temperature to 65 ^{o}F or less in winter rose from the age group under 35 to the 35 to 49 year old group, but dropped off sharply in the older age groups.

There was a significant interaction between age and marital status with respect to closing-off rooms not used (see Table 23 for lambda-coefficients). The probability of closing off rooms among married families declined continually as age increased, while it rose with age among non-married families.

As one might have expected, the probability of closing off rooms declined as the number of dependents in a family increased. There was no effect of family size on turning down either water heater or room thermostats.

Table 23

Lambda-Coefficients of Three-Way Interaction for Variables Close-off Rooms, Marital Status, and Age of Head of Household

Close-off Rooms	Marital Status	Age of Head of Household <35	35-49	50-64	>64
Done Now	Married	.128	.031	-.037	-.120

Low-income families were more likely to turn down the water heater thermostat to below 120 ^{o}F than middle- or high-income families. No significant income effect existed relative to closing off rooms, or to turning down the room thermostat. Since low-income families are more likely to live in small dwellings they may find it harder to close off rooms. They may also be more likely to have a heating system that is not thermostatically controlled.

In summary, there was no consistent relationship between marital status and curtailments as in the case of efficiency improvements. Families in the middle stages of the family-life-cycle and those with fewer dependents may have found it easiest to cut energy use, while families in the later stages of the life-cycle had difficulties cutting their energy use through curtailments. Low-income families were more likely to cut down their energy consumption through curtailments.

A Profile of Different Family Types at Different Income Levels

In order to find some of the underlying factors that determine why families differ in the conservation actions they have taken, a profile of family types at different income levels was developed. The method used to develop this profile parallels the procedure in the previous section. Again, five-way frequency tables were created

Table 24

Lambda-Coefficients for Two-Way Interaction Between Family Composition, Income, and Socioeconomic as well as Housing Factors

Variable Category	Age of Head of HH. <35	35-49	50-64	>64	Marital Stat. Married	No. of Dependents 0	1	2	Income (in $1,000) <15	15-<30	≥30
State											
Arizona	-.005	-.134	.115	.023	.038	0	0	0	0	0	0
Colorado	.135	.106	-.103	-.138	-.084	0	0	0	0	0	0
Oregon	-.130	.028	-.013	.115	.046	0	0	0	0	0	0
Location											
Urban	.146	-.033	-.041	-.071	-.178	0	0	0	-.196	-.041	.237
Type of House											
Mobile Home	-.172	-.062	.156	.078	.145	.082	.055	-.137	.343	.046	-.389
Single Family	-.236	-.045	.078	.202	.201	-.278	-.022	.301	-.358	.008	.351
Multi Family	.407	.106	-.234	-.280	-.347	.197	-.304	-.164	.016	-.054	.038
Tenure											
Home Owner	-.552	-.080	.326	.305	.344	-.042	-.024	.067	-.311	.086	.225
Size of House											
Small	.542	.009	-.274	-.277	-.252	.343	-.001	-.342	.772	.054	-.826
Medium	-.056	-.081	.029	.109	.146	-.088	.013	.074	-.097	.164	-.067
Large	-.486	.072	.246	.168	.106	-.256	-.012	.268	-.675	-.217	.893
Year of Construction											
Before 1960	-.122	-.180	.207	.092	0	0	0	0	.271	.023	-.293
1960 to 1974	-.153	.076	.116	-.039	0	0	0	0	.002	-.005	.003
1975 or after	.275	.100	-.323	-.053	0	0	0	0	-.272	-.018	.290

Table 24 (Continued)

Variable Category	Age of Head of HH. < 35	35-49	50-64	>64	Marital Stat. Married	No. of Dependents 0	1	2	Income (in $1,000) < 15	15-<30	≥30
Years in Present Home											
Less than 2 Years	1.127	.147	-.523	-.751	0	.177	-.013	-.165	0	0	0
2 to 8 Years	.083	.081	-.150	-.014	0	-.088	-.112	.200	0	0	0
9 Years or more	-1.211	-.227	.671	.765	0	-.089	.125	-.036	0	0	0
Main Fuel for Heating											
Electricity	0	0	0	0	0	0	0	0	0	0	0
Heating Oil	0	0	0	0	0	0	0	0	0	0	0
Wood	0	0	0	0	0	0	0	0	0	0	0
Natural Gas/Other	0	0	0	0	0	0	0	0	0	0	0
Education											
High School Dipl.	-.514	-.157	.331	.339	.131	0	0	0	.524	.001	-.524
College Degree	.239	.090	-.134	-.195	.006	0	0	0	.044	.014	-.058
Graduate Work	.275	.067	-.198	-.144	-.137	0	0	0	-.567	-.014	.582
Occupation											
Worker	.198	.014	.050	-.260	.371	0	0	0	.457	.069	-.526
Clerical	-.126	-.044	.018	.151	-.311	0	0	0	-.037	-.088	.125
Professional	-.073	.031	-.067	.110	-.061	0	0	0	-.420	.020	.401

containing the three variables which constitute family composition, income, and each of the following variables in turn: state, rural/urban location, type of housing, tenure, size of the house, number of years in present home, year in which house was built, major type of fuel used to heat the house, highest educational level in the family, and occupation of the head of household. Then log-linear models were fitted to these tables to determine which of the relationships were significant. Only the interactions between family composition, income, and personal and housing characteristics are reported. The lambda-coefficients for all two-way interactions are presented in Table 24.

State

Families were sampled from Arizona, Colorado, and Oregon in order to represent the range of climatic conditions in the western region. In Arizona and Oregon the head of household tended to be older than in Colorado. There were relatively more married families in Colorado than in either Arizona or Oregon. There was a three-way interaction between age, marital status, and state (see Table 25 for lambda-coefficients).

Table 25

Lambda-Coefficients of Three-Way Interaction for Variables State. Marital Status, and Age of Head of Household

State	Marital Status	Age of Head of Household <35	35-49	50-64	>64
Arizona	Married	-.203	-.017	-.036	.255
Colorado	Married	.057	.041	.016	-.114
Oregon	Married	.146	-.024	.020	-.140

In Arizona, families past retirement age were more likely to be married than in either Colorado or Oregon. No differences between states existed in the number of dependents and level of family income.

Rural/Urban Location

Respondents tended to be younger in urban areas (inside SMSA's) than in rural areas (outside SMSA's). The age group under 35 had a much higher likelihood of living in an urban area. Non-married families also were more common in urban than in rural areas. Income tended to be higher in urban areas. Particularly, families in the highest income bracket were more likely to live in an urban area. There were no significant differences between urban and rural families as to the number of dependents living in the household.

Housing Characteristics

Type of housing. Families where the head of household was 50 years of age or older were more likely to live in single-family units or mobile homes, while younger families were more likely to live in multi-family units, especially when the head of household was under 35 years of age.

Married families most often lived in single-family detached houses, followed by mobile homes. Non-married families were relatively more likely to live in multi-family units. There was a significant three-way interaction between age, marital status, and type of house (see Table 26 for lambda-coefficients). Non-married families past retirement age were even less likely to live in multi-family units than were married families in that age group. This may be due to older widowed people staying in the family home, while some married seniors choose an apartment for greater convenience and/or savings.

Table 26

Lambda-Coefficients of Three-Way Interaction for Variables Type of House, Marital Status, and Age of Head of Household

Type of House	Marital Status	Age of Head of Household < 35	35-49	50-64	>64
Mobile H.	Married	.002	.068	-.167	.098
Single-Fam..	Married	.015	.215	.017	-.247
Multi-Fam.	Married	-.016	-.282	.150	.149

Families living in single family houses tended to be larger, while those living in mobile homes tended to be smaller, and those living in multi-family units had the least number of dependents.

The likelihood of living in a single family detached house increased with income, while the probability of living in a mobile home decreased. Families living in multiple-unit housing were more likely to be in either the low or the high income group, but less likely to be in the middle income bracket.

Tenure. Home ownership was more common in the higher age brackets. It was less common in the age group under 35. Married families were considerably more likely to live in their own home than non-married families. Home owners also tended to have larger families than renters.

The likelihood of home ownership increased with income, but there were two significant three-way interactions involving income and tenure (see Tables 27 and 28 for lambda-coefficients). Families past retirement age in the high income bracket were more likely to rent their home while the same family type in the low income bracket was more likely to be a home owner.

Table 27

Lambda-Coefficients of Three-Way Interaction for Variables Tenure, Family Income, and Age of Head of Household

Tenure	Income	Age of Head of Household <35	35-49	50-64	>64
Own	Low	-.132	-.182	.017	.307
	Medium	-.011	-.170	-.016	.196
	High	.154	.351	0	-.504

Similarly, non-married families with high incomes were relatively more likely to be renters than their married counterparts.

Table 28

Lambda-Coefficients of Three-Way Interaction for Variables Tenure, Family Income, and Marital Status

Tenure	Marital Status	Income Low	Medium	High
Own	Married	-.040	-.112	.152

Size of the house. The probability of living in a small home decreased with age,whereas the probability of living in a medium sized or large house in general increased with age. Families where the head of household was under 35 years of age had a much greater probability of living in a small rather than a large home.

Married families tended to live in medium sized or large homes, while non-married families tended to live in small homes. Larger families were inclined to live in larger houses. It is an expression of the greater need for space as the number of people in a household increases and thus, in part, responsible for the higher energy use of large families. Similarly, the size of the house increased with income for higher income families can afford a larger house.

Year in which the house was built. Older people generally lived in older houses. An exception were those past retirement age who were less likely to live in houses built before 1975 than families of the preceeding age category (i.e., 50 to 64 years of age). This could be attributed to the somewhat higher probability that families past retirement age lived in multi-family units; possibly retirement housing complexes. Similarly, the higher a family's income was, the newer the home they lived in tended to be. There were no significant differences in marital status or family size regarding the year in which a house was built.

Number of years in the present home. The older the head of household, the longer a family had lived in its present home. The under 35 year olds were especially prone to have stayed for less than two years in their present residence. The over 50 year olds, to the contrary, most likely had lived for over eight years at their current address. Small families were among those more likely to have lived for less than two years in their present home than were large families. No clear family size trend existed in houses occupied two to eight years, and over eight years. There was no significant difference in marital status or income level regarding the number of years a family had spent at the same place.

Main type of fuel used for heating. There were no significant differences between family types and levels of income as to the major source of energy used for heating.

In summary, as families moved through the family-life-cycle they tended to move out of rented, multi-family units into single family homes they owned. As families grew larger, their homes tended to get larger and they tended to be less mobile so that the homes in which they lived also tended to be older. Low-income families were more likely to live in mobile homes. They were also more likely to rent, and live in smaller and older houses than families with medium and high incomes.

Personal Characteristics

Highest level of education in the family. The younger the head of household in a family, the higher the level of education in that family tended to be. The higher the educational level of a household was, the more likely it was a non-married household. This was, in part, a result of the higher educational level among those under 35 years of age, who were less likely to be married than older individuals. There was a strong and consistent relationship between income and education such that high levels of education were more likely to be found in the high income bracket. No significant relationship existed between level of education and family size.

Occupation of the head of household. Blue collar work was more common among married families, while both clerical and professional occupations were more likely among non-married families. Income tended to be lower among blue collar occupations and higher among clerical and professional occupations. No significant relationship existed between type of occupation and the number of dependents living in a family. There were more blue collar workers among respondents under 35 years of age then there were among those past retirement age (retired persons were asked to refer to their last position). The likelihood for clerical type work increased with age, while no consistent age pattern existed for professionals.

In summary, families in the early stages of the family-life-cycle tended to be better educated, particularly when they were not married. This has implications for their income or, more importantly, for their future earning potential. In later stages of the family-life-cycle there was a move away from blue collar occupations towards clerical and professional type occupations, which may partly offset the income trend suggested by the relationship with education.

With the information about the relationships between personal and housing characteristics on one hand, and family composition and income on the other, it was possible to test directly which of these underlying factors was responsible for differences in the probability of having taken conservation actions.

The Impact of Personal and Housing Characterisitcs on Energy Efficiency Improvements and Curtailments

The relationships between personal and housing characteristics on one hand, and energy efficiency investments and curtailments on the other were tested using a two-stage stepwise logistic regression procedure. At the first stage all personal and housing characteristics, as well as climatic conditions, were included in the stepping procedure. Once the non-significant variables had been identified a revised regression model was calculated containing only the significant ($p \leq .05$) variables. Two of the revised models failed to provide an adequate fit between observed frequencies and the cell frequencies predicted by the model. The model predicting outside wall insulation had a chi-square goodness-of-fit value of 73.60 with 51 degrees of freedom and $p = .021$. The model predicting evaporative coolers only narrowly failed to meet the criterion for adequate fit with a chi-square value of 57.76 with 41 degrees of freedom and $p = .043$. All other models provided an adequate fit to the observed cell frequencies (i.e., p-values in excess of .05).

Determinants of Energy Efficiency Investments

The lambda-coefficients indicating the relationships between personal and housing characteristics and five selected energy efficiency improvements are summarized in Table 29.

Physical and Housing Factors

Tenure was related to all but one conservation feature. Home owners were more likely to live in houses that had outside wall insulation, good caulking and weatherstripping, double pane or storm windows, and outdoor window shades. Evaporative coolers were equally likely to be installed by renters as by home owners. In short, a home that was owner occupied tended to have more energy saving features than a rented home.

The year in which the home was built was reduced to the distinction between before 1975 and 1975 or after to coincide with the first round of massive energy price increases following the 1973 oil embargo, and allowing for some time lag. Homes built after 1974 were more likely to have wall insulation, good caulking and weatherstripping, and double pane or storm windows. They were no more likely to have outside window shades and even less likely to have evaporative coolers. Stricter building codes and a greater awareness of high energy prices by consumers are most likely reasons why newer houses were more energy efficient. Gray (1982) in a study of Californian households also found, that the average R-value for wall insulation was higher in new homes than in older ones.

The type of housing made a considerable difference regarding energy saving features. Mobile homes tended to have less wall insulation than regular single family houses but more than multi-family units. The same relationship held for caulking and weatherstripping, and

Table 29

Lambda-Coefficients for Two-Way Interaction Between Socioeconomic and Housing Factors, and Energy Efficiency Improvements

Variable Category	Wall Insulation	Caulk-ing	Storm Windows	Window Shades	Evaporative Cooler
Tenure					
Home Owner	.555	.558	.425	.441	0
Year When Home Built					
After 1974	.814	.429	.743	0	- .166
Location					
Urban	-.279	0	0	.115	- .243
Size of Home					
Medium	.073	.150	0	0	0
Large	.415	.027	0	0	0
Type of House					
Single Family	.076	.391	.131	-.113	- .084
Multi Family	-.411	-.370	-.579	-.302	-1.048
Income					
Over $20,000	0	.121	.157	0	0
Education					
College or More	0	0	0	0	- .214
Heating Degree Days					
Over 4,500	0	0	1.077	0	0
Cooling Degree Days					
Over 750	0	0	0	.518	1.169

double pane or storm windows. Mobile homes, however, were more likely to have ouside window shades than single-family homes, and even more so than multiple housing units. In a mobile home an awning may serve as a substitute for the patio in a regular house. This same relationship existed in the case of evaporative coolers. Thus, the single-family home had the most energy saving features, followed by the mobile home, while multi-family units had the least amount of energy saving features.

The size of a house was related to wall insulation and weatherstripping. The likelihood of wall insulation increased with the size of a house, while caulking and weatherstripping was most likely done in a medium-sized house and least likely in small or large houses. Large houses were equally likely to have any of the other energy saving features which is somewhat surprising, since greater savings from energy efficiency investments might be realized in a large home.

Urban versus rural location had an effect on wall insulation and evaporative coolers. Both were more likely in rural than in urban areas.

Climate had a significant impact on the likelihood of several energy efficiency measures. Double pane or storm windows were more often found in a cold climate than in a mild climate. Other energy saving features were equally likely in cold and mild climates. Evaporative coolers and outside window shades, however, were more common in hot climates.

Socioeconomic Factors

Income had a direct effect on the probability of caulking and weatherstripping and double pane or storm windows. Both items were more likely to be found in high income families, independent of the type of house and the year it was built, and whether the family rented or owned it.

Education was significantly related only to evaporative coolers. They were more common among less educated people. The high intercorrelation between education, income, type of house, location, and age is probably the primary reason for this rather unexpected relationship.

Occupation was not related to any of the energy efficiency investments.

In summary, the family that could afford to live in its own, preferably single-family detached house, of medium to large size, and built after 1974 was most likely to live in an energy efficient house, especially if the family had a high income and lived in a rural area. A cold climate encouraged investing in double pane or storm windows, while hot climate was related to using evaporative coolers and outside window shades.

Determinants of Energy Curtailments

The likelihood of reduced energy use was influenced by tenure, size of home, income, education, age, and climate. A summary of the lambda-coefficients is given in Table 30.

Physical and Housing Factors

Tenure was related to closing off rooms not used and setting the water heater thermostat to 120 ^{o}F or less. Both actions were more likely taken by home owners than by tenants. Renters usually live in more confined spaces which makes it less feasible for them to close off rooms. It can also be expected that they do not rent more living space than they actually need. At times they may lack control over temperature settings on their water heater when the manager takes care of that.

Table 30

Lambda-Coefficients for Two-Way Interaction Between Socioeconomic and Housing Factors, and Energy Curtailments

Variable Category	Close-off Rooms	Water Heater Below 120 °F	Room Temp. Below 65 °F in Winter
Tenure			
Home Owner	.207	.442	0
Size of Home			
Medium	.151	0	0
Large	.160	0	0
Income			
Over $20,000	-.100	-.147	0
Education			
College or More	0	0	.096
Heating Degree Days			
Over 4,500	.200	-.116	.194
Age of Head of HH.			
Between 35 and 64	0	0	.178
Over 64	0	0	-.538

The size of the home was related to closing off rooms not used. The smaller the home the less feasible and necessary it becomes to close off rooms, since all rooms may be needed.

Climate had a significant impact on all of the three energy cutting measures. In a cold climate people were more likely to close off rooms they did not use and set their room thermostat to 65 °F or less in winter. It is interesting to note that they were less likely, however, to have their water heated to only 120 °F or less.

Socioeconomic Factors

Income was negatively related to closing off rooms and setting the water heater thermostat at 120 °F or less. Families with higher incomes may be able to afford the convenience of heating or cooling the entire house, and having the water heated to a high temperature.

Education was significantly related to setting the room thermostat to 65 °F or less in winter. People with a higher education were more inclined to have lower room temperatures in winter. This may have to do with the fact that education is positively related to a belief in the seriousness of the energy situation (Cunningham and Lopreato, 1977; Marganus, Olson, and Badenhop, 1982).

Since many studies have indicated a need for higher room temperatures among older people, the effect of age on thermostat settings was tested. Results from this study confirm previous findings that older people maintain higher room temperatures in winter. Families headed by a person past retirement age were much less likely to have their room thermostats turned to 65 °F or less in winter.

In summary, there were behavioral constraints on curtailments among renters and people living in smaller homes. Families with high incomes were less likely to curb their energy use than low-income families. People who lived in colder climates were more inclined to lower their thermostat settings and close off rooms they did not use. Older families had a need to maintain higher indoor temperatures in winter than young or middle aged families.

The Likelihood of Claiming Tax Credits or Using Loans by Family Composition and Income

In order to promote energy conservation the 1978 Energy Tax Act created a fifteen percent federal income tax credit for residential energy conservation expenditures (Hirst et al., 1982). For home solar applications, up to forty percent of system cost could be claimed as tax credits. In addition, most states followed with tax credit provisions of their own. There were state tax credit programs in all three states included in the sample.

An analysis of families taking advantage of tax credits revealed that not all types of families were equally likely to have made a claim. Young families were least likely, whereas the next age group, the 35 to 49 year olds, were most likely to have claimed a federal tax credit on their income tax. The probability then decreased slightly in older age groups, as indicated by the lambda-coefficients in Table 31.

Since young families tend to live in rented appartments it is not surprising that they were the least likely to claim tax credits. The next age group, however, seems to be active enough to make investments, and also have the resources to do so. There was no age effect on use of state tax credits.

The probability of claiming either federal or state tax credits rose steadily with income, just as did the likelihood to have invested in energy efficiency. Tax credits clearly have a regressive effect and benefit those with higher incomes more. This may be justifiable in an emergency situation where energy savings are most important, but equity considerations should not be forgotten. With an easing of the energy supply situation a more considerate approach to encourage energy conservation should be developed.

Making loans available for energy saving home improvements may be part of a more equitable incentive program. All family types at all income levels had about the same probability of having used a loan for energy efficiency improvements, with the exception of families past

Table 31

Lambda-Coefficients for Two-Way Interaction Between Family Compisition, and Taking Federal Tax Credits and Bank Loans

Variable Category	Age of Head of HH. <35	35-49	50-64	>64	Marital Stat. Married	No. of Dependents			Income (in $1,000) <15	15-<30	≥30
Fed. Tax Credit	-.179	.098	.068	.013	0	0	0	0	-.269	.009	.261
State Tax Credit	0	0	0	0	0	0	0	0	-.240	-.026	.265
Bank Loan	.227	.235		-.462	0	0	0	0	0	0	0

retirement age (Table 31). Since loan usage was not related to income, unlike tax credits, a government program of home improvement loans may distribute incentives more equitably. Unfortunately, the data for subsidized utility loan programs were insufficient to make any statements about their effectiveness in reaching low-income families, but there is no indication that families with higher incomes took more advantage of utility loans either.

DISCUSSION

The relationships between the stage in the family-life-cycle and other socioeconomic and housing factors as they determine the likelihood of certain energy conservation actions form a consistent pattern. They may be viewed in a recursive fashion where one set of variables is cause and effect simultaneously for the other set of variables. Both vantage points are important in designing a low income weatherization program. To identify the likely clientele of such a program the information from the analysis of conservation actions by family composition and income is useful. But in order to decide which conservation measures to promote and how to implement them, information about housing and socioeconomic factors is needed. Linking the two viewpoints provides a sound basis for developing weatherization programs for disadvantaged families.

A separate analysis of each conservation action proved to be an appropriate procedure, since differences in the factors determining conservation actions existed. They may otherwise have been covered up in an analysis of aggregate data, as in the case of an energy conservation index. A number of conservation actions, however, were governed by the same variables, allowing to group them together.

Wall and ceiling insulation, caulking and weatherstripping, and double pane or storm windows were all related to family-life-cycle variables and income much in the same way. They were more common where the head of household was married and at later stages in the family-life-cycle. They also became more prevalent as income increased. It is little surprising that they were also similarly related to socioeconomic and housing characteristics. For example, they were more often found in larger single-family detached houses which were owner occupied. At the same time older and married people were more likely to live in these types of houses, which completes the circle. Thus, interfamily differences in energy conservation actions were largely determined by differences in the built environment.

Low-income families, headed by a young unmarried individual should be a primary target group, for they are most in need of a weatherization program. There is substantial evidence for what keeps them from investing in energy efficiency. They are the most likely occupants of rental units in multi-family housing built before the energy crisis. These dwellings also tend to be smaller than average. The primary target of a low-income weatherization program, therefore, has to be an extensive retrofit program of rental units built before 1975 with wall and ceiling insulation, storm windows, and good weatherstripping and caulking. Benefits from these actions can be expected to be somewhat higher in severely cold climates.

Families headed by a person past retirement age were not disadvantaged as far as weatherization of their homes was concerned. In fact, they were more likely to live in a well insulated house than younger families of the same size and with the same income. Unfortunately, there was a disproportionate number of retired families in the lowest income group. The latest poverty statistics indicate, however, that retirement age may no longer be equated with poverty. In 1982, for the first time, the percentage of families below the poverty line was below the average for the over 65 year olds (The Wall Street Journal, August 3, 1983). Nonetheless, median income for this age group remains below average.

Having outdoor window shades was not sensitive to income and having an evaporative cooler was negatively related to income. These energy saving measures stood in contrast to investments that make a house more weathertight. In general they were still related positively to the age of the head of household and were more commonly taken by married families, but the relationships were less clearcut. An analysis of the underlying factors revealed that evaporative coolers and outdoor window shades were most common in mobile homes in a hot climate, although evaporative coolers were almost as likely to be found in conventional single-family houses. They were more often found in rural areas and in families in the later stages of the family-life-cycles.

Curtailments, such as closing off rooms not used or lowering thermostat settings tended to be negativley related to income, and followed an inverted U-shaped curve in relation to age of the head of household. They were least likely taken by very young and very old families. The room thermostat was lowered to 65 ^{o}F or less more often by non-married families, while rooms were closed off and waterheater temperatures were lowered more often by married families. These relationships could be traced back to homeownership which seemed to facilitate closing off rooms and lowering the water temperature. Moreover, families usually do not rent more living space than they need, and rental units tend to be smaller in the first place. Waterheater temperature settings are more likely to be controlled centrally by the manager in rented units, leaving no discretion to the tenant. Rooms were less likely to be closed off by large families, but they were more likely to be closed off in midsized to large houses.

From these relationships arises a consistent pattern which spells out that energy conservation actions are less a matter of individual choice, where some elect to conserve and others do not, but rather a matter of feasibility, where some are able to conserve and others are not. The list of evidence is rather convincing:

- Low income families are less able to afford high cost conservation measures, like for example wall or ceiling insulation.
- Renters are limited in their decisions to make structural changes to save energy.
- Renters tend to live in smaller dwellings which do not allow them to close off rooms.
- Renters have less control over waterheater thermostat settings.
- Older people have less tolerance for high and low temperatures due to poorer blood circulation and thus need to maintain a closer comfort range.
- Families with higher incomes tend to live in newer houses which have a larger number of energy saving features already built in.

This list illustrates the major point. Behavioral constraints in the built environment, as well as personal characteristics, largely determine which conservation actions are taken. These behavioral constraints have also been held responsible by other researchers for the generally weak relationship between pro-conservation attitudes and actual behavior (Cunningham and Lopreato, 1977; Stern and Gardner, 1981; Marganus, Olson, and Badenhop, 1982).

An effective weatherization program for disadvantaged families therefore should be aimed at reducing these behavioral constraints. As pointed out earlier, rental units are a primary target, but also making loans available to low-income families, allowing them to take advantage of energy saving investments, has high priority. Tax credits to tenants are a poor choice to help low-income families since they are less likely to be utilized by these families. As the economic benefits of energy conservation become more widely recognized, tax credits may even be gradually phased out.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH

Findings from this study are summarized in a form reflecting the three general approaches designed to help low-income families cope with rising energy prices. These approaches are fuel assistance programs, life-line utility rate schedules, and weatherization programs. A complete list of results from testing the hypotheses stated in the first chapter is included in Appendix B.

Low-Income Fuel Assistance Programs and Life-Line Utility Rate Structures

Residential energy expenditures increased sharply over the past decade. Families in the sample spent on average more than $ 900 per year for residential energy. This amounted on the average to more than five percent of a family's budget. The burden of higher energy cost, however, was not shared equally. Overall energy expenditures were lower in the youngest and in the oldest age bracket than in the middle-age brackets. But lower consumption was insufficient to offset the sharply lower average income in the oldest age bracket. As a consequence, the average percentage of income spent on residential energy was well above average for families past retirement age. Single parents tended to spend somewhat less on energy than their married counterparts but again it represented a larger share of their budget, although these differences were not significant. Energy expenditures peaked in the middle stages of the family-life-cycle when children were present, to form an inverted U-shaped curve across the stages. This result was consistent with findings by Fritzsche (1982).

Average scores on the Index of Well Being followed the reverse pattern. They were higher in the younger and older age brackets than in the middle stages of the FLC. The Index of Well Being varied most strongly with respect to family size. Families with several dependents tended to score low on the index, meaning they had to make the largest cuts in other areas of consumption to meet the challenges of higher fuel prices.

Energy expenditures varied more extensively across stages in the family-life-cycle than they did across levels of income. The opposite was true for the energy budget share and Index of Well Being. For families with incomes under $ 10,000 per year, the percentage of income spent on residential energy averaged sixteen percent. Scores on the Index of Well Being did not improve markedly until the family income reached $ 20,000 a year.

Implications for low-income fuel assistance programs. In order to be eligibile for low-income energy assistance programs, total family income may not exceed 125 percent of the official poverty level; that is $ 5,230 per year for a single person and $ 12,404 for a family of five. There are four implications for the design of low-income energy assistance programs.

First, the 125 percent eligibility criterion appears insufficient and should be revised upward to at least 150 percent of the poverty level as it is done, for instance, in Wyoming. This would bring the eligibility level for a single person up to $ 6,275 and for a five-person household up to $ 14,885. The critical line below which the energy budget share rises sharply and family well being declines appears to be close to $ 15,000. Hence, raising the eligibility criterion to 150 percent of the poverty level would at least bring large families closer to the $ 15,000 level.

Second, one-person households need special attention. Average energy expenditures of one-person households were over $ 650 compared to an average of $ 1,080 for families with three or more dependents. This difference appears small compared to the huge difference in the eligibility criterion to receive energy assistance. The problem is that energy needs do not shrink proportionately as a household becomes smaller. This problem is aggravated for single retired people since their average energy expenditures exceeded $ 700 a year. The current eligibility criterion for energy assistance benefits, based on the official poverty definition, is unfavorable to small households, in particular for single retired people. The eligibility level should therefore be raised even more for small households.

Third, low-income families spent on average more than $ 750 per year on residential energy which accounted for almost 16 percent of their income. In order to bring this figure down to the average for all households, benefits would have to cover almost two thirds of energy expenditures, or an average of $ 500 per low-income family.

Fourth, climate was found to have no significant impact on energy expenditures. Potential savings in heating cost in warm climates were lost to the need for airconditioning and the use of more expensive fuels, electricity in particular. Adjustments for benefit levels based on climatic differences, therefore, do not appear to be critical.

Implications for designing life-line utility rates. Life-line utlity rates alone appear insufficient to help disadvantaged families meet their energy needs. In order to help a low-income family, the amount of subsidized electricity would have to be quite large. This, however, would tend to benefit all, not just low-income families. Life-line utility rates should be viewed as only part of the solution, and should be complemented by a targeted low-income fuel assistance program.

Low-Income Weatherization Programs

Families considered disadvantaged because they spend a high percentage of their income on home energy and because of a low score on the Index of Well Being, were also the disadvantaged families concerning investments in energy efficiency. Low-income families were less likley to invest in energy efficiency than middle- or high-income families. Families headed by a non-married person were also less likely to invest in energy efficiency than those headed by a married person, especially when that person was under 35 years of age. What kept these families from improving the energy efficiency of their homes was, above all, their inability to afford the high initial cost of these investments. But disadvantaged families also tended to live in older, multi-family dwellings, and were more likely to have rented their home rather than owned it. A landlord, however, may have little incentive to invest in energy efficiency as long as rising fuel cost can be passed on to the tenant. The tenant, in turn, has no incentive to invest in rented housing for oftentime the renter may not be around long enough to gain the benefits from such investments through lower utility cost.

Families past retirement age were less likely to have invested in energy efficiency than the average family since a disproportionate number of them belonged in the lowest income group. After accounting for the effect of income the elderly would actually be more likely to have invested in energy saving measures than younger families.

Implications for a low-income weatherization program. A low-income weatherization program should ideally supplement a government fuel assistance program. It would have the same target group as a fuel assistance program. Thus, it would also benefit those families who most need help in dealing with high energy cost. An effective retrofit program for rental units in multi-family housing would offer the most room for improving the energy efficiency of the present housing stock.

Tax credits versus loan programs. Tax credits were claimed mostly by middle- to high-income households, and therefore are an inadequate approach to help low-income families make investments in energy conservation. At best, tax credits encourage a faster pace in the adoption of energy efficiency measures by middle- and high-income families. Loans for energy saving home improvements, on the other hand, were used equally by all income groups. A government backed loan program geared at stimulating investments in multi-family rental units may be a more equitable way to redistribute tax money and encourage energy conservation.

The importance of behavioral constraints. Low-income families are restricted in their ability to conserve energy in several ways. They are oftentimes unable to afford the high initial cost of investing in energy efficiency. Being more likely to live in rented dwellings they lack the incentive and control to make investment decisions. There was also evidence that renters had less control over water heater thermostat settings. Closing off rooms that were not used was not as feasible in either a small dwelling or for a large family compared to a small family in a large house. For older people, a limit to lowering thermostat settings in winter is given by their typically narrower comfort range concerning room temperatures. In general it appears that the decision to invest in energy efficiency or to curtail energy consumption is less a matter of individual choice, but rather a matter of having the option of doing so.

Thus, an effective low-income weatherization program should try to eliminate behavioral constraints where possible and make appropriate provisions in cases where they cannot be overcome, such as, with older people needing higher room temperatures in winter. Granting home improvement loans at favorable rates to low-income families directly or to landlords has the potential to not only help low-income families cope with rising energy cost, but also to save valuable energy resources and improve the quality of the housing stock at the same time.

Recommendations for Further Research

Survey research has the advantage that large populations can be studied without being prohibitively costly. Its major shortcoming, however, is lack of control over extraneous variables. For instance, self-reported energy expenditures formed the basis on which inferences on energy consumption patterns across family types and income levels were made in this study. Metered energy use data in physical units would have been a preferable measure of energy consumption.

Behavioral constraints were identified as important obstacles in the way of energy conservation actions. The mail-survey is very limited in gathering information on contextual variables, such as physical or structural limitations to energy conservation. A carefully monitored experiment, varying the number and severeness of constraints on behavior should be carried out to quantify the effect of behavioral constraints.

The family-life-cycle concept appears to provide a useful framework for studying residential energy consumption. Non-traditional family types, however, were not well represented in this study and should be the target of an exclusive survey of singles, and single-parent families.

Finally, now that low-income energy assistance, weatherization, and life-line utility rate programs are well under way, an evaluation under the criteria developed in this study and possibly a revision of some aspects of the programs should be undertaken.

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APPENDICES

APPENDIX A

Statistical Comments

APPENDIX A

STATISTICAL COMMENTS

Comments to the Statistical Analysis in Chapter 3

Contrasts were specified to test specific components of the grouping variables and the form of relationship. The grouping variables were measured on four levels and linear, quadratic, and cubic contrasts were fitted to the group means. Table 1 gives the coefficients that were specified in the contrasts.

Coefficients for Testing Contrasts

Level of Contrast	Coefficients for Categories One	Two	Three	Four
Linear	-3	-1	1	3
Quadratic	-1	1	1	-1
Cubic	-1	3	-3	1

Since the data were subject to outliers, winsorized means were computed for parts of the analysis. A winsorized mean of order n sets the n most extreme observations equal to observation (n - 1). A winsorized mean is a more robust measure than the arithmetic mean.

The assumption of equal variances within groups, necessary for the ordinary F-test of between-group differences was relaxed by using Welch and Brown-Fortsythe F-tests which do not assume equal variances within groups.

Comments to the Statistical Analysis in Chapter 4

Since explanatory and response variables in this analysis were mostly nominal or ordinal, at best, analysis of variance and multiple regression analysis were inappropriate statistical tools. Equivalent methods to treat multivariate problems for nominal and ordinal data have been developed and are now available for large scale computer application (i.e., in the Biomedical Computer Program Package version 1981).

The method is known in its most general form as log-linear analysis. Logistic regression, or logit analysis, is a special case of log-linear analysis where one variable is treated as the dependent variable and the rest as independent variables, much as in the case of multiple regression analysis (Goodman, 1977). In log-linear analysis cases are classified according to 1,2,3,...,n categorical variables. A four-way table, for instance, where all four variables are dichotomous has 2^4 = 16 different cells. A model is fitted to the observed cell frequencies that describes each cell frequency as the product of the overall geometric mean of cell means, each of the main effects, and all possible two-way, three-way,... and up to n-way interactions between the n variables in the model. By taking the natural logarithm on either side of the equation, the expression becomes additive or linear in its parameters, hence the name log-linear analysis.

A model that contains all possible interactions is called a full model and will reproduce the observed cell frequencies exactly. The goal is to find a model that contains as few interactions as possible and still fits the data adequately. A chi-square goodness-of-fit test can be used as a test statistic to decide whether observed frequencies and frequencies estimated by the reduced model are significantly different. Degrees of freedom for this test are equal to the difference in degrees of freedom between the full model (d.f. = 0) and the reduced model which is tested. If the chi-square value is not significant the reduced model can be judged adequate.

The models are hierarchical. A higher order interaction always implies the lower order interactions and main effects. For instance, the three-way interaction ABC implies the three two-way interactions AB, AC, and BC, as well as the main effects A, B, and C.

After the most parsimonious model with adequate fit has been selected, its parameters indicate which of the relationships are required to explain the distribution of cell frequencies. A marital status-income interaction, for example, indicates that income differs between married and non-married individuals. For each level of each variable and interaction in the model a parameter is calculated (the log-odds) which represents the impact of this specific variable or interaction on the expected frequencies under the model. A parameter greater than zero increases the odds that a case will fall into that specific cell, while a parameter value of less than zero decreases the odds for cases to be in that cell. These parameters are referred to as lambda-parameters and are somewhat comparable to the beta-parameters in multiple regression analysis with dummy variables. Whenever a variable has more than two categories, i.e., low, intermediate, and high, design variables are generated. The lambda-coefficient of one design variable stands for the difference between low and intermediate, and the lambda-coefficient of the other design variable compares low with high. For a variable with n categories, (n - 1) lambda-parameters are estimated.

Similar estimates are produced in logistic regression. The Biomedical Computer Program Package, offers a stepwise procedure to select variables which have a significant effect on the dependent variable, and thus enables the researcher to screen a larger number of variables with a reasonable amount of effort than in general log-linear analysis. Logit analysis is therefore also less expensive to run on the computer. As a general rule, however, cost increase rapidely with the number of cases (proportional) and the number of variables and categories (geometrically). Stepwise logistic regression is about five times more expensive than regular stepwise multiple regression analysis.

APPENDIX B

Summary of Results from Hypothesis Testing

APPENDIX B

SUMMARY OF RESULTS FROM HYPOTHESIS TESTING

The research findings are summarized in a form as to correspond to the list of hypotheses stated in the introductory problem statement. For each hypothesis the test statistic which was used to determine the significance level for rejecting the null hypothesis will be reported along with the significance level that was found.

In order to determine whether differences in personal and housing characteristics existed between families at different stages in the family-life-cycle and at different income levels the following hypotheses were tested:

H_o1 There is no difference between families at different stages in the family-life-cycle and at different income levels as to the:

H_o1 a	Occupation of head of household.	by	marital status	$p \leq .05$
			age of family	$p \leq .05$
			family size	n.s.
			income	$p \leq .05$
H_o1 b	Highest education in the family.	by	marital status	$p \leq .05$
			age of fmly.	$p \leq .05$
			family size	n.s.
			income	$p \leq .05$
H_o1 c	Type of house.	by	marital status	$p \leq .05$
			age of family	$p \leq .05$
			family size	$p \leq .05$
			income	$p \leq .05$
H_o1 d	Size of house (in sq.ft).	by	marital status	$p \leq .05$
			age of family	$p \leq .05$
			family size	$p \leq .05$
			income	$p \leq .05$

H_o1 e	Year of construction.	by	marital status	n.s.
			age of family	$p \leq .05$
			family size	n.s.
			income	$p \leq .05$
H_o1 f	Years in present home.	by	marital status	n.s.
			age of family	$p \leq .05$
			family size	$p \leq .05$
			income	n.s.
H_o1 g	Tenure (rent vs. own).	by	marital status	$p \leq .05$
			age of family	$p \leq .05$
			family size	$p \leq .05$
			income	$p \leq .05$
H_o1 h	Main fuel used for heating.	by	marital status	n.s.
			age of family	n.s.
			family size	n.s.
			income	n.s.
H_o1 i	Location (rural vs. urban).	by	marital status	$p \leq .05$
			age of family	$p \leq .05$
			family size	n.s.
			income	$p \leq .05$
H_o1 j	State.	by	marital status	$p \leq .05$
			age of family	$p \leq .05$
			family size	n.s.
			income	n.s.

Test statistic: Fitting of log-linear model to five-way frequency table using chi-square goodness-of-fit test.

In order to find differences in energy expenditures between families at different stages in the family-life-cycle and at different income levels the following hypotheses were tested:

H_o2 a There is no significant difference in energy expenditures at different income levels. $F = 7.91$ 8; 1466 df $p \leq .001$

H_o2 b There is no significant difference in energy expenditures across stages in the family-life-cycle.

by marital status	$t^* = 2.55$	1,185 df	$p = .011$
age of family	$F = 6.70$	3; 1196 df	$p \leq .001$
family size	$F = 6.28$	3; 1196 df	$p \leq .001$

H_o2 c There is no significant interaction between income and the stage of the family-life-cycle. F = .99 26; 1360 df n.s.

In order to find differences in the percentage of income spent for residential energy between families at different stages in the family-life-cycle and at different income levels the following hypotheses were tested:

H_o3 a There is no significant difference in the percentage of income spent for residential energy between families at different levels of income. F = 156.5 8; 1466 df $p \leq .001$

H_o3 b There is no significant difference in the percentage of income spent for residential energy between families at different stages in the family-life-cycle.

by marital status	t*= -4.66	1185 df	$p \leq .001$
age of family	F = 18.73	3; 1196 df	$p \leq .001$
family size	F = 3.44	3; 1196 df	p = .016

$H.o^3$ c There is no significant interaction between income and stage of the family-life-cycle F = 1.68 26; 1360 df p = .018

In order to find differences in perceived family well being between families at different stages in the family-life-cycle and at different income levels the following hypotheses were tested:

H_o4 a There is no significant difference in perceived family well being between families at different income levels.
F = 47.64 8; 1994 df $p \leq .001$

H_o4 b There is no significant difference in perceived family well being between families at different stages in the family-life-cycle.

by marital status	t*= .42	1484 df	n.s.
age of family	F = 4.55	3; 1484 df	p = .004
family size	F = 8.83	3; 1484 df	$p \leq .001$

H_o4 c There is no significant interaction between income and stage in the family-life-cycle. F = 1.26 26; 2049 df n.s.

Test statistic: One- and two-way analysis of variance.

* Differences due to marital status were tested with linear contrasts.

In order to find the overall relationships between family well being and energy expenditures, percentage of income spent on energy, and income, and the relationships between income and energy expenditures, as well as the percentage of income spent on energy the following hypotheses were tested:

H_o5 a There is no significant relationship between energy expenditures and family well being. $r = .0178$ $t = .65$ 1334 df n.s.

H_o5 b There is no significant relationship between the percentage of income spent on energy and family well being.
$r = -.2470$ $t = -9.07$ 1266 df $p \leq .001$

H_o5 c There is no significant relationship between income and family well being. $r = .3703$ $t = 18.70$ 2201 df $p \leq .001$

H_o5 d There is no significant relationship between income and energy expenditures. $r = .1727$ $t = 6.73$ 1473 df $p \leq .001$

H_o5 e There is no significant relationship between income and the percentage of income spent on energy.
$r = -.4575$ $t = 34.34$ 1473 df $p \leq .001$

Test statistic: Significance of the Pearson product-moment correlation coefficient was tested with a t-test.

In order to determine the likelihood with which families at different stages in the family -life-cycle and at different income levels had taken a variety of conservation actions the following hypotheses were tested:

H_o6 There is no significant difference between families at different stages of the family-life-cycle and at different income levels as to the likelihood that they have taken the following conservation actions:

H_o6 a Outside wall insulation.	by marital status	$p \leq .05$
	age of family	$p \leq .05$
	family size	n.s.
	income	$p \leq .05$
H_o6 b Four inches of ceiling insulation.	by marital status	$p \leq .05$
	age of family	$p \leq .05$
	family size	n.s.
	income	$p \leq .05$

H_o6 c Good caulking and weatherstripping.	by	marital status	$p \leq .05$
		age of family	$p \leq .05$
		family size	n.s.
		income	$p \leq .05$
H_o6 d Double pane or storm windows.	by	marital status	$p \leq .05$
		age of family	$p \leq .05$
		family size	n.s.
		income	$p \leq .05$
H_o6 e Evaporative cooler.	by	marital status	$p \leq .05$
		age of family	$p \leq .05$
		family size	n.s.
		income	$p \leq .05$
H_o6 f Outdoor window shades.	by	marital status	n.s.
		age of family	$p \leq .05$
		family size	n.s.
		income	n.s.
H_o6 g Wood burning stove.	by	marital status	$p \leq .05$
		age of family	n.s.
		family size	$p \leq .05$
		income	n.s.
H_o6 h Close-off rooms not in use.	by	marital status	$p \leq .05$
		age of family	$p \leq .05$
		family size	$p \leq .05$
		income	n.s.
H_o6 i Water heater temp. below 120 ^oF.	by	marital status	$p \leq .05$
		age of family	n.s.
		family size	$p \leq .05$
		income	$p \leq .05$
H_o6 j Room temp. below 65 ^oF in winter.	by	marital status	$p \leq .05$
		age of family	$p \leq .05$
		family size	n.s.
		income	n.s.

Test statistic: Fitting of log-linear models to five-way frequency tables using chi-square goodness-of-fit test.

In order to find underlying factors determining the differences between families at different stages in the family-life-cycle the following hypotheses were tested:

H_o7 There is no significant difference in socioeconomic and physical/structural factors as to the likelihood of the following conservation actions:

H_o7 a Outside wall insulation.	by	Income	n.s.
		Education	n.s.
		Occupation	n.s.
		Type of house	$p \leq .05$
		Constr. year	$p \leq .05$
		Size of house	$p \leq .05$
		Tenure	$p \leq .05$
		Location	$p \leq .05$
		Heating dd.	n.s.
		Cooling dd.	n.s.
H_o7 b Good caulking and weatherstripping.	by	Income	$p \leq .05$
		Education	n.s.
		Occupation	n.s.
		Type of house	$p \leq .05$
		Constr. year	$p \leq .05$
		Size of house	$p \leq .05$
		Tenure	$p \leq .05$
		Location	n.s.
		Heating dd.	n.s.
		Cooling dd.	n.s.
H_o7 c Double pane or storm windows.	by	Income	$p \leq .05$
		Education	n.s.
		Occupation	n.s.
		Type of house	$p \leq .05$
		Constr. year	$p \leq .05$
		Size of house	n.s.
		Tenure	$p \leq .05$
		Location	n.s.
		Heating dd.	$p \leq .05$
		Cooling dd.	n.s.
H_o7 d Outdoor window shades.	by	Income	n.s.
		Education	n.s.
		Occupation	n.s.
		Type of house	$p \leq .05$
		Constr. year	n.s.
		Size of house	n.s.
		Tenure	$p \leq .05$
		Location	$p \leq .05$
		Heating dd.	n.s.
		Cooling dd.	$p \leq .05$

Hypothesis		Variable	Result
H_o7 e Evaporative coolers.	by	Income	n.s.
		Education	$p \leq .05$
		Occupation	n.s.
		Type of house	$p \leq .05$
		Constr. year	$p \leq .05$
		Size of house	n.s.
		Tenure	n.s.
		Location	$p \leq .05$
		Heating dd.	n.s.
		Cooling dd.	$p \leq .05$
H_o7 f Close-off rooms not in use.	by	Income	$p \leq .05$
		Education	n.s.
		Occupation	n.s.
		Type of house	n.s.
		Constr. year	n.s.
		Size of house	$p \leq .05$
		Tenure	$p \leq .05$
		Location	n.s.
		Heating dd.	$p \leq .05$
		Cooling dd.	n.s.
H_o7 g Water heater temp. below 120 ^{o}F.	by	Income	$p \leq .05$
		Education	n.s.
		Occupation	n.s.
		Type of house	n.s.
		Constr. year	n.s.
		Size of house	n.s.
		Tenure	$p \leq .05$
		Location	n.s.
		Heating dd.	$p \leq .05$
		Cooling dd.	n.s.
H_o7 h Room temp. below 65 ^{o}F in winter.	by	Income	n.s.
		Education	$p \leq .05$
		Occupation	n.s.
		Type of house	n.s.
		Constr. year	n.s.
		Size of house	n.s.
		Tenure	n.s.
		Location	n.s.
		Heating dd.	$p \leq .05$
		Cooling dd.	n.s.
		Age of family	$p \leq .05$

Test statistic: Stepwise logistic regression procedure eliminates non significant terms based on an approximate F-test using a variance-covariance matrix.

In order to determine whether there is a difference between families at different stages in the family-life-cycle and at different income levels regarding the use of loans to finance energy efficiency investments and claiming state and federal tax credits for doing so, the following hypotheses were tested:

H_o8 a There is no significant difference between families at different stages in the family-life-cycle and at different income levels in their use of loans to finance energy efficiency investments.

by marital status	n.s.
age of family	$p \leq .05$
family size	n.s.
income	n.s.

H_o8 b There is no significant difference between families at different stages in the family-life-cycle and at different income levels regarding claiming federal tax credits for energy efficiency investments.

by marital status	n.s.
age of family	$p \leq .05$
family size	n.s.
income	$p \leq .05$

H_o8 c There is no significant difference between families at different stages in the family-life-cycle and at different income levels regarding claiming state tax credits for energy efficiency investments.

by marital status	n.s.
age of family	n.s.
family size	n.s.
income	$p \leq .05$

Test statistic: Fitting of log-linear models to five-way frequency tables using chi-square goodnes-of-fit test.

APPENDIX C

Analysis of Variance Tables

Table I

Analysis of Variance Table
for Variable Energy Expenditures by Income

Source	Sum of Squares	df	Mean Squares	F	p(F)
Between Groups	30,440,001	8	3,805,000	7.91	≤.001
Within Groups	705,171,210	1466	481,017		
Total	735,611,211	1474			
Welch		8; 481		13.26	≤.001
Brown-Forsythe		8; 1019		8.62	≤.001

Table II

Analysis of Variance Table
for Variable Energy Budget Share by Income

Source	Sum of Squares	df	Mean Square	F	p(F)
Between Groups	50,538	8	6,317.374	156.5	≤.001
Within Groups	59,167	1466	40.359		
Total	109,706	1474			
Welch		8; 483		73.93	≤.001
Brown-Forsythe		8; 74		66.79	≤.001

Table III

Analysis of Variance Table
for Variable Index of Well Being by Income

Source	Sum of Squares	df	Mean Square	F	p(F)
Between Groups	24,099	8	3,012.448	47.64	≤.001
Within Groups	138,742	2194	63.237		
Total	162,841	2202			
Welch		8; 758		58.86	≤.001
Brown-Forsythe		8; 1673		47.60	≤.001

Table IV

Analysis of Variance Table
for Variable Energy Expenditures by Family Type

Source	Sum of Squares	df	Mean Square	F	p(F)
Between Groups	30,416,990	24	1,267,374	4.47	≤.001
Within Groups	403,973,000	1424	283,688		
Total	434,389,990	1448			
Welch		24 ; 248		4.97	≤.001
Brown-Forsythe		24 ; 351		4.17	≤.001

Table V

Analysis of Variance Table
for Variable Energy Budget Share by Family Type

Source	Sum of Squares	df	Mean Square	F	p(F)
Between Groups	3,870.22	24	161.259	4.71	≤ .001
Within Groups	46,983.35	1372	34.244		
Total	50,853.57	1396			
Welch		24; 235		4.18	≤ .001
Brown-Forsythe		24; 256		4.02	≤ .001

Table VI

Analysis of Variance Table
for Variable Index of Well Being by Family Type

Source	Sum of Squares	df	Mean Square	F	p(F)
Between Groups	5,955.31	24	248.138	3.42	≤ .001
Within Groups	158,422.23	2181	72.637		
Total	164,377.54	2205			
Welch		24; 441		3.50	≤ .001
Brown-Forsythe		24; 1218		3.39	≤ .001

Table VII

Two-Way Analysis of Variance Table
for Variable Energy Expenditures by Family Income

Source	Sum of Squares	df	Mean Square	F	p(F)
Family Type	15,104,952	13	1,151,519	2.42	$=.003$
Family Income	8,266,764	2	4,133,382	8.62	$\leq.001$
Interaction	12,362,450	26	475,478	.99	$=.477$
Error	652,453,710	1360	479,745		
Total	688,187,876	1401			
Welch		41; 222		4.55	$\leq.001$
Brown-Forsythe		41; 344		3.05	$\leq.001$

Table VIII

Two-Way Analysis of Variance Table
for Variable Energy Budget Share by Family Income

Source	Sum of Squares	df	Mean Square	F	p(F)
Family Type	931.54	13	71.657	1.44	$=.135$
Family Income	8,223.07	2	4,111.534	82.50	$\leq.001$
Interaction	2,174.58	26	83.638	1.68	$=.018$
Error	67,780.69	1360	49.839		
Total	79,109.89	1401			
Welch		41; 222		12.14	$\leq.001$
Brown-Forsythe		41; 132		7.31	$\leq.001$

Table IX

Two-Way Analysis of Variance Table
for Variable Index of Well Being by Family Income

Source	Sum of Squares	df	Mean Square	F	p(F)
Family Type	6,041.61	13	464.739	7.60	$\leq$.001
Family Income	13,508.31	2	6,754.156	110.41	$\leq$.001
Interaction	2,004.85	26	77.109	1.26	$\leq$.171
Error	125,346.15	2049	61.174		
Total	146,900.91	2090			
Welch		41; 387		12.40	$\leq$.001
Brown-Forsythe		41; 1227		12.05	$\leq$.001

APPENDIX D

Summary Tables from Stepwise Logistic Regression

Table X

Caulking

Step	Variable	Lambda Coeff.	DF	Improvement χ^2	Improvement P-value	Goodness of Fit χ^2	Goodness of Fit P-value
0	Constant					361.72	.000
1	Tenure	.558	1	199.36	.000	162.36	.000
2	Age of the Home	.429	1	50.29	.000	112.07	.000
3	Type of House	-.370 .391	2	44.43	.000	67.64	.118
4	Income	.121	1	8.08	.004	59.55	.281
5	Size of Home	.027 .150	2	7.37	.025	52.18	.467

Table XI

Wall Insulation

Step	Variable	Lambda Coeff.	DF	Improvement χ^2	Improvement P-value	Goodness of Fit χ^2	Goodness of Fit P-value
0	Constant					577.34	.000
1	Age of Home	.814	1	232.69	.000	344.65	.000
2	Tenure	.555	1	178.85	.000	165.80	.000
3	Location	-.279	1	38.02	.000	127.78	.000
4	Size of Home	.415 .073	2	40.35	.000	87.43	.002
5	Type of House	-.411 .076	2	13.84	001	73.60	.021

Table XII

Double Pane or Storm Windows

Step	Variable	Lambda Coeff.	DF	Improvement χ^2	Improvement P-value	Goodness of Fit χ^2	Goodness of Fit P-value
0	Constant					665.88	.000
1	Heating Degree Days	1.077	1	322.03	.000	343.85	.000
2	Age of the Home	.743	1	174.52	.000	169:33	.000
3	Tenure	.425	1	97.85	.000	71.48	.003
4	Type of House	-.579 .131	2	23.20	.000	48.29	.173
5	Income	.157	1	9.44	.002	38.85	.477

Table XIII

Evaporative Cooler

Step	Variable	Lambda Coeff.	DF	Improvement χ^2	Improvement P-value	Goodness of Fit χ^2	Goodness of Fit P-value
0	Constant					613.51	.000
1	Cooling Degree Days	1.169	1	407.44	.000	206.07	.000
2	Type of House	-1.048 -.084	2	111.14	.000	94.93	.000
3	Location	-.243	1	18.17	.000	76.76	.001
4	Education	-.214	1	13.30	.000	63.46	.018
5	Age of Home	-.166	1	5.70	.017	57.76	.043

Table XIV

Window Shades

Step	Variable	Lambda Coeff.	DF	Improvement X^2	Improvement P-value	Goodness of Fit X^2	Goodness of Fit P-value
0	Constant					169.29	.000
1	Cooling Degree Days	.518	1	88.84	.000	80.45	.000
2	Tenure	.441	1	37.45	.000	43.00	.003
3	Type of House	-.302 -.113	2	10.01	.007	32.99	.024
4	Location	.115	1	4.25	.039	28.74	.052

Table XV

Set Water Heater Thermostat = 120°F

Step	Variable	Lambda Coeff.	DF	Improvement X^2	Improvement P-value	Goodness of Fit X^2	Goodness of Fit P-value
0	Constant					79.59	.000
1	Tenure	.442	1	48.83	.000	30.76	.006
2	Income	-.147	1	9.58	.002	21.18	.070
3	Heating Degree Days	-.116	1	5.49	.019	15.68	.206

Table XVI

Close off Some Rooms

Step	Variable	Lambda Coeff.	DF	Improvement χ^2	Improvement P-value	Goodness of Fit χ^2	Goodness of Fit P-value
0	Constant					120.21	.000
1	Tenure	.207	1	24.78	.000	95.43	.000
2	Heating Degree Days	.200	1	15.41	.000	80.03	.001
3	Size of House	.160 .151	2	17.21	.000	62.82	.026
4	Education	.135	1	5.69	.017	57.13	.060
5	Income	-.100	1	3.95	.047	53.18	.096

Table XVII

Set Room Thermostat to 65°F or Lower

Step	Variable	Lambda Coeff.	DF	Improvement χ^2	Improvement P-value	Goodness of Fit χ^2	Goodness of Fit P-value
0	Constant					89.72	.000
1	Age of Head of H.H.	-.538 .178	2	58.19	.000	31.53	.000
2	Heating Degree Days	.194	1	16.51	.000	15.02	.059
3	Education	.096	1	4.15	.042	10.87	.145

APPENDIX E

List of Original Variables

Table XVIII

List of Original Variables

	Name	Description	Type	Fmt.	Miss.	Min.	Max.
1	STATE	Arizona, Colorado, Oregon	nomin.	2.0	99	1	8
2	RURBAN	Rural versus urban location	nomin.	1.0	9	1	2
3	GROCERY	Cut back on groceries	ordin.	1.0	9	1	4
4	DINING	Cut back on meal eaten out	ordin.	1.0	9	1	4
5	DRIVING	Cut back on driving the car	ordin.	1.0	9	1	4
6	HEALTH	Cut back on health care	ordin.	1.0	9	1	4
7	HOLIDAYS	Cut back on vacations	ordin.	1.0	9	1	4
8	RECREAT	Cut back on recreation	ordin.	1.0	9	1	4
9	SCHOOL	Cut back on education	ordin.	1.0	9	1	4
10	HOUSE	Cut back on rent, mortg. or upkeep	ordin.	1.0	9	1	4
11	APPLIANC	Cut back on appliances/furnishings	ordin.	1.0	9	1	4
12	SAVINGS	Cut back on savings	ordin.	1.0	9	1	4
13	CLOTHES	Cut back on clothes	ordin.	1.0	9	1	4
14	WELLBENG	Overall feeling of well being	ordin.	1.0	9	1	5
15	DBLPANE	Double pane or storm windows	nomin.	1.0	9	1	6
16	CAULKING	Good weatherstripping and caulking	nomin.	1.0	9	1	6
17	ROOFINS	At least 4" of ceiling insulation	nomin.	1.0	9	1	6
18	WALLINS	Outside wall insulation	nomin.	1.0	9	1	6
19	WDSTOVE	Wood burning stove	nomin.	1.0	9	1	6
20	SOLWATER	Solar water heater	nomin.	1.0	9	1	6
21	SOLHEAT	Solar room heating	nomin.	1.0	9	1	6
22	EVCOOLER	Evaporative cooler	nomin.	1.0	9	1	6
23	SHADES	Outdoor window shades	nomin.	1.0	9	1	6
24	NOMONEY	No money spent on energy efficiency	nomin.	1.0	9	0	1
25	UTILOAN	Used loan from utility company	nomin.	1.0	9	0	1
26	BANKLOAN	Used other loan or credit	nomin.	1.0	9	0	1
27	FEDTAX	Federal income tax credit	nomin.	1.0	9	1	3
28	STATETAX	State tax credit	nomin.	1.0	9	1	4
29	TAXIMPAC	Impact of taxc credit on investmt.	ordin.	1.0	9	0	4
30	SHUTROOM	Close off some rooms	nomin.	1.0	9	1	4
31	HOTWATER	Set water heater to 100'F or less	nomin.	1.0	9	1	4
32	HEATING	Set therm. at or below 65'F winters	nomin.	1.0	9	1	4

Table XVIII (continued)

	Name	Description	Type	Fmt.	Miss.	Min.	Max.
33	HOUSETYP	The type of house	nomin.	2.0	99	10	50
34	TENURE	Own vs. rent	nomin.	1.0	9	1	4
35	SIZE	Size of home in sqft.	ordin.	1.0	9	1	4
36	RESIDENC	Years of residence in present home	contin.	2.0	99	.5	98
37	AGEHOME	Year of construction (decade)	ordin.	1.0	9	1	6
38	BUILT	Exact age of home	contin.	2.0	99	0	12
39	FARM	Home in part of farm	nomin.	1.0	0	1	9
40	MONTHS	Number of months in present home	contin.	2.0	99	1	12
41	ELECTRIC	Cost for electricity in 1980	contin.	4.0	9999	0	8998
42	KWHOURS	Amount of kwh used in 1980	contin.	5.0	99999	0	89998
43	OIL	Cost for oil in 1980	contin.	4.0	9999	0	8998
44	WOOD	Cost for wood in 1980	contin.	4.0	9999	0	8998
45	CORDS	Number of cords used in 1980	contin.	3.0	999	0	99
46	NATRLGAS	Cost for natural gas in 1980	contin.	4.0	9999	0	8998
47	MCF	Millions of cubic feet used in '80	contin.	4.0	9999	0	8998
48	THERMS	Amount of therms in 1980	contin.	4.0	9999	0	8998
49	OTHERS	Cost for other fuels in 1980	contin.	4.0	9999	0	8999
50	ROOMHEAT	Main fuel source for space heating	nomin.	1.0	9	1	6
51	MARITAL	Marital status of respondent	nomin.	1.0	9	1	6
52	AGESELF	Age of respondent	contin.	2.0	99	16	98
53	SELFSEX	Sex of respondent	nomin.	1.0	9	1	2
54	RELATIV1	First additional family member	nomin.	1.0	-	0	8
55	AGE1	Age of first add. family member	contin.	2.0	-	0	98
56	RELATIV2	Second additional family member	contin.	2.0	-	0	8
57	RELATIV3	Third additional family member	contin.	2.0	-	0	8
58	RELATIV4	Fourth additional family member	contin.	2.0	-	0	8
59	RELATIV5	Fifth additonal family member	contin.	2.0	-	0	8
60	OCCSELF	Occupation of respondent	nomin.	3.0	999	10	90
61	OCCSPOUSE	Occupation spouse	nomin.	3.0	-	0	999
62	EDUCSELF	Education of respondent	ordin.	2.0	99	1	9
63	EDUCSPOU	Education of spouse	ordin.	2.0	-	0	99
64	INCOME	Total yearly family income	ordin.	2.0	99	0	9
65	HEATNGDD	Heating degree days	contin.	5.0	10000	1	9998
66	COOLNGDD	Cooling degree days	contin.	4.0	6	1	2998

APPENDIX F

Questionnaire

1

THE BIG PICTURE

Q- 1 Some people feel that energy is a serious national problem, but other people feel it is not. We would like to know your opinion. Do you consider meeting the United States' energy needs during the next ten to twenty years to be: (Please circle number of your opinion.)

1 NOT A SERIOUS PROBLEM
2 A SOMEWHAT SERIOUS PROBLEM
3 A SERIOUS PROBLEM
4 A VERY SERIOUS PROBLEM

Q- 2 One way to meet our future energy needs is to cut back on energy use. Another way is to increase energy production. Which one of the following choices do you feel our country should make in order to meet our future energy needs: (Please circle number of your opinion.)

1 DEPEND ENTIRELY ON CUT-BACKS IN ENERGY USE
2 DEPEND MOSTLY ON CUT-BACKS IN ENERGY USE
3 DEPEND EQUALLY ON CUT-BACKS AND INCREASED ENERGY PRODUCTION
4 DEPEND MOSTLY ON INCREASED ENERGY PRODUCTION
5 DEPEND ENTIRELY ON INCREASED ENERGY PRODUCTION

Q- 3 To what extent do you favor or oppose each of the items listed below as a way of helping to meet our country's future energy needs?

	Please circle your opinion for each item				
A More use of solar energy.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
B Reduce energy use in homes.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
C More use of nuclear power	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
D More use of western coal.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
E Reduce energy use in business and industries.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
F More use of oil from western shale. .	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
G Reduce energy use in individual travel.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
H More oil imports.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
I More exploration for oil in the U.S.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
J Reduce energy use by agriculture. . .	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
K More use of wind energy	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR

ENERGY DIRECTIONS

Q- 4 Here are some actions that might be considered in order to reduce energy use in the United States. Please indicate the extent to which you favor or oppose each of them.

	Please circle your opinion for each item				
A Place higher taxes on gasoline. . . .	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
B Require home thermostats to be no higher than 65°F in winter.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
C Require home thermostats to be no lower than 78°F in summer	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
D Require everyone's home to pass an energy "audit" (must have adequate insulation, double-pane or storm windows, etc.).	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
E Provide larger tax credits for improving home energy efficiency. .	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
F Provide larger tax credit for adding home <u>solar</u> heating or cooling .	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
G Require utility companies to charge lowest <u>rates</u> to low energy users and highest <u>rates</u> to high users . .	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
H Discourage building homes away from towns and cities to lessen travel by car.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
I Change building codes and mortgage requirements to encourage new types of energy-saving housing.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
J Keep 55 MPH speed limit	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
K Require better label information on appliances telling how much energy they use.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
L Require utilities to provide regular reports to users on whether energy use is higher or lower than in previous years.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
M Require manufacturers to make appliances that use less energy . .	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR
N Rely on state instead of federal programs to encourage energy conservation.	STRONGLY OPPOSE	OPPOSE	NEUTRAL	FAVOR	STRONGLY FAVOR

3

WAYS TO CUT BACK

Q- 5 If the United States faced a crisis and it were essential for every family to voluntarily cut back its energy use, which one of the following would you be more willing to do? (Please circle number of your opinion.)

1 REDUCE WINTER HOME HEATING TO NO HIGHER THAN 65°F AND SUMMER COOLING TO NO LOWER THAN 78°F
2 REDUCE AUTOMOBILE USE BY ABOUT ONE-FOURTH

Q- 6 If our government had to take drastic action to save energy, which one of the following would you be more willing to accept?

1 RATION HOME HEATING FUEL AND ELECTRICITY SO THAT PEOPLE GET ABOUT ONE-FOURTH LESS
2 RATION GASOLINE SO THAT PEOPLE GET ABOUT ONE-FOURTH LESS

Q- 7 If you were asked to reduce your energy consumption during the entire next year by one-fourth--that is, 25 percent less than you now consume--do you feel you could do it?

1 DEFINITELY YES
2 PROBABLY YES
3 I DON'T KNOW
4 PROBABLY NO
5 DEFINITELY NO

Q- 8 Costs for heating fuel, gasoline, and electricity have gone up a great deal in the last few years. To what extent, if at all, have higher energy costs made you cut back on any of the items listed below.

	To what extent have higher energy costs made you cut back? (Please circle your answer.)			
A Groceries.	NONE	A LITTLE	SOME	A LOT
B Meals out.	NONE	A LITTLE	SOME	A LOT
C Driving the car (or other vehicle)	NONE	A LITTLE	SOME	A LOT
D Health care.	NONE	A LITTLE	SOME	A LOT
E Vacations.	NONE	A LITTLE	SOME	A LOT
F Recreation	NONE	A LITTLE	SOME	A LOT
G Education.	NONE	A LITTLE	SOME	A LOT
H Housing (rent, mortgage or upkeep)	NONE	A LITTLE	SOME	A LOT
I Purchase of appliances or furnishings. . . .	NONE	A LITTLE	SOME	A LOT
J Money put in savings	NONE	A LITTLE	SOME	A LOT
K Clothes.	NONE	A LITTLE	SOME	A LOT

Q-9 All things considered, do you feel that changes in the cost of energy in the last five years have made your life: (Please circle number of your answer.)

1 A LOT WORSE THAN IT WAS
2 A LITTLE WORSE THAN IT WAS
3 NO EFFECT
4 A LITTLE BETTER THAN IT WAS
5 A LOT BETTER THAN IT WAS

ENERGY EFFICIENCY AT HOME

4

Q-10 Listed below are certain energy-saving features that might be added to your home (by you or if you rent, your landlord). For each item, please circle the one best answer:

Energy-saving measures:	Existed When I Moved In	Added Since I Moved In	Plan To Add Within Two Years	Doesn't Exist And No Plans To Add Within Two Years	I Don't Know	Doesn't Apply To My Home
A Double panes or storms on most windows. . . .	EXISTED	ADDED	PLAN	NO	DK	NA
B Good weatherstripping and caulking on most doors and windows. . .	EXISTED	ADDED	PLAN	NO	DK	NA
C More than 4 inches of ceiling insulation . .	EXISTED	ADDED	PLAN	NO	DK	NA
D Insulation in outside walls.	EXISTED	ADDED	PLAN	NO	DK	NA
E Thick floor insulation .	EXISTED	ADDED	PLAN	NO	DK	NA
F Storm doors on all entrances.	EXISTED	ADDED	PLAN	NO	DK	NA
G Clock set-back thermostats.	EXISTED	ADDED	PLAN	NO	DK	NA
H Glass doors on fireplaces	EXISTED	ADDED	PLAN	NO	DK	NA
I Wood-burning stove . . .	EXISTED	ADDED	PLAN	NO	DK	NA
J Solar hot-water heater .	EXISTED	ADDED	PLAN	NO	DK	NA
K Solar heating.	EXISTED	ADDED	PLAN	NO	DK	NA
L Evaporative cooler . . .	EXISTED	ADDED	PLAN	NO	DK	NA
M Outdoor window shades. .	EXISTED	ADDED	PLAN	NO	DK	NA
N Insulated window coverings	EXISTED	ADDED	PLAN	NO	DK	NA
O Other: (Please write in) ________	EXISTED	ADDED	PLAN	NO	DK	NA

Q-11 Thinking about the last three years (1978 --1980), about how much money have you spent to improve the energy efficiency of your home (e.g., weather-stripping, insulation, set-back thermostats, storm doors, solar equipment)? (If none, please put "0.")

$________ YOU SPENT IN 1978

$________ YOU SPENT IN 1979

$________ YOU SPENT IN 1980

5

Q-12 In order to pay for any energy efficiency improvements made in your home from 1978 to 1980, which did you do: (Please circle all that apply.)

1 SPENT NO MONEY ON ENERGY EFFICIENCY IMPROVEMENTS
2 USED MONEY FROM CURRENT INCOME
3 DELAYED OTHER PURCHASES
4 CUT BACK ON OTHER PURCHASES
5 USED LOAN FROM UTILITY COMPANY
6 USED OTHER LOAN OR CREDIT
7 USED MONEY FROM SAVINGS
8 OTHER (Write in) ________________

Q-13 In recent years, it has been possible to claim federal and, in some places, state tax benefits for improving the energy efficiency of one's home. Which best describes your awareness of these tax benefits? (Please circle the number of your answer in each column.)

Federal Income Tax Credit (Circle one answer)	State Tax Benefit (Circle one answer)	
1	1	NOT AWARE OF THIS BENEFIT
2	2	AWARE, BUT HAVE MADE NO CLAIM
3	3	AWARE, AND A CLAIM MADE ON 1978, 1979, OR 1980 TAXES
	4	NO TAX BENEFIT IN MY STATE

→ (If claim made) Would you have probably made these improvements if the tax benefits had not been available?

1 DEFINITELY NO
2 PROBABLY NO
3 PROBABLY YES
4 DEFINITELY YES

Q-14 Here are some other efforts you may or may not be doing to save heating and cooling costs in your home. For each item, tell whether you now do it, or plan to do it in the future.

(Please circle the best answer.)

Energy-saving efforts	This Is Done Now	Don't Do Now, But Plan To Do Within Two Years	Don't Do Now, And No Plans For Future	Doesn't Apply To My Home
A Close off some rooms	NOW	PLAN	NO PLAN	NA
B Have water heater set to 120°F (or less)	NOW	PLAN	NO PLAN	NA
C In winter, set thermostat at 65°F or lower	NOW	PLAN	NO PLAN	NA
D In summer, set thermostat at 78°F or higher	NOW	PLAN	NO PLAN	NA
E Change use of rooms to take advantage of sun-warmed or shaded areas	NOW	PLAN	NO PLAN	NA
F Open and close window coverings to take advantage of sun and temperature differences	NOW	PLAN	NO PLAN	NA
G Home inspected ("audited") for energy efficiency	NOW	PLAN	NO PLAN	NA

Q-15A People have different concerns about housing and make many choices about the housing units in which they live. Here are some statements which express people's concerns about housing. To what extent do you agree or disagree with each statement?

		To what extent do you agree or disagree? (Please circle your answer.)				
		STRONGLY AGREE	AGREE	UNDECIDED	DISAGREE	STRONGLY DISAGREE
A	Homeowners are the backbone of our country.	SA	A	U	D	SD
B	It is all right to bring up children in apartments.	SA	A	U	D	SD
C	Homeownership is one of the best ways to get a tax break	SA	A	U	D	SD
D	If I had two school-age children of the same sex, I would prefer that they had separate bedrooms	SA	A	U	D	SD
E	It is all right if the value of my home does not keep up with inflation	SA	A	U	D	SD
F	People should consider the rate of return on their investment when buying a home. .	SA	A	U	D	SD
G	Neighbors should not be expected to take care of each other's property	SA	A	U	D	SD
H	People wanting quality in housing construction are limited to custom-built homes. .	SA	A	U	D	SD
I	Home improvements should only be done if they add to the resale value of that home.	SA	A	U	D	SD
J	A home-buyer should make the largest down payment he/she can.	SA	A	U	D	SD
K	Building equity in a home is a good idea. .	SA	A	U	D	SD
L	Young people today should consider renting as their permanent housing choice	SA	A	U	D	SD
M	The risks involved in buying a home worry me.	SA	A	U	D	SD
N	People should live close to the place where they work	SA	A	U	D	SD
O	I would prefer not to know the rate of return on my housing investment	SA	A	U	D	SD
P	Home-buyers ought to buy detached single-family dwellings.	SA	A	U	D	SD
Q	Families with enough income ought to own their own homes	SA	A	U	D	SD
R	A home should be kept in good repair to assure resale value	SA	A	U	D	SD
S	I would not pay cash for my home even if I could	SA	A	U	D	SD
T	The federal government should not give tax breaks for homeownership.	SA	A	U	D	SD
U	A person's home is a poor indicator of that person's social status.	SA	A	U	D	SD
V	I prefer to live in a neighborhood where people have similar incomes	SA	A	U	D	SD
W	A home-buyer should pay cash for a home . .	SA	A	U	D	SD
X	The amount of space needed in a home is greater if there are more people in the household	SA	A	U	D	SD

7

ABOUT YOUR HOME

Q-16 Which of the following best describes the building in which you live? (Please circle number of your answer.)

1 A MOBILE HOME OR TRAILER
(If Yes Is It:) ____*IN A MOBILE HOME PARK OR SUBDIVISION*
____*ON A LOT YOU OWN*
____*ON A LOT YOU RENT*
2 A ONE-FAMILY HOUSE DETACHED FROM ANY OTHER HOUSE
3 A BUILDING FOR TWO TO FOUR HOUSEHOLDS (FAMILIES)
4 A BUILDING FOR FIVE OR MORE HOUSEHOLDS (FAMILIES)
5 OTHER: (Please describe.)________________

Q-17 Is the home in which you live:

1 RENTED BY YOU
2 OWNED BY YOU
3 OWNED IN CONDOMINIUM BY YOU
4 OTHER: (Please describe.)________________

Q-18 Which of these broad categories best describes the number of square feet in your home? Do not include a garage, unfinished basement, or space rented to members of another household. Just your best estimate is fine.

1 LESS THAN 500 SQUARE FEET
2 501 TO 1,000 SQUARE FEET
3 1,001 TO 1,500 SQUARE FEET
4 1,501 TO 2,000 SQUARE FEET
5 2,001 TO 2,500 SQUARE FEET
6 MORE THAN 2,500 SQUARE FEET

Q-19 How many rooms do you have in your home? Please do not count bathrooms, porches, balconies, foyers, halls, half-rooms, or space rented to other households.

_____NUMBER OF ROOMS

Q-20 How many years have you lived in your present home?

_____NUMBER OF YEARS (if less than a year, _____ MONTHS)

Q-21 To the best of your knowledge, about when was your home built? We mean first constructed and not when remodeled, added to, or converted.

1 BEFORE 1940
2 1940 TO 1949
3 1950 TO 1959
4 1960 TO 1969
5 1970 TO 1974
6 1975 OR AFTER → (If known, please put exact year: _____.)

Q-22 How do you feel about the energy efficiency of your present home? (Please circle number of your opinion.)

1 ABOUT AS ENERGY EFFICIENT AS IT CAN BE
2 A LITTLE IMPROVEMENT CAN BE MADE
3 SOME IMPROVEMENT CAN BE MADE
4 A LOT OF IMPROVEMENT CAN BE MADE

HOME ENERGY COSTS

8

Q-23 Compared to homes similar to yours, do you feel your home is: (Please circle number of your answer.)

1 A LOT LESS ENERGY EFFICIENT
2 SOMEWHAT LESS ENERGY EFFICIENT
3 ABOUT THE SAME
4 SOMEWHAT MORE ENERGY EFFICIENT
5 A LOT MORE ENERGY EFFICIENT

Everyone

Q-24 About how much a month do you pay for rent or house payments? (Include space rent if in mobile home park.)

1 NO PAYMENT OR RENT
2 LESS THAN $100
3 $100 TO $199
4 $200 TO $299
5 $300 TO $399
6 $400 TO $499
7 $500 TO $749
8 $750 TO $999
9 $1,000 OR MORE

Home owners only

What is the value of your home? That is, about how much do you think it would sell for if it were for sale?

1 LESS THAN $25,000
2 $25,000 TO $49,999
3 $50,000 TO $74,999
4 $75,000 TO $99,999
5 $100,000 TO $124,999
6 $125,000 TO $174,999
7 $175,000 TO $249,999
8 MORE THAN $250,000

Q-25 Next, we would like to ask about how much energy it took to run your home in 1980. Please answer as best you can. If your bills are handy, they could be very helpful. (If you lived in your home only during part of 1980, please put number of months here: ______.)

Please provide as much of the following as you can. Your best estimate will be fine.

	Your Cost For 1980 (Put "R" if included in rent.)	Approximate Amount Used In 1980
A Electricity	$________COST	________KILOWATT HOURS
B Heating oil	$________COST	________GALLONS
C Wood	$________COST	________CORDS
D Natural gas	$________COST	________ ________ (Put purchase unit: cubic feet or therms?)
E Other: (e.g., coal, propane, or?) ____________	$________COST	________ ________ (Put purchase unit)

Q-26 Which of the above is your main source of energy for:

____________WATER HEATER

____________SPACE HEATING

9

Finally, we would like to ask a few questions about yourself to help with analysis of the results.

Q-27 Where is your residence located?

____________________ COUNTY

____________________ ZIP CODE

____________________ TOWN OR CITY IN WHICH (OR NEAREST TO) YOUR RESIDENCE IS LOCATED

→ Is your home: (Please circle.)

1 INSIDE THE CITY LIMITS
2 OUTSIDE THE CITY LIMITS

Q-28 Do you have any of these recreation-related items: (Circle all that you have.)

1 A HEATED SWIMMING POOL, HOT TUB OR JACUZZI
2 A SECOND HOME OR CABIN
3 A MOTOR HOME
4 ANOTHER RECREATIONAL VEHICLE (e.g., CAMPER)
5 NONE OF THE ABOVE

Q-20 Are you: (Please circle number of your answer.)

1 MARRIED
2 DIVORCED
3 WIDOWED
4 SEPARATED
5 NEVER MARRIED

Q-30 Please list everyone who lives in your household by their relationship to you, starting with the adult(s). (Please list as husband, wife, parent, friend, son, daughter, etc.--names aren't necessary.)

		Age (In Years)	Sex (M = Male; F = Female)
1	Yourself	☐	☐
2	____________	☐	☐
3	____________	☐	☐
4	____________	☐	☐
5	____________	☐	☐
6	____________	☐	☐

If more space is needed, please put ages here:

FEMALES ____; ____; ____; ____;

MALES ____; ____; ____; ____

Please answer these questions for yourself and your spouse or other adult living partner (if you have one).

YOURSELF	SPOUSE OR LIVING PARTNER
Q-31 Are you:	Is he/she:
1 EMPLOYED FULL TIME	1 EMPLOYED FULL TIME
2 EMPLOYED PART TIME	2 EMPLOYED PART TIME
3 NOT EMPLOYED OUTSIDE THE HOME	3 NOT EMPLOYED OUTSIDE THE HOME
4 UNEMPLOYED	4 UNEMPLOYED
5 STUDENT	5 STUDENT
6 RETIRED	6 RETIRED
Q-32 Your usual occupation when employed (or before retirement):	His/her usual occupation when employed (or before retirement):
____________TITLE	____________TITLE
____________KIND OF WORK	____________KIND OF WORK
____________TYPE OF COMPANY OR BUSINESS	____________TYPE OF COMPANY OR BUSINESS
Q-33 (If employed) About how far is it from home to where you work?	(If employed) About how far is it from home to where he/she works?
______MILES	______MILES
Q-34 Your highest level of education:	His/her highest level of education:
1 NO FORMAL EDUCATION	1 NO FORMAL EDUCATION
2 GRADE SCHOOL	2 GRADE SCHOOL
3 SOME HIGH SCHOOL	3 SOME HIGH SCHOOL
4 HIGH SCHOOL GRADUATE	4 HIGH SCHOOL GRADUATE
5 TRADE SCHOOL	5 TRADE SCHOOL
6 SOME COLLEGE	6 SOME COLLEGE
7 COLLEGE GRADUATE	7 COLLEGE GRADUATE
8 SOME GRADUATE WORK	8 SOME GRADUATE WORK
9 A GRADUATE DEGREE	9 A GRADUATE DEGREE

Q-35 Some people have many types of investment experiences, and others do not. Which of the following types of investments, if any, have you owned in the last ten years: (Please circle all that apply.)

1 A BUSINESS
2 A HOME
3 OTHER REAL ESTATE THAN YOUR HOME
4 UNITED STATES SAVINGS BONDS
5 PASSBOOK SAVINGS ACCOUNT
6 TIME SAVINGS DEPOSITS
7 MUTUAL FUNDS
8 MUNICIPAL BONDS
9 TREASURY NOTES OR BILLS
10 GOLD OR SILVER COINS
11 STOCKS OR BONDS OF CORPORATIONS
12 MONEY MARKET CERTIFICATE
13 NONE

Q-36 Which of these broad categories describes your total family income before taxes in 1980? (Please circle the appropriate category.)

1 LESS THAN $5,000
2 $5,000 TO $9,999
3 $10,000 TO $14,999
4 $15,000 TO $19,999
5 $20,000 TO $24,999
6 $25,000 TO $29,999
7 $30,000 TO $39,999
8 $40,000 TO $49,999
9 $50,000 OR MORE