ENERGY EDUCATION FOR LIMITED RESOURCE OKLAHOMANS: A POLICY EVALUATION

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ENERGY EDUCATION FOR LIMITED RESOURCE

OKLAHOMANS: A POLICY EVALUATION

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WITH

LOVE AND SINCERE APPRECIATION

TO

ANNA LOUISE WILLIAMS

"MAMA LOUISE"

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CHAPTER I

INTRODUCTION

In today's society, the availability and cost of energy greatly influence the quantity and quality of goods and services, employment, and the quality of life in the home, community and nation. Energy implications are present in most aspects of individual and family living.

Many households in the United States are facing economic and social stress as a result of the current energy situation. According to one report (Task Force on National Trends and Family Educational Needs, 1980), primary areas of concern related to energy which impact upon households nationally are:

- Lack of consistent, comprehensive energy policy,
- Lack of understanding and acceptance of energy facts and issues,
- Lack of credibility of many information sources,
- Increases in the cost of energy and the long-range outlook of continued increases,
- Lack of understanding of alternative energy sources and their environmental, social and economic benefits, and costs.

Some households are especially hard pressed to stretch incomes to meet rising energy costs and other economic demands. Limited resource households which include low income, aged, handicapped, and isolated households are especially affected. Their ability to meet rising expenses is generally less elastic than other households.

Reducing the quantity of household energy use is one approach to controlling utility costs of individual consuming units. Stobaugh and Yergin (1979), in the book "Energy Future", contend that energy conservation is a productive alternative to help our country deal with its energy problem. In a report sponsored by the Ford Foundation (1979) titled "Energy the Next Twenty Years", seven fundamental realities that define the energy problem were identified. One of the realities focused on energy conservation. According to the report, energy conservation in the short and long run is the cleanest, quickest, and cheapest way to react to higher energy costs. Over a twenty year period, from 1979 to 1999, conservation will quantitatively become an important energy source. Further, according to this report, effective conservation involves the energy management decisions of millions of diverse individuals; thus conservation cannot realistically be mandated or centrally managed. Energy conservation requires that information and incentives be provided to energy users to enable them to make their own adjustments in energy use. The Ford Foundation report summarizes energy conservation potential and implementation as follows:

> . . . energy conservation is one of the most important "sources" of energy, which will be used to substitute for other forms of energy as they become more costly and scarce in the next twenty years and beyond. Increased use of this source is a trend to be welcomed, even encouraged, by

> explicit policy, not fought. Although the bulk of the conservation will be the result of normal economic forces and individual self-interested actions, energy policy has an important role in reducing and offsetting some important market imperfections and stimulating use of this energy source to its full economic potential (Ford Foundation, 1979, p. 35).

To effectively manage increasingly expensive energy resources, households need information that will help them make sound decisions about how to reduce their energy use and that will help them learn how to apply new cost effective technologies that have potential for lower energy use. Households also may need incentives to encourage them to invest some of their limited resources in improvements that could help them decrease their energy consumption. These incentives can be provided through education (Williams and Braun, 1981). The Office of Consumer Affairs concluded in a 1980 report that with limited fuel resources and soaring prices, energy education is becoming more and more important. Such education is the basis of self-help efforts that can teach families how to cope more effectively with upwardly spiraling energy costs and how to improve the quality of their housing.

Society challenges public policymakers across the country to help households with their energy related problems. Basically, policymakers have designed public policy options to help individuals and families cope with household energy problems: (1) subsidies, (2) services in-kind, and/or (3) education. The third option, education, is built on the rationale that people can be taught to increase self-sufficiency and self-control which will reduce their need for government services or subsidies.

Agencies and groups in both private and public sectors have attempted a variety of residential energy programs. Many of these efforts have taken into account that poor and/or elderly households are hardest hit by energy problems (U.S. Office of Technology Assessment (OTA), Vol. I, 1979). Due to the lack of comprehensive program evaluation however, many of these programs have come under severe criticism by policymakers and taxpayers, as well as some program participants (Consumer Energy Council of America, 1981).

Policymakers and administrators face difficult choices on how to allocate scarce resources to various programs. They search for answers to such questions as:

- Which programs will bring the most benefit to the most people?
- What criteria should be used to ensure that the neediest are reached first?
- How many public dollars should be directed toward helping poor households reduce energy use, and how many to help pay utility and fuel bills?
- How does a national goal of raising energy prices to levels that reflect true costs affect limited resource households?
- How can federal, state and local governments mitigate the adverse side-effects of an otherwise desirable policy?

According to the U.S. Office of Technology Assessment report on residential energy conservation (Vol. II, 1979), price mechanisms that encourage conservation through the marketplace do indeed exacerbate financial problems of low and fixed income households. Tax incentives and penalties also discriminate against the poor. Direct subsidies could address some of the problems the poor face in paying utility bills; however, this is a short term solution which critics argue will fail to address the source of the problem and tend to become self-perpetuating.

Policymakers and taxpayers who are assessing conservation potential and the effects of conservation practices must take into account the differences in people's situations. To date, little is known about what motivations lead to energy conservation behaviors and what programs would be most successful in accelerating the rate of adoption of energy conserving behavior (Makela, Chatelain, Dillman, D., Dillman, J., and Tripple, 1983). Further, little or no systematic benefit-cost analysis has been undertaken to analyze the impact of various energy programs on households, communities, states and the nation (Consumer Energy Council of America, 1981). Such information is vital to developing energy policy which will serve all sectors of the nation.

Research designed to clarify the role of energy education that is directed toward self-help in assisting households to cope with energy problems is badly needed. Further, such research must address benefits and costs of an energy education policy option.

Statement of Problem

The purpose of this research is to analyze the impact of self-help energy conservation changes made by limited resource households (low income, elderly, handicapped, and isolated) when they used self-help efforts to reduce their household energy use and increase their comfort; and further, to analyze the impact that self-help efforts have on society in general. The households made the conservation changes during a period of increased utility costs, high inflation, and during the delivery of an energy education program which focused on self-help for limited resource households. It is assumed that an aggregate of conditions including an educational project contributed to the households' decisions to adopt energy conservation practices. This study will clarify the impact the energy education project had on limited resource households as it was conducted from May 1982 to May 1983 using the Oklahoma Cooperative Extension Service network for program delivery. The present researcher is particularly interested in the benefit-cost relationship of an energy education project implemented using the existing Cooperative Extension network. This economic impact information is vital to assist public and private decisionmakers in their efforts to cope with current energy problems. Further, policymakers require such information to help them formulate policies that successfully address energy problems of the limited resource sector of our nation.

CHAPTER II

LITERATURE REVIEW

Residential Energy Use

Energy use in the residential sector accounts for approximately 20 percent of the total amount of energy used in the United States (U.S. Department of Energy, 1980). For this reason, private households have been the target of many energy conservation efforts sponsored by a variety of public and private agencies and groups.

Data on residential energy use, for the most part, are based on interpretations of aggregate consumption data. Dole (1975) developed an average energy use pattern for individual households. Dole's breakdown of residential energy use is shown in Table I. Energy use patterns help household members determine potential areas within the home for energy conservation and also help them determine the impact of a given conservation practice on total residential energy use. Specific percentages vary according to geographic location but generally the pattern of energy use remains the same, i.e., space heating uses the largest portion of energy within the home. In Oklahoma however, air-conditioning uses a larger portion of the total amount of energy than Dole indicates in his national averages. Space heating and air-conditioning require 68 to 70 percent of the total energy used in Oklahoma households. Oklahomans spend almost as many dollars cooling their homes in the summer as they do heating their homes in the winter. Therefore when considering energy management strategies for the home, reducing the cooling load on a home in Oklahoma is just as important as reducing the heating load.

TABLE I

RESIDENTIAL ENERGY USE PATTERNS

Energy Use Categories	Percent of Total Household Energy Use
Space Heating	55.5
Water Heating	14.5
Refrigeration/Freezing	7.7
Lighting	5.7
Cooking	5.1
Air-Conditioning	4.6
Drying	1.7
Other	5.7

Housing Structure as it Relates to Energy Use

Design and construction features of a residence have a great impact on the amount of energy used. When careful consideration is given to the design and construction of houses in regard to energy efficiency, households can avoid the use of large quantities of energy. The U.S. Office of Technology Assessment (Vol. I, 1979) documented the potential of reducing energy use in new and existing homes by 30 to 60 percent. This can be accomplished by increasing the efficiency of the "thermal envelope" and improving the efficiency of the heating and cooling systems and other household equipment. Households can increase thermal efficiency by adding insulation, adding storm windows, and reducing infiltration by caulking and weatherstripping. Technology already available can at least double the energy efficiency of housing, but further improvements in technology can promise a significant impact on savings (U.S. OTA, Vol. I, 1979). According to Stobaugh and Yergin (1979), a family occupying a residence can substantially reduce its household energy use with no loss of comfort.

Behavior as it Relates to Residential Energy Use

A number of variables influence the total amount of energy used in a household. According to work done by Princeton University researchers (Socolow, 1978), the level of energy use in a given home is greatly influenced by the attitudes, choices, and behavior of its occupants. In a sample of nine identically constructed townhouses, each with similar orientation and equipment, the units of natural gas used for heating varied by as much as a factor of 2 to 1. When the occupant changed, gas consumption also changed. During the 1972 and 1976 monitoring period, one house moved from the highest gas user to the lowest user when the occupant changed (Socolow, 1978). Data on the direct impact of behavior on energy consumption have only recently become available and the early returns indicate that the way an occupant uses a home makes a substantial difference in how much energy the household uses (Carr, Feng and Schwartz, 1978; Socolow, 1978). For example, thermostat and air-conditioning settings can greatly impact residential energy use. The amount of hot water a family uses for various activities will substantially impact on the amount of energy used to heat the water. Such factors as the types of window coverings and their use, using natural or mechanical ventilation, and opening and closing doors all combine to affect the total energy use of any given household. Family living patterns and the behavior of individual family members impact total residential energy use. Based on research findings, Bailey (1979) suggested that energy conservation policies and programs should focus on incentives designed to bring about behavioral changes.

Adoption of Energy Conservation Practices

Americans are responding to increased energy costs by reducing the direct use of energy in the home. The pattern of energy use established by households in the 1960's has changed dramatically. Residential energy use, which grew at a rate of 4.6 percent per year during the 1960's, has grown at an average of 2.6 percent per year since 1970 (U.S. OTA, Vol. I, 1979).

According to a study sponsored by Honeywell's Energy Management Information Center (Survey, 1983), home energy costs rank second only to the cost of food as a consumer concern. In the Honeywell study, 68 percent of the Honeywell survey respondents had implemented energy conservation efforts in their homes. A majority believed that they could further reduce their energy use without a serious reduction in their standard of living. Nearly 40 percent said they would like to cut back further on energy use but could not. Lifestyle reasons, such as personal comfort and work schedules, were cited most often (35%) as obstacles to further cutbacks. Of the respondents, 32 percent gave the lack of motivation and inability to control family behavior as reasons for not conserving, while 13 percent cited economic reasons such as the cost of a new furnace or energy saving equipment. Further, according to these findings, older, less educated, and poorer respondents were less likely to believe they could cut back on energy use without jeopardizing their standard of living.

No single factor determines the ultimate amount of energy used in a home. It is clear, however, that individuals and families are in control of a significant portion of the decisions that affect energy use. In short, within the real limits of finances, technical capabilities, and knowledge, these households control the operational aspects of home energy use. Certain characteristics of the family unit influence an individual or family's decision to adopt conservation practices. These characteristics include socioeconomic level, stage of life cycle, life style and personal preferences, and beliefs of individual family members (Bailey, 1979; Bronner, Lindamood and Hanna, 1983; Marganus, Olson and Badenhop, 1982).

Special Needs of Limited Resource Households

A national survey conducted by the Ford Foundation (1976) reported that lower income households use less energy in maintaining their households; however, they spend a greater portion of their income on direct energy costs than higher income households.

According to a report prepared by Consumer Federation of America for the U.S. Office of Technology Assessment (U.S. OTA, Vol. II, 1979), between 1974 and 1985 the percentage of income spent on home fuels will increase dramatically for all income groups, but the greatest percentage increases will be for the low income group. Table II summarizes this projected trend. According to this report, the burden of home energy costs are greatest for low income consumers and will become more acute in the future.

TABLE II

PERCENT OF DISPOSABLE INCOME SPENT ON HOME FUELS

Percent of Poverty Line	1974	1985
Less than 100	13.0	20.9
Less than 125	10.7	17.5
125 to 199	5.7	9.3
200 to 300	4.2	6.9
More than 300	2.8	4.7
All households	3.9	6.2

The consequences of increasing energy prices are particularly severe for the aged. Typically the elderly must manage on a fixed or declining resource base while expenses such as medical services and food continue to rise in price. Another factor amplifying the impact of energy price increases on the elderly is the structural condition of most elderly housing. Elderly Americans are far more likely to be found living in high energy consuming single family dwellings. The majority of the elderly own their own homes and over half of those homes are over 30 years old. For the elderly in all income groups, the burden of rising energy prices is greater than for other age groups. The Consumer Federation of America Study on Energy (U.S. OTA, Vol. II, 1979) projected that this trend will become more pronounced in the future as indicated in Table III.

TABLE III

PERCENT OF DISPOSABLE INCOME SPENT ON HOME FUELS ACCORDING TO AGE

Percent of Poverty Line	Age	1974	1985
Less than 100	Less than 60	11.4	18.5
	60 or Older	16.2	27.0
Less than 125	Less than 60	9.3	15.9
	60 or Older	13.7	22.7
125 to 199	Less than 60	5.3	8.4
	60 or Older	7.4	12.6
200 to 299	Less than 60	4.1	6.3
	60 or Older	5.0	8.3
300 or Greater	Less than 60	2.7	4.7
	60 or Older	2.8	4.8
All Households	Less than 60	3.7	5.9
	60 or Older	4.7	7.4

Table IV further indicates a slightly greater burden of energy costs on rural households (U.S. OTA, Vol. II, 1979)

TABLE IV

PERCENT OF DISPOSABLE INCOME SPENT ON HOME FUELS SCALED BY POVERTY LINE AND LOCATION

Percent of Poverty Line	Location	1974	1985
Less than 100	Urban	12.4	20.4
	Rural	14.0	22.0
Less than 125	Urban	10.2	17.0
	Rural	11.7	18.5
125 to 199	Urban	5.3	9.1
	Rural	6.6	10.0
200 to 299	Urban	4.1	6.7
	Rural	4.9	7.6
300 or Greater	Urban	2.7	4.6
	Rural	3.3	5.3
All Households	Urban	3.6	5.9
	Rural	5.1	7.7

Clearly in relation to other groups, limited income households pay larger portions of their income for residential energy and live in less thermally efficient dwellings. Further, within the ranks of low income groups, the cost of energy is felt most severely by elderly and rural households. Clearly, these groups fall within the limited resource category.

Programs Designed to Assist Limited Resource Households

Policymakers at federal, state, and local levels have recognized the special needs of limited resource households and have established a variety of programs to assist this group. In fact, recognition of the need for energy related assistance was underscored in the administration's National Energy Plan which stated:

> No segment of the population should bear an unfair share of the total burden, and none should reap undue benefits from the nation's energy problems. In particular, the elderly, the poor, and those on fixed incomes should be protected from disproportionately adverse effects on their income (U.S. Executive Office of the President, 1977, p. 27).

Basically, three approaches to assist limited resource households were used by policymakers at local, state and federal levels. These include (1) monetary assistance to pay utility bills, (2) weatherization services, and (3) education to stimulate self help. Policymakers placed a strong emphasis on monetary assistance and weatherization and placed little emphasis on energy education for the limited resource sector. Energy education programs have focused on middle to upper income households because limited resource households have been considered unable to help themselves when managing household energy problems. According to a report prepared by Consumer Federation of America:

> It can be assumed that the ability of low-income consumers to conserve could be increased to some extent by educational efforts. However, although individual households could be taught how to improvise weatherstripping, or in some cases, how hot water heaters or wood stoves could be used more effectively, for the most part, low-income consumers cannot

> conserve energy because of their lack of financial resources to make energy conserving home improvements. Any effort to stimulate residential conservation by the low-income population, therefore must be accompanied by the resources necessary to accomplish such conservation (U.S. OTA, Vol. II, 1979, p. 89).

The Consumer Federation of America concluded that limited resource households are not in a position through self-help efforts to reduce residential energy use. Others (Braun, Williams and Murray, 1979; Murray, L., 1978) however, conclude that limited resource households can reduce household energy use and increase comfort through self-help efforts which are motivated by energy education. Nonetheless, the primary focus of limited resource energy programs has been on monetary subsidies and weatherization rather than education designed to stimulate self-help.

Braun, Williams and Murray (1979) developed their program on the concept that money resources are only one group of resources available to the household coping with energy problems. These authors contend that although money income is a major resource available to families, other resources should also be considered in coping with energy problems. Money income alone does not achieve a desired level of living. No resource available to the family is used in isolation. In any given situation, a family uses a combination or mix of resources to accomplish desired goals. Liston (1966) classified family resources by seven dimensions: money, property, human, community, natural, space, and time. Encompassed within several of these dimensions are two resources of great importance, namely: human energy and information. Families on a modest money income that do well, know how to manage these limited resources by substituting more plentiful resources for those available in less adequate quantities.

Kyrk (1953) referred to the variety of resources available to the family when she pointed out that the income of a household economic unit consists of both money and nonmoney receipts. Money receipts include inflow during a specified time period from paid employment earnings of all members who are considered part of the economic unit; profits from business enterprise, rents, royalties, interest and dividends from investments; transfer payments; gifts; and, other miscellaneous sources. Nonmoney income includes inflow of goods and services during a period of time from sources other than money and includes estimated use-value of occupancy of owned dwelling and of other durable goods owned; unpaid services of family members; and, goods or services received as gifts or from the natural environment. The patterns of income from money and nonmoney sources differ widely within given households from time to time and among households from place to place at a given time. Therefore, the levels of household consumption cannot be predicted in terms of money income available. Rather, consideration must be given to total income, of which real income is an essential part. According to Gross, Crandall and Knoll (1973), total income is the flow of goods and services for consumption during a period of time (i.e., real income), whether these goods and services are obtained through use of a medium of exchange or from other sources.

Energy education for limited resource households is developed on the concept of a resource unit available to households in coping with residential energy problems. This means that although households may have limited monetary resources, they have a wide variety of both human and non-human resources to draw on when addressing residential energy problems.

Energy Assistance Programs

Smith (1982) compiled an overview of federal energy assistance programs from 1974 to 1981; the overview provides the following information. The federal government established the Energy Crisis Assistance Program (also referred to as the Special Crisis Intervention Program) through the 1974 Amendment to the Economic Opportunity Act. This program was intended to provide immediate relief to low income consumers from the burdens of increased residential energy prices. This "crisis assistance" program was administered by the Community Services Administration (CSA) through local Community Action Agencies. Although the CSA program provided financial and some in-kind (i.e., blankets or clothing) heating related aid to low income households with emergency needs, it primarily assisted eligible households in weatherizing their homes. In order to be eligible for assistance, households had to have an income below 125 percent of the poverty level.

In 1977, 1978, and 1979 the federal government reaffirmed its commitment to provide energy related assistance to the poor and needy by appropriating $200 million for assistance programs. The thrust of these programs was on crisis assistance and involved the provision of emergency fuel supplies to eligible recipients mainly through direct payments to fuel vendors.

President Carter announced the decontrol of domestic oil prices in April of 1979. Price increases associated with decontrol, along with increases in the Organization of Petroleum Exporting Countries (OPEC) crude oil prices, contributed to even higher energy prices in the United States. Recognizing the hardship that these higher prices would impose on limited resource households, the federal government significantly increased its efforts to aid limited resource households by appropriating $1.6 billion for energy related assistance for fiscal year 1980. The overall program consisted of two major components: The Energy Allowance Program and The Energy Crisis Assistance Program. Under the Energy Allowance Program, the Department of Health and Human Services allocated $400 million to those persons who were receiving Supplemental Security Income (SSI), that is the low income, handicapped, and elderly, to assist in defraying higher energy costs. In addition, $800 million was set aside for the states as block grants. Under the guidelines for the program, energy assistance was restricted to households with income not to exceed 125 percent of the poverty level with the exception of those households which had already qualified for another welfare program such as Food Stamps, Aid to Families with Dependent Children, or General Assistance.

The Energy Crisis Assistance Program represented an extension of the Crisis Intervention Program that was administered by the Community Action Administration. This program made available an additional $400 million to the states to provide aid to low income families with unforseen energy related contingencies. The energy assistance program for fiscal year 1981, for the most part, followed the blueprint of the fiscal year 1980 program with a budget increase of $1.85 billion.

The Reagan Administration had proposed for each fiscal year since 1981 reduced funding for energy assistance programs. In addition, the current administration has sought to consolidate low income assistance for energy and non-energy related emergencies. To date, Congress has blocked consolidation proposals and substantial funding cuts. However, the Reagan Administration continues to propose reduced budgets and consolidated block grants to the states to cover fuel and other energy assistance. Such proposals indicate a lower priority in the future for energy assistance programs at the federal level.

According to a report cited by Smith (1982) and prepared by the Trans Century Corporation, problems associated with limited resource energy assistance efforts, due in part to funding delays in the allocation of funds and difficulties in interpreting and administering program guidelines, prompted some program participants, taxpayers, and policymakers to characterize the programs as "ineffective, short-term, shortsighted, and too little too late" (Smith, 1982, p. 216). Others consider energy assistance a "band-aid" measure, one which does not get at the root of the problem but only addresses relieving some of the most severe symptoms of the problem (U.S. OTA, Vol. II, 1979).

In addition to federally funded energy assistance to limited resource households, several states initiated their own assistance programs. Unlike the federal efforts, many state initiatives did not limit assistance to emergency needs. Moreover, the state programs used a variety of benefit delivery systems that included fuel stamps, two-party checks, state income tax credits for program participants, sales tax credits for energy providers, and vouchers (U.S. OTA, Vol. II, 1979). State energy assistance programs are continuing to meet with a variety of implementation and delivery problems. Many states are experiencing difficulty with assistance programs reaching those households with the most need. With current budget problems being experienced in several states, many have considered or are considering discontinuation of state funded energy assistance programs.

Smith (1982) pointed out in his article that many of the concerns raised about the formulation and delivery of energy assistance programs at both state and federal levels have their roots in the Congressional preferences for short range rather than long range planning. Since members of both state and federal legislative bodies face elections every two to four years, there is a bias toward concentrating on those pressing issues that lend themselves to short term planning. The immediate need of energy assistance within a limited time frame therefore, would seem to be a prime candidate for short term planning. However, the yearly consideration of energy assistance during the federal and state budget process has not been conducive to building upon strengths and weaknesses of the previous year's program. Formal evaluations of assistance programs have not been conducted by project personnel or outside researchers. Program modifications that have been implemented have primarily been the result of Congressional hearings that highlight specific energy related problems encountered by needy households rather than the result of a systematic and comprehensive assessment of the operation of previous assistance efforts. Moreover, under the present one year funding approach, planning for the succeeding year's program is well underway before the previous year's program is in full operation. According to Smith, "The importance of good data on program activities cannot be overemphasized. The lack of such data has no doubt hampered program planning and evaluation efforts to date" (Smith, 1982, p. 260).

Weatherization Programs

The Emergency Energy Conservation Services program authorized by the Economic Opportunity Act of 1974 was designed to enable low income households, including the elderly and near poor, to participate in energy conservation programs. The energy conservation programs were to lessen the impact of energy prices on limited resource groups and reduce residential energy consumption. The focus of the Emergency Energy Conservation Services program was on weatherization. The program was administered by the Community Services Administration (CSA). Through the program, local Community Action Agencies provided energy conserving home improvements at no charge to the limited resource households. In 1978, the Energy Conservation and Production Act mandated a supplemental weatherization program to be administered by the Department of Energy (DOE). The purpose of the DOE weatherization program was to assist in achieving a prescribed level of weatherization for targeted dwellings, particularly those of the elderly, handicapped and low income. The program also was designed to aid limited resource households least able to afford higher utility bills, and to help them conserve energy. The program was implemented through the states by Community Action Agencies, which had carried out the CSA weatherization program. The basic difference between the CSA and DOE weatherization programs was that CSA focused on ameliorating the impact of high energy prices on limited resource households while the DOE program aimed at maximizing units of energy conserved within the limited resource residential sector.

Much of the success or failure of these weatherization programs in a particular area depended upon local factors, such as the availability of labor and other federal, state and local resources to supplement and support the weatherization efforts. Local policy advisory committees advised the Community Action Agency (CAP) on how best to implement the program, including decisions such as which homes to weatherize, how much to spend on each within the guidelines, and where to purchase materials. The majority of committee members were limited resource consumers who served along with utility company representatives, local officials, and community leaders. Some factors contributing to the effectiveness of the weatherization program were mandated from the federal level, for example, how funds could be expended; what types of improvements could be made; and the amount of funds that could be used to cover labor and administrative costs. Program effectiveness was based on an estimated fuel savings of 15 to 35 percent. Actual savings, which have not been documented to date, depend greatly on whether the agency attempted to cover as many homes as possible or did a thorough job on those dwellings weatherized (U.S. OTA, Vol. II, 1979).

The Consumer Energy Council of America Research Foundation completed a comprehensive evaluation of the effectiveness of low income weatherization programs with particular emphasis on the results achieved in the low income weatherization program conducted by the United States Department of Energy (Consumer Energy Council of America, 1981). The Consumer Energy Council of America study examined the effectiveness of the weatherization of 6,000 homes in 25 states. General study results were as follows:

1. For the DOE program, the average investment in weatherization was $968 per house and the reduction in energy consumption averaged 26.7 percent.
2. For the weatherization conducted by Community Services Administration, the average investment was $1,742 per house and the reduction in energy consumption was 30.5 percent.
3. For weatherization performed on non-low income homes by research institutions and private companies, the average investment was $1,132 per house and the reduction in energy consumption was 31 percent.

The Consumer Energy Council of America concluded that there is no doubt that weatherization can accomplish major energy savings. Further, low income weatherization programs seem to save approximately the same amount of energy as non-low income weatherization programs. This was especially true when analysis was restricted to a basic set of conservation measures and not a complete retrofit, which is very costly and goes beyond the general approach of the weatherization program. Based on a model developed by the Consumer Energy Council of America, a combined weatherization and assistance approach was preferable to an assistance only approach because the combined approach was determined to be more cost effective in delivering energy services to limited resource households. Further when analyzing the economics of weatherization, the Consumer Energy Council concluded that the costs of weatherization programs are low when compared with the costs of producing energy. Moreover, this group concluded that "the cost of conservation is competitive with the cost of the cheapest source of produced energy, natural gas" (1981, p. 54).

Although weatherization seems to be a very effective method of helping limited resource households cope with rising energy prices, the Consumer Federation of America pointed out that with current funding levels at an average cost of $800 per house, it would take 40 years for the 10 million limited resource households in need to be weatherized (U.S. OTA, Vol. II, 1979). Programs generally have waiting lists of hundreds of eligible households.

The tenuous nature of federal funding is often cited as a significant problem. Because funding and allocation is provided on an annual basis by Congress, program administrators never know if or how much they are to receive in the following year. It is therefore very difficult to conduct long range planning and coordination. It is also difficult to retain the most qualified staff. Similarly, at the local level, the amount and uncertainty of funding creates a sense of insecurity. According to the Consumer Federation of America, this results in ". . . a preoccupation on the part of many CAP's with impressing decision makers with the sheer numbers of dwellings they have insulated. As a result, quality suffers" (U.S. OTA, Vol. II, 1979, p. 158).

Energy Education Programs

Using data from a large number of studies completed in the area of consumer attitudes and behavior with respect to energy conservation, the U.S. Office of Technology Assessment (Vol. I, 1979) concluded that consumers are becoming more aware of the need for conservation but that this awareness does not necessarily lead to conservation behavior. However, many consumers lack practical knowledge concerning the accomplishment of conservation and have a degree of mistrust about government and industry as information sources. In their report they further stated that impediments to consumer conservation include inadequate information, conflicts with other goals, lack of perceived financial reward, doubts about others' motivations and commitments, and complacency about forthcoming technological solutions.

These conclusions clearly point to a need for quality energy education which moves individuals and families from the point of awareness to adoption of energy efficient practices. Education is essential to providing the basis of informed decision making by a sizable segment of the population. How this educational challenge is met now and in the future will in large part determine the quality of technological solutions to be developed, but most importantly, will affect energy use habits of generations to come (United States Department of Energy, 1979).

There are some basic measures which all households can take to reduce residential energy use, however in order for households to take advantage of any potential benefits of conservation measures available, it is necessary for them to be aware first of the existence and nature of the problem and second, of what to do and where to go to deal with problems. Even when limited resource households identify their difficulties related to energy use, they are often unaware of ways in which to best deal with their problems. In addition, energy saving goods which are available, such as home insulation and fuel efficient heating and cooling systems, are often not within the range of affordability of the limited resource household. Low budgets for outreach efforts associated with federal conservation and home repair assistance programs limit the number of limited resource households directly informed of these programs (U.S. OTA, Vol. II, 1979).

It is important that households receiving home weatherization assistance also receive education related to residential energy management. Proper maintenance and lifestyle of household members living in a retrofitted home can make a great difference in the actual effectiveness of the retrofit job. The Community Services Administration found more than a 50 percent difference in energy savings in houses with identical physical characteristics from a National Bureau of Standards retrofit experiment in New Jersey. This study concludes that it is very important that occupants of weatherized houses understand what has been done to their homes and what they need to do to obtain the maximum benefit from the weatherization (Socolow, 1978).

The Consumer Federation of America pointed out that simply distributing literature or informing consumers of ways to conserve energy is not enough; education targeted at limited resource households must be credible. They concluded that consideration must be given to the difficulty of changing habits of elderly people (U.S. OTA, Vol. II, 1979). Thus, energy education targeted toward the limited resource household must take into consideration special needs and limitations of this group if it is to be successfully implemented.

Nowak (1983), in a discussion of land conservation education, outlined four objectives that must be met if conservation education is to be effective. These could also apply to energy conservation education. The four objectives were (1) to assist in recognizing instances of excess, (2) to recognize the causes of excess, (3) to promote appropriate conservation technologies (technologies do not sell themselves), and (4) to assist program managers and audiences in understanding conservation decisions. Further, Nowak (1983) made some suggestions regarding the implementation of conservation education. First, it is important to increase the visibility of the product--conservation. According to Nowak, you do not wait for the public to ask about conservation efforts; you tell them quite explicitly, using many different communication techniques. He also suggested that critical areas of need be targeted with conservation education thrusts. In addition, technologies must be adapted to local situations, according to Nowak.

Energy Extension Service

Congress, by creating the Energy Extension Service (EES) and appropriating $15 million to fund EES for fiscal year 1979, recognized that something was needed to encourage small energy users, including private households, to adopt energy conservation. Energy Extension Service was considered an alternative approach to assisting small energy users cope with energy related problems. Highlights of the EES approach included the following:

1. One-to-one communication with small energy users, as opposed to the traditional mass information and education programs.
2. The need for a long-term investment, focusing on fundamental change occurring over time.
3. Diversity--encouraging services tailored to the specific needs of different types of energy users in different parts of the country.
4. The use of existing institutions--using those institutions most appropriate to meeting the needs of a particular type of energy user.
5. Flexible response--rewarding, rather than penalizing institutions which adjust their energy outreach services when not effective.
6. Institutional credibility--assure that the institutions offering outreach services are highly respected among the people they serve. (U.S. Department of Energy, 1979).

The Energy Extension Service Program was piloted in ten states for 18 months to determine the best implementation strategies. Based on a review of the ten EES pilot projects, the National Energy Extension Service Advisory Board concluded that personalized technical assistance and information in energy conservation worked to stimulate small energy users to save energy or to switch to renewable energy sources. The advisory board made a variety of recommendations; among them were the following:

1. The EES program should have adequate funding--at least $35 million would be necessary to nationally deliver the range and type of services delivered in the pilot states program.
2. The Department of Energy (DOE) should continue to emphasize in the EES program states: control, diversity, local delivery, and one-to-one contact with small energy users.
3. Where appropriate, the DOE should encourage the transfer of EES program responsibility from the state level to delivery organizations at the local level.
4. The DOE should encourage EES programs to address the energy problems of low income clients in urban and rural areas.
5. The DOE should incorporate the lessons learned in the pilot program, in management and operations, into the EES regulation and procedures for the nationwide program.

The Energy Extension Service was not intended by Congress, nor was it seen by its federal and state administrators, to focus on limited resource households. The low income weatherization assistance came from the Department of Energy's low income program, while Energy Extension Service funds were aimed at the general public. Of the ten EES pilot states, eight had a residential sector emphasis. One of these programs was oriented primarily at low and moderate income residents and another had a low income program component. The majority of the pilot programs focused on education for the general public. This trend has continued after the Energy Extension Service was implemented on a national level (U.S. Department of Energy, 1979).

Energy Audits

The Residential Conservation Service was mandated by Congress in the 1978 National Energy Plan. The primary purpose of the program was to provide residential energy users with detailed information related to the thermal efficiency of their home. Major public utilities were required to provide computerized energy audits to their residential customers. The computerized energy audit is an educational tool designed to analyze the thermal efficiency of a specific house and to provide detailed benefit and cost information on a variety of energy conserving measures. Audits are obtained from all major utility companies under the provisions of the Residential Conservation Service program. In addition, in Oklahoma, all rural electric cooperatives offer a computerized energy audit to their customers. The cost for an audit varies from company to company, but usually costs $15 or less. Special rates are often available for senior citizens and low income households. Audits offered by rural electric cooperatives are free to cooperative customers.

After a residential customer requests an audit, a trained and certified auditor surveys the house and indicates how the house uses energy. They tell the customer ways to reduce energy consumption and help the customer determine whether solar or wind energy equipment would be feasible for a specific residence. When the audit is complete, the auditor discusses the results with the customer, gives detailed information about each energy saving recommendation, and answers questions. The customer is given cost estimates for recommended improvements and information about materials and suppliers, equipment suppliers, installation, and financing (Planergy, 1981).

In 1982, a comprehensive evaluation of the Oklahoma Residential Energy Service, the ECHO program, was conducted. The following summary of findings is relevant to this research:

> In summary, the ECHO Home Energy Audit Program is very effective in influencing customers who participate to conserve energy more conscientiously. However, it is not effective in the sense that only one percent of all customers elect to participate. Those participants are clearly more affluent than the average consumer. The lower income customers are not benefitting from the program due to their lack of participation, which can be caused by either an unwillingness to pay the $15 fee or simply not knowing about the availability of the program (Elrick and Lavidge, Inc., 1982, p. 8).

To date, an evaluation of the rural electric cooperative audit program in the State of Oklahoma has not been conducted to determine the impact of this program. However, the evaluation of the Oklahoma ECHO Home Energy Auditing Educational Program indicates that it is not reaching the limited resource segment of the state.

Cooperative Extension

The Cooperative Extension Service of the United States Department of Agriculture was established under the provisions of the Smith-Lever Act of 1914. It is the largest informal educational network in the world, with programs in operation in every state, the District of Columbia, Guam, the Virgin Islands, and Puerto Rico. The Cooperative

Extension Service is decentralized, it emphasizes the local definition of problems and needs.

The Cooperative Extension Service is acknowledged to be an effective program, however it does not generally aim its programs at particular groups, such as limited resource households. According to a report prepared by the Consumer Federation of America (U.S. OTA, Vol. II, 1979), the Cooperative Extension Service has done much more for middle and upper income groups than it has done for the poor.

The Cooperative Extension Service began its energy education campaign about one year before the OPEC embargo. Since that time, Cooperative Extension Service has distributed a wealth of energy conservation information written at both the federal, state, and county levels. Cooperative Extension Service energy conservation literature is usually written on a higher vocabulary level than is generally considered appropriate for reaching low income people. For example, Tennessee Valley Authority (TVA) found that the energy conservation materials it had distributed to limited resource consumers in the valley were not sufficiently comprehensible to the target group, which had an average educational level lower than that of other groups. As a result of this experience, TVA shifted to educational materials on a third grade reading level. The Cooperative Extension Service normally targets fourth grade reading level when preparing educational materials (U.S. OTA, Vol. II, 1979).

A delivery system successfully used by the Cooperative Extension Service to reach low income households is the Expanded Food and Nutrition Program. This program, which has been operational for over a decade, uses paraprofessionals to work on a one-to-one basis with low income families with children to help them improve their nutrition and dietary habits. Extensive evaluations of this program have documented the effectiveness of this paraprofessional, individualized approach to nutrition education (French, Christopher, and Shieh, 1981). The Consumer Federation of America (U.S. OTA, Vol. II, 1979) suggested that the Expanded Foods and Nutrition Delivery model could be successfully transferred to provide energy education to limited resource households. According to Consumer Federation of America, this approach could help insure that low income people, especially those in rural areas, be given the fullest possible opportunity to learn and benefit from energy conservation techniques. To date the transfer of the Expanded Foods and Nutrition model to energy education for limited resource households has not been extensively implemented. With the exception of energy programs conducted by Oklahoma and Texas Cooperative Extension, there is no documented evidence of energy programs using the Expanded Foods and Nutrition model.

In several states, the Cooperative Extension Service and the Energy Extension Service have joined and cooperatively implemented energy education programs. Generally, funds have been used by the Cooperative Extension Service to implement programs which meet joint and compatible objectives of Cooperative Extension and Energy Extension Service. Again, the primary focus of these joint programs, has not been on the limited resource sector, but on small energy users in general.

The Cooperative Extension Service has increasingly been challenged to identify and evaluate program results. In 1982 in response to changing accountability and evaluation demands, state and federal Extension units established the National Accountability and Reporting Service. The focus of the new system represented a shift in emphasis, from reporting staff inputs and number of program participants to reporting program results. Further, the system was designed for proactive and systematic program planning, implementation, and evaluation. This new reporting system required identifying and highlighting the economic and social consequences of Extension programs. The approach also required development of programs that incorporated accountability and evaluation plans into plans of work and program design. Further, within each program area, i.e., Agriculture, Home Economics, Youth and Rural Development, major program thrusts were identified for a four-year period. These program thrusts, or major program areas, form the content base for the new accountability and reporting system. Within Home Economics, family financial security, energy and environment, foods and nutrition, and safety were identified as the four major program areas. Again, energy was identified as an important educational thrust. This system will take several years to fully implement. The new system was developed using four-year plans of work for staff and three types of program accountability and evaluation: (1) impact studies, (2) accomplishment reporting, and (3) input and participation information. Impact studies are technically valid, in-depth, national or state evaluations conducted to assess the economic and/or social consequences of selected high priority programs. Accomplishment reporting consists of brief narrative reports of program results and supporting statistical data representing statewide aggregation of data for each major program area. Accomplishment reports are housed at the federal level in a computer retrieval system. Input and participation information is comprised of data reported in numerical form, including resources used to conduct Extension programs and participants served (State, 1982).

For this study, thirty-five Cooperative Extension residential energy related program accomplishment reports were retrieved and reviewed for residential energy projects reported during 1982 and 1983. These reports were reviewed for the present study to determine if eleven project design, implementation, and evaluation components were reported. The eleven components were selected to determine if Cooperative Extension energy programs implemented during 1982-1983 were designed to meet the special needs of limited resource households. Further programs were reviewed to determine if program impact was systematically determined and documented in a benefit/cost framework. The eleven components are

1. Focus on an audience of low income, elderly, isolated, and/or handicapped individuals and families, i.e., limited resource households;
2. Focus on a rural audience;
3. Provide paraprofessional, one-to-one, or small group delivery;
4. Emphasize self-help;
5. Identify and document pre-condition of the house, household members and the presence of energy saving practices before program delivery;
6. Identify and document the post-condition of the house, and energy saving practices at the close of the project or reporting period;

7. Identify and document specific changes;
8. Identify and document the cost of program implementation and changes made;
9. Identify and document the benefit of changes made;
10. Relate benefits and costs;
11. Determine from program participants why they made changes.

Table V reports the review of these 35 projects and documents the presence of the eleven program components. Of the 35 national Cooperative Extension Energy projects reviewed, 15 focused on a limited resource audience but only one had a specified rural focus. Only five of the projects used a paraprofessional, one-to-one or small group delivery system. However, all 35 stressed self-help solutions to residential energy problems. Only four programs identified and reported household characteristics, housing conditions, and the presence of selected household energy conservation practices or strategies prior to project delivery. Further, only six projects identified and reported these conditions after project delivery. Of the 35 projects, 16 documented and reported specific changes made at the end of the project or reporting period. Ten programs documented the cost of project delivery and cost of making changes, while nineteen quantified and reported benefits to project clientele. Only one project report related benefits to costs. One program also reported asking program participants why changes were made.

A review of Program Accomplishment Reports for Cooperative Extension Energy projects reported during 1982 and 1983 reveals an

TABLE V

SUMMARY OF RESIDENTIAL ENERGY PROJECTS CONDUCTED BY THE COOPERATIVE EXTENSION SERVICE

Date	Title	Audience Focus on Low Income, Elderly, Isolated Handicapped	Location Rural Focus	Paraprofessionals One-to-One or Small Group Delivery	Self-Help Emphasis	Pre-Condition	Post-Condition	Specific Changes Documented	Quantified Cost-Household Agency Etc.	Benefit Quantified & Documented	Relate Benefit to Cost	Why Changes Were Made
8/82	Energy and the Homeowner (Using Energy Wisely, Solar and Renewable Energies) - New York	Yes	No	No	Yes	No	No	No	No	No	No	No
8/82	Energy Education - Massachusetts	No	No	No	Yes	No	No	Yes	No	Yes	No	No
8/82	Energy (Family Education) - North Dakota	No	No	Yes	Yes	No	No	Yes	No	No	No	No
8/82	Family Aide Program - Maryland	Yes	No	Yes	Yes	No	No	No	No	No	No	No
8/82	Home Energy Conservation - Illinois	No	No	No	Yes	No	No	No	No	No	No	No
8/82	Housing and Home Improvement for Limited Resource Neighborhoods - Texas	Yes	No	No	Yes	No	No	No	No	No	No	No
8/82	Making Oregon Homes More Energy Efficient	No	No	No	Yes	No	No	Yes	No	Yes	No	Yes
8/82	Residential Energy Conservation - New Hampshire	No	No	No	Yes	No	No	No	No	No	No	No
8/82	West Virginia Families Assess Household Energy Efficiency	No	No	No	Yes	No	No	No	Yes	No	No	No
8/82	Weatherization - South Carolina 1890 Extension Program	Yes	No	Yes	Yes	No	No	Yes	Yes	Yes	No	No
12/82	Residential Energy Conservation, North Dakota	No	No	No	Yes	No	No	No	Yes	Yes	No	No
12/82	Residential Energy (State Wide Summary) - Maryland	Yes	No	No	Yes	No	No	Yes	No	Yes	No	No
1/83	Energy Conservation Accept - Colorado	No	No	No	Yes	No	No	No	Yes	No	No	No
1/83	Energy Conservation Programs for the Handicapped and Low Income, Louisiana	Yes	No	No	Yes	No	No	No	No	No	No	No
1/83	Home Improvement and Energy Conservation Program in 12 North Alabama Counties	Yes	No	No	Yes	No	No	No	No	Yes	No	[illegible]

1/83	Residential Energy Conservation Education Program, Louisiana	No	No	No	Yes	No	No	No	No	No	No	No
2/83	Behavioral Changes Save Household Energy in Florida	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No
2/83	Energy Conservation Accomplishments in Mississippi	Yes	No	No	Yes	No	No	Yes	No	Yes	No	No
2/83	Energy Conservation and Education in Tennessee	No	No	No	Yes	No	No	Yes	No	Yes	No	No
2/83	Energy Conservation - Arkansas 1890	Yes	No	No	Yes	No	No	Yes	Yes	Yes	No	No
2/83	Energy Conservation - Kentucky (1890)	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
2/83	Energy Conservation - South Dakota	No	No	No	Yes	No	No	No	No	No	No	No
2/83	Energy Management and Decision Making - Missouri	No	No	No	Yes	No	No	No	Yes	Yes	No	No
2/83	Louisiana Homes Increase Energy Efficiency	No	No	No	Yes	No	Yes	Yes	No	Yes	No	No
2/83	Missouri - Home Energy Conservation	No	Yes	No	Yes	No	No	Yes	Yes	Yes	No	No
2/83	New York State Energy in the Home	No	No	No	Yes	No	No	No	No	No	No	No
2/83	Residential Energy Conservation - Mississippi 1890	Yes	No	No	Yes	No	No	Yes	No	No	No	No
2/83	Self Help Weatherization For Low Income Hispanics in New Jersey	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	No	No
2/83	Weatherization - Missouri	Yes	No	No	Yes	No	No	No	Yes	Yes	No	No
3/83	Energy Conservation: Escambia County, Florida	Yes	No	No	Yes	No	No	Yes	No	Yes	No	No
3/83	Energy Management Decision Making - Massachusetts	No	No	No	Yes	No	No	Yes	No	Yes	No	No
3/83	Families Monitor Household Energy Use/Cost - West Virginia	No	No	No	Yes	Yes	Yes	No	No	No	No	No
3/83	Housing and Residential Energy Program - Montana	No	No	No	Yes	No	No	No	No	No	No	No
3/83	Improving Residential Energy Efficiency in Arkansas	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes	No	No
3/83	Residential Energy Management - Nebraska	No	No	No	Yes	No	No	No	No	No	No	No
	Total Number of Programs with Program Component Present	15	1	5	35	4	6	16	10	19	1	1

Source: NARS Computer Search

Key Words: 1) Energy, 2) Residential Energy Conservation, 3) Family Housing Energy Conservation attempt to evaluate and document social and economic impacts of residential energy projects. These preliminary attempts reflect a need for refined and more sophisticated methods of evaluation and reporting. If economic and social consequences of programs are to be pointed out to influential decisionmakers, they must be collected, documented, and evaluated in such a way as to be easily integrated into policy decisions. At this point in time, these tasks have not been accomplished.

Other Energy Education Programs

Two computer searches were completed to locate energy education programs which had been conducted to meet the specific needs of limited resource households. Neither the Education Resources Information Center (ERIC) search or a search of the holding available to the National Agricultural Library (AGRICOLA) located additional energy education programs for limited resource households. This further supports that few educational programs are designed to target limited resource households and further, of those serving limited resource households, few are systematically documenting program impact from a benefit/cost perspective.

Evaluating Energy Education Programs for Policy Formation

Hirst (1981) indicated that few people understand energy conservation programs, and specifically how well they work. Adequate information on factors affecting energy use and the performance of specific projects is not available to Congress, United States

Department of Energy officials, state and local officials and the public. Because of this lack of information, it is difficult for these decisionmakers to determine how much emphasis to place on various programs and what policies to formulate to support various program thrusts.

Hanke (1979) suggests in his article that energy conservation policies at federal, state and local levels have been accepted and promoted in an unquestioned way. He further stated, that many energy conservation policies are not well grounded. Maximizing economic efficiency is an important objective for energy conservation policy formation, that is, to maximize the net benefits from the adoption of a policy. This objective focuses on maximizing the difference between the total benefits and the total costs of energy conservation policies. Hanke strongly suggests in his article that a policy which yields benefits greater than incremental costs is a desirable policy and should be adopted.

Policies which support energy education for limited resource households should be reviewed in this economic context. If this approach is not taken, a variety of negative results could occur; among these are (1) energy education efforts which are not economically effective could be continued resulting in wasted resources, or (2) energy education programs with very favorable economic impacts could be discontinued due to lack of supportive policies. In either case, the needs of limited resource households and society in general would not be adequately served.

The present study is designed to provide benefit-cost information related to self-help energy conservation practices adopted by limited resource households. Study results are expected to assist in the formulation of policy regarding energy education for limited resource households. The methodology used to implement the study is discussed in Chapter III.

CHAPTER III

METHODOLOGY

Introduction

The purpose of this research was to analyze the impact of self-help changes made by limited resource households (low income, elderly, handicapped, and isolated) in their efforts to reduce their household energy use and increase the comfort of their households. The research focused on the impact that self-help efforts have on the energy use of private households and further, the potential impact on society in general. It was assumed that an aggregate of conditions, including an educational project conducted by Oklahoma State University Cooperative Extension from May 1982 to May 1983, contributed to the households' decisions to adopt energy conservation practices.

In social science, theory building and policy research are often conducted in situations where the independent variable is not under experimental control; quasi-experimental designs are particularly relevant in such situations. According to Campbell and Stanley (1963) these designs attempt to introduce logic of experimentation in situations lacking control over scheduling of experimental stimuli (the when and the who of exposure) and the ability to randomize exposures. This is the case of the present research study. The primary emphasis of the project was to deliver energy education to limited resource households thereby enabling households to reduce energy use, control utility costs and increase household comfort. However, project impact assessment was also an important objective. Resource limitations and restrictions imposed by the funding agency did not permit a controlled experiment, so a quasi-experimental design meets project objectives and fits within resource constraints.

A variety of quasi-experimental designs have been developed in response to limitations of traditional experimental design. Specific design selection is determined by the research question and characteristics of the particular research setting. All quasi-experimental designs attempt to manipulate data, to provide controls for confounding variables, and to probe the data for causal dependencies.

It is imperative that when researchers use a specific quasi-experimental design they be thoroughly aware of which variables that particular design fails to control. When researchers interpret the data they must consider in detail the likelihood of uncontrolled factors accounting for the results. The more implausible the effect of uncontrolled factors becomes, the more "valid" the experiment. Checks of internal and external validity (Campbell and Stanley, 1963) make researchers aware of competing interpretations of the data. The researchers should design the best experiment possible, deliberately seeking out settings that provide the best opportunity for control. They should interpret the data with full awareness of the points on which the results are equivocal. Every experiment is imperfect, so the imperfections cited for quasi-experimental design should not be used as excuses for not aggressively pursuing social impact analysis using this design approach.

For the present study, such factors as increases in utility costs, increases or decreases in household income and other educational efforts, could have potentially influenced the adoption of energy conservation practices. These factors along with the Energy Education for Limited Resource Oklahomans project are taken into consideration. The void in research directed toward assessing the impact of residential energy programs, particularly educational programs, supports the need for this research. Such research is necessary if policymakers are to make sound decisions to assist limited resource households in coping with energy related problems.

If social impact research is to be a tool for policy decisions it must be valid. Another equally important criterion for evaluating this type of research is usefulness. Researchers consider validity to be of obvious importance but usefulness is equally important to the policymaker. Usefulness is related to validity but must encompass such intangibles as the type of information the policymaker is willing to use and the ability of the policymaker to obtain timely results. Researchers can argue that if research is not valid it will be worse than useless to a policymaker. As strong an argument can be made about the need for usefulness; if research efforts are ignored by key decisionmakers, their validity is somewhat beside the point.

In social impact research directed toward policy development, researchers must discover the range of validity which will provide meaningful guidance to the policymaker. A variety of quasi-experimental designs offer the realism of a field setting and at the same time provide potential for valid conclusions that can direct further research, program development and policy formation (Roos, 1973).

The intent of this research is to contribute to policy development related to assisting limited resource households to cope with residential energy problems. At this point in time, few data are available to determine the impact of energy education in assisting limited resource households in coping with energy problems. Further, no data are currently available that document the benefits and costs of energy education for limited resource households. The interests of this researcher are (1) to determine and document the impact of energy education on limited resource households within the context of high utility costs and other intervening variables, and (2) to determine the benefits and costs of such self-help education on the target group and other sectors of society. Findings from this research will help fill the void in data needed by policymakers, at both federal and state levels, when they try to determine the best and most cost effective approach to assist the limited resource segment of the population with energy related problems.

Definition of Terms

ADOPTION: The final stage in the process of acceptance of an innovative idea or product, i.e., voluntary use (Perceptions of Alternative Housing: A Data Book, 1983).

BEHAVIORAL CHANGES: The changes that can be made in household behavior to increase comfort and decrease energy usage. These changes in family or individual habits and lifestyle contribute to energy conservation (Williams and Wilson, 1983).

BENEFITS: The positive outcomes from educational activities or the favorable consequences of projects (Treasury Board Secretariat, 1976).

BENEFIT-COST ANALYSIS: An analytical method which provides for the comparison of benefits and costs in a consistent manner (Christensen and Pontius, 1983).

BENEFIT-COST RATIO: The sum of the discounted benefits of a project divided by the sum of the discounted costs of a project. The higher the benefit-cost ratio the more attractive the project (Christensen and Pontius, 1983).

CONSERVATION PRACTICE: The efficient utilization and avoidance of waste in natural resource application (Lansberg, Schanz, Schurr and Thompson, 1974).

COSTS: The value of all resources required for planning, implementation, and operation for the duration of the program (Christensen and Pontius, 1983).

ENERGY: The capacity to do work and overcome resistance or potential forces, inherent power, capacity for action, and such forces or power in action (U.S. Department of Energy, 1980). For the purposes of this study, energy is the quantity of fuel used to condition residential space and do other household functions such as water heating, lighting, etc.

ENERGY CONSERVATION: The use of a minimal amount of energy to achieve a desired task, such as heating or cooling a structure, i.e., reducing waste.

ENERGY EDUCATION: The process of developing and delivering education concerning efficient energy use.

ENERGY MANAGEMENT: The process of being aware of the facts of energy consumption and losses within a home and of identifying the actual requirements or trade-offs of each energy conservation option relating to household safety, comfort, convenience and the use of other household resources, i.e., to make conscious decisions related to residential energy use as related to households' needs and wants.

FAMILY: Two or more individuals residing in the same household related by blood or commitment. The terms household and family are interchangeable in this study.

HOUSEHOLD: An individual, group of individuals, or family supported by a common resource base and living in the same housing unit.

OPPORTUNITY COSTS: The benefits given up for some alternative use of funding or other resources (Christensen and Pontius, 1983).

LIMITED RESOURCE HOUSEHOLD: An individual or group of individuals living in the same housing unit who have substantial resource limitations which reduce their capabilities to provide for themselves. Limitations include one or more of the following: low income, old age, physical or psychological isolation, and/or physical handicaps.

PARAPROFESSIONAL: A person from within the target community or group who is known and trusted by the group. This person is trained to deliver energy education to the target group.

PRESENT VALUE: The estimated future costs and benefits of a project evaluated at the time the investment decision is made (Christensen and Pontius, 1983).

STRUCTURAL CHANGE: A practice that stops infiltration and/or blocks heat flow through use of such things as caulking, weatherstripping, storm windows and doors, insulation, and window treatments. These changes in the physical structure of the house or some part thereof contribute to energy conservation (Williams and Wilson, 1983).

SELF-HELP: The renovation of a housing unit by an owner or occupant with the benefit of technical assistance, guidance and supervision from a knowledgeable person (U.S. Congress, House Committee on Banking, Finance, and Urban Affairs, 1981).

Research Objectives

The purpose of this study was to determine and analyze the impact of energy conservation practices adopted by limited resource households in Choctaw and Pushmataha counties in Oklahoma. Specific research objectives were as follows:

I. Determine the energy conservation practices adopted by selected limited resource households participating in an energy education project from May 1982 to May 1983.

A. Determine the pre-household and housing conditions, including the presence of energy conservation practices.

B. Determine the energy conservation changes made by the households during Phase I of the energy education project.

C. Determine the changes made by the households during Phase II of the energy education project.

D. Analyze the differences between number of energy conservation practices present at the beginning of the project and at the two data collection points after implementing the project.

II. Determine the benefit/cost relationship of the energy conservation changes made by the limited resource households in their efforts to reduce their household energy use.

A. Identify Costs

1. Dollar

a. Corporation Commission (to fund the project)

b. Household

c. Other agencies and groups

2. Opportunity Costs

B. Determine the benefits to limited resource households participating in the Energy Education for Limited Resource Oklahomans project and to society.

1. Economic

a. Projected utility cost avoidance

2. Social

a. Increased comfort

b. Change in attitude/conservation ethic, etc.

c. Increased skill

III. Analyze the benefit/cost relationship in terms of policy alternatives and development.

The benefit-cost analysis specifically determines the costs and benefits of an energy education project using the Cooperative Extension framework for delivery.

Research Design

A pretest and post-test design involving three measurements of the dependent variable (household energy conservation practices) was used in this study. In this design, households act as their own control group with comparisons made before and after treatment. The most obvious shortcoming of this design is that one cannot be certain that some factor or event other than the treatment is responsible for post-test changes (Campbell and Stanley, 1963).

For the present study, treatment was an energy education project, Energy Education for Limited Resource Oklahomans, conducted in southeastern Oklahoma from May 1982 to May 1983. The primary objective of the project was to motivate limited resource households to adopt energy conservation practices to reduce their household energy use and to increase the comfort of their households. Households were not assigned to controlled environments, rather they were observed in naturally occurring conditions. No effort was made to manipulate conditions and subjects for research purposes. Every effort was made however, to develop a system to document household changes made during the project period. Within the constraints of time and budget, this system can be used to assess the impact of the educational effort as it and other events influenced limited resource households.

This study focused on gross outcomes or change in the number of energy conservation practices present in the household during the study period. Gross outcome was defined as the total change in a group subject to an intervention, regardless of whether the extent of change related to the intervention or to extraneous variables (Rossi, Freeman and Wright, 1979).

A variety of significant events other than the energy education project could have contributed to adoption or non-adoption of energy conservation practices by the target audience. Utility rate increases, changes in household income and influences of state and national energy awareness campaigns could have influenced decisions to adopt or to not adopt energy conservation practices during the observation period. The Energy Education for Limited Resource Oklahomans project conducted from May 1982 to May 1983 was also an event which could have contributed to household energy conservation efforts.

Limitations

The present study was limited by a variety of factors. These included:

1. The independent variable in this study was not under experimental control. The research design did not control intervening variables such as utility rate changes, changes in family composition, changes in family income, and educational efforts that might have influenced study results.

2. The study sample was not randomly drawn. The primary focus of the project from which this study comes (Energy Education For Limited Resource Oklahomans) was to deliver energy education to the target group. Energy education was provided to any household fitting the profile of the target population. Therefore, results cannot be generalized for all limited resource households.
3. The study assumed that all participant households received the same quantity and quality of energy education. Variation in teaching methods and skills of paraprofessional energy educators were not accounted for in the study.
4. Completeness and accuracy of data collection was based upon the skill, ability and training of paraprofessional aides as they interpreted existing household and housing characteristics throughout the project.
5. The study was also limited by the knowledge and perception of participant households as they interpreted their household and housing characteristics throughout the project.
6. A variety of project benefits was considered intangible from an economic standpoint because adequate information was not available to assign economic value to these benefits.
7. Benefit-cost analysis is limited to those project components that can be evaluated in economic terms. For

the present study, benefit-cost measures were not imposed on project components that were non-economic in nature.

Data Source

Data for the present study were collected as part of the Energy Education for Limited Resource Oklahomans project which was implemented by the Oklahoma Home Economics Cooperative Extension Service and funded by the Oklahoma Corporation Commission. The purpose of the project was to implement a program to deliver energy management information to Oklahomans with limited resources and in addition help these households increase their comfort, decrease their energy loss and control their utility costs. The project emphasized inexpensive home-produced, easy-to-install methods of energy conservation designed to reduce heat gain in the summer and heat loss in the winter.

Paraprofessional energy educators delivered the energy education to the target population. Paraprofessionals taught basic weatherization practices. In presenting weatherization methods, the educators stressed cost effectiveness, ease of installation, and reduction of heat gain in the summer and heat loss in the winter. In addition to these housing modifications, the paraprofessionals suggested how to reduce energy use by adopting energy efficient habits within the home. They stressed benefit-cost and wise buying practices when they discussed both behavioral and structural modifications with household members.

Project Objectives

The objectives of the energy education project were the following:

1. To help limited resource households increase their comfort, decrease their energy loss and control their utility costs.
2. To help consumers analyze and evaluate energy saving products and services prior to purchase.
3. To analyze the relationship between household characteristics and the adoption of energy conservation practices.
4. To identify the reasons why the individuals and families did or did not adopt energy efficient practices.
5. To develop recommendations for expanded energy education programs for Oklahoma residents.
6. To encourage agencies and groups involved in energy education efforts to realize the importance of an on-going energy conservation program emphasis.

Project Management

Due to the time span, limits on human resources and money available for the project, project coordinators decided to:

1. conduct the project in two counties;
2. use paraprofessional energy education aides;

3. provide information to individuals and families on low-cost aspects of weatherization and a variety of energy efficient household habits;
4. challenge each aide to reach 100 households through any means available with information to persuade members to adopt recommended energy management practices;
5. encourage aides to work with existing groups and agencies such as senior citizen groups, civic, religious and social groups, the Department of Economic and Community Affairs, the Department of Human Services, utility companies and other resources.

Project coordinators provided the aides a variety of training experiences from mid-May 1982 to mid-May 1983. The training included an overview of the project and sessions on how to work with people, limited resource households as a special group, basic energy management concepts, computerized energy audits, summer and winter energy management strategies, and record keeping. Sessions were designed to introduce aides to new material and let them practice or experience the concepts presented. Weekly training was held after the aides began their field work.

Energy education aides were provided a variety of support materials. These materials included a handbook containing basic information on the project, aide responsibilities, project forms and reference materials. In addition to the handbook, each aide received a kit of demonstration materials. These materials were designed to assist the aides as they made individual contacts or worked in small group meetings. Techniques and energy management strategies for the kit contents were chosen based on the following criteria: (1) effectiveness in reducing household energy use and increasing comfort, (2) cost, and (3) feasibility of home production.

Project Site

Choctaw and Pushmataha Counties, located in southeastern Oklahoma, were the sites for the energy project. These counties were selected for a variety of reasons including the success of previous projects in these counties and the characteristics of the population.

The energy education project served limited resource households. One characteristic that identifies a person or family as being a limited resource household is age. Generally, the older the ages of the individuals, the less resources they have available. According to population estimates of the Oklahoma Employment Securities Commission, Pushmataha had 16.5 percent and Choctaw had 19.2 percent of their population ages 65 and older. Both counties were above the state average of 12.6 percent of the county population 65 or older.

A limited resource population in general tends to have a lower median income and educational level than the rest of the population; they tend to live in older, less energy efficient housing; they tend to have a high proportion of female headed households living alone in single family units; and they tend to be more isolated and less able to travel. Therefore, they are vulnerable to increases in energy costs and to persons seeking to sell goods and services to reduce energy costs--often at a price inconsistent with the value of the goods and services.

Pushmataha and Choctaw Counties were prime targets for the project based on a high proportion of their populations in the older age group, with unemployment rates well above the state average with 45.4 percent and 29.9 percent respectively of the population below the poverty level, and with per capita incomes of $4,386 and $5,997, respectively (again below the state average).

Methods Used to Reach Target Group

The primary method used by the paraprofessionals to reach and teach clientele was the one-to-one or individualized approach. The paraprofessionals sought participants by knocking on doors and explaining the project, or by obtaining referrals from satisfied project participants. They used kits of visual and hands-on literature to interest the clients in a variety of structural and behavioral practices that could reduce energy use. In addition, paraprofessionals conducted home energy audits to provide data on the actual thermal condition of the housing unit and the potential return rate on energy conserving measures.

Households selected for involvement in the project were not randomly selected but were selected based on need. After initial contact, paraprofessional aides made periodic visits to provide additional energy education information, to assess progress, and to encourage adoption of energy management strategies. At the end of each project phase (summer and winter), paraprofessional aides collected post-treatment data to ascertain changes made by households participating in the project.

Procedure for Data Collection

On or near the first visit with a limited resource household, the paraprofessional collected data to determine the household characteristics and housing conditions. These data assisted the project staff in determining if the target population was being reached and assisted the paraprofessional in addressing needs specific to the household. After the summer project phase and at the end of the winter project phase, the paraprofessionals determined which practices and the number of practices adopted. In addition, data were collected to determine why households did or did not adopt energy conservation practices, if they planned energy conservation projects in the future, and who influenced their energy conservation decisions. Further, data were collected to determine the amount of household time and money used to accomplish each conservation practice, and to determine if energy conservation efforts were subsidized by assistance from outside the household. The type of subsidy, source and amount of hours and/or dollars contributed were documented at the end of each project phase. (Refer to Appendix A for the data collection instrument.)

Paraprofessionals offered each household they contacted a residential energy audit free of charge. They completed the audits on the first or second visit to the house. The paraprofessionals used the auditing process and output form as a teaching tool. The auditing process helped create a better awareness of current household conditions in terms of thermal efficiencies, and assisted the paraprofessional in pointing out specific problem areas within the home. The audit not only provided cost-benefit information to the homeowner/renter, but provided data to establish housing conditions before the provision of energy education.

The audit provided the following information on which to base decisions:

1. energy consumption and cost based on current housing thermal efficiency and living habits;
2. projected energy consumption and cost based on improving the thermal efficiency of the house to an ideal standard;
3. projection of the percentage of energy use reduction which could be achieved as a result of various housing modifications such as caulking and weatherstripping, adding storm windows and doors, and insulation;
4. projected annual dollar savings that could result from bringing the house from current conditions to recommended standards;
5. information on dollars that could be invested to increase the pay-back for these investments; and,
6. water heating analysis which included various temperature settings and savings due to installing an insulation wrap.

Refer to Appendix B for the computerized energy audit calculation methodology, input forms, and sample output.

Nature of Sample

The Energy Education for Limited Resource Oklahomans project reached and taught individuals in 558 households in Choctaw and Pushmataha Counties from May 1982 to May 1983, 166 of which were reached during both the winter and summer project phases and had residential energy audits performed on the houses. These 166 households formed the sample for the present study. Table VI documents the profile of the study sample. A comparison of the demographic profile of 558 households contacted by the project and the 166 household sample used for the present study, indicates that both groups have very similar demographic profiles (Williams and Wilson, 1983). That is, the 166 households composing the present study sample are not different from the 558 households contacted by the project.

Operational Variables

Dependent Variables

The principal dependent variable was the number of energy conservation practices present in a limited resource household at a given point in time. For this study, a variety of conservation practices were identified which could contribute to efficient energy use. Conservation practices used in this study were both behavioral and structural in nature. The focus was on conservation practices whose impacts on residential energy use were both well-documented and quantifiable in terms of reduced energy use and economic benefit. Not all practices could be easily converted to potential energy savings and economic benefits. Conservation practices documented for this

TABLE VI

CHARACTERISTICS OF CURRENT STUDY SAMPLE

Characteristic	N	%
Sex of Household Head		
Male head, Female present	75	45.18
Female head, Male present	5	3.01
Male and Female co-heads	21	12.65
Male head, no Female present	4	2.41
Female head, no Male present	61	36.75
Age of Household Head		
18-29 years	12	7.83
30-39 years	28	16.87
40-49 years	26	15.66
50-61 years	18	10.85
62-75 years	44	26.50
Over 75 years	37	22.29
Education of Household Head		
8 Years or less	70	43.48
Some High School	16	9.94
High School Graduate	60	37.27
High School + Some College	10	6.21
College Graduate or more	5	3.11
Family Size		
One person	52	31.33
Two persons	32	19.28
Three persons	23	13.86
Four persons	28	16.87
Five or more persons	31	18.68
Income		
Less than $6000	87	60.00
$6000 to $12000	55	37.93
$12001 to $18000	3	2.07
$18001 to $24000	0	0.00
Over $24000	0	0.00
Number of Children		
Zero	82	49.40
One	26	15.66
Two	26	15.66
Three	21	12.65
Four	5	3.01
Five or more	6	3.62

TABLE VI (Continued)

Characteristic	N	%
Residence Type		
Single Family	159	95.78
Duplex	1	0.60
Apartment	0	0.00
Mobile Home	6	3.61
Other	0	0.00
Tenure		
Rent	42	25.30
Own	124	74.70
Live Rent Free	0	0.00
Part of Utility Bill Paid		
All	157	94.58
Part	9	5.42
None	0	0.00

study fell within five categories: (1) installation of basic weatherization, (2) installation of window covering, (3) changes in the use/type of heating and cooling equipment, (4) change in the use/type of water heating, and (5) miscellaneous others. Each category includes the following energy conservation practices:

1. Basic Weatherization Installation
   a. Ceiling insulation
   b. Wall insulation
   c. Floor insulation
   d. Duct insulation
   e. Caulking and weatherstripping
   f. Storm doors
   g. Storm windows
2. Window Covering Installation
   a. Indoor roll-up shades
   b. Roman shades
   c. Draperies
   d. Drapery liners
   e. Window inserts
   f. Venetian blinds
   g. Outdoor roll-up shades
   h. Awnings
   i. Sun screen
   j. Solar control film
3. Heating and Cooling Equipment: Changes in Use or Type
   a. Increased summer thermostat setting
   b. Decreased winter thermostat setting

c. Purchased energy efficient cooling equipment

d. Purchased energy efficient heating equipment

e. Added ceiling fan

f. Added portable fan

g. Added attic fan

4. Water Heating: Changes in Use

a. Repaired leaky hot water faucets

b. Insulated hot water pipes

c. Insulated hot water tank

d. Reduced hot water tank temperature

5. Other Energy Conservation Practices

a. Added louvered visors to window

b. Added louvered visors to door

c. Added louvered visors to cooling unit

d. Added deciduous trees

e. Added deciduous shrubs

f. Added evergreen trees

g. Added evergreen shrubs

h. Made and used windbreakers

i. Added winter humidity

Each of these practices are sub-variables which make up the dependent variable, household energy conservation practices.

Basic Weatherization Practices

This category includes caulking, weatherstripping, adding storm windows and doors, and insulating ceiling, walls, floor and air ducts.

Depending on the beginning condition of a structure, these practices have potential for substantial reduction of household energy use.

Caulking and Weatherstripping. In all climates, unconditioned air infiltrates a structure and replaces conditioned air; it then must be heated or cooled to the desired interior temperature. Openings in the structure often result from poor design or construction. Foundation movement, wood rot and wood warping also contribute to the development of holes and cracks in older homes. Caulking and weatherstripping are extremely cost-effective practices to reduce infiltration energy loss (United States Department of Energy, 1980). Caulking and weatherstripping are usually the most cost effective conservation practices most households can make. It is generally less costly to pay for caulking and weatherstripping than to pay for the energy necessary to condition the air that leaks through cracks.

Insulation. An uninsulated structure wastes energy by allowing heat to flow from conditioned to unconditioned areas or from unconditioned to conditioned ones. To retard this heat flow, households can install insulation between the conditioned and unconditioned environments. Numerous surveys and census data evaluations indicate that a substantial portion of the homes in America need insulation to eliminate unnecessary energy loss and heat gain (United States Department of Energy, 1980).

Heat flows from warm areas to cool areas. The greater the difference in temperature between the two areas, the greater the heat flow. Air trapped inside the insulation impedes the flow of heat because still air has low conductivity. The motion of air causes heat flow while still air impedes it. Good insulation, or insulation with a high R-value (low U-value), effectively traps many pockets of air.

CEILING INSULATION: The term ceiling insulation refers to materials designed to resist heat flow when installed between the conditioned area of a structure and the unconditioned attic, where the conditioned area of a building extends to the roof. The term ceiling insulation also applies to materials used between the underside and upperside of the roof.

WALL INSULATION: The term wall insulation refers to materials designed to resist heat flow when installed within, or on, the walls separating the conditioned areas of a structure and the unconditioned areas of a structure from the outside air.

FLOOR INSULATION: The term floor insulation refers to materials designed to resist heat flow when installed between the conditioned area of a structure and unconditioned basement, crawl space, or outside area beneath the crawl space. If the first level conditioned area of a building is on ground level concrete slab, floor insulation also refers to materials installed around the perimeter of the slab or on the slab. In the case of mobile homes, floor insulation means skirting used to enclose the space between the structure and the ground.

DUCT INSULATION: The term duct insulation refers to insulation added to heating and cooling air supply ducts that run through unconditioned parts of the house such as the attic, garage, or basement. All supply ducts in unconditioned spaces can be wrapped with a one or two inch insulation blanket. Return ducts passing through unconditioned spaces can also be insulated.

Storm Windows and Storm Doors. In an average house, windows and doors cover twenty percent of the side walls. No window or door, regardless of how weathertight or well protected, can provide the resistance to heat transfer or infiltration as efficiently as a well insulated, tightly sealed wall. Between 20 and 50 percent of the total energy loss in a well-insulated structure occurs through and around windows and doors (United States Department of Energy, 1980). Increasing the resistance of windows and doors to heat transfer and infiltration can thus be an effective part of residential energy conservation practices.

In areas such as Oklahoma, additional glazing is cost-effective, whether it be a primary window, a primary window plus a storm/insulating unit, or a thermal/multipane window used as the primary window. The term storm/insulating window describes a window or glazing material placed inside or outside a prime window unit to increase the thermal resistance of the prime unit. A storm/insulating window creates an insulating air space between the storm/insulating unit and the prime unit, and helps block and control drafts caused by air infiltration through cracks in and around the window.

A storm/insulating door describes a door or glazing material placed inside or outside a primary door unit to increase the thermal resistance of the prime unit. The door creates an insulating air space between the storm/insulating unit and the prime unit, and helps block and control drafts caused by air infiltration through cracks and holes in and around the prime door.

There are three common types of storm/insulating windows and doors which can serve as additional glazing: plastic sheeting; single pane glass in a frame; and combination screen and glass. In most cases, these storm windows and doors will be used to retrofit existing structures. The selection of additional glazing depends on thermal quality, cost, aesthetics, ease of installation and maintenance. Plastic sheeting material gives the same effective insulation as glass storm units (United States Department of Energy, 1980). Sheeting can be used to cover doors, windows, or screens, or it can be mounted on its own separate fitted frame. Many households select this option because of its low cost and its effectiveness in reducing household energy use.

Window Coverings

Storm/insulating windows are effective in reducing household energy use however additional practices can be adopted to improve the efficiency of windows. In the winter, the heat loss per unit area through windows is typically three to four times as great as through walls; in the summer, the total heat entering through a sunlit window may be more than ten times the amount of heat that enters through an adjacent wall of the same area (Dix and Lavan, 1974). A variety of interior and exterior window coverings, if properly installed and used, can effectively reduce both winter heat loss and summer heat gain.

Indoor Roll-Up Shades. A study conducted by the Illinois Institute of Technology (Dix and Zalman, 1974) measured the effectiveness of light-colored, opaque roller shades in reducing residential energy use. The objective of this study was to determine the effectiveness of typical shade installations on typical residential windows with normal air circulation. The roller shades tested were hung inside the window frame with a clearance of 1/4 inch at their vertical edges. Shade hanging arrangement and the room air flow pattern were found to be very important factors in heat flow reduction by shades. This study concluded that inside mounted window shades would reduce winter heat loss through windows by 28 percent. Further, according to this study energy savings provided by roller shade usage during air conditioner operation are larger than during heating. In the Illinois Institute of Technology study, test shades achieved a 50 percent heat gain reduction. This heat reduction included both solar radiation and conductive heat gain due to indoor/outdoor temperature difference.

Roman Shades. The Roman shade design seems to be the most popular and practical for home construction. Designs can be adapted to most windows and patio doors. These shades are permanently sealed at the top when mounted. The bottom is sealed with weights and fasteners. A shade with a 1/2 inch layer of fiberfill gives an effective insulating value of approximately R-3 (Buesing, 1981). In Oklahoma, the use of Roman shades would result in a 52 percent reduction in winter heat loss and a 33 percent reduction in summer heat gain through windows (Dix and Zalman, 1974).

Draperies and Drapery Liners. Draperies alone, by one estimate, account for 60 percent of all window covering sales for residential use. None of these window coverings can substantially reduce heat loss when installed in the traditional manner.

Pinched-pleated draperies hung in the conventional manner on a traverse rod are not effective in preventing heat loss. The wide gap between the drapery and the window frame creates a tunnel for convection air movement behind the drapery where the air is cooled as it passes the window in the winter. This cooling accelerates air movement (Cukierski, 1981). According to the Illinois Institute of Technology (Dix and Zalman, 1974), a typical drapery reduced heat loss in the winter by six to seven percent. Energy savings can be achieved by sealing the drapery on the top, side and bottom edges. A light-colored drapery with a white surface backing reduced heat gain by 33 percent (Dix and Zalman, 1974). Adding drapery liners to light weight thinly woven draperies can improve their ability to reduce heat flow; however, the key to reducing energy use with draperies and drapery liners is to seal these treatments on the top, bottom, and sides to reduce heat flow by convection (Haynes, Simons, McDougal and Mize, 1969).

Window Inserts. Winter heat loss through windows can be reduced by covering the window with an insulating panel or insert. Common materials used for window panels and inserts include the following: expanded polystyrene extruded-plain; expanded polystyrene molded beads; expanded polyurethane; cork; cork/paper; board/cork; plywood; cardboard layers; and cardboard faced and backed polystyrene or polyurethane. R-values for various insert materials range from more than eight to less than one. Energy efficiency depends a great deal on the materials used to construct the insert.

If a gap exists between the insulating panel and the glass and air can circulate behind the panel and across the glass, thus the effectiveness of the panel in reducing heat loss will be drastically reduced. This is a problem with standard movable shutters. Air leaks are created between the louvers of the shutters where one shutter joins another and usually between the shutter and the window frame. However, if the panels fit tightly to the perimeter of the wall opening so that air cannot circulate into the room, a separation of the panel from the glass will increase the panel's effectiveness by providing an insulating layer of trapped air. Window inserts installed in this manner will reduce winter heat loss and summer heat gain (Cukierski, 1981; Hager and Phillips, 1980).

Venetian Blinds. According to the Illinois Institute of Technology (Dix and Zalman, 1974), a typical venetian blind reduces heat gain by 29 percent if fully closed and by 18 percent in the common open 45 degree setting. Venetian blinds were found in this study to reduce heat loss by six to seven percent.

Outdoor Roll-up Shades, Awnings, Sunscreen and Solar Control Film. Protecting the inside of a house from solar heat gain can cut the summer cooling load of a house. However, interior shading is not effective in preventing solar heat from getting to the glass area. Once heat is inside the glass area, a portion of the heat is trapped and the load on the house cooling system increases. Exterior shading devices which will reduce solar heat gain include trees, shrubs, trellises, louvers, awnings, shutters, solar screen, solar control films and roof overhangs. Landscaping and louvers will be discussed in another section of this chapter. The amount of shading available to a house has a great effect upon its seasonal energy consumption. The goal of shading for conservation is to provide maximum winter heat gain and to eliminate as much as possible summer solar heat gain (United States Department of Energy, 1980).

Awnings and roll-up shades are designed to protect glass areas during the summer only. Awnings can protect from summer heat gain without interfering with winter sun rays because of change in the direction of the sun's rays during different seasons. Awnings allow for natural ventilation and natural lighting while protecting the house from excessive summer heat gain. Outdoor roll-up shades act in much the same fashion. They protect window areas from summer heat gain when rolled down but can be adjusted when the sun is not shining on the window to allow view out the window. Natural light can enter through the window when the shade is rolled down as well as when it is up. This flexibility which allows for natural light and ventilation in addition to protecting window areas from excessive solar heat gain, is very important to most households (Yellott and Ewing, 1976). Awnings and outdoor roll-up shades reduce summer heat gain by 65-75 percent (Konzo, 1980).

The most frequently used solar screens are made of metal and plastic. They are placed in regular window screen frames and used to cover the entire window when needed. Sun screens can reflect as much as 70 percent of the solar heat hitting a window in the summer.

A variety of plastic films are available that adhere to the inside surfaces of window glass. These films are commonly called "solar control film." The films are attached to the interior window glass with either a water-activated or pressure-sensitive adhesive. Solar films reflect the sun's rays away from the interior of the house. Solar films are usually left in place year round, although some strippable films are available. Both solar screens and films reduce the amount of natural light in a room and change the exterior view (Seaman, 1978). Solar control films reflect as much as 75 percent of the sunlight striking glass. The amount of reflectance depends on the type and color of film. Solar control film should be used only on windows that do not provide useful cold-weather heat gain. They should be used only on east and west facing windows. These films also increase the R-value of glass by about 35 percent but are not very useful for substantially reducing heat loss (Langdon, 1980).

Heating and Cooling Equipment

Heating and cooling account for the largest portion of residential energy use. A variety of practices related to heating and cooling can be adopted by households to reduce the amount of energy required to maintain comfortable living space for household members.

Thermostat Control. Computer studies and field tests have shown thermostat setback to be an effective method of saving energy during the heating season. According to Beckey and Nelson (1981), the greater the duration and amount of thermostat setback, the greater the energy savings. Setting the thermostat back at night and up during the day (dual setback) is twice as effective as a single setback period. More than half of the homes in their field test in Edmond, Oklahoma, achieved energy savings of 25.6 percent using dual setback. In no instance did any house use more energy while on a setback schedule.

According to the United States Department of Energy (1980), for each degree reduction in temperature, a two to three percent reduction in fuel costs can be expected. Actual savings depend on climate.

Raising the temperature setting on an air-conditioning system in the summer can also reduce the amount of energy used in the structure. The United States Department of Energy (1980) recommends a 78 degree F. summer space temperature for air-conditioned structures to maintain comfort while controlling utility costs. According to the National Bureau of Standards, for every degree of Fahrenheit increased on a thermostat in the summer there is a 10 percent energy savings for cooling. This savings diminishes as the setting is increased (Betancourt, 1980).

Heating System Replacement. Most oil and gas furnaces in homes today are only 55 to 65 percent efficient over a heating season, meaning that 35 to 45 percent of the heat goes up the chimney and never heats the house (Murray, T., 1982). Electric resistance heating is 100 percent efficient, however, electric resistance heating is the heating system that costs the most to produce a therm of useable energy (Jones and Harp, 1980). Many homeowners are replacing inefficient older systems with more efficient systems such as high efficiency gas and oil furnaces with efficiencies as high as 97 percent and heat pumps with Coefficients of Performance of 3.0 or higher. New efficient wood burning heating systems are also being used to replace all or part of conventional fuel systems in some homes. These new energy efficient heating systems can reduce residential energy use for heating by 50 percent or more.

Cooling System Replacement. According to the 1980 Census, of the 386,600 year-round housing units in Oklahoma, 28 percent do not have air-conditioning, 34 percent have central air-conditioning systems, and 38 percent have one or more individual room units. Air conditioners, whether individual room units or central systems, can be compared using energy efficiency ratings (EER). Those with EER values of five to six are inefficient; those with an EER of ten or above are efficient, using only about half as much energy for the same amount of cooling as the less efficient systems. Most systems five years of age or older have an EER of six or less, thus replacement of an old inefficient system can result in reduced energy use for cooling (United States Department of Energy, 1980).

Fans. The least energy demanding cooling systems are simple air movers. Included among these are portable fans, ceiling fans and whole-house attic fans. Fans are effective in one of two ways, or both: circulating inside air, and replacing inside air with outside air. The cooling effect of air movers directly relates to the speed of the air, which increases the evaporative cooling of the body. Portable fans are usually used for circulating inside air and can be used to blow hot air out of the home and move cooler air into the structure. Such fans have very low operating costs since they generally have a power rating of 200 watts or less depending on the size. A ceiling fan can also be used to produce a cooling effect because the movement of the air facilitates the evaporation rate and makes people feel cooler. Ceiling fans are somewhat more expensive than portable fans. The ceiling fan moves air around the room effectively, but does not force hot air out of the house. Whole-house attic fans remove hot air from the structure. Fans are usually located to blow hot air out of the home; cooler air will replace it through open windows (United States Department of Energy, 1980). The key to energy efficiency in using fans is whether the fan replaces the use of a more expensive cooling system such as a central air-conditioning or room air-conditioning unit. If the use of these units is replaced by the use of a fan, substantial energy savings can result. As noted earlier, for every degree the thermostat is increased in a central air-conditioning unit, a ten percent savings in cooling costs results.

Water Heating

Domestic hot water can account for 15 to 20 percent of residential energy costs. Water heating is the second largest energy consuming system in the home, next to space heating and cooling. This consumption can often be reduced by half with no negative effects on health, comfort or convenience. Domestic hot water is usually desired at a moment's notice, any time of the day or night. Water heaters must therefore remain ready to supply hot water throughout every day of the year. To perform this task, the water heater must keep the water at a nearly constant temperature as determined by the thermostat setting.

Free-standing water heaters must maintain water temperatures higher than the temperature of their surroundings; therefore water heaters are subject to conductive heat loss. Heat escapes through the walls of the tank from the warm inside area to the cooler outside area. Conductive heat loss in water heaters is affected by the surface area of the tank, the period of time for which the water must be heated, the temperature difference between the water and its surrounding, and the insulating qualities of the material between the water and its surroundings. Energy used to heat water can be reduced by reducing the hot water tank temperature, insulating the tank and piping, and reducing the amount of hot water used by the household.

The touch temperature for hot water is 105 degrees F. Water at 115 degrees F. can cause first degree burns. Many hot water heaters are routinely set at 150 to 180 degrees F. This high setting, like many other energy inefficient practices, is intended to guarantee endless hot water. On tank-type water heaters, the setting can be reduced to save large amounts of energy (United States Department of Energy, 1980).

When safety permits, water heater insulation is an energy conserving practice. It requires an investment of money for materials and possibly for labor. Insulation for free-standing water heaters is usually most effective if the unit is located in an unconditioned area. If the water heater is located in a conditioned area, the difference between the desired water temperature and the average ambient air temperature becomes critical. Payback periods for money invested in insulation materials will be shorter for tanks located in unconditioned, cool areas than for those located in conditioned, warm areas. In unheated spaces, domestic hot water pipes should be insulated to prevent excessive heat loss when hot water is transported from the tank to points of use or held in pipes for future use.

The cost of heating water depends on the amount of water used for household purposes. There are several ways to conserve hot water and use it more efficiently so that energy requirements and costs will be less. Leaky hot water faucets, for example, can waste up to 6,000 gallons of hot water a year (Morrison, 1979). Fixing a leaky hot water faucet can result in a major energy savings (Howe and Vaughn, 1972; Washington Suburban Sanitary Commission, 1974; McPherson, 1978).

Other Energy Conservation Practices

Louvered Visors. Exterior louvers can be used to protect doors and windows while allowing for natural light and ventilation. Vertically attached to the eave and the ground for the width of the window or door, the louver provides protection from solar heat gain during the summer and allows increased heat during the winter. Louvers allow light to enter year round to reduce the need for artificial lighting while protecting these areas from radiant heat gain (Seaman, 1978).

Landscaping. Using plant materials wisely can help reduce residential energy use. Winter heating bills may be reduced as much as 15 percent while the energy needed for summer cooling may be cut by as much as 50 percent. By selecting and placing plant materials properly, shade can be created, cool breezes can be channeled, winter winds can be blocked, and other factors such as glare can be controlled (van der Hoeven, 1982).

Deciduous trees and shrubs planted on the southern, southwestern and western sides of the house will block the summer sun but let the winter's warming sun through. A recent study showed that a difference of eight degrees Fahrenheit between shaded and unshaded walls was equivalent to a 30 percent increase in insulating value needed for the shaded wall (van der Hoeven, 1982).

Deciduous or evergreen trees and shrubs on the eastern, southern, and western sides of an outdoor air-conditioning condenser will make it run more efficiently. The hotter a condenser gets, the harder it must work. As much as a three percent savings in the efficiency of the air-conditioning system can be realized simply by shading the condenser from the summer's hot sun. Ample space should be allowed for air to circulate (van der Hoeven, 1982).

Two or more rows of evergreen trees and shrubs planted on the north and northwest sides of the house will block the winter wind. Windbreaks reduce winter energy consumption between 23 and 30 percent (van der Hoeven, 1982; Welch, 1979).

Windbreakers. Windbreakers or draft dodgers are sand or fiber filled tubes placed around windows or doors to block air infiltration. Some areas within older homes are particularly difficult to caulk and weatherstrip to reduce air infiltration. Windbreakers can be successfully used in these areas to reduce air leakage. These devices are particularly useful when rooms are closed off to block air flow into the conditioned portion of the house. The amount of energy used to heat or cool a structure is partially based on the amount of space to be conditioned. The amount of energy used that can be reduced is nearly proportional to the relative reduction in the amount of space to be conditioned. Closing off unused or seldom-used rooms will reduce the house heating and cooling load, particularly if air infiltration between the unconditioned and conditioned space is controlled. Windbreakers can be successfully used to control air infiltration (United States Department of Energy, 1980).

Humidity. In the winter, a high relative humidity makes people feel warmer because there is less surface heat loss, and thus comfort is possible at a lower actual temperature. Humidifying the indoors in cold seasons can reduce heating load.

Summary of Dependent Variables

A wide variety of energy conservation practices are available to households that will successfully reduce household energy use. Actual energy use reduction may vary greatly depending on the size of the house, the number of people living in it, living habits, house construction, and orientation. Because energy conservation practices interact, savings estimates are not purely additive. Home energy audits take into consideration the unique characteristics of a house and household members to provide a more accurate estimate of savings that can be expected by implementing various conservation practices (Planergy, 1981).

Education is often needed to assist people in making decisions related to energy conservation practices appropriate for their specific situation. The education process must first acquaint members of the household with the basic principles of household energy use and how energy is lost within their own home. The second step is to identify the actual requirements or trade-offs of each management option, such as concerns about health, safety, comfort, time versus convenience, mechanical inability, inertia or costs. The third step is to assign benefits to the options to help household members develop a process to compare investments of time, human energy, money, etc., to the benefits of reduced energy use in order to make a decision.

Independent Variables

The primary independent variable of interest for this study is the amount of education provided by the Energy Education for Limited Resource Oklahomans project conducted in Choctaw and Pushmataha Counties from May 1982 to May 1983. The educational message delivered to limited resource households in these counties included practices outlined in the discussion of the dependent variables. The primary objective of the project was to motivate limited resource households to use some of their limited resources to adopt conservation practices that had the potential of reducing household energy use while making the household a more comfortable place in which to live.

Intervening Variables

Several intervening variables must be considered as contributors to changes in energy conservation practices adopted by limited resource households in Choctaw and Pushmataha Counties. These include increased utility costs, changes in family composition, increases or decreases in household income, and other educational efforts that might have reached and had an impact on the target audience.

Utility Costs. According to Jones and Harp (1981b) residential energy conservation in Oklahoma is a function of economics. These authors contend that energy conservation investments are dependent upon both the price of energy and the characteristics of the individual home. They projected that as energy costs increase the feasibility of adopting energy conservation practices increases. The Office of Technology Assessment (Vol. I, 1979) supported research by Cunningham and Lopreato (1977) which showed that consumer motivation to invest in conservation measures stems largely from a basic desire to save money and resist rising prices. However, a study conducted by Henderson (1982) found that a utility company price increase all by itself does not affect the propensity to adopt energy conservation practices when socioeconomic and demographic variables along with attitude, knowledge and previous energy conservation behavior are controlled. Moreover, Cunningham and Lopreato (1977) conclude that the low income group in their study, families with less than $5,000 per year, was the least price responsive. Results such as these suggest that although utility rate increases during May 1982 to May 1983 may have influenced participant households to adopt energy conservation practices, they may not have had a large influence.

Income. A Ford Foundation Study (Newman and Day, 1975) which has since been confirmed by other consumer surveys, found that household energy use rises with income. An Austin, Texas study (Walker and Draper, 1975) found that short-term response to electricity price increases among household energy users varied sharply by income group. According to this study, while upper income households increase consumption despite rising prices, low income households show very little change in consumption in response to price increases. Walker and Draper (1975) conclude that the middle income group offers the greatest potential for conservation, since this group has both a margin for conserving and economic incentive to do so. Bailey (1979) analyzed the influence of socioeconomic variables, including income, on conservation behavior. This author concludes that socioeconomic variables influence energy conservation behavior both directly and indirectly by first influencing attitude and then influencing behavior. In the Bailey study (1979) the higher the income group the greater the propensity to adopt energy conservation practices. Kelkeary (1975) argues that income is the strongest predictor of both energy knowledge and conservation with the relationship being curvilinear. That is, in this study, the highest knowledge and conservation scores came from the middle income group. Morrison and Gladhart (1976) found income to be the single best predictor of residential energy consumption.

These data suggest that, for the present study, changes in income during the project period could have influenced the adoption of energy conservation practices by participant households. This would be particularly true if the income change was large enough to shift households from a low income to a middle income level. This drastic shift does not seem very likely since the national trend since 1978 has been toward an increase in the number of persons living in poverty rather than an upward shift in income for the low income group (Institute for Research on Poverty, 1984).

Family Composition. Henderson (1982) concludes that previous retrofitting behavior was the most significant predictor of propensity to adopt energy conservation practices. Age of the head of the household and household size also contribute to the Henderson (1982) prediction of propensity to retrofit. For this study, younger heads of household and larger households who have few energy saving features were more likely to retrofit their home than households headed by older persons and small households.

Other Energy Conservation Education

According to Cunningham and Lopreato (1977), the greater the amount of energy conservation education presented at the local level, the more efficacious it will be. They contend that mass media campaigns have been only slightly successful and should be reexamined in terms of both content and mode of distribution. It is likely, according to these authors, that the same information will be differently received if it is presented personally to the individual rather than through mass media.

This information suggests that effective energy education efforts must be carefully designed if the educational message is to result in behavior change. Braun, Williams, and Murray (1979) suggest that an energy conservation program that succeeds in getting household members to adopt conservation practices must carefully plan program content and delivery. Specifically, the energy education must determine who will send what message(s) to which target audience(s) using which mode(s) of delivery (Lasswell, 1948). Effective answers to these decisions must be based on knowledge and understanding of communication theory.

Diffusion of an innovation (an idea or practice) is a process of getting people to make changes in behavior in addition to attitudes and knowledge. The goal of diffusion is for people to adopt ideas or practices.

Decision making which leads to adoption or rejection of the innovation or practice is a process consisting of several steps. These steps frequently occur in a sequence which we may consider as stages of adoption.

The first stage of adoption is awareness of an idea or practice. Awareness may occur by chance, or be the result of an individual or household who recognizes a problem or is dissatisfied with an existing situation, i.e., rising utility bills. The second stage is one of interest. If an individual or household knows of the existence of an innovation, more detailed information may be sought. This leads to stage three, evaluation of the new. This stage involves a mental process of determining the appropriateness of the innovation to the individual or household in terms of needs, wants, and goals. If the decision is affirmative, the next stage, trial, is undertaken. The final stage is adoption, whereby an individual or household accepts an innovation as part of their behavior or lifestyle (Lionberger, 1974). Individuals concerned with getting people to adopt energy conservation can use the knowledge of the diffusion and adoption processes in planning energy education delivery systems.

While every individual or household moves through the adoption process, a variety of information is needed. An awareness of this need for varying kinds of information at different stages as well as appropriate sources of this information will increase an educator's effectiveness. Sources of information can be classified as (1) the mass media, such as radio, TV, newspapers, magazines, leaflets or brochures; (2) personal contact with advisors or representatives from business, utilities, government, private and public organizations; and (3) interpersonal contact between friends and associates.

The importance of understanding these categories is that sources of information impact on the decisions made by individuals and households during the adoption process. Studies of these channels of information delivery reveal that mass media is effective in creating awareness during the early stages of adoption, but interpersonal communication during the later stages is needed for persuasion (Rogers, 1983). In short, mass media cannot be expected to reach and influence all members of a target audience. Rather, mass media can influence a few people who become opinion leaders. These individuals in turn influence others (Katz, 1957).

Researchers who have studied the persuasion effect of information conclude that decisions are influenced through interpersonal communication with other people. Specifically, the effect of groups on the adoption of an innovation has been studied and the results strongly support the influence of "significant others" on adoption behavior (Riley and Riley, 1961).

Thus, communication theory can be helpful to the educator in planning programs that will succeed in getting individuals and households to reduce energy use. With knowledge of the process of diffusion of information, stages of adoption of an innovation, sources of information, and impact of others on adoption, the educator can develop and implement appropriate educational programs.

Williams and Braun (1981) studied the impact of three treatments on the adoption of energy conservation practices on rural limited income households. The media method (Treatment I) was a flyer mailed to households containing a conservation message and offering additional information and assistance. The group method (Treatment II) was a series of public energy education meetings and Treatment III was individualized delivery of energy education to target households. Based on analysis of these three approaches, these authors concluded that the individualized method was the most effective method of reaching and teaching limited resources households basic energy conservation.

Data Analysis

Impact Determination

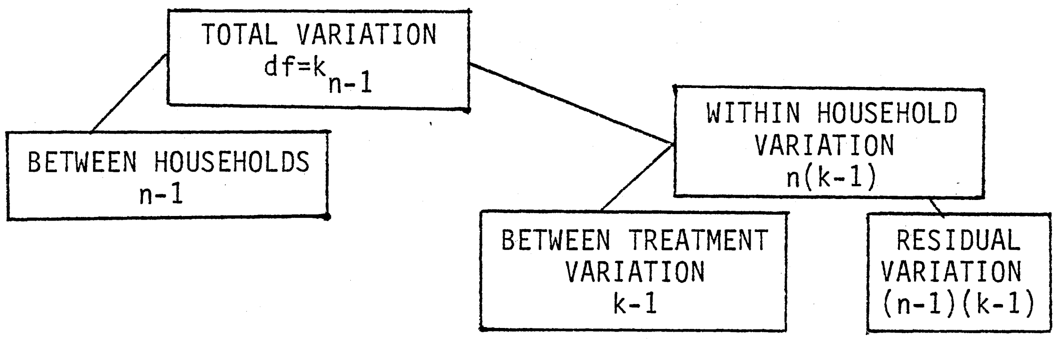
To test research Objective One, a statistical test was run to determine if a significant difference existed between the average number of conservation practices present in participant households at the beginning of the project, at the end of Phase I (summer), and at the end of Phase II (winter) of the project. An analysis of variance procedure based on single factor experiments with repeated measures was used (Winer, 1971).

According to Winer (1971), for experimental work in the behavioral sciences, the elements forming the statistical population are frequently people. Because of large differences in experiences and background, the responses of people to the same experimental treatment may show relatively large variability. In many cases, much of this variability is due to differences between people existing prior to the experiment. If this latter source of variability can be separated from treatment effects and experimental error, then the sensitivity of the experiment may be increased. If this source of variability cannot be estimated, it remains part of the uncontrolled source of variability and thus automatically becomes part of experimental error.

One of the primary purposes of experiments in which the same subject is observed under each of the treatments is to provide a control on differences between subjects. In this type of experiment, treatment effects for subject "i" are measured relative to the average response made by subject "i" on all treatments. In this sense, each subject serves as his own control--responses of individual subjects to treatments are measured in terms of deviations about a point which measures the average responsiveness of that individual subject. In this way, variability due to differences in the average responsiveness of the subject is eliminated from the experimental error (if an additive model is appropriate).

The present study is a single-factor experiment with repeated measures since the energy conservation practices present in 166 households were observed three times, at the beginning of the project, at the end of Phase I (summer), and at the end of Phase II (winter). The total number of practices present were reported at the end of Phase II. Thus, the observations were dependent, rather than independent. According to Winer (1971), if the population distribution involved is multivariate normal, the terms dependent and correlated are synonymous. The analysis of variance model used to analyze these data assumed correlated or dependent observation.

Schematic I summarizes the analysis of variance model and corresponding degrees of freedom used for this study.



Schematic 1. Partition of the total variation

where

K = treatments

n = observations

The F ratio provides a test hypothesis that T_1, = T_2 = ... T_k,

where

T's represent treatment effects.

Paired t-tests were run on the mean number of energy conservation practices present at the beginning of the project, after Phase I (summer), and after Phase II (winter). These t-tests were used to determine if significant mean differences exist between the following pairs of means:

Pair One - - X_B and X_I

Pair Two - - X_I and X_{II}

Pair Three - X_{II} and X_B

when

X_B = mean number of practices present at the beginning of the project

X_I = mean number of practices present at the end of Phase I

X_{II} = mean number of practices present at the end of Phase II

Benefit-Cost Analysis

Energy conservation practices adopted by limited resource households were analyzed in a benefit-cost formula to assess the social returns from self-help approaches for coping with energy problems faced by these households. The Energy Education for Limited Resource Oklahomans project was considered to be a motivating force influencing the adoption of energy conservation practices by the target group. This analysis was used to compare project outcomes with project objectives.

Four basic steps were used in the benefit-cost analysis. These steps included:

1. Identification of the type and nature of results of the Energy Education for Limited Resource Oklahomans project. Each identified result was categorized as either a benefit or cost.
2. Monetary values were assigned to identified benefits and costs whenever possible.

3. Present values of benefits and costs were calculated so that benefits and costs occurring at different times could be compared.
4. Benefits and costs were compared by means of two alternative decision criteria--the benefit-cost ratio and net present value.

Identification of Benefits and Costs

Project benefits and costs are summarized in the Benefit/Cost Matrix presented in Table VII. As indicated above, benefits and costs are analyzed from a societal perspective (Masters, Garfinkel and Bishop, 1978).

The primary tangible (i.e., can be valued in money terms) economic benefit of adopting self-help energy conservation practices is reduced household energy use. Additional benefits, including increased household comfort, increased knowledge and skills of project participants and paraprofessionals, and increased skill of professional staff in implementing energy education projects, are identified as intangible direct project benefits. Other intangible direct project benefits would include the pride and feelings of accomplishment the limited resource households achieve when making self-help changes. Indirect benefits include improved communication among local and area agencies working with limited resource households, and development of marketable skills of paraprofessionals and project participants. Reduced dependence on foreign energy sources is an additional direct tangible benefit, but it is not estimated due to lack of available data.

Costs. Costs are typically divided into two broad categories of fixed and variable costs. Fixed costs are those costs that in the short run do not change in total amount as output is varied. Variable costs are those costs that do change in total amount as output varies. The short run is defined as a period of time short enough that the productive capacity of the unit under study cannot be increased. Christensen and Pontius (1983) have related fixed and variable costs to Cooperative Extension Programs such as the Energy Education for Limited Resource Oklahomans project. According to Christensen and Pontius, for specific projects within Extension, staff resources may be regarded as fixed costs in the economic sense. Similarly, the ownership costs associated with the hardware of Extension such as cars, typewriters, duplicating machines, microcomputers, etc., are fixed. This means they have been made and incurred without regard to a specific project or number of projects. These costs are considered "sunk costs", which means that expenditures already made may be irrelevant to a specific project decision. Carrying this one step further, Christensen and Pontius (1983) contend that the only costs which can be assessed to a specific project are the variable costs; that is, the additional costs for personnel, materials, travel, etc. that are directly attributable to the project and which would not have occurred had the program not been initiated. These additional costs are termed marginal costs.

Using the Christensen-Pontius approach to costs, the costs associated with the Energy Education for Limited Resource Oklahomans project are summarized in Table VII. Project costs include additional personnel to implement the project, travel associated with the project, supplies, educational material, and any additional costs to Oklahoma State University or Cooperative Extension incurred to implement the project. All costs associated with the project were considered as opportunity costs, i.e., benefits given up for some alternative use of funding or resources. Market prices were used whenever possible to determine costs. Costs associated with non-paid time spent related to the project were treated as opportunity costs in the sense that time was assigned a fair market price and used as a cost. This procedure was used for time spent by project participants to hear the educational message as well as time spent by these households to implement energy conservation practices. In addition, time spent by those outside the study sample to assist participant households in adopting energy conservation practices was treated as an opportunity cost and assigned a market value. In addition, money spent by project participants to purchase materials to implement conservation practices are costs to project participants. Additional costs are the funds spent by other agencies to assist some program participants in implementing conservation practices.

Benefits. Christensen and Pontius (1983) point out that the most difficult aspect of program evaluation is that of measuring the benefits from Extension program efforts such as the Energy Education for Limited Resource Oklahomans project. Extension often invests program dollars in what is called the "creating of human capital." Extension offers educational opportunities to participants and they may make use of what they have learned in ways both intended and unintended by the educator and program designer. According to

Christensen and Pontius, it makes little sense to impose economic benefit-cost measures on program objectives that are non-economic in nature.

Project Objective One of the Energy Education for Limited Resource Oklahomans project is analyzed in the present study using benefit-cost procedures. The analysis focuses on the economic benefit of energy conservation practices adopted by participant households.

For the purpose of this study, project objective one, which was analyzed using benefit-cost procedures, was to help limited resource households increase their comfort, decrease energy loss, and control their utility costs. Objective One focuses on the economic benefit of energy conservation practices adopted by participant households.

Data were collected to determine specific conservation practices adopted by participant households. These data were then matched with input and output data from the computerized energy audit performed on the participant household. Computerized energy audit output data were used to estimate monetary benefits from specific conservation practices adopted, taking into consideration the thermal characteristics of participants houses. The calculation methodology for estimating economic benefits of conservation practices was based primarily on energy savings derived from using American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) procedures (1981) and on residential energy research conducted in Oklahoma by utility companies and Oklahoma State University. The calculation method for determining energy savings was developed by the Department of Agricultural Engineering at Oklahoma State University and was used for implementing the federally mandated Residential

Conservation Service Program. Calculation procedures appear in Appendix III of the Oklahoma State Plan Residential Conservation Service Program and are also included in Appendix B of this study (Oklahoma Corporation Commission, 1983). Not all conservation practices documented on the data collection instrument, Energy Education For Oklahoma Families (Appendix A), were included in the audit methodology for calculating benefits. The conservation practices included were adding insulation to ceiling, wall, floor and supply ducts; caulking and weatherstripping; adding storm doors; adding storm windows; increasing summer thermostat setting, decreasing winter thermostat setting; and reducing the tank temperature on water heaters. A computer program was used to match benefits projected in audit output with actual practices adopted by participants' households and documented on the Energy Education For Oklahoma Families survey form.

Energy savings from adoption of other conservation practices adopted by participant households were calculated by hand, based on the thermal characteristics of a specific house, using ASHRAE fundamentals as well as other research studies related to a specific practice. Savings from adding window coverings were based on ASHRAE fundamentals (1981), a study conducted by the Illinois Institute of Technology (Dix and Zalman, 1974) and studies by Hager and Phillips (1980) and Yellott and Ewing (1976).

Energy savings from retrofitting with energy efficient cooling and heating equipment were based on ASHRAE fundamentals. Savings from adding ceiling, portable and attic fans were contingent on reduced thermostat settings. This calculation was made using the computerized energy audit methodology.

Landscaping energy savings were calculated using data from Kansas State University Engineering Extension Service data (van der Hoeven, 1982). Savings from adding louvered visors to doors, windows and cooling units were based on calculations based, in turn, on ASHRAE fundamentals. Savings from repairing leaky hot water faucets were calculated based on studies done by Howe and Vaughn (1972); McPherson (1978); Morrison (1979) and the Washington Suburban Sanitary Commission (1974).

Energy savings for each household were determined using hand calculations and the computerized energy audit methodology. These savings were then totaled to determine savings each year for all households in the sample. This amount was used as the basis for determining benefits. It is important to note that such savings are estimated and not actual energy savings obtained by monitoring energy use of each participant household.

Estimating the Monetary Value of Costs and Benefits

Monetary values for project costs were determined by reviewing project expenditures and documenting actual costs for the following budget categories:

1. Personnel
    a. Project site coordinator
    b. Paraprofessional energy educators
2. Travel and Lodging
    a. Project site coordinator

b. Paraprofessional energy educators

c. County professional staff

d. State professional staff

3. Educational Materials

a. Energy education kits

b. Printed materials

c. Demonstration materials

4. Supplies

a. Office supplies

5. Other Direct Costs

a. Phone

b. Postage

c. Audio-visual equipment rental

d. Meeting room rental

e. Advertising

Only costs directly related to delivering energy education to participant households were considered costs for the purpose of this study. Costs related to evaluation and impact assessment were not included in these figures. The decision to leave the evaluation and impact assessment costs out is based on the fact that energy education could have been delivered to the target population without making any effort to document project results; i.e., it is argued that the impact of the project would have occurred irrespective of efforts to document project results. This is not to minimize the importance of evaluation and impact assessment, but to say that the educational phase could have been conducted without impact assessment and evaluation. This researcher believes that a decision to eliminate evaluation and impact assessment would be a serious mistake from a program development standpoint, but from the standpoint of applying benefit-cost analysis, a realistic decision. Further, the cost assessment was approached from the standpoint of an outside funding source, i.e., the number of dollars necessary to support a special limited resource energy project within the support framework of Cooperative Extension. For this reason, the organizational overhead for Cooperative Extension input to the project was considered a fixed cost and not included in the benefit-cost analysis. According to Christensen and Pontius (1983), organizational overhead costs would have been incurred anyway, and for the most part would have continued regardless of the continuance of a specific project such as the Energy Education for Limited Resource Oklahomans project.

Monetary values for first-year benefits were determined by matching actual 1983 utility rates for natural gas and electricity to estimates of energy savings based on the computerized energy audit and hand calculations, as explained above. Monetary values for benefits in subsequent years were determined by combining estimates of yearly energy savings with estimates of effective lifetime of adopted practices and projections of real utility rate increases.

The adoption of an energy conserving practice, such as added insulation, results in benefits for a number of years. The value of benefits depends on the length of time the practice effectively reduces energy use and the cost of energy over that time period. The period of effective time for each conservation practice will vary from practice to practice. For example, insulation will be effective for

20 or more years, caulking and weatherstripping will be effective for approximately 5 years, and plastic storm windows, depending on care and use can be effective for 3 or more years before needing to be replaced (U.S. Department of Energy, 1980).

Another factor that should be taken into consideration in determining future benefits is the period of time the participants will live in the house. The expected number of years of residency should be considered for practices that are behavioral in nature. Practices that result in additions to the structure do not require consideration of this variable. The sample population consists largely of relatively permanent residents, many of whom are aged. However, rather than applying mortality tables to the population, benefits were projected for a ten year time period for behavioral practices adopted because of the educational effort. Structural practices were assumed to yield benefits for their entire expected period of effectiveness.

Increases in energy costs over time were also taken into consideration by applying the appropriate projections from Wharton Econometric Forecasting Associates (1984, p. 97). All non-participant project costs were accrued the first year, however some participant costs accrued to households over time to maintain or repeat conservation practices adopted the first year, for example, materials needed to replace plastic storm windows and doors.

When the time streams of benefits and costs were established, each was expressed as a present value by discounting annual estimates by the appropriate discount rate. In as much as the latter is often a critical determinant of project feasibility, an extended discussion seems in order.

Discount Rate Concepts

There is a continuing controversy, with a long history, concerning the appropriate discount rate to use in evaluating public investments (Randall, 1981). This controversy does not solely concern numerical values, per se; rather, much of it concerns the concept of what the discount rate ought to measure. Experts disagree on both the proper numerical value of the discount rate and its conceptual foundation. Some argue for adoption of the social rate of time preference as the conceptual foundation, resulting in a numerical discount rate below market rates. Others support the social opportunity cost of capital as the conceptual basis, and a correspondingly higher discount rate (Sassone and Schaffer, 1978).

The correct discount rate, which Sassone and Schaffer (1978) term the social discount rate, is that rate which when applied to future costs and benefits yields their actual present social value. In other words, the proper rate is the rate at which society as a whole is willing to trade off present costs and benefits for future costs and benefits.

Sassone and Schaffer (1978) reviewed a variety of discount rate concepts including market interest rates, the marginal productivity of investment, and corporate discount rate, the Pigouvian rate, and the social opportunity cost of capital.

Market interest rates are associated chiefly with corporate and government bonds, and with debt instruments of financial institutions, such as commercial banks and savings and loan associations. Essentially a bond is the promise of the borrower to pay Y dollars to the lender T years from now in exchange for the lender giving the borrower X dollars now. Y is always greater than X. Many different rates are observed simultaneously in the market place due to differences in the risk the lender takes. When financial institutions lend money, the interest rate is explicitly stated.

The marginal productivity of investment is the real rate of return that the economy's marginal investment projects yield (Sassone and Schaffer, 1978). In this context, "real" means the net increment to national output, valued in dollars. For example, if the least profitable investment projects undertaken in the economy give an annual net return of $6 for a $100 initial investment, then the marginal productivity of investment is six percent. This means, if extra investment funds were made available and if they were invested in the private sector, a six percent return would be realized by the economy. Likewise, if investment funds were withdrawn from the private sector, a return of six percent would be foregone by the economy.

The corporate discount rate is the rate used by corporations to evaluate potential investment projects. It includes both a risk premium and a markup for corporate taxes. The corporate discount rate is usually very high. Sassone and Schaffer (1978) project that it could be as high as 15 to 20 percent.

The government borrowing rate is the rate at which the government borrows money from the private sector. Some argue that this rate is reasonable for benefit-cost analysis because if some individuals are willing to lend money to the government at six percent, they must feel better off receiving their money back plus six percent at some time in the future than they do in using it now. Therefore, according to Sassone and Schaffer (1978), if a government project has a return of six percent or more, consumers are better off if the project is undertaken.

The own personal discount rate is the rate at which an individual is willing to trade off present consumption for future consumption. The own personal discount rate is the slope of the consumer's intertemporal indifference curve evaluated at the current distribution of present and future consumption. In contrast to the own personal discount rate, the own social discount rate reflects one's own preferences for social behavior. The own social discount rate is an individual's judgement as to the correct growth path of real per capita consumption in the economy. The own social discount rate depends heavily on one's anticipated income stream and dependence on the general state of the economy. Own personal discount rates will not necessarily coincide with own social discount rates.

A. C. Pigou, a noted British welfare economist, observed that individuals have faulty perceptions concerning the future and are inclined not to make sufficient provisions for it. According to Pigou, individuals weigh their welfare too heavily and that of future generations too lightly. Therefore, the government's task is to correct this bias favoring present generations, thus acting as the trustee of the future. Pigou concluded that government should use a lower discount rate than shortsighted individuals would when evaluating public investment projects (Sassone and Schaffer, 1978).

The methods of determining discount rates discussed above provide many alternatives for determining the appropriate discount rate to be used in benefit cost analysis. If a low discount rate is adopted for benefit-cost analysis, this would enable projects with benefits occurring farther in the future to prove more acceptable. The argument for low (lower than market rates) social discount rates rests on the difference between an individual's preference in his capacity as an individual and his preference as a member of a society capable of collective action. Lower discount rates give greater weight to the future than do higher rates.

Randall (1981) argues that it is inappropriate to use estimates of the social discount rate that are considerably lower than market-generated discount rate estimates. Randall contends that to bias the efficiency evaluation of a project by manipulating the social discount rate in order to make the inefficient appear feasible does not serve that cause of greater efficiency. However, Randall points out that capital markets are seldom perfect, thus a single clear cut private discount rate can not be identified. The following procedure is suggested by Randall (1981):

1. The social discount rate should reflect the marginal efficiency of investment (MEI). The banking system's prime lending rate is a reasonable indicator of MEI, although it includes an adjustment for the rate of inflation and for the corporate income tax.
2. Although the public sector is large and diversified, public investments are not risk free. For this reason, the risk premium included in the prime lending rate is appropriate for public investment.

3. So long as future revenue streams from public investments are valued at real prices (i.e., net of inflation), the social discount rate should be the real rate of interest, not the monetary rate of interest. Thus, the prime rate of interest must be adjusted downward to account for inflation. Randall projects the real rate of interest in the United Sates, and reflected by the prime lending rate, at about 2.5 to 3 percent net of corporate income taxes.
4. Where corporate income taxes approach fifty percent, a private corporation undertaking an investment needs to earn approximately twice the real prime rate. This suggests that MEI in the private sector is about 6 percent in real terms in the United States.

Based on these conclusions, Randall (1981) suggests that public investments should be evaluated using a social discount rate of about six percent.

Olson (1983), referencing a study by Feldstein and Summers (1977), suggests that one way of approximating the value for the marginal social discount rate is to start with the annual real rate of return on private investment and adjust for effective rates of taxation on corporate and personal income. The annual real rate of return on private investment and the effective rates of taxation on corporate and personal income are 12.4, 40 and 30 percent, respectively. Using this approach, Olson concluded that the value of the marginal social discount rate is approximately five percent or less than half of the annual rate of return on private investment.

Olson also suggests that for those reluctant to assume diminishing marginal utility of consumption, or a particular elasticity of value, the only alternative seems to be to infer the value of the marginal social discount rate from a country's optimal combinations of investment and saving or real growth rate. For the United States, the real growth rate averaged about 3.5 percent during the 1945 to 1975 period (Gramlich, 1981).

Both the Randall and Gramlich procedures appear to have merit. Thus, benefits and costs in this study are discounted by two social discount rates, four and six percent, to determine not only project feasibility, but also to determine how sensitive such a verdict is to the discount rate.

Net Present Value

The following net present value formula will be used to estimate the present value of the future costs and benefits of the educational project.

$$NPV = \left[\frac{B_1}{1+i} + \frac{B_2}{1+i} + \ldots \frac{B_n}{(1+i)^n}\right] - \frac{C_1}{1+i} + \frac{C_2}{1+i} + \ldots \frac{C_n}{(1+i)^n}$$

where

NPV = Net Present Value

B_t = Benefits in Year t

C_t = Costs in Year t

i = Discount Rate

n = The Total Time Horizon

According to Christensen and Pontius (1983), if the net present value is positive, it indicates that the project yields a net benefit to society.

Benefit-Cost Ratio

The above results are also reported in the form of benefit cost ratio, defined as the sum of the discounted benefits of the project divided by the sum of the discounted costs of the project. A value for this ratio greater than 1 indicated a net benefit to society from the educational project.

Results of the benefit-cost analysis are reported in Chapter V. Impact determination and analysis are reported in Chapter IV.

CHAPTER IV

IMPACT DETERMINATION

This chapter includes the empirical research results and an interpretation of those results. The focus of this study was on the impact of an energy education project conducted from May 1982 to May 1983 using the Oklahoma Cooperative Extension network for program delivery. The purpose of the study was to determine and analyze energy conservation changes made by limited resource households in Choctaw and Pushmataha Counties of Oklahoma. Further, benefits and costs associated with these changes were analyzed to determine policy implications. Results of the benefit-cost analysis and policy recommendations are presented in later chapters.

Research results are presented in two major sections. The first section addresses research objective one. This objective deals with determining the extent to which participant households adopted energy conservation practices at three data collection points during the project. The objective focused on the extent to which project households adopted energy conservation practices after the summer project phase and after the winter project phase. The number of conservation practices present at the beginning of the project was used as a pre-condition base to determine the extent of project impact. The second part of this chapter addresses the impact of intervening variables such as changes in utility prices, household income, and other educational programs impacting participant households during the study period. The extent to which intervening variables influenced changes made by participant households in relation to the impact of the energy conservation educational project are discussed.

Adoption of Energy Conservation Practices

This section examines the extent to which participant households adopted energy conservation practices during the study period. Households were surveyed three times by paraprofessional energy aides to determine if any of 37 different conservation practices were present. A portion of the Energy Education For Oklahoma Families survey form was completed at each data collection point. The collection points were the beginning of the project, the end of Phase I (summer), and the end of Phase II (winter). The number of practices present in each of the 166 participant households was documented on the Energy Education For Oklahoma Families survey form (Appendix A).

It is important to consider adoption rates of the 166 households composing the present study sample as related to the total number of households contacted during the Energy Education for Limited Resource Oklahomans project conducted in Choctaw and Pushmataha Counties of Oklahoma from May 1982 to May 1983. This comparison is particularly important to determine if the 166 households in the study sample tended to adopt more practices than the total group. If this were the case, the present study would indicate unrealistically high adoption rates. A comparison of these two groups indicate little difference.

TABLE VII

BENEFIT-COST MATRIX FOR ENERGY CONSERVATION PRACTICES

Benefits	Costs
- - - - DIRECT TANGIBLE - - - -	
Reduced household energy use	<u>Money</u> Project: personnel travel educational materials office supplies other direct phone, postage, audio visual rental, advertising, etc. Participant Households Materials Subsidy From Outside Participant Households <u>Opportunity Cost</u> Participant Household time to participate in educational project time to install conservation practices Time Provided By Individuals and Groups Outside the Household
- - - - DIRECT INTANGIBLE - - - -	
Increased household comfort	
Pride and feelings of accomplishment for households making changes	
Increased human knowledge and skill of participant household members and paraprofessionals	
Increased skill of project staff in developing, implementing and evaluating special projects	

TABLE VII (Continued)

Benefits	Costs
- - - - - INDIRECT TANGIBLE - - - - -	
Reduced dependence on foreign sources of energy	
- - - - - INDIRECT INTANGIBLE - - - - -	
Improved communications among local and area agencies working with limited resource households	Agency money Agency personnel
Develop marketable skills of paraprofessionals and clients	

For example, reducing the water heater temperature was the practice which was adopted most frequently by both groups. Over 76 percent of the study sample adopted this practice while 88.8 percent of the total group adopted this practice. Storm windows were applied by 72.7 percent of the total households contacted while only 23.06 of the study sample adopted this practice. However, 20.02 percent of the study sample caulked and weatherstripped while only 13.7 percent of the total group adopted this practice. Ceiling insulation was added by 9.07 percent of the study sample and 5.1 percent of the total number of households contacted by the project (Williams and Wilson, 1983). Based on this review, it is assumed that the adoption rate for the study sample was not substantially different from the adoption rate for the total number of households contacted during the project period.

Table VIII presents survey results for the 166 households composing the study sample. According to these data, each household had an average of 9.233 of the 37 energy conservation practices present at the beginning of the project before energy education aides delivered the educational message. Data collection at the end of summer (Phase I), reflected that an average of 1.144 energy conservation practices per household were added during Phase I. This resulted in an average of 10.367 energy conservation practices per household. Another 1.018 practices per household were added during the winter phase (Phase II). The average number of practices present at the end of Phase II was 11.385. Each household made an average of 2.162 changes during the project period.

TABLE VIII

ENERGY CONSERVATION PRACTICES PRESENT IN PARTICIPANT HOUSEHOLDS

Energy Conservation Practices	Practices Present At Beginning		Practices Added During Phase I		Practices Added During Phase II		Total Change	
	N	%	N	%	N	%	N	%
Ceiling Insulation	99	59.64	2	1.24	13	7.83	15	9.07
Wall Insulation	79	47.59	1	0.62	0	0.00	1	0.62
Floor Insulation	5	3.01	0	0.00	0	0.00	0	0.00
Caulking and Weatherstripping	79	47.59	9	5.56	24	14.46	33	20.02
Duct Insulation	26	15.66	1	0.63	0	0.00	1	0.63
Storm Doors	96	57.83	0	0.00	7	4.22	7	4.22
Storm Windows	33	19.88	3	1.85	35	21.21	38	23.06
Indoor Roll-Up Shades	55	33.13	1	0.63	5	3.03	6	3.66
Roman Shades	2	1.21	1	0.62	3	1.81	4	2.43
Draperies	106	63.86	3	1.85	5	3.01	8	4.86
Drapery Liners	35	21.08	2	1.24	0	0.00	2	1.24
Window Inserts	0	0.00	0	0.00	1	0.60	1	0.60
Venetian Blinds	3	1.81	0	0.00	0	0.00	0	0.00
Outdoor Roll-Up Shades	8	4.82	3	1.86	1	0.60	4	2.46
Awnings	4	2.41	2	1.24	1	0.60	3	1.84
Sun-Screen	0	0.00	0	0.00	0	0.00	0	0.00
Solar Control Film	6	3.61	3	1.85	1	0.60	4	2.45
Louvered Visors-Windows	0	0.00	0	0.00	0	0.00	0	0.00
Louvered Visors-Doors	1	0.60	0	0.00	0	0.00	0	0.00
Louvered Visors-Cooling Unit	6	3.61	2	1.24	0	0.00	2	1.24
Landscaping-Deciduous Trees	120	72.29	1	0.62	1	0.60	2	1.22
Landscaping-Deciduous Shrubs	32	19.28	3	1.85	0	0.00	3	1.85
Landscaping-Evergreen Trees	9	5.42	0	0.00	1	0.60	1	0.60
Landscaping-Evergreen Shrubs	9	5.42	2	1.24	0	0.00	2	1.24
Ceiling Fan	8	4.82	10	6.17	2	1.21	12	7.38
Portable Fan	134	80.72	5	3.09	1	0.60	6	3.69
Whole House/Attic Fan	33	19.88	0	0.00	1	0.60	1	0.60
Home Heating System	166	100.00	0	0.00	4	2.41	4	2.41

TABLE VIII (Continued)

Energy Conservation Practices	Practices Present At Beginning		Practices Added During Phase I		Practices Added During Phase II		Total Change	
	N	%	N	%	N	%	N	%
Home Air-Conditioning System	105	63.25	5	3.13	1	0.60	6	3.73
Leaky Hot Water Faucets	-	6.67	0	0.00	2	1.21	2	1.21
Insulated Hot Water Pipes	23	13.86	0	0.00	0	0.00	0	0.00
Insulated Hot Water Tank	38	22.89	0	0.00	0	0.00	0	0.00
Reduced Hot Water Temperature	-	-	107	66.05	17	10.24	124	76.29
High 141°- 160°	-		-	-	-	-	-	-
Medium 121°- 140°	88	55.70	-	-	-	-	-	-
Low 100°- 120°	15	9.49	-	-	-	-	-	-
Made and Used Windbreakers	-	-	1	0.62	9	5.42	10	6.04
Added Humidity in Winter	-	-	0	0.00	6	3.61	6	3.61
Other	-	-	22	13.25	22	13.25	44	26.94
Reduced Winter Therm. Setting	37	22.42	1	0.62	6	3.61	7	4.23
Increased Summer Therm. Setting	14	8.49	5	3.09	0	0.00	5	3.09
AVERAGE NUMBER OF PRACTICES ADDED	-		1.144		1.018		2.162	
AVERAGE NUMBER OF PRACTICES PRESENT	9.223		10.367		11.385		-	

N = Number of households with practice present at beginning of project and number of households adding conservation practices during the project.

% = Percent of total households in study with practice present or added.

Analysis of variance was used to determine if a significant difference existed between the average number of conservation practices present at the beginning of the project and at each of the data collection points after delivering the educational project. The analysis of variance was designed for a single factor experiment with repeated measures. The results of this analysis (Table IX), using a one tailed test for correlated data, indicated mean differences at the .0001 level of significance.

TABLE IX

ANALYSIS OF VARIANCE--SINGLE FACTOR EXPERIMENT HAVING REPEATED MEASURES

Source of Variance	SS	df	MS	F
Between Households	7132.635	497		
Within Households	726.667	332		
Between Treatments	388.639	2	194.319	189.704**
Residual	338.028	330	1.024	

F (2,330) = 4.61

The calculated F value of 189.704 indicated highly significant mean differences between the number of practices present in the participant households at the beginning of the project and at each data collection point after the educational effort was implemented. A "t" statistic was used to determine which means were different.

Paired t-tests were completed on the mean number of practices present at the beginning of the project, at the end of Phase I and at the end of Phase II. This test determined if a significant difference existed between the average number of practices present at each data collection point during the project, i.e., $X_B \neq X_I$; $X_I \neq X_{II}$ and $X_{II} \neq X_B$

where

X_B = mean number of practices present at the beginning of the project

X_I = mean number of practices present at the end of Phase I

X_{II} = mean number of practices present at the end of Phase II

Results of the paired t-tests indicated significant mean differences at the .0001 level for all three pairs of means. T values for $X_B \neq X_I$, $X_I \neq X_{II}$ and $X_{II} \neq X_B$ were 13.25, 9.29 and 16.33 respectively. All t values were highly significant. These findings suggest that a significant number of conservation practices were added by participant households during each phase of the educational project.

These data support the hypothesis that the average number of energy conservation practices present in participant households were significantly different at each data collection point. That is, a significant number of conservation practices were added during each project phase. A greater number of practices were added during Phase I (summer), than during Phase II (winter). However, from an energy conservation perspective, the types of practices added during the winter phase had more potential for reducing household energy use than those added during the summer phase of the project.

In terms of specific practices adopted, the greatest number of households, 124, reduced hot water tank temperatures. This is not surprising since this practice is very easy to accomplish, costs virtually nothing to implement, and does reduce household energy use. Most participant households reduced water tank temperatures during Phase I of the project, indicating that this may be an easy, effective practice to adopt first when establishing a household energy management plan.

Thirty-eight households, or 23.06 percent of the study sample, added storm windows to their house. Most of the storm windows added were heavy gauge, six millimeter, clear plastic. Plastic storm windows are just as efficient as glass storm windows from a thermal standpoint and are much less expensive. In addition, plastic storm windows can be made and installed by household members. Most storm windows were applied during Phase II, or the winter phase of the project. Caulking and weatherstripping were added by 33 households, or about 20 percent of the participant households. This practice, which is relatively inexpensive, is very effective in reducing infiltration energy losses.

Surprisingly, 15 households, or nine percent of the participant households, added ceiling insulation. This is a very cost effective conservation measure but requires a relatively high capital investment to adopt. This practice was probably concentrated among households in the upper income range of the sample. Again, insulation was added primarily during the winter phase of the project.

Ceiling fans were added by 12 participant households with 10 added during the summer phase and two added during the winter phase.

Ceiling fans can substantially reduce summer cooling costs if they are used to replace and/or reduce the use of a central air conditioning system or a window air conditioning unit.

A variety of other energy conservation practices were added by participant households. A review of the data indicates that most of these were practices specific to the unique characteristics of the particular household. The only significant exception was that 7 of the 44 households reported closing off rooms of their house in an effort to reduce energy use during the winter.

In summary, the basic energy conservation practices adopted by participant households were adding storm windows, caulking and weatherstripping, and adding ceiling insulation. Eighty-six households, almost 52 percent of the participant households, adopted one or more of these major energy conservation practices. Conservation practices related to household water heating alone were adopted by 124 participant households, or 76.29 percent of participant households. A variety of other conservation practices were adopted by participant households but these practices were not adopted by large numbers of participant households. This finding indicates that there is a limited number of basic conservation practices that tend to be adopted by a large portion of participant households, while most practices are selected to meet the unique needs of individual limited resource households.

Intervening Variables

It is important to identify and discuss the potential impact of events and conditions other than the educational project (Energy

Education for Limited Resource Oklahomans) occurring during the study period that may have influenced the adoption of energy conservation practices by participant households. Intervening variables included changes in residential energy prices, changes in household income, and other educational efforts which may have impacted the target audience. It is important to examine the potential impact these intervening variables have on households in the adoption of energy conservation practices designed to reduce household energy use. Specific attention was directed toward the responsiveness of efforts to reduce energy use to changes in residential energy price and changes in participant household income. If participant households are highly responsive to changes in energy price and changes in household income, this responsiveness must be considered along with the potential impact of the energy education project.

Elasticity of Demand for Energy

Elasticity of demand is a concept that deals with the responsiveness of quantity demanded to changes in other relevant variables, such as own price, income and price of substitute products (Randall, 1981). In terms of the present study, two factors must be considered: the impact of the changes in the price of residential energy on the quantity of energy demanded and the impact of the changes of household income on the quantity of energy demanded. As pointed out earlier, the household survey was not designed to gather data on these variables. Nonetheless, the potential impact of changes in residential energy prices and household income must be considered.

Price Elasticity of Demand

Price elasticity of demand (E_p) for residential energy (RE) measures the relationship between the proportional change in the quantity of residential energy demanded as a result of a change in the price of residential energy. That is:

$$E_p = \frac{\Delta RE}{\Delta P_{RE}} \cdot \frac{P_{RE}}{RE}$$

where

E_p = Price Elasticity

RE = Quantity of Residential Energy Demanded

P_{RE} = Price of Residential Energy per unit

Price elasticity of demand is almost always negative. The demand for RE is price elastic if the price elasticity of demand is greater, in absolute value, than -1; that is, if a one percent change in price results in a change in quantity consumed greater than one percent. If the price elasticity of demand for residential energy lies between 0 and -1, the demand for residential energy is price inelastic. Hence, a one percent change in price results in less than a one percent change in quantity demanded. Randall (1981) concludes that the demand for things that are sometimes called "necessities of life" is usually price inelastic, while the demand for discretionary items is often price elastic. For example, the price elasticity for basic food items and shelter is usually inelastic while the price elasticity for vacations and good jewelry is usually price elastic. Randall (1981) further states that estimates of price elasticity of demand provide very useful information for policy analysis. That is, if the demand for energy was price elastic, an increase in the price of energy to consumers would be an effective way to induce them to reduce the quantity demanded, i.e., to conserve. However, if the demand for residential energy was price inelastic, price increases would be a much less effective way of encouraging conservation.

The impact of changes in the price of residential energy during the study period on the number of conservation practices adopted by participant households is of particular interest in this study. Did participant households adopt conservation practices primarily due to the motivation and education provided by the project or due to other intervening variables, such as changes in utility prices?

The results of several studies (Ford Foundation, 1976; Walker and Draper, 1975; Cunningham and Lopreato, 1977) indicate that E_p varies with household income level. According to Walker and Draper (1975), upper income households show very little change in energy consumption in response to price increases. Cunningham and Lopreato (1977) concluded that low-income households (less than $5,000 per family per year) are least responsive to increases in electricity and natural gas price. In the Cunningham and Lopreato (1977) study, a group of low income consumers reported a very moderate reduction in consumption at any price for electricity and natural gas. It was suggested that for these respondents consumption probably is already minimal; hence, a slight to moderate reduction is all they could accomplish. Middle-income groups in this study were the most responsive to changes in utility prices.

Short Run Elasticity of Demand

Griffin and Steele (1980) conclude that the time frame within which elasticities of energy demand are considered is very important. They contend that the short run demand for energy is highly inelastic with respect to price while long run demand for energy is more elastic with respect to price. Griffin and Steele (1980), reported long run elasticities for the residential-commercial sector as -2.26 for natural gas and -.88 for electricity. They caution however that these long run responses may take many years to achieve.

Given the one year period for the present study, short run elasticities of price (and income) are the most relevant. The short run is defined here as the period within which a household's stock of appliances and demographic profile is fixed (Barnes, Gillingham and Hagemann, 1981 and 1982).

Income Elasticity of Demand

The other important demand elasticity concept is the income elasticity of demand (E_I), which relates changes in quantity demanded to changes in the consumer's income. For the present case:

where

RE = Quantity of Residential Energy Demanded

Y = Household Income

Intervening Variables and the Adoption of Energy Conservation Practices

Residential energy prices and income of participant households are intervening variables, in the sense that a change in either would tend to create changes in the amount of energy consumed and presumably in the frequency with which energy conservation practices are adopted by participant households in the short run. In particular, an increase in residential energy prices would reduce consumption, possibly through adoption of energy conservation practices. Adoption of such practices is more likely the larger the residential energy price change and the larger the price elasticity of demand for residential energy. Likewise, following this logic, the likelihood of adoption of energy conservation practices would be smaller, the smaller the change in price and the smaller the elasticity of demand for residential energy. In addition, an increase in household income would result in an increase in residential energy consumption tending to offset a rise in energy price. The larger the change in income and the income elasticity of demand, the less likely that energy conservation practices would be adopted.

To conclude, the likelihood of participant households adopting energy conservation practices due to utility price change and income change is smaller the:

1. smaller the increase in residential energy prices;
2. smaller the price elasticity of demand for residential energy;
3. larger the increase in household income;
4. larger the income elasticity of demand for residential energy.

Short Run Elasticities of Demand for Electricity

Numerous studies have been conducted to determine price and income elasticity of demand for electricity. Table X summarizes studies which focus on short run price and income elasticity for residential household electricity demand. Although there have been several time series studies, and/or studies using large aggregate data sets, they were omitted on the grounds of inapplicability to the case under study.

TABLE X

ESTIMATED SHORT RUN ELASTICITIES FOR RESIDENTIAL ELECTRICITY

Study	Date	Elasticity Coefficients Price	Income
Houthakker (Taylor, 1975)	1962	-0.89	1.16
Anderson	1973	-0.91	1.13
Wilder and Willenborg	1975	-1.00	0.16
Acton, et al.	1976	-0.70	0.40
Battalio, et al.	1978	-0.20 to -0.32	NE
Barnes, et al.	1980	-0.55	.20
Roth	1981	-0.11	NE

*NE - Not Estimated

A review of Table X reveals substantial variation in short run estimates of both price and income elasticities of demand for residential energy. Price elasticity estimates range from -0.11 to -1.00, and the range of reported income elasticities is from .16 to 1.16. These variations stem from differences in type and source of data, econometric methods used, and the treatment of the price structure. In general, though the more recent estimates are based on better specified models, they are better indicators of the behavior of current household decisionmakers. Thus, both the price and income elasticities of demand for the study group are likely to be quite small, and similar in terms of absolute value.

Short Run Residential Demand for Natural Gas

Barnes, Gillingham and Hagemann (1982) conducted a study on the short run residential demand for natural gas. This study determined the level of natural gas consumption for study households and related it to their stock of gas appliances and a demographic profile. Using this research approach, they found an overall, short run price elasticity of demand for natural gas to be -0.682. Based on this finding, they concluded that short run residential demand for natural gas is price inelastic. However, this value is substantially more elastic than a 1977 estimate by Bloch (Barnes, Gillingham and Hagemann, 1982). The Bloch (1977) and Barnes, Gillingham and Hagemann (1982) price elasticity estimates are based (correctly) on household data using marginal prices. Other studies of natural gas are based (incorrectly) on aggregate data using average prices, and a review of these studies is not included in this discussion.

Data on the income elasticity of demand for natural gas are quite scarce. The most recent, and probably the most relevant data for this study, is an estimate of 0.65 by MacAvoy (1983, 116), based on regression analysis of data from the Monthly Energy Review of the Department of Energy.

These limited results indicate that the effect of a one percent change in price on the quantity consumed of natural gas is relatively close to the effect of a one percent change in income. Given similar results for electricity, the relevance of the two intervening variables - price and income - depends largely on the size of the percentage changes in price and income which actually occurred for the study group during the study period. The latter depends, in part, on the sources of energy for each household.

Energy Sources for Participant Households

Data collected on participant households indicate that the primary sources of residential energy for the study sample were electricity and natural gas. According to the Energy Education For Oklahoma Families survey, 74.1 percent of participant households were heated by natural gas with another 5.4 percent heated with electricity. Electricity was the primary energy source for space cooling and operation of other household equipment such as lights, refrigerators, freezers, equipment used for entertainment, etc.

Suppliers of electricity to residents of Choctaw and Pushmataha Counties of Oklahoma are Choctaw Rural Electric Cooperative and Public Service Company of Oklahoma. Of the 166 households in the study served by these utilities, 65 percent were served by Public Service of Oklahoma and 35 percent were served by Choctaw Rural Electric Cooperative. Natural gas was supplied to participant households by Lone Star Gas Company.

According to computerized energy audits done on each participant household, average estimated electrical use for each household was 1272.637 KWH per month during the summer (June through September) and 381.791 KWH per month for the rest of the year. Each participant household had an estimated natural gas usage of 14.689 MCF per month during the winter (November through April) and an estimated use of 4.539 MCF per month for the rest of the year. These projections assume natural gas space heating and water heating, electric space cooling, and electric use for the operation of other household appliances.

Utility Rates

Utilities such as Public Service Company of Oklahoma and Lone Star Gas Company have established customer rates which are regulated by the Oklahoma Corporation Commission. Choctaw Rural Electric Cooperative is not regulated by the Oklahoma Corporation Commission but follows a similar system of establishing customer rates as other major utilities in the state.

Established rates are based on the utilities' normal operating costs, investment in power generating and transmission facilities and return on investment for stockholders and/or owners. In addition to the basic rate, utilities are allowed to automatically adjust rates to reflect fluctuations in the cost of fuel to the utility. This provision is called a fuel adjustment clause. Utilities use a fuel adjustment clause to recover the difference between a pre-established fuel price and the price actually paid for fuel (Office of Consumer Affairs, 1980).

Electricity Prices During Study Period

Table XI reports electricity prices for the two electric utilities serving participant households, Public Service Company of Oklahoma (PSO) and Choctaw Rural Electric Cooperative (Choctaw REC). During the study period, neither utility increased their customer charge. PSO charged $4.50 per month and Choctaw REC charged $8.00 per month. Public Service Company of Oklahoma increased their rates once during the study period. This rate increase went into effect June 4, 1982. The increase impacted all residential rate levels. Fuel adjusted rates for the off-peak period in January 1982 and January 1983 were $.046317/KWH (.0556 - .009285) and $.057275/KWH (.05841 - .001135) respectively. The adjusted rate in January 1983 was 23.7 percent higher than the January 1982 adjusted rate. On peak rate, changes for PSO may have increased as little as five percent [(.05841 - .0556)/.0556)].

Choctaw Rural Electric Cooperative did not have a rate increase during the study period, but the fuel adjustment charge did influence the per KWH rate paid by Choctaw REC customers. Fuel adjustments vary from month to month and can result in either an increase or decrease in price per KWH paid by a household. In the case of Choctaw REC, fuel adjustments just prior to the study period (January 1982) and during the study period resulted in increased prices paid by customers. For example, from January 1982 to January 1983, winter rates increased from $.047109/KWH (.0487 - .001591) to $.07224/KWH (.0487 + .02354), a 53.34 percent per KWH increase in the price of electricity. Between May 1982 and May 1983, there was a 9.74 percent

TABLE XI

ELECTRIC PRICES DURING STUDY PERIOD

	PSO	CHOCTAW REC
Customer Charge	$4.50 per month	$8.00 per month
Rate: On Peak (Summer)		
All KWH	.0556 per KWH[1] (1-15-82/6-3-82) .05841 per KWH (6-4-82/End of Study	.0520 per KWH[3]
Off Peak (Winter)		
All KWH	---	.0487 per KWH[4]
First 400 KWH	.0556 per KWH[2] (1-15-82/6-3-82) .05841 per KWH (6-4-82/End of Study)	---
All KWH Over 400	.0398 per KWH (1-15-82/6-3-82) .04183 per KWH (6-4-82/End of Study)	---
	$/KWH	$/KWH
Fuel Adjustment		
January 1982	-.009285	.001591
February 1982	-.001736	.000411
March 1982	.000701	.001428
April 1982	-.002186	.002910
May 1982	-.001909	.020886
June 1982	-.002036	.023386
July 1982	-.000132	.017841
August 1982	.002612	.012742
September 1982	.001079	.014460
October 1982	.001359	.020299
November 1982	.000819	.024367
December 1982	-.001267	.023084
January 1983	-.001135	.023540
February 1983	-.001060	.025456
March 1983	.001018	.024547
April 1983	.001485	.023587
May 1983	.003432	.027988

[1]The "On Peak Season" rate schedule for Public Service Company of Oklahoma applies during the billing months of June through September

[2]The "Off Peak Season" rate schedule for Public Service Company of Oklahoma applies during the billing months of October through May

[3]Summer rates for Choctaw Rural Electric Cooperative apply to usage May through September inclusive

[4]Winter rates for Choctaw Rural Electric Cooperative apply to usage October through April inclusive

increase in the summer rate schedule for participant households served by Choctaw REC. During this period, summer prices increased from \$.072886/KWH (.0520 + .020886) in May 1982 to \$.079988 (.0520 + .027988) in May 1983.

<u>Natural Gas Prices During Study Period</u>

According to data, as reported in Table XI, the rate charged for natural gas by Lone Star Gas Company did not change from January 1982 to May 1983. Changes in natural gas rates for participant households were due to fluctuations in the price paid by Lone Star Gas Company for natural gas and reported as a fuel adjustment on Table XII.

Fuel adjustments during the study period ranged from 39 to 94.52 cents per MCF. These fuel adjustments resulted in a 7.9 percent per MCF price increase for the first MCF of gas consumed between January 1982 (\$4.25/MCF + \$.33 = \$4.83/MCF) to January 1983 (\$4.25/MCF + \$.71 = \$5.21/MCF) for the winter rate schedule. Participant households paid 13.07 percent more per MCF for all natural gas used over the first MCF during this period. Between May 1982 to May 1983, summer rate schedule natural gas prices increased 10.13 percent for the first MCF used and 17.09 percent per MCF for all additional natural gas uses within the month.

Income for Target Group

Income data were collected for participant households on the first visit to the home. Fifty-nine percent of the households had an income of less than \$6,000 per year in 1982-1983 dollars. Another

TABLE XII

NATURAL GAS PRICES DURING STUDY PERIOD
LONE STAR GAS COMPANY

Rate		
Summer[1]		
First 1 MCF or Fraction Thereof		$4.25 per MCF
All Consumption Over 1 MCF		$2.36 per MCF
Winter[2]		
First 1 MCF of Fraction Thereof		$4.50 per MCF
All Consumption Over 1 MCF		$2.61 per MCF
Fuel Adjustment		$/MCF[3]
January	1982	.3300
February	1982	.3300
March	1982	.4100
April	1982	.4400
May	1982	.3900
June	1982	.3900
July	1982	.7400
August	1982	.6300
September	1982	.7000
October	1982	.6300
November	1982	.7600
December	1982	.7900
January	1983	.7100
February	1983	.8000
March	1983	.8088
April	1983	.9452
May	1983	.8602

[1]Summer rates apply to use between meter reading dates in May and October.

[2]Winter rates apply to all usage not under the Summer schedule.

[3]MCS means thousand cubic feet or the quantity of gas occupying one thousand cubic feet of space at 60 degrees Fahrenheit (60°F) and an absolute pressure of 14.65 pounds per square inch.

38.1 percent had incomes of between $6,001 and $12,000 per year. These findings, in light of the Cunningham and Lopreato (1977) study suggest that very little change in conservation practices could be attributed to income of the participant households. Substantial change in household income, however, could have potentially influenced conservation practices adopted by participant households. Unfortunately, data were not collected at the end of the project to determine if income had changed substantially during the study period.

Given the general low income profile of participant households along with their age, 47.7 percent over 62 years of age, it was assumed that a large number of project households received the majority of their income from social security benefits. Social security recipients received cost of living increases as a result of increases in the consumer price index during the study period. Although the average household increase from this source was almost seven percent, an adjustment for inflation occurring during the study period implies an increase in real income of only 3.9 percent during the study period. A 3.9 percent increase in real income would not have substantially changed the income level of participant households with an aged head.

Based on the low income profile of all participant households, it was assumed that many households not eligible for social security benefits were receiving Aid to Families with Dependent Children (AFDC) and Food Stamps. This assumption is further supported by the percent of families in Choctaw and Pushmataha Counties receiving AFDC and state supplemental payments compared to the rest of Oklahoma. During FY 1983, 9.1 percent of the population in Choctaw County and 12.1

percent of the population in Pushmataha County received AFDC and supplemental payments. During this same period, the average number of households in the state receiving these payments was 4.2 percent (Oklahoma Department of Human Services, 1983).

The last basic allotment change for households receiving AFDC occurred in April, 1979 (Oklahoma Department of Human Services, 1984). When cost of living increases are considered, this would result in a small reduction in real income during the study period of about 3.9 percent. Food Stamp allotments were increased in January 1983. When this 4.3 percent increase was adjusted for inflation it resulted in a .4 percent increase in the real value of Food Stamps (U.S. Department of Commerce, 1983).

Unemployment rates during the study period also increased. In Choctaw County, unemployment was 9.8 percent in May 1982 and rose to 14.2 percent in May 1983. Unemployment in Pushmataha County was 11.9 percent in May 1982 and increased to 16.4 percent by May 1983 (Oklahoma Employment Security Commission, 1983b). These facts strongly suggest that there was no upward pressure on wages for low wage occupations in these counties during the study period.

Income data for the study area then suggest little or no increase in household income during the study period. In fact, there is some evidence of slight decreases in real income for households in the two counties included in the study.

Other Educational Efforts Impacting Target Group

No other major energy education effort which focused on individual delivery of the educational message was conducted during the study period. Mass media efforts such as radio and television announcements, as well as printed material used as bill stuffers by major utilities, were used during this period. Articles related to residential energy conservation appeared in local newspapers and utility company newsletters. According to studies done to determine the impact of education on the adoption of energy conservation practices, these efforts serve to increase awareness of energy conservation but do little to motivate adoption of energy conservation practices (Cunningham and Lopreato, 1977; Braun, Williams and Murray, 1979; and Williams and Braun, 1981). It is suggested that although mass media energy education efforts did increase awareness of energy conservation during the study period, these efforts did little to encourage participant households to adopt energy conservation practices.

Summary Concerning the Impact of Intervening Variables

How important was the omission of questions from the household survey that could have provided information on the intervening variables of price and income? As indicated above, this depends on the values for the price and income elasticities of demand, the percentage changes which occurred in price and income, and the proportion of households affected by these changes.

The literature strongly suggests that price and income elasticity values are similar enough for both electricity and natural gas that this potential source of difference played virtually no role during the study period. However, inferences based on population characteristics indicate that virtually no change in real income occurred for the study population while they were faced with higher energy prices. This result alone suggests that price changes could have induced households to adopt some conservation practices.

Although the conservation-inducing effect of price changes was probably positive, it was likely to be small. A casual review of the price change estimates may appear to indicate otherwise. However, a comparison of the change in winter rates for natural gas, and of the changes in summer rates for electricity, yields price changes in the range of five to ten percent. Surely this change, coupled with relatively price-inelastic demand values, implies a small influence from changes in utility rates during the study period. Thus, although these price increases may have impacted adoption somewhat, it can be assumed that the educational project contributed substantially to adoption as well. Further, it is postulated that the educational project offered viable alternatives for energy conservation that may have been overlooked had participant households not been made aware of the potential benefit of such practices, i.e., the desire to conserve due partially to increased prices may not have resulted in action had the participant household not received the energy education.

CHAPTER V

BENEFIT-COST ANALYSIS

Consumers face difficult decisions daily as they attempt to allocate scarce resources among their needs and unlimited wants. Similarly, public decisionmakers such as elected and appointed officials, educators, agency directors and others seek answers to such questions as: In what areas are the needs greatest? What allocation of resources will provide the highest utility for the citizens of the city, county, state, nation and world? Which methods will provide utility at the least cost? Consumers and public decisionmakers alike face the problems of scarcity and the best use of resources to attain goals (Volker and Deacon, 1980).

While such an analogy is appropriate to some extent, pertinent differences between public decisionmakers and individual decisionmakers need to be considered. Hinrichs and Taylor (1976) point out three such differences between public and private sector decision making.

1. The nature of decision making in the public sector is a group process. Inherent in the process are the interactions, pressures and bargaining among different

groups for their own particular interests. Therefore, there is no single consumer or producer whose welfare is to be maximized.

2. The nature of goods in the public sector is often quite different from those in the private sector. The public sector is concerned primarily with public goods available for all, such as clean air, parks and quasi-collective goods that society can produce at a lower price such as education. In recent years, the public sector has devoted a great deal of attention to the cost and availability of energy resources.
3. The nature of goals is substantially different in public and private sectors. Public sector goals are highly complex, rapidly changing and more difficult to know and measure than for those of individuals. When a group acts, some members may gain more than others and some may lose more than others.

Keeping in mind the public and individual needs for information in decision making, the nature of decision making in the public sector versus the private sector, and the pressure for accountability and prudent use of resources, it becomes important to use economic principles and sound evaluation tools and techniques when implementing programs to serve individual consumers as well as the public good. All projects and programs are dependent on funding. Budget constraints have a large impact upon the funding and the resulting output of individual projects and programs. Therefore, economic considerations become a part of every project at one stage or another.

According to Sassone and Schaffer (1978), economics may be partitioned into two areas: (1) positive economics and (2) normative economics. Positive economics describes, explains and predicts actual economic phenomena. It is devoid of value judgement, that is, positive economics does not state whether conditions or events are good or bad. Normative economics, however; explicitly introduces value judgements and norms in assessing the relative desirability of different economic conditions. The commonly used term for normative economics is welfare economics. Welfare economics relates to society's allocation of scarce resources for the purpose of maximizing social welfare. Welfare, as used in this sense, refers to the well-being of all the members of a society concerning resources.

Benefit-cost analysis is applied welfare economics. The question posed is whether a particular decision or a particular allocation of resources helps or hinders a society. For the purposes of the present study, benefit-cost analysis is used to analyze the Energy Education for Limited Resource Oklahomans project. Energy conservation practices adopted by limited resource households in southeastern Oklahoma are also evaluated, using data common to both tasks. The economic analysis focuses on the benefits and costs of adopting various energy conservation practices in an effort to reduce household energy consumption and increase household comfort.

Tables XIII and XIV report first year benefits and costs associated with the adoption of fourteen energy conservation practices by selected households in Choctaw and Pushmataha Counties of Oklahoma from May 1982 to May 1983.

TABLE XIII

FIRST YEAR BENEFITS FOR ENERGY CONSERVATION PRACTICES ADOPTED BY SELECTED HOUSEHOLDS IN SOUTHEASTERN OKLAHOMA

Item	Number of Households Adopting Practice	Mean Projected Dollar Savings For Each Practice	Total Projected Dollar Savings For Each Practice	Total Projected Dollar Savings
Benefits From Reduced Energy Use				
1. Ceiling Insulation	14	$104.56	$1,463.84	
2. Wall Insulation	1	3.75	3.75	
3. Storm Windows	33	28.01	924.33	
4. Storm Doors	5	4.46	23.30	
5. Caulking and Weatherstripping	30	15.26	457.20	
6. Duct Insulation	1	53.24	53.24	
7. Reduced Water Heater Temperature	103	37.42	3,854.26	
8. Changed Thermostat Setting	5	33.16	165.80	
TOTAL PROJECTED DOLLAR SAVINGS DOCUMENTED BY AUDIT				$6,945.72
9. Indoor Roll-up Shades	4	39.01	156.04	
10. Roman Shades	4	14.38	57.52	
11. Draperies	1	28.44	28.44	
12. Awnings	2	21.53	21.53	
13. Solar Control Film	3	14.68	14.68	
14. Repaired Hot Water Faucets	2	36.67	36.67	
TOTAL PROJECTED DOLLAR SAVINGS DOCUMENTED BY HAND CALCULATIONS				402.44
TOTAL PROJECTED SAVINGS				$7,348.16

TABLE XIV

FIRST YEAR COSTS FOR ENERGY CONSERVATION PRACTICES ADOPTED BY SELECTED HOUSEHOLDS IN SOUTHEASTERN OKLAHOMA

Item	Costs
1. Energy Project	
Personnel	$12,094.76
Travel	1,650.04
Educational Materials	483.06
Supplies	51.46
Other Direct Costs	350.26
TOTAL	$14,629.58
2. Households Supplies	7,008.50
3. Subsidy	
Government	5,330.00
Utility	-0-
Business	-0-
Civic	-0-
Family	1,215.00
Religious	-0-
Other	-0-
4. Opportunity	
Household Time for Educational Message (996 hrs total)	2,689.20
Household Time to Implement Practice (364 hrs total)	982.80
Subsidy Time	
Government (262 hrs total)	1,399.08
Utility	-0-
Business (5 hrs total)	26.70
Civic	-0-
Family	183.60
Religious	-0-
Other (65 hrs total)	347.10
TOTAL COST	$33,811.56

Benefits

The primary economic benefit of adopting energy conservation practices comes from reduced household energy use. Data from the computerized energy audit were merged with data collected on the Energy Education for Oklahoma Families survey form to determine the economic impact of the significant number of energy conservation practices adopted by participant households as reported in Chapter IV. Computerized energy audit output projected yearly dollar savings for various conservation practices based on the thermal characteristics of each participant's house and prevailing energy prices. The Energy Education for Oklahoma Families survey form documented actual practices adopted by participant households. When these data were merged, projected yearly dollar savings for a specific practice were matched with only those households adopting the practice.

Projected first year dollar savings were found for eight energy conservation practices in Table XIII, (items 1 through 8). Table XIII records the number of households that adopted the practice and the average first year projected dollar savings for each practice. A total of 125 participant households made one or more energy conservation changes which could be credited with projected dollar savings by using the computerized energy audit. These changes resulted in an average projected first year dollar savings of $55.56 per household. Total projected dollar savings for all participant households documented by the computerized energy audit were $6,945.72.

In addition to projected dollar savings using the computerized energy audit, hand calculations, described in Chapter III, were done to determine the dollar savings associated with energy conservation practices nine through fourteen as shown in Table XIII. These practices were adopted by participant households but not included in the computerized audit methodology.

Thirty-five participant households made additional changes in an attempt to reduce household energy use and increase comfort. Due to the thermal characteristics of the house, the type of equipment used in the household, how the adopted practice interfaced with other practices adopted, and/or how the practice was documented, dollar savings could be projected for only 16 of the 35 households making changes. For example, 12 participant households added ceiling fans, a practice which has potential for reducing energy required to cool the house by reducing the use of the existing air conditioning system. However, these 12 households either did not have an air conditioning system before adding the ceiling fan or did not indicate that the thermostat setting on the existing air conditioning system was adjusted upward. Dollar savings for adding the 12 ceiling fans could not be projected due to lack of adequate data documentation. Another eight households added landscaping during the study period. Due to difficulty in determining when this landscaping would impact household energy use, these changes were not included in the projected first year dollar savings.

It is believed that although the present researcher did not assign monetary value to some adopted energy conservation practices, the practices did or will increase household comfort for participant households. This was one of the Energy Education for Limited Resource Oklahomans project objectives. When participant households were surveyed at the end of the project to determine their reasons for making changes, the households cited the reason of increased comfort more than saving money.

Six types of energy conservation practices (Table XIII, items 9 through 14) adopted by 16 households were included in projections of economic benefit. The conservation practices included increasing the thermal efficiency of windows by covering or shading them to reduce winter heat loss and/or summer heat gain, and repairing leaking hot water faucets. Table XIII documents the number of participant households adopting each practice and the average projected dollar saving for each adopted practice. The total first year projected savings for these practices (items 9 through 14) were $402.40.

Table XIII also reports the total projected first year dollar savings for all energy conservation practices adopted by participant households. When savings projected by the computerized energy audit were added to savings from conservation practices not included in the audit, the total projected first year dollar savings were $7,348.16. This dollar amount was used as the benefit figure for benefit-cost analysis.

Costs

Costs associated with the adoption of energy conservation practices by selected limited resource households in southeastern Oklahoma include: (1) direct costs of implementing the Energy Education for Limited Resource Oklahomans project, (2) the cost of materials and supplies used and paid for by participant households to implement energy conservation practices, (3) the opportunity costs associated with adopting energy conservation practices, and (4) the cost of materials and supplies provided as subsidies to assist participant households in implementing energy conservation practices. For the purposes of this study, opportunity costs include time spent by participant households to receive the educational message provided by paraprofessional energy educators, time spent by participant households to implement energy conservation practices, and time spent by individuals outside participant households to assist these households in implementing energy conservation practices. Monetary values were determined for each cost category. These values are reported in Table XIII.

Direct Costs

Costs associated with implementing the Energy Education for Limited Resource Oklahomans project were determined by analyzing accounting records kept for the project. All direct costs incurred as a result of delivering energy education to the 166 households composing the study sample were documented and included in the benefit-cost analysis.

A total of 558 households were reached during two project phases in Choctaw and Pushmataha Counties. As shown in Table XIV, total expenses for delivering the energy education portion of the project were determined to be $49,173.41. The per household figure for delivering energy education during the project was $88.13. This average cost per household was then used to determine the total cost of delivering energy education to the 166 households composing the study sample. Again, as concluded in Chapter IV, the adoption rate for the study sample is not substantially different than the adoption rate for the total group. Thus, this average cost approach for assigning cost is appropriate for benefit-cost analysis.

Project expenses were categorized into five areas which included personnel, travel, educational materials, supplies and other direct costs. Personnel included the salary and wages of the project coordinator, paraprofessional energy educators, and a secretary who assisted in reporting and accounting for the project. Travel associated with the project included travel expenses for the project site coordinator, paraprofessional energy educators, and county professional staff who traveled on project related business. Educational materials included the costs of energy education kits used to demonstrate energy conservation concepts and procedures, printed material used as handouts and references for energy educators and demonstration materials used to teach energy conservation techniques and procedures.

The total direct cost to deliver the energy education project to 166 participant households was $14,629.58 as shown in Table XV. The largest cost item was personnel. This is not surprising since the project focused on individual and small group delivery. Such a delivery system is very personnel intensive. The second largest cost item was travel. Again, high travel costs are understandable since paraprofessional educators were to seek households having the greatest need, and those households that did not tend to receive energy education from traditional sources.

TABLE XV

DELIVERY OF EDUCATION PORTION OF ENERGY EDUCATION FOR LIMITED RESOURCE OKLAHOMANS, MAY 1982-May 1983 DIRECT COST SUMMARY

	Phase I	Phase II	Total	Cost Per Client N=558	Cost For Sample N=166
Personnel	$20,596.41	$20,056.68	$40,653.09	$72.86	$12,094.76
Travel	2,466.01	3,079.08	5,545.09	9.94	1,650.04
Educational Materials	1,484.65	137.28	1,621.93	2.91	483.06
Office Supplies	117.37	56.73	174.10	.31	51.46
Other Direct	521.97	657.23	1,179.20	2.11	350.26
TOTALS	$25,186.41	$23,987.00	$49,173.41	$88.13	$14,629.58

Educational supplies were the third largest cost item. The largest portion of this amount was spent to construct demonstration kits to assist paraprofessional educators in delivering the educational message. Energy education demonstration kits were hand constructed at a total cost of $250 each. The useful life of each kit was determined to be five years. An annual cost of $50 per kit was assigned as the cost of each of six kits used by the paraprofessionals.

Other direct expenses which included telephone, duplicating costs, paid advertising, photo processing, audio-visual equipment rental, meeting room rental and other miscellaneous expenses was the fourth largest cost. Office supplies composed the smallest portion of the total cost of implementing the project.

Participant Costs to Implement Practices

Participant households that adopted energy conservation practices spent a total of $7,008.50 to implement these practices. These expenditures were reported by participant households and documented on the Energy Education for Oklahoma Families survey form (Appendix A). The magnitude of the resources committed by participant households to implement conservation practices is an important finding in light of the statements made by the Consumer Federation of America (USOTA, Vol. II, 1979), that limited resource households were unable to help themselves due to monetary resource constraints. This finding strongly suggests that limited resource households will use some of their limited monetary resources for energy conservation practices if they are educated and motivated to do so.

Opportunity Costs

Another cost associated with household participation in the energy education project was the time the participants spent receiving the energy education message. Each paraprofessional energy educator kept records on the amount of time spent with each participant household. The educator spent an average of six hours delivering the energy education message during approximately three visits to the household. This time, which is an opportunity cost to the households, was valued at $2.70 an hour, thus the total cost to participant households to receive the educational message was $2,689.20. The hourly rate used to determine this cost was based on a weighted hourly rate for the income reported on the Energy Education for Oklahomans survey form. This figure is consistent with 1982 per capita income reported for Choctaw and Pushmataha Counties by the Center for Economic and Management Research (1982). The per capita income for Choctaw County was $5,774 per year which would be an average hourly wage rate of $2.89. Pushmataha County had a per capita income of $4,658 which was a wage rate of $2.33 per hour.

Participant households also spent time implementing energy conservation practices. According to data reported by participant households, the participants spent a total of 364 hours implementing conservation practices. These hours were treated as opportunity costs for the households and valued at $2.70 per hour. The total value of household time spent to implement conservation practices was $982.80 as shown in Table XIV.

Subsidies

Participant households received assistance or subsidies from sources outside the household to implement energy conservation practices. The types of subsidy included money, services and goods. Direct monetary subsidies and the value of goods were valued according to current market prices and the value reported by participant households. Time spent by outside sources to provide services to participant households was treated as an opportunity cost. It was valued according to the prevailing hourly wage rate in the area to determine the monetary value of time and services offered to implement energy conservation practices.

Government sources provided monetary resources and goods valued at $5,330, as well as 262 hours of time to support participant households in the energy management efforts. Subsidy hours from government sources were valued at the average hourly wage rate prevailing in the area at the time of the study (Oklahoma Employment Security Commission, 1983a), $5.34 per hour. Using this procedure, the value of hours provided by government sources was $1,399.08. This resulted in a total subsidy of $6,729.08 to participant households from government sources.

Business sources provided five hours of time to implement energy conservation practices adopted by participant households. This time subsidy was valued at $5.34 per hour for a total cost of $26.70.

Family members outside the participant households provided $1,215 in money and goods to support energy conservation efforts of participant households. In addition, family members outside participant households provided 68 hours to implement energy conservation practices. This subsidy time was valued at $2.70 per hour which is consistent with the income of participant households. The total time provided by family members outside the participant household was valued at $183.60 for a total of $1,398.60 provided by family members. The amount is recorded as a cost on Table XIV.

Miscellaneous subsidy sources provided 65 hours to support participant households. These hours were valued at the average hourly wage rate in the area of $5.34 per hour. The value of these hours was treated as an opportunity cost with a total value reported in Table XIV of $347.10.

Table XIV reports total costs associated with the adoption of energy conservation practices by selected households in southeastern Oklahoma as $33,811.56. This cost figure was used in the benefit-cost analysis for the adoption of energy conservation practices by 166 limited resource households.

Difficulties of Assessing Economic Values

Marginal costs associated with the adoption of energy conservation practices were well documented for the present study since the present researcher found it relatively easy to establish monetary values for these cost items. However, project benefits as presented in Chapter III, Table VII, were much more difficult to value in monetary terms. Benefits associated with energy savings were documented but due to inadequate data or lack of acceptable methodology for establishing the value of some energy conservation practices, several practices were not included in the estimates of monetary benefits. The present researcher postulates that the projected value of reduced energy use resulting from the adoption of energy conservation practices is low. Several costs, however, which did not result in benefits which could be assigned economic value were included in the benefit-cost analysis. These costs included $1,567 of participant household funds and $100 in subsidized funds used to purchase ceiling fans. In addition, 8.5 household hours and 9 subsidy hours were included in cost figures. Unfortunately, ceiling fan installation could not be credited with any monetary benefits. Portable fans and attic fans costing participant households $172.50 were included in costs with no monetary benefits assigned to these practices. Participant households spent 34.5 hours adding landscaping to their homes at a cost of $50.00. Again, these costs were included in the benefit-cost analysis with no corresponding benefit associated with the practice included in the analysis.

Of greatest concern however, is the fact that several benefits that resulted from participant households adopting energy conservation practices were not valued in economic terms at all. These benefits, presented in Table XIII, did accrue to participant households and society, but adequate methodology was not available to assign monetary value to these benefits. The dilemma of the present study is consistent with Christensen and Pontius (1983) who suggested that the most difficult aspect of program evaluation is that of measuring the benefits from program efforts such as Cooperative Extension education efforts.

Another problem area related to valuing benefits associated with the adoption of energy conservation practices is the lag concept.

Data were collected on energy conservation practices present in participant households from May 1982 to August 1982 with all follow-up data collected on changes made by participant households on or before May 1983. As Christensen and Pontius point out, knowledge gained from an educational program may not be put into action for months or years. If this is the case with the present study, several energy conservation practices with potential monetary benefits could have been adopted after the relatively short data collection period.

Long Term Benefits and Costs

The long term benefits of the energy conservation practices studied are determined by the length of time they will be in place and effective in reducing residential energy use. Future residential energy prices will also determine the long term benefits of conservation practices adopted by participant households. Based on energy literature (U.S. Department of Energy, 1980) the present researcher makes the following assumptions concerning the length of time the 14 energy conservation practices will be effective in reducing energy use:

Three Years:

- Plastic Storm Windows
- Plastic Storm Doors

Five Years:

- Caulking and Weatherstripping
- Indoor Roll-up Shades
- Roman Shades

Draperies

Solar Control Film

Repaired Hot Water Faucets

Ten Years:

Reduced Water Heater Temperature

Changed Thermostat Setting

Twenty Years:

Ceiling Insulation

Wall Insulation

Duct Insulation

Awnings

It is important to point out studies by W. J. Braun (1980) and Braun, Williams and Lauener (1982) which concluded that energy education has a long term impact on knowledge, behavior and skills of participant households. These researchers concluded, based on studies conducted one to three years after the delivery of energy education, that limited resource households continue to use and expand energy conservation practices initially adopted.

Residential energy costs affect the amount of economic benefit households receive from various energy conservation practices. If residential energy costs go down, benefits associated with conservation practices are reduced. On the other hand, if residential energy costs increase from year to year, benefits will increase as well. Wharton Econometric Forecasting Associates (1984) project residential energy costs from 1984 through 1993. Table XVI reports the Wharton growth forecast for residential natural gas and electricity prices and the Consumer Price Index for a ten year period (1983-1993). Residential energy prices must be considered in light of the general rate of inflation which is indicated by the Consumer Price Index (Wharton Econometric Forecasting Associates, 1984, p. 7). The real rate of projected utility price change is the nominal rate minus the projected rate of inflation. The ten year average annual energy price change as projected by the Wharton forecast is 80 percent. This rate of price change was used for projected utility price changes for the ten year period from 1993 to 2002.

According to projected utility costs calculated by the computerized energy audit, participant households spend approximately an equal number of dollars on electricity as on natural gas. Thus, it is assumed that changes in natural gas and electric prices impact participant households equally. For this reason, changes in natural gas prices and changes in electricity prices were weighted equally to determine the average change in utility prices (Table XVI).

Table XVII reports the projected stream of benefits and costs associated with energy conservation practices adopted by selected limited resource households in southeastern Oklahoma. These benefits and costs are adjusted to reflect only those practices in effect at a given point in time and to reflect changes in real utility prices. Benefits and costs were discounted at two rates, four percent and six percent to determine the present value of benefits for a 20 year period from 1983 to 2002.

TABLE XVI

GROWTH FORECAST FOR RESIDENTIAL ENERGY PRICES

Year	CPI	Natural Gas % Increase Nominal	Natural Gas % Increase Real	Electricity % Increase Nominal	Electricity % Increase Real	Average Real Energy Price Change
1984	4.6	3.0	-1.6	6.5	1.9	0.15
1985	5.6	12.6	6.0	6.3	0.7	3.35
1986	5.9	9.0	3.1	4.8	-1.1	1.00
1987	6.3	8.9	2.6	5.7	-0.6	1.00
1988	5.7	7.5	1.8	5.2	-0.5	0.65
1989	6.0	7.5	1.5	4.8	-1.2	0.15
1990	4.9	7.3	2.4	3.8	-1.1	0.65
1991	6.0	7.3	1.3	5.1	-0.9	0.20
1992	5.5	7.4	1.9	4.5	-1.0	0.45
1993	5.5	7.5	2.0	4.3	-1.2	0.40

Relationship of Benefits to Costs from Various Perspectives

A variety of individuals and groups contributed to attaining benefits reported in this study. Among these are the funding agency which supported the Energy Education for Limited Resource Oklahomans, the Oklahoma Cooperative Extension Service, individuals, agencies, and groups outside participant households contributing to participant

TABLE XVII

STREAM OF BENEFITS AND COSTS FOR ENERGY CONSERVATION PRACTICES

	Benefits			Costs		
Year	Undiscounted	Discounted @ 4%	Discounted @ 6%	Undiscounted	Discounted @ 4%	Discounted @ 6%
1982-3	$ 7,356.15	*$ 7,356.15	*$ 7,356.15	$33,811.56	*$33,811.56	*$33,811.56
1984	7,359.19	7,076.14	6,942.62	321.96	309.08	302.64
1985	7,605.72	7,031.90	6,769.05	339.99	326.39	319.59
1986	6,691.12	5,948.40	5,617.99	-0-	-0-	-0-
1987	6,758.04	5,776.78	5,353.00	-0-	-0-	-0-
1988	5,934.17	4,877.45	4,434.36	-0-	-0-	-0-
1989	5,943.05	4,696.89	4,189.63	-0-	-0-	-0-
1990	5,981.70	4,545.59	3,978.17	-0-	-0-	-0-
1991	5,993.68	4,379.51	3,760.50	-0-	-0-	-0-
1992	6,020.63	4,230.01	3,563.60	-0-	-0-	-0-
1993	1,692.93	1,143.68	945.33	-0-	-0-	-0-
1994	1,706,48	1,108.50	898.95	-0-	-0-	-0-
1995	1,720.12	1,074.39	854.85	-0-	-0-	-0-
1996	1,733.90	1,041.33	812.91	-0-	-0-	-0-
1997	1,747.76	1,009.29	773.03	-0-	-0-	-0-
1998	1,761.75	978.23	735.12	-0-	-0-	-0-
1999	1,775.85	948.14	699.06	-0-	-0-	-0-
2000	1,790.05	918.95	664.75	-0-	-0-	-0-
2001	1,804.40	890.68	632.16	-0-	-0-	-0-
2002	1,818.80	863.28	601.13	-0-	-0-	-0-
TOTAL	$83,195.49	$65,895.29	$59,582.36	$34,473.51	$34,447.03	$34,433.79

*First year benefits and costs were not discounted.

household energy conservation efforts, and, most important, the participant households that adopted energy conservation practices. Each of these individuals and groups might view benefits and costs associated with the adoption of energy conservation practices by participant households a little differently.

Table XVIII reports calculated net present values for the benefits and costs associated with the adoption of energy conservation practices by selected households in southeastern Oklahoma. Net present values were calculated using undiscounted benefits and costs (interest rate equal to zero percent) as well as benefits and costs discounted at four percent and six percent. All net present value calculations yielded positive net present values and benefit-cost ratios greater than 1.

From the perspective of society in general the net present value was $48,721.98 while the value for benefits and costs discounted at four percent was $31,448.26 and $25,148.57. This finding is very impressive given the first year cost of $33,811.56 for implementing energy conservation practices. This first year cost was the primary cost of implementing energy conservation practices with minimal cost occurring after the initial first year cost. Given these findings, the adoption of self-help energy conservation practices by limited resource households yields a net benefit to society.

Benefit-cost ratios for benefits and costs to society associated with adoption of energy conservation practices are also reported in Table XVIII. The benefit-cost ratio values for benefits and costs to society is 2.41 while the ratio value for benefits and costs discounted at four percent is 1.91 and for benefits and costs discounted by six percent the ratio value is 1.73. These ratios indicate the importance of the discount rate selected for benefit-cost analysis. In all cases, as the discount rate increases, the benefit-cost ratio value decreases. However, even when the real discount rate of six percent is used, the ratio indicating the relationship of benefits to costs is very favorable. Clearly, benefits to society for adopting self-help energy conservation practices by limited income households are greater than the costs associated with the adoption of energy conservation practices.

TABLE XVIII

RELATIONSHIP OF BENEFITS TO COSTS FOR ADOPTING ENERGY CONSERVATION PRACTICES

Perspective	Undiscounted	Discounted @ 4%	Discounted @ 6%
Society			
Net Present Value	$48,721.98	$31,448.26	$25,148.57
Benefit-Cost Ratio	2.41 : 1.00	1.91 : 1.00	1.73 : 1.00
Oklahoma Corporation Commission			
Net Present Value	$68,565.91	$51,265.71	$44,952.78
Benefit-Cost Ratio	5.69 : 1.00	4.50 : 1.00	4.07 : 1.00
Participant Households			
Net Present Value	$71,853.04	$54,579.32	$48,279.63
Benefit-Cost Ratio	7.33 : 1.00	5.82 : 1.00	5.27 : 1.00

The Oklahoma Corporation Commission, through Energy Extension Service and State Energy Conservation Plan funds, supported a project designed to educate and motivate limited resource households to adopt energy conservation practices. Support of such projects implements the Commission's goal of reduced energy use in the residential sector and improved efficiency of energy use. This agency is particularly interested in the return on their investment of $14,629.50 that contributed to the energy education of 166 households. All costs to the funding agency were incurred the first year of the project. Net present value and benefit-cost ratios calculated on only funding agency costs, provides the funding agency an indication of the value of their investment in educating limited resource households to reduce residential energy consumption (Table XVIII). Net present value on undiscounted benefits is $68,565.91 and $51,265.71 on benefits discounted at four percent. The net present value on benefits discounted at six percent is $44,952.78. Benefit-cost ratio values calculated using only funding agency costs result in an undiscounted value of 5.69 and a value of 4.50 when discounted at four percent. Discounting benefits at six percent yields a benefit-cost ratio value of 4.07. All of these calculations reveal a substantial return on the Oklahoma Corporation Commission's investment in the Energy Education for Limited Resource Oklahomans project.

One of the key motivations for individual households to adopt energy conservation practices is the possibility of a net positive economic benefit. If benefits of adopting energy conservation practices are analyzed using only costs incurred by the households adopting the practice, this gives the household some indication of the return on the private household dollars invested in energy conservation efforts. For the present study, the 166 households invested $7,008.50 in supplies, and invested a total of 1,360 hours valued at $3,672 to learn how to implement energy conservation practices in their households the first year. Additional time was needed to reapply plastic storm windows and doors the second and third year. This resulted in total undiscounted costs to participant households of $11,342.45. If total household costs are discounted at four percent the household cost is $11,315.97, and if discounted at six percent, the household cost is $11,302.73. If only the investment of participant households is considered in calculating net present value and benefit-cost ratios, this will give individual households an indication of the return on their investment. When this private household investment is analyzed in relation to benefits, the undiscounted net present value is $71,853.04. When net present value of the private household investment is discounted at four percent the value is $54,579.32 and when discounted at six percent the net present value is $48,279.63. Benefit-cost ratios calculated at undiscounted rates, a four percent discount rate and a six percent discount rate results in the following values respectively: 7.33, 5.82, and 5.27 for resources invested by participant households to adopt energy conservation practices. This finding clearly indicates a substantial economic benefit to participant households for investing some of their limited resources in energy conservation efforts.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

This research was designed to analyze the impact of self-help changes made by limited resource households in their efforts to reduce household energy use and increase household comfort. Limited resource households include low-income, elderly, handicapped, and/or isolated households. The study focused on the impact that self-help efforts have on the energy use of private households and further, the potential impact that self-help efforts have on society. It was assumed that an aggregate of conditions, including an educational project conducted by Oklahoma State University Home Economics Cooperative Extension from May 1982 to May 1983 contributed to the households' decisions to adopt energy conservation practices.

Research focused on the economic benefits and costs related to the adoption of energy conservation practices by limited resource households in southeastern Oklahoma. Further the relationships of benefits and costs of adopting energy conservation practices were evaluated to determine policy implications.

Data for the study were collected as part of the Energy Education for Limited Resource Oklahomans project. The Oklahoma Corporation Commission provided the funds for the project. The purpose of the project was to implement a program to deliver energy management information to Oklahomans with limited resources and in addition to help these households increase their comfort, decrease their energy losses and control their utility costs. Paraprofessional energy educators under the direction of a site coordinator and the leadership of county and state Cooperative Extension professionals, delivered the energy education message to limited resource households. Small group and individualized in-home delivery methods were used to reach and teach the target group. The project emphasized inexpensive, home produced, easy-to-install methods of energy conservation designed to reduce heat gain in the summer and heat loss in the winter.

The project reached and taught individuals in 558 households in Choctaw and Pushmataha counties in Oklahoma. Of the households reached, 166 were reached during both the summer and winter project phases and had computerized energy audits performed on their houses. These 166 households formed the sample for the present study. The study sample was similar to the total group in terms of demographic characteristics and energy conservation adoption patterns and rates.

On or near the first visit with the households, the paraprofessional collected data to determine household characteristics and housing conditions. After the summer project phase and at the end of the winter project phase, paraprofessionals determined which practices and the number of practices adopted by participant households. In addition, data were collected to determine why households did or did not adopt energy conservation practices, if they planned energy conservation projects in the future, and who influenced their decisions to adopt. Computerized energy audits were used to document the thermal conditions of participant houses at the beginning of the project and to project dollar savings if various energy conservation practices were adopted.

Principle Findings

A review of the demographic characteristics of participant households revealed that all participant households fell within the definition of limited resource households. Participant households tended to be low income; many were elderly and were located in rural, relatively isolated counties in southeastern Oklahoma. This review led to the conclusion that the Energy Education for Limited Resource Oklahomans project reached the appropriate target group.

Data were further reviewed from two major analytical perspectives: extent of adoption, and economic consequences of adopting energy conservation practices by the 166 participant households. Analysis of variance procedures and paired t tests were run to determine if significant differences existed between the average number of conservation practices present in participant households at the beginning of the project, at the end of the summer phase of the project, and at the end of the winter project phase.

The analysis of variance indicated significant difference at the .0001 level. This finding indicated that significant mean difference existed between the average number of energy conservation practices present at each data collection point. Paired t tests completed on the mean number of practices present at each of the three data collection points, indicated that all means were significantly different at the .0001 level. This finding indicated that significant difference existed between the number of energy conservation practices present at the beginning of the project and the number of practices adopted by participant households during the summer phase of the project. Significant difference also existed between the number of energy conservation practices adopted during the summer project phase and the number of energy conservation practices adopted during the winter project phase. Further, significant difference existed between the number of conservation practices present at the beginning of the project and the number of practices adopted during the winter phase of the project. These empirical findings support the conclusion that participant households made significant housing and behavioral changes in an effort to reduce residential energy use. This finding demonstrates that limited resource households, given adequate information and motivation, will adopt self-help energy management strategies.

The significant amount of change documented by this empirical analysis was carefully considered in light of events and conditions existing during the study period. The impact of the energy education project, changes in utility prices, changes in household income, and the influence of other educational efforts existing during the study period were reviewed.

Natural gas and electricity prices increased somewhat during the study period. A comparison of the changes in winter rates for natural gas and the changes in summer rates for electricity, yielded price changes in the range of five to ten percent. This change, coupled with relatively price-inelastic demand values, implied a small influence from changes in utility rates during the study period Virtually no change in real income occurred for participant households during the study period. Thus, changes in household income were disregarded as a viable source of motivation for energy conservation practices adopted by participant households. Educational efforts other than the Energy Education for Limited Resource Oklahomans project, conducted during the study period, were very low key and focused at the household's awareness level. These educational efforts may have resulted in some increased knowledge of participant households but probably did little to motivate change. Thus, although variables other than the Energy Education for Limited Resource Oklahomans project may have impacted adoption somewhat, the results of this study indicate that this educational project contributed substantially to the adoption of energy conservation practices by limited resource households in southeastern Oklahoma.

Energy conservation practices adopted by limited resource households were analyzed in a benefit-cost formula to assess the economic returns of self-help approaches used to help limited resource households cope with energy problems. The Energy Education for Limited Resource Oklahomans project was considered a motivating force in influencing the target group to adopt energy conservation practices. The benefit-cost analysis was designed to provide both private and public decisionmakers with information regarding the value of residential energy education for limited resource households. The question posed was, "Are participant households and is society in general better off as a result of the energy conservation practices adopted by selected households in southeastern Oklahoma?" This study indicates that, "yes", participant households as well as society are better off as a result of limited resource households adopting energy conservation practices. Further, benefit-cost analysis provided valuable information to the agency funding the Energy Education for

Limited Resource Oklahomans project to help the agency determine if public funds invested in the project were invested properly.

Benefit-cost analysis was performed on all costs associated with implementing energy conservation practices, including the cost of providing the educational project; money and time invested by participant households; and money, goods, services and time provided by subsidy sources. The resulting net present value for undiscounted costs and benefits was $48,721.98. Net present value resulting when benefits and costs were discounted at four percent was $31,448.26 and $25,148.57 when discounted at six percent. Further, benefit-cost ratio values were 2.41, 1.91, and 1.73 when calculated at undiscounted rates, at four percent, and six percent respectively. These findings indicate a substantial net positive benefit to society resulting from energy conservation practices adopted by limited resource households.

Further analysis of costs and benefits indicate substantial return to limited resource households for their investment of time, money, and effort into energy conservation practices. Benefit-cost ratios calculated at undiscounted, a four percent discount rate and a six percent discount rate resulted in the following ratio values respectively: 7.33, 5.82, and 5.27. This is a substantial net positive benefit to the household. This finding suggests substantial returns to limited resource households for investing some of their resources in energy conservation practices.

When only the direct costs incurred by the Corporation Commission for funding the Energy Education for Limited Resource Oklahomans project were analyzed in relation to benefits, the analysis yielded net present values of $68,565.91 (undiscounted), $51,265.71

(discounted four percent) and $44,952.78 (discounted six percent). Further, benefit-cost ratios based only on funding agency direct costs resulted in an undiscounted value of 5.69 and a value of 3.50 when discounted four percent. Discounting benefits at six percent resulted in a benefit-cost ratio value of 3.07.

Clearly, based on the results of benefit-cost analysis, this researcher concludes that society, participant households and the agency funding the energy education project accrued significant economic benefits. These findings demonstrate the potential economic benefit of energy education for limited resource households.

Recommendations

Suggested recommendations are based on the results of this research project. The recommendations are presented in three categories: (1) recommendations related to the development, implementation and evaluation of an energy education project designed to meet the unique needs of limited resource households; (2) recommendations regarding energy policy formation; (3) recommendations for future research.

Program Related Recommendations

1. In an effort to reduce project delivery costs, this researcher suggests linking the educational component of an energy education project with other agencies and groups offering energy related services. For example, rather than having paraprofessional energy educators complete computerized energy audits, the energy

educators could work with utility companies to complete audits on participant households. This strategy would reduce costs of delivering the educational message, assist utility companies in reaching clientele they have difficulty in reaching with the audit, increase the participant households' awareness of services provided by other community agencies and groups, as well as increase the knowledge of utility company personnel regarding the unique needs of limited resource clientele. Another possible linkage is with civic, religious, and service groups. These volunteer groups could be used to multiply efforts of energy project staff. Such groups could provide a variety of support services including: conducting public meetings, displays, demonstrations, and assisting participant households in implementing conservation practices.

2. Another recommendation is to improve the data collection system to include additional checks on accuracy and consistency of data collection procedures. Survey instruments were consistently checked by the project site coordinator, however, several potential economic benefits could not be claimed by this study due to missing data and/or data incorrectly reported. Additional data control procedures would substantially increase the accuracy of the project's accountability.
3. A further recommendation is to revise the project accounting procedures to more readily reflect costs incurred by a specific site. When benefit-cost

procedures were completed on project related costs, it was sometimes difficult to separate costs specifically related to the educational delivery on site and other project related costs. This revision is particularly important as the project expands to include multiple sites.

4. The project staff should develop and distribute a procedures manual to assist agencies and groups wishing to implement energy education programs for limited resource households. This manual would incorporate knowledge gained regarding the development, implementation and evaluation of energy education efforts designed to reach and teach the hard to reach limited resource population.

5. This researcher recommends that training and evaluation materials developed as a result of the Energy Education for Limited Resource Oklahomans project and other similar projects conducted by Oklahoma State University Home Economics Cooperative Extension be packaged into self-contained units. Thus, these materials could be used by other agencies and groups wishing to implement energy education programs targeted at a limited resource audience.

Policy Recommendations

1. The researcher recommends that policymakers consider energy education, along with monetary subsidies and

weatherization, as a viable approach to helping limited resource households cope with residential energy price increases. This means that energy education would receive funding support comparable to the levels of support for weatherization and monetary subsidies.

2. Energy program planners and researchers should perform benefit-cost analysis on energy education projects to increase the knowledge base necessary to support policy decisions at local, state, and federal levels regarding the role of education in assisting limited resource households to cope with energy related problems.
3. Energy program planners and researchers should perform benefit-cost analysis on other programs such as weatherization and monetary assistance programs to determine the relationship of benefits to costs thus providing a knowledge base for future policy decisions regarding energy assistance programs.

Future Research Recommendations

1. Future researchers could refine the research design used for the present study to include a control for intervening variables such as utility rate changes, changes in household income, changes in household composition, and other educational programs being conducted simultaneously with the educational effort being studied. This would provide a clearer link between energy conservation changes made and the

independent variable under study, in this case the energy education project. The research design could be further refined to include random selection of participant households and a control group. Again, these design refinements would help establish a stronger link between changes made by households in the study sample and the educational project.

2. Future research needs to quantify benefits related to the adoption of energy conservation practices. Several benefits related to adopting energy conservation practices for the present study were not quantified in monetary terms due to the lack of sound methodology to assign dollar values to these benefits. If an accurate benefit-cost relationship is to be determined, researchers should attempt to quantify all benefits related to the adopting of energy conservation practices. For example, research is badly needed to determine the economic benefits associated with increased household comfort. Does increased comfort increase household productivity as well as improve the household environment from a health and social standpoint? These important research questions need to be explored.

3. Researchers need to develop inferential research methods to assist in determining the impacts of energy education programs similar to the Energy Education for Limited Resource Oklahomans project conducted in Choctaw and

Pushmataha Counties from May 1982 to May 1983. For example, over 6,000 households have been reached by similar projects conducted throughout Oklahoma since 1977. How can the economic impact of these educational efforts be assessed? Further, how can future energy education projects modeled after the energy education project conducted in southeastern Oklahoma be evaluated in terms of their economic impact using the most efficient research design and data collection techniques? These research questions are important from a policy standpoint since the educational project impact must be accurately determined with the least amount of project funds devoted to the effort. The bulk of project funds should go to serving the target population. Resource efficient techniques of impact assessment must be developed to reach this program objective.

4. Researchers need to determine how the lag effect relates to the period of time for adoption of practices suggested by an educational program such as the Energy Education for Limited Resource Oklahomans project. This would require that adoption data be collected on participant households on a long term basis.
5. Future projects should collect actual utility data on participant households to relate actual utility use patterns to energy savings projected by the computerized energy audit methodology. Researchers and policymakers

need to study the feasibility of formally linking subsidy and weatherization programs with an educational component to increase the impact of all of these program efforts.

SELECTED BIBLIOGRAPHY

Acton, J., Mitchell, B., and Mowill, R. (1976). Residential demand for electricity in Los Angeles: An econometric study of disaggregate data. Santa Monica, California: The Rand Corp.

American Society of Heating, Refrigeration, and Air-Conditioning Engineers. (1981). Handbook of fundamentals. New York: Author.

Anderson, K. P. (1973). Residential energy use: An econometric analysis. (R-1297-NSF). Santa Monica, California: The Rand Corp.

Bailey, A. W. (1979). Socioeconomic variables and attitudes of consumers related to energy conservation behavior. Unpublished doctoral dissertation, Ohio State University, Columbus, Ohio.

Barnes, R., Gillingham, R., and Hagemann, R. (1981, November). The short-run residential demand for electricity. Review of Economic Statistics, 63(4), 541-552.

Barnes, R., Gillingham, R., and Hagemann, R. (1982, January). The short-run residential demand for natural gas. Energy Journal, 3(1), 59-72.

Battalio, R. C., Kagel, J. H., Winkler, R. C., and Winett, R. A. (1979). Residential electricity demand: An experimental study. The Review of Economics and Statistics, 61(2), 180-189.

Beckey, T. and Nelson, L. W. (1981). Field test of energy savings with thermostat setback. ASHRAE Journal, 23(1), 67-70.

Betancourt, A. A. (1980). A fan for all seasons. Historic Preservations, 32(4), 28-31.

Bloch, F. (1977). Residential demand for natural gas. (Research Memorandum No. 210). Econometric Research Program, Princeton University, Princeton, New Jersey.

Braun, B., Williams, S., and Lauener, N. L. (1983). Energy assistance for the aged. Stillwater, Oklahoma: Cooperative Extension Service, Oklahoma State University.

Braun, B., Williams, S., and Murray, L. (1979, January). Models for energy conservation communication systems. Proceedings of the 1979 National Conference on Technology for Energy Conservation, (pp. 500-504). Tucson, Arizona.

Braun, W. J. (1980). The use of paraprofessionals in influencing senior citizens to adopt weatherization practices. Unpublished paper presented to Seminar in Social Gerontology, Stillwater, Oklahoma.

Bronner, D., Lindamood, S., and Hanna, S. (1983, June). Factors related to winter thermostat settings. Poster Session #18 presented in research proceeding of 74th annual meeting and exposition of the American Home Economics Association, Milwaukee, Wisconsin.

Buesing, J. W. (1981, August). Energy conserving window treatments: insulated shades and draperies. (Publication No. B3064). Madison, Wisconsin: University of Wisconsin Extension.

Campbell, D., and Stanley, J. (1963). Experimental and quasi-experimental design for research. Boston: Houghton-Mifflin Company.

Carr, R. I., Feng, C. C., and Schwartz, R. A. (1978, January). Residential energy use decisions. Proceedings of the 1978 National Conference on Technology for Energy Conservation, (pp. 434-439). Albuquerque, New Mexico.

Center for Economic and Management Research, College of Business Administration, The University of Oklahoma. (1982). Statistical Abstract of Oklahoma 1982. Norman, Oklahoma: Author.

Christensen, R. L., and Pontius, J. (1983, December). Using economics in evaluation of Extension programs. Paper presented at National Extension Workshop on Evaluation, Washington, D. C.

Consumer Energy Council of America. (1981). Comprehensive analysis of the costs and benefits of low income weatherization. Washington, D. C.: Author.

Cukierski, G. (1981). Insulating windows: The inside story. (Extension Publication Information Bulletin No. 172). Ithaca, New York: New York State College of Human Ecology, Cooperative Extension and New York State College of Agriculture and Life Science.

Cunningham, W. H., and Lopreato, S. C. (1977). Energy use and conservation incentives. New York: Praeger Publishers.

Dix, R. C., and Zalman, L. (1974, December). Window shades and energy conservation. Chicago, Illinois: Illinois Institute of Technology.

Dole, S. H. (1975, June). Energy use and conservation in the residential sector: A regional analysis. (Report No. R-1614-NSE). Santa Monica, California: Rand Corporation.

Elrick and Lavidge, Inc. (1982, October). Energy conservation survey report of findings. (Report No. AGS: CM #10-0733). Atlanta, Georgia: Author.

Feldstein, M. S., and Summers, L. (1977). Is the rate of profit falling? Brookings Papers on Economic Activity 1. (pp. 211-277). Washington, D.C.: The Brookings Institute.

Ford Foundation. (1976). The American energy consumer: Rich, poor and in-between. In A Time to Choose America's Energy Future. (Fourth Printing). Cambridge, Massuchusetts: Ballinger Publishing Company.

Ford Foundation. (1979). Energy the next twenty years. Cambridge, Massuchusetts: Ballinger Printing Company.

French, A. M., Christopher, J. R., and Shieh, S. J. (1981, June). An assessment of the conduct of the expanded food and nutrition program in selected sites. Rosslyn, Virginia: Inter-America Research Associates, Inc.

Gramlich, E. M. (1981). Benefit-cost analysis of government programs. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

Griffin, J. M., and Steele, H. B. (1980). Energy economics and policy. New York: Academic Press, Inc.

Gross, I. H., Crandall, E. W., and Knoll, M. M. (1973). Management for modern families. New York: Appleton-Century-Crofts.

Guralnik, D. B. (Ed.) (1978). Webster's new world dictionary of the American language. Cleveland, Ohio: William Collins World Publishing Co., Inc.

Hager, N. E., Jr., and Phillips, W. W. (1980). Reducing heat loss through window retrofitting. ASHRAE Journal, 22(3), 55-58.

Hanke, S. H. (1979). On the benefits and costs of energy conservation. Journal of Energy and Development, 5(1), 123-124.

Hanrahan, J. (1981). The rebirth of ceiling fans. Appliance, 38(2), 19-23.

Haynes, B. C., Simons, J. W., McDougal, K. F., and Mize, J. J. (1969, November). Thermal properties of carpets and draperies. (Research Bulletin No. 68). Athens, Georgia: University of Georgia College of Agriculture Experiment Stations and United States Department of Agriculture Research Service, Agricultural Engineering Division.

Henderson, D. Y. (1982). Rising energy prices and the propensity to retrofit the dwelling. Unpublished master's thesis, Iowa State University, Ames, Iowa.

Hinrichs, H., and Taylor, G. M. (1976). Systematic analysis. New York: Praeger.

Hirst, E. (1981). The role of data in evaluating energy conservation programs. Evaluation and Program Planning, 4, 219-228.

Howe, C. W., and Vaughn, W. J. (1972, February). In-house water savings. Journal of American Water Works Association, 118-121.

Institute for Research on Poverty. (1984). Poverty in the United States: Where do we stand now? IRP FOCUS, 7(1) (ISSN: 0195-5705).

Jones, L. K., and Harp, S. (1981a). Calculation procedures: Oklahoma residential conservation service program plan. Unpublished manuscript.

Jones, L. K., and Harp, S. L. (1981b, June). Comparison of three economic evaluation techniques for energy conservation measures. Paper presented at 1981 American Society of Agricultural Engineers meeting, Orlando, Florida.

Jones, K., and Harp, S. (1980). Fuel type and thermal efficiency: major factors in home heating costs. Stillwater, Oklahoma: Oklahoma State Cooperative Extension Service.

Katz, E. (1957, Spring). The two step flow of communication: An update report on an hypothesis. Public Opinions Quarterly, 21, 237-252.

Katz, E., Levin, M. L., and Hamilton, H. (1963, April). Traditions of research on the diffusion of innovation. American Sociological Review, 28(2), 237-252.

Kelkeary, R. (1975). The energy crisis and decision-making in the family. (Publication No. PB238783). Springfield, Virginia: National Information Service, U.S. Department of Commerce.

Konzo, S. (1980). Summer comfort. Council Notes, 4(1), Urbana-Champaign, Illinois: University of Illinois, Small Homes Council-Building Research Council.

Kyrk, H. (1953). The family in the American economy. Chicago, Illinois: University of Chicago Press.

Landsberg, H. H., Schanz, J. J., Schurr, S. H., and Thompson, A. P. (1974). Energy and the social sciences, an examination of research needs. Washington, D. C.: Resources for the Future, Inc.

Langdon, H. E. (1980). Movable insulation. Emmaus, Pennsylvania: Rodale Press.

Lasswell, H. E. (1948). The structure and function of communication in society. In L. Byson (Ed.), The Communication of Ideas. (p. 37). New York: Harper and Row.

Lionberger, H. F. (1974). The innovation acceptance decisions people make. Considerations for Community Decisionmaking. Columbia, Missouri: University of Missouri Extension Division.

Lionberger, H. F., and Gwin, P. H. (1982). Communication strategies: A guide for agriculture change agents. Danville, Illinois: The Inter-State Printers and Publishers, Inc.

Liston, M. I. (1966). Management in the family group. Unpublished manuscript, Iowa State University, Ames, Iowa.

MacAvoy, P. W. (1983). Energy policies. New York: W. W. Norton.

Makela, C., Chatelain, L., Dillman, D., Dillman, J., and Tripple, P. (1983). Energy directions for the United States: A western perspective. (Publication No. 13). Corvallis, Oregon: Western Rural Development Center.

Marganus, M., Olson, G., and Badenhop, S. (1982, August). Attitudes and behavior toward energy consumption. Proceedings of the Impact of Energy Policy and Technology on the Family Conference. Knoxville, Tennessee: University of Tennessee, College of Home Economics.

Masters, S., Garfinkel, I., and Bishop, J. (1978, Fall). Benefit-cost analysis in program evaluation. Journal of Social Service Research, 2(1), 79-93.

McPherson, M. B. (1978). Conservation in household water use. In D. Holtz and S. Sebastian (Eds.), Municipal Water Systems. Bloomington, Indiana: Indiana University Press.

Morrison, B. M., and Gladhart, P. M. (1976, January). Energy and families: The crisis and response. Journal of Home Economics, 68(1), 15-18.

Morrison, J. W. (1979). The complete energy-saving home improvement guide. New York: Avco Publishing, Inc.

Murray, L. F. (1978). Energy education methodologies for limited income families. Unpublished master's thesis, Oklahoma State University, Stillwater, Oklahoma.

Murray, L., Braun, B., and Williams, S. (1979, January). Energy education methodologies for limited income families. Proceedings of the 1979 National Conference on Technology for Energy Conservation. (pp. 466-470). Tucson, Arizona.

Murray, T. J. (1982). Selecting a new furnace. (Report No. E 3190). Madison, Wisconsin: University of Wisconsin Extension.

Newman, D. K., and Day, D. (1975). The American energy consumer: A report to the energy policy project of the Ford Foundation. Cambridge, Massachusetts: Ballinger Publishing Company.

Nowak, P. J. (1983, March). Adoption and diffusion of soil and water conservation practices. The Rural Sociologist, 3(2), 83-91.

Office of Consumer Affairs. (1980). People power: What communities are doing to counter inflation. Washington, D. C.: Author.

Oklahoma Corporation Commission, Energy Conservation Services Division. (1983). Echo 2: Energy conservation helps Oklahomans, Oklahoma state plan residential conservation service program. Oklahoma City, Oklahoma: Author.

Oklahoma Department of Human Services. (1984, March). Environmental scanning report. Oklahoma City, Oklahoma: Author.

Oklahoma Department of Human Services. (1983). Fiscal year 1983 statistical report, July 1, 1982 to June 30, 1983. (DHS Publication No. 83-58). Oklahoma City, Oklahoma: Author.

Oklahoma Employment Security Commission. (1983a). County employment and wage data. Oklahoma City, Oklahoma: Author.

Oklahoma Employment Security Commission. (1983b, July 15). Oklahoma labor market. Oklahoma City, Oklahoma: Author.

Olson, K. W. (1983). State trust funds financed by severance taxes: A cost-benefit analysis. Unpublished paper, College of Business Administration, Oklahoma State University, Stillwater, Oklahoma.

Paolucci, B., Hall, O. A., and Axinn, N. W. (1977). Family decision making: An ecosystem approach. New York: John Wiley and Sons.

Perceptions of alternative housing: A data book. (1983, September). (Southern Cooperative Series Bulletin No. 298). Athens, Georgia: University of Georgia, College of Agriculture Experiment Station.

Planergy, Inc. (1981). Energy conservation helps Oklahoma. Austin, Texas: Author.

Randall, A. (1981). Resource economics, an economic approach to natural resource and environmental policy. Columbus, Ohio: Grid Publishing, Inc.

Riley, J. W., Jr., and Riley, M. W. (1961). Mass communication and the social system. In R. K. Merton (Ed.), Sociology Today. (pp. 537-578). New York: Basic Books, Inc.

Rogers, E. M. (1983). Communication of innovations. New York: The Free Press.

Roos, N. P. (1973). Quasi-experimental approaches, testing theory and evaluating policy. In J. A. Caporaso and L. L. Roos, Jr. (Eds.), Evanston, Illinois: Northwestern University Evaluation.

Rossi, P. H., Freeman, H. E., and Wright, S. R. (1979). Evaluation: A systematic approach. Beverly Hills: Sage Publications.

Roth, T. P. (1981, September). Average and marginal price changes and the demand for electricity. Applied Economics, 13(3), 377-388.

Sassone, P. G., and Schaffer, W. A. (1978). Cost-benefit analysis, a handbook. New York: Academic Press.

Seaman, P. B. (1978, September). Energy saving window treatments. (Publication No. L-1674). College Station, Texas: Texas Agricultural Extension Service.

Smith, M. M. (1982, Spring). The low-income energy assistance program. Journal of Energy and Development, 1(2), 253-269.

Socolow, R. H. (1978, April). The Twin Rivers program on energy conservation in housing: Highlights and conclusions. Energy and Buildings, 1(3), 225.

Spector, P. E. (1981). Research designs. Beverly Hills: Sage Publications.

State Extension plan of work report guidelines October 1, 1983 - September 30, 1987: Extension accountability evaluation system. (1982, July). Washington, D. C.: United States Department of Agriculture.

Stobaugh, R., and Yergin, D. (Eds.). (1979). Energy future. New York: Random House.

Survey measures consumer energy concerns. (1983, January). Energy Conservation Digest, 6(2), 5.

Task Force on National Trends and Family Educational Needs. (1980). Extension Home Economics in the '80's. Lexington, Kentucky: College of Agriculture Cooperative Extension Service.

Taylor, L. D. (1975). The demand for electricity: A survey. Bell Journal of Economics, 6(1), 74-110.

Thompson, M. S. (1980). Benefit-cost analysis for program evaluation. Beverly Hills: Sage Publications.

Treasury Board Secretariat, Planning Branch. (1976). Benefit-cost analysis guide. Ottawa, Canada: Information Canada.

U. S. Congress, House Committee on Banking, Finance and Urban Affairs. (1981). Basic laws of housing and community development. (Committee Print No. 97-9). Washington, D. C.: Government Printing Office.

U. S. Department of Commerce, Bureau of Economic Analysis. (1983, October). Survey of current business, 63(10). Washington, D. C.: Author.

U. S. Department of Energy. (1979, March). Evaluation of the Energy Extension Service Pilot Program. DOE/CS-0074. Washington, D. C.: Author.

U. S. Department of Energy. (1983, April). Synopsis of the annual energy review and outlook-1982. Washington, D. C.: Author.

U. S. Department of Energy, Office of the Assistant Secretary of Conservation and Solar. (1980). Residential conservation service auditor training manual, Washington, D. C.: Author.

U. S. Executive Office of the President. (1977). National energy plan. Washington, D. C.: Author.

U. S. Office of Technology Assessment. (1979a). Residential energy conservation, Volume I. Washington, D. C.: Government Printing Office.

U. S. Office of Technology Assessment. (1979b). Residential energy conservation, Volume II. Unpublished working paper. Washington, D. C.

van der Hoeven, G. A. (1982, November). Energy efficient landscaping. Manhattan, Kansas: Kansas State University Cooperative Extension Service.

Volker, C. B., and Deacon, R. E. (1980). Report on evaluation of benefits from research in home economics. Ames, Iowa: Iowa Agriculture and Home Economics Experiment Station.

Walker, N. E., and Draper, L. (1975). The effects of electricity price increases on residential usage by three economic groups: A case study. Texas Nuclear Power Policies. Austin, Texas: University of Texas Center for Energy Studies.

Washington Suburban Sanitary Commission. (1974). Final report: Washington Suburban Sanitary Commission's water conservation/waste water reduction, customer education and behavior change program. Hyattsville, Maryland: Author.

Welch, W. C. (1979, January). Landscaping for energy conservation. (Publication No. L-1709). College Station, Texas: Texas Agricultural Extension Service

Wharton Econometric Forecasting Associates. (1984). Long-term forecast, 2(2). Philadelphia, Pennsylvania: Author.

Wilder, R. P., and Willenborg, J. F. (1975). Residential demand for electricity: A consumer panel approach. Southern Economic Journal, 42(2), 212-217.

Williams, S., and Braun, B. (1981). Energy education for limited income families: The Choctaw project. (Final Report for Contract No. 291-46-G-69119-45-5). Stillwater, Oklahoma: Oklahoma Cooperative Extension Service.

Williams, S. E., and Wilson, K. (1983). Energy education for limited resource Oklahomans. Stillwater, Oklahoma: Oklahoma State University Cooperative Extension Service.

Winer, B. J. (1971). Statistical principles in experimental design. (2nd ed.). New York: McGraw-Hill Book Company.

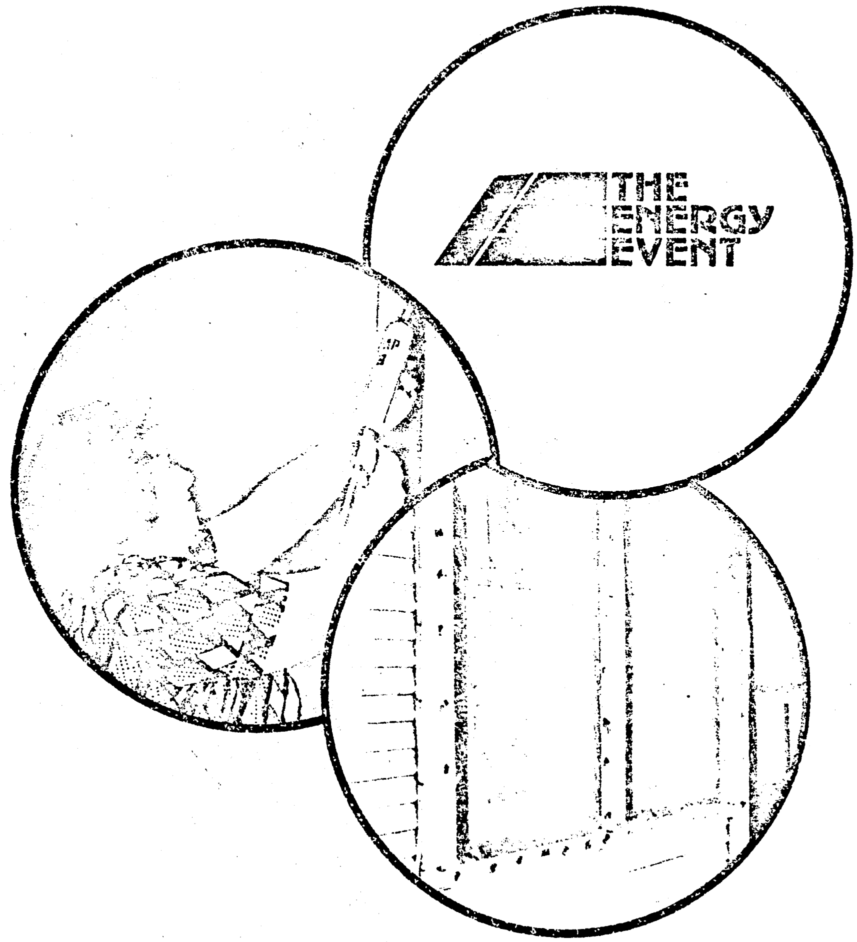
Yellott, J. I., and Ewing, W. B. (1976, July). Energy conservation, exterior shading of fenestration techniques. ASHRAE Journal, 18(7), 23-30.

APPENDIXES

APPENDIX A

ENERGY EDUCATION FOR OKLAHOMA FAMILIES

FORMS BOOKLET



Energy Education For Oklahoma Families

Forms Booklet

Oklahoma State University
Cooperative Extension Service and
Oklahoma Corporation Commission

ID Number ___ ___ ___ ___

Name________________________________

THE ENERGY EVENT

ID Number	Date	Aide Name

Respondent __ __ __ __1-4

Card No. 01 5-6

District __7

County __8

City __9

Aide __10

HOUSEHOLD AND HOUSING INFORMATION

INSTRUCTIONS: Ask the following questions and put an "X" in the space that matches the answer.

I. INFORMATION ABOUT OCCUPANTS

1. What is the sex of the household head?
   ____1. Male head, female present
   ____2. Female head, male present
   ____3. Male and female co-heads
   ____4. Male head, no female present
   ____5. Female head, no male present __11

2. In what year was the head of household born? ________ year ______ age __ __12-13

3. How many years of schooling did the head of household complete?____ years __ __14-15

   What is the highest grade or degree completed by the head of household? __________

4. How many people are living in this house? ________ # people __ __16-17

5. What is your family's monthly household income? ________ monthly __ __ __ __18-21

6. How many children are living in this house? ________ # children __ __22-23

	SEX	AGE	SEX	AGE
Example	M	3	___	___
	___	___	___	___
	___	___	___	___

__24 __ __25-26
__27 __ __28-29 __30 __ __31-32
__33 __ __34-35 __36 __ __37-38

II. INFORMATION ABOUT THE HOUSE

7. In which type of house do you live?
   ____1. Single family
   ____2. Duplex
   ____3. Apartment
   ____4. Mobile home
   ____5. Other (specify) ______________________ __39

8. Do you rent or own your home?
   ____1. Rent
   ____2. Own
   ____3. Live rent free __40

9. Do you pay any part of your utility bill (electric, water, gas)?
   ____1: All
   ____2. Part
   ____3. None __41

THE ENERGY EVENT

Should Complete On First Visit To Home

ID Number	Date	Aide Name

Respondent ____ 1-4

Card No. 04 5-6

BEGINNING HOUSING CONDITION

INSTRUCTIONS

Survey the house and record whether or not the following items are present.

Items	NA	yes	no	if yes, indicate N	S	E	W	
1. Ceiling insulation *if yes, record R-Value* ______								
2. Wall insulation *if yes, record R-Value* ______								__7 __ __8-9
3. Floor insulation *if yes, record R-Value* ______								__10 __ __11-12
4. Caulking and/or weatherstripping check the condition that best describes the house now								__13 __ __14-15 __16 __17
____ Good Condition - Tight fitting windows and doors, caulked and weatherstripped.								
____ Fair Condition - Average fit, partially caulked and weatherstripped.								
____ Poor Condition - No caulking or weatherstripping.								
5. Duct insulation *if yes, check below*								
____ 1 inch								
____ 2 inch								__18 __19
6. Storm doors								__20 __21 __22 __23 __24
7. Storm windows								__25 __26 __27 __28 __29
8. Indoor roll-up shades								__30 __31 __32 __33 __34
9. Roman shades								__35 __36 __37 __38 __39
10. Draperies								__40 __41 __42 __43 __44
Drapery liners								__45 __46 __47 __48 __49
12. Window inserts								__50 __51 __52 __53 __54
13. Venetian blinds								__55 __56 __57 __58 __59

THE ENERGY EVENT

Respondent — — — —1-4

Card No. 05 5-6

Items	NA	yes	no	if yes, indicate N	S	E	W	
14. Outdoor roll-up shades								—7 —8 —9 —10 —11
15. Awnings								—12 —13 —14 —15 —16
16. Sun screen								—17 —18 —19 —20 —21
17. Solar control film								—22 —23 —24 —25 —26
18. Louvered visors for windows								—27 —28 —29 —30 —31
19. Louvered visors for doors								—32 —33 —34 —35 —36
20. Louvered visors for cooling units								—37 —38 —39 —40 —41
21. Landscaping — Deciduous trees								—42 —43 —44 —45 —46
22. Landscaping — Deciduous shrubs								—47 —48 —49 —50 —51
23. Landscaping — Evergreen trees								—52 —53 —54 —55 —56
24. Landscaping — Evergreen shrubs								—57 —58 —59 —60 —61
25. Winter thermostat setting record setting here ______								—62 — —63
26. Summer thermostat setting record setting here ______								—65 — —66-67
27. Ceiling fan								—68
28. Portable fan								—69
29. Whole house/attic fan								—70
30. Home heating system								—71

if yes, check type

- __ Natural gas - Central forced air
- __ Natural gas - Floor furnace or wall heater
- __ Propane - Central forced air
- __ Propane - Floor furnace or wall heater
- __ Electric resistance - Central forced air
- __ Electric resistance - Floor furnace or wall heater —72
- __ Heat pump
- __ Wood heat
- __ Other (specify) ______________________

THE ENERGY EVENT

Respondent — — — —1-4

Card No. 06 5-6

Items	NA	yes	no	if yes, indicate N	S	E	W	
31. Home air conditioning system								
if yes, check								—7
__ Central forced air system or								—8
__ Window unit, *if yes indicate*								—9
__ age of unit (years) and if								—10
__ cools whole house, *if not indicate*								—11
__ number of rooms cooled								—12
32. Leaky hot water faucets								—13
33. Insulated hot water pipes								—14
34 Insulated hot water tank								—15
35. Hot water tank								—16

if yes, check the current temperature setting

__ High = 141° - 160°

__ Medium = 121° - 140° —17

__ Low = 100° - 120°

Are any of the following conditions present in the house? (check NO if not present, MINOR or MAJOR if present)

No	Minor	Major		
____	____	____	A. Leak(s) in the roof	—18
____	____	____	B. Crack(s) (other than hairline) in walls or ceilings	—19
____	____	____	C. Sag(s) or bulge(s) in walls or ceilings	—20
____	____	____	D. Peeling paint on inside walls	—21
____	____	____	E. Peeling paint on outside walls	—22
____	____	____	F. Decay of door and/or window frame	—23
____	____	____	G. Uneven floors	—24
____	____	____	H. Holes or badly worn places in floor coverings	—25
____	____	____	I. Broken or missing window panes	—26
____	____	____	J. Broken or missing materials on exterior walls or foundation	—27

THE ENERGY EVENT

ID Number	Date	Aide Name

Respondent __ __ __ __ 1-4
Card No. 07 5-6

MID PROJECT CONSERVATION CHECKLIST

INSTRUCTIONS
Record all changes made by this household from the time you first contacted them. For each question put a check (✓) in the appropriate block indicating the change.

ACTIVITIES	NA	yes	no	If yes, indicate N	S	E	W	Household time spent	Household money spent	If subsidized, indicate kind	$	hours	sources		
1. Added ceiling insulation *if yes, record R-Value* ______														__7	
2. Added wall insulation *if yes, record R-Value* ______														__22	
3. Added floor insulation *if yes, record R-Value* ______														__37	
4. Added caulk and/or weatherstripping *check the condition that best describes the house now* __ Good Condition - Tight fitting windows and doors, caulked and weatherstripped. __ Fair Condition - Average fit, partially caulked and weatherstripped. __ Poor Condition - No caulking or weatherstripping.														__52	Card No. 08 5-6
5. Added duct insulation *if yes, check below* __ 1 inch __ 2 inch														__7 __8	
6. Added storm doors														__26 __27 __28 __29 __30	
7. Added storm windows														__45 __46 __47 __48 __49	Card No.
8. Added indoor roll-up shades														__64 __65 __66 __67 __68	09 5-6
9. Added roman shades														__21 __22 __23 __24 __25	
10. Added draperies														__40 __41 __42 __43 __44	Card No.
11. Added drapery liners														__59 __60 __61 __62 __63	10 5-6
12. Added window inserts														__21 __22 __23 __24 __25	
13. Added venetian blinds														__40 __41 __42 __43 __44	Card No.
14. Added outdoor roll-up shades														__59 __60 __61 __62 __63	11 5-6
15. Added awnings														__21 __22 __23 __24 __25	
16. Added sun screen														__40 __41 __42 __43 __44	Card No.
17. Added s[illegible] control film														__59 __60 __61 __62 __63	12 5-6
18. Added l[illegible]ered visors for windows														__21 __22 __23 __24 __	

THE ENERGY EVENT

ACTIVITIES	NA	yes	no	if yes, indicate N	S	E	W	Household time spent	Household money spent	if subsidized, indicate kind	$	hours	sources	Codes	Card
19. Added louvered visors for doors														__40 __41 __42 __43 __44	Card No.
20. Added louvered visors for cooling units														__59 __60 __61 __62 __63	13 5-6
21. Added landscaping - deciduous trees														__21 __22 __23 __24 __25	
22. Added landscaping - deciduous shrubs														__40 __41 __42 __43 __44	Card No.
23. Added landscaping - evergreen trees														__59 __60 __61 __62 __63	14 5-6
24. Added landscaping - evergreen shrubs														__21 __22 __23 __24 __25	
25. Reduced winter thermostat setting														__40	
if yes, record temp. setting ______															
26. Increased summer thermostat setting														__55	
if yes, record temp. setting ______														Card No. 15 5-6	
27. Added ceiling fan														__7	
28. Added portable fan														__22	
29. Added whole house/attic fan														__37	Card No.
30. Purchased efficient heating equipment														__52	16 5-6
if yes, record kind ______															
31. Purchased efficient cooling equipment														__21	
if yes, record EER ______															
32. Repaired leaky hot water faucets														__36	
33. Insulated hot water pipes														__51	Card No.
34. Insulated hot water tank														__66	17 5-6
35. Reduced hot water tank temp. setting														__21	
if yes, check the current temp. setting __ High = 141° - 160° __ Medium = 121° - 140° __ Low = 100° - 120°															
36. Made and used windbreakers														__36	
37. Added humidity in the winter														__51	
38. Record other energy conserving activities															Card No.
Specify ______														__66 __67 __68 __69 __70	18 5-6
______														__21 __22 __23 __24 __25	

KEY

Kind of heating equipment
1 = Natural gas - Central forced air
2 = Natural gas - Floor furnace or wall heater
3 = Propane - Central forced air
4 = Propane - Floor furnace or wall heater
5 = Electric resistance - Central forced air
6 = Electric resistance - Floor furnace or wall heater
7 = Heat pump
8 = Wood heat
9 = Other

Time Spent By household
Convert all time to hours
i.e. 1 day = 8 hours
30 min. or more = 1 hour

Money Spent By household
Round to nearest whole dollars
i.e. $.50 = $1.00
$.75 = $1.00

Subsidy (Kind)
1 = Money
2 = Services (record time spent by service provider)
3 = Goods

Subsidy ($ Amount)
Round to nearest whole dollars

Subsidy (Source)
1 = Government
2 = Utility
3 = Business
4 = Civic
5 = Family
6 = Religious
7 = Other

THE ENERGY EVENT

ID Number	Date	Aide Name

Respondent __ __ __ __ 1-4
Card No. 19 5-6

FINAL PROJECT CONSERVATION CHECKLIST

INSTRUCTIONS
Record all changes made by this household from the time you first contacted them. For each question put a check (✓) in the appropriate block indicating the change.

ACTIVITIES	NA	yes	no	if yes, indicate N	S	E	W	Household time spent	Household money spent	if subsidized, indicate kind	$	hours	sources	
1. Added ceiling insulation · *if yes, record R-Value* _____														__7
2. Added wall insulation *if yes, record R-Value* _____														__22
3. Added floor insulation *if yes, record R-Value* _____														__37
4. Added caulk and/or weatherstripping *check the condition that best describes the house now*														__52
__ Good Condition - Tight fitting windows and doors, caulked and weatherstripped.														Card No. 20 5-6
__ Fair Condition - Average fit, partially caulked and weatherstripped.														
__ Poor Condition - No caulking or weatherstripping.														
5. Added duct insulation														__7 __8
if yes, check below														
__ 1 inch														
__ 2 inch														
6. Added storm doors														__26 __27 __28 __29 __30
7. Added storm windows														__45 __46 __47 __48 __49 Card No.
8. Added indoor roll-up shades														__64 __65 __66 __67 __68 21 5-6
9. Added roman shades														__21 __22 __23 __24 __25
10. Added draperies														__40 __41 __42 __43 __44 Card No.
11. Added drapery liners														__59 __60 __61 __62 __63 22 5-6
12. Added window inserts														__21 __22 __23 __24 __25
13. Added venetian blinds														__40 __41 __42 __43 __44 Card No.
14. Added outdoor roll-up shades														__59 __60 __61 __62 __63 23 5-6
15. Added awnings														__21 __22 __23 __24 __25
16. Added sun screen														__40 __41 __42 __43 __44 Card No.
17. Added [illegible] control film														__59 __60 __61 __62 __63 24 5-6
18. Added [illegible]ared visors for windows														__21 __22 __23 __24 __

THE ENERGY EVENT

ACTIVITIES	NA	yes	no	If yes, indicate H	S	E	W	Household time spent	Household money spent	If subsidized, indicate kind	$	hours	sources	
19. Added louvered visors for doors														__40 __41 __42 __43 __44 Card No. 25 5-6
20. Added louvered visors for cooling units														__59 __60 __61 __62 __63
21. Added landscaping - deciduous trees														__21 __22 __23 __24 __25
22. Added landscaping - deciduous shrubs														__40 __41 __42 __43 __44 Card No. 26 5-6
23. Added landscaping - evergreen trees														__59 __60 __61 __62 __63
24. Added landscaping - evergreen shrubs														__21 __22 __23 __24 __25
25. Reduced winter thermostat setting														__40
if yes, record temp. setting ______														
26. Increased summer thermostat setting														__55
if yes, record temp. setting ______														Card No. 27 5-6
27. Added ceiling fan														__7
28. Added portable fan														__22
29. Added whole house/attic fan														__37 Card No.
30. Purchased efficient heating equipment														__52 28 5-6
if yes, record kind ______														
31. Purchased efficient cooling equipment														__21
if yes, record EER ______														
32. Repaired leaky hot water faucets														__36
33. Insulated hot water pipes														__51 Card No.
34. Insulated hot water tank														__66 29 5-6
35. Reduced hot water tank temp. setting														__21
if yes, check the current temp. setting __ High = 141° - 160° __ Medium = 121° - 140° __ Low = 100° - 120°														
36. Made and used windbreakers														__36
37. Added humidity in the winter														__51
38. Record other energy conserving activities														Card No.
Specify ______														__66 __67 __68 __69 __70 30 5-6
______														__21 __22 __23 __24 __25

KEY

Kind of heating equipment
1 = Natural gas - Central forced air
2 = Natural gas - Floor furnace or wall heater
3 = Propane - Central forced air
4 = Propane - Floor furnace or wall heater
5 = Electric resistance - Central forced air
6 = Electric resistance - Floor furnace or wall heater
7 = Heat pump
8 = Wood heat
9 = Other

Time Spent By household
Convert all time to hours
i.e. 1 day = 8 hours
30 min. or more = 1 hour

Money Spent By household
Round to nearest whole dollars
i.e. $.50 = $1.00
$.75 = $1.00

Subsidy (Kind)
1 = Money
2 = Services (record time spent by service provider)
3 = Goods

Subsidy ($ Amount)
Round to nearest whole dollars

Subsidy (Source)
1 = Government
2 = Utility
3 = Business
4 = Civic
5 = Family
6 = Religious
7 = Other

THE ENERGY EVENT

ID Number	Date	Aide Name

Respondent __ __ __ __ 1
Card No. 31 5

FOLLOW-UP INFORMATION

AIDES: I would now like to ask you some general questions concerning energy conservation activities.
DO NOT READ RESPONSES TO THE PARTICIPANTS!

1. Why did you decide to weatherize your home? (You may check more than one response.)
   __1. For more comfort __7
   __2. My utility bills were too high __8
   __3. To save money __9
   __4. My friends did and/or relatives did __10
   __5. To save energy for future generations __11
   __6. Because the supply of energy is so scarce __12
   __7. Have not adopted any energy conservation activities __13
   __8. Other (please specify) ______________ __14

2. Why did you decide not to weatherize your home? (Do not ask this question if the participant answers item 1.)
   __ 1. Lack of money __15
   __ 2. Weather (too cold or too hot) __16
   __ 3. Too close to vacation time __
   __ 4. Rent residence (Landlord should do it) __
   __ 5. It won't save energy __19
   __ 6. Don't have the time __20
   __ 7. Not able to do the work __21
   __ 8. Don't know how __22
   __ 9. Home already weatherized __23
   __10. Other (please specify) ______________ __24

3. Do you plan to do any weatherization projects in the future?
   __1. Yes COMMENTS: ______________
   __2. No ______________ __25
   __3. Do not know yet ______________

4. What person or persons influenced you most to weatherize your home?
   __1. The Energy Aide
   __2. Friend
   __3. Relative
   __4. My family
   __5. Community leader __26
   __6. No one influenced the decision
   __7. Other (please specify) ______________

5. How did you get the structural changes made?
   __1. Did them myself COMMENTS: ______________
   __2. Friends helped me ______________ __
   __3. Family helped ______________
   __4. Paid workmen ______________
   __5. Service group ______________

THE ENERGY EVENT

ID Number	Date	Aide Name

TEACHING RECORD

INSTRUCTIONS:
For each learning experience, record date, what you did, reaction, date and purpose of next visit.

Planned Learning Experiences	
1. ______	Date ______
2. ______	
3. ______	
4. ______	Date ______
5. ______	
6. ______	
7. ______	Date ______
8. ______	
9. ______	
10. ______	Date ______
11. ______	
12. ______	

THE ENERGY EVENT

TEACHING RECORD

Date ______________	Date ______________
Date ______________	Date ______________
Date ______________	Date ______________
Date ______________	Date ______________

APPENDIX B

CALCULATION PROCEDURES

CALCULATION PROCEDURES

OKLAHOMA RESIDENTIAL CONSERVATION SERVICE PROGRAM PLAN

Calculation methodology set forth under the Oklahoma Plan is based primarily on ASHRAE fundamentals and residential energy research conducted by the Agricultural Engineering Department at Oklahoma State University. Utility companies in Oklahoma have been directly involved in the study. Detailed data on both actual fuel consumption and thermal characteristics of the house were collected on approximately 200 homes. Using this data, various calculation techniques were investigated. From the study, a calculation methodology, specific to Oklahoma, was developed.

Calculation procedures are described for each program practice. The procedures are based primarily on the OSU study and on ASHRAE fundamentals and procedure.

Seasonal Energy Use Equations

I. Cooling Energy Use.

$$E = (Q * C)/(COP * 3413) \quad \ldots\ldots\ldots\ldots \quad (1)$$

E = Energy use during cooling season (Kw-hr)

C = Full load cooling hours - (developed for each county in Oklahoma)

COP = Coefficient of performance for the air conditioning unit. (Based either on on-site determination of EER or on manufacturer's data.)

Q = Structural cooling load - (Calculation procedure explained independently for each practice.)

II. H ating Season Energy Use.

$$E = (24 * DD * Q)/[(T_1-T_0) * H_v * N] \quad (2)$$

E = Energy Use in Heating

DD = Degree Days (Developed for each county in Oklahoma)

Q = Structural Heat Load - (Calculation procedure explained independently for each practice)

T_1-T_0 = Design temperature difference

H_v = Heat value of fuel
(Natural Gas = 1,000 BTU/cu. ft.;
Propane = 92,000 BTU/gal.;
Electricity = 3413 BTU/Kw-hr.)

N = Furnace efficiency.

Units of energy consumed during the heating and cooling seasons can be calculated using the above equations. Once these units of energy are calculated, the price of energy can be applied to determine seasonal costs.

The major function of structural energy conservation practices is to decrease energy requirements by decreasing the value of "Q" in both equations. Decreasing heating and cooling loads result in decreased seasonal energy use and decreased seasonal cost. The amount of decrease in seasonal cost represents savings incurred by various conservation practices.

Calculation methodologies for ceiling insulation, wall insulation, floor insulation, window treatments, storm doors, caulking, weatherstripping, and duct insulation are based on the above principles. A detailed discussion of each of these program practices follows.

1. <u>Ceiling Insulation</u> - Energy savings due to addition of ceiling insulation occur in both heating and cooling. Basic calculation methodology is given below.

Heating: $q = (U_{c2} - U_{c1}) * A_c * (T_i - T_0)$

q = Change in heat loss due to change in ceiling U-value.

A_c = Ceiling area

$T_i - T_0$ = Design temperature difference

U_{c1} = Present ceiling U-value

U_{c2} = Recommended ceiling U-value

After calculating "q", equation 2 is used to evaluate energy savings in the heating season.

Cooling: $q = (U_{c2} - U_{c1}) * A_c * ETD$

q = Change in heat gain due to change in ceiling U-value.

ETD = Equivalent temperature difference based on ASHRAE Fundamentals Handbook, Chapter 25.

The value of "q" is used in equation 1 to evaluate energy savings in the cooling season.

Total Annual Savings = Heating savings + cooling savings

Simple Payback = Cost of insulation/Annual dollar savings

NOTE: Cost of insulation assumes installed cost.

2. <u>Wall insulation</u>: Same basic methodology used for ceiling insulation is used for evaluation of savings due to installation of wall insulation.

Heating: $q = (U_{w2}-U_{w1}) * A_w * (T_1-T_0)$

q = Change in heat loss

A_w = Exterior wall area

T_1-T_0 = Design temperature difference

U_{w1} = Present wall U-value

U_{w2} = Recommended wall U-value

Cooling: $q = (U_{w2}-U_{w1}) * A_w * ETD$

ETD = Equivalent temperature difference based on ASHRAE Fundamentals Handbook, Chapter 25.

Savings for cooling and heating are evaluated by using equations 1 and 2.

Total Annual Savings = Heating savings + cooling savings

Simple Payback = Cost of insulation/Annual dollar savings

3. <u>Floor Insulation</u>: Savings due to floor insulation only occur during the heating season in Oklahoma. In Oklahoma, two basic floor construction types exist. One is suspended frame construction and the other is concrete slab. Only suspended frame floors offer potential for adding insulation.

Methodology:

$q = (U_{f2}-U_{f1}) * A_f * (T_i-T_{cs})$

q = Change in heat loss due to addition of floor insulation

A_f = Floor area

T_i = Indoor temperature

T_{cs} = Temperature of crawl space

Crawl space temperatures are normally different from outdoor air temperatures. Actual crawl space temperature is primarily dependent upon infiltration of outdoor air into the crawl space. Based upon HUD and FHA property standards, a typical crawl space temperature in Oklahoma may be calculated by the following equation.

$$T_{cs} = 7/8\ T_{csu} + 1/8\ T_0$$

T_{csu} = Temperature of an equivalent unvented crawl space. (Assuming no infiltration)

T_0 = Outdoor design temperature

After determining the value of "q", equation 2 is used to evaluate seasonal energy and cost savings.

Simple Payback = Cost of floor insulation/Annual dollar savings

4. Storm or thermopane window treatments: The addition of storm or thermopane windows result in energy savings in both heating and cooling seasons. Evaluation of savings must be made in both seasons.

Heating: $q = (U_2 - U_1) * A * (T_1 - T_0)$

q = Change in heat loss

A = Window area

$T_1 - T_0$ = Design temperature difference

U_1 = U-value of regular single glazed windows

U_2 = U-value of combination storm or thermopane window

Utilize equation 2 to evaluate savings.

Cooling: $q = A * (HGF_1 - HGF_2)$

q = Change in heat gain

HGF_1 = Heat gain factor for single glazed windows based upon ASHRAE Fundamentals Handbook.

HGF_2 = Heat gain factor for double glazed windows.

The heat gain factor is sensitive to orientation. Therefore, a separate calculation will be made for South, North, East and West facing windows. A value of "q" will be obtained for each orientation. The total value of "q" will then be used in equation 1 to evaluate total seasonal energy savings.

Total Annual Savings = Heating savings + Cooling savings

Simple Payback = Total cost/Annual dollar savings

5. <u>Calking and Weatherstripping</u>: Caulking and weatherstripping have direct effects on air infiltration. Under the Oklahoma plan, infiltration characteristics of windows and doors are classified in three groups.

a. Good Fit - Caulked and weatherstripped

b. Average Fit - Partially caulked and weatherstripped

c. Poor Fit - No caulking and weatherstripping

By visual inspection, windows and doors will be classified as one of the above. Each of the above conditions is then associated with a air infiltration rate. Rates are based on a 15 mph wind in the winter and 7 1/2 mph wind in summer. Rates are given in the following table.

Condition	Winter Air Infiltration Rate (cu. ft./hr. ft. of crack)	Summer Air Infiltration Rate (cu. ft./hr. ft. of crack)
1	14	8.4
2	28	16.8
3	56	33.6

Using these values, ASHRAE crack length procedures are used to calculate energy loss due to air infiltration. Crack length procedures give more accurate results than the air change method. Total crack length is estimated by multiplying the total window area by 1.5. However, ASHRAE crack length procedures suggest using only 1/2 of the total crack length. Therefore, to estimate the linear feet of caulking and weatherstripping material window area is multiplied by 1.5, while it is multiplied by 0.75 to estimate energy losses.

The basic equations used to estimate potential energy savings due to caulking and weatherstripping are given as follows:

Heating:

$$q = [(WTA * 0.75) * (Q_1-Q_2) * 0.24 * (T_i-T_0)]/11.5$$

q = Change in loss due to caulking and weatherstripping

WTA = Total window area

Q_1 = Air infiltration rate based on present infiltration characteristics

Q_2 = Air infiltration rate based on improved caulking and weatherstripping

T_i-T_0 = Design temperature difference

0.24 = Specific heat of air

11.5 = Specific volume of outdoor air at design condition

"q" is then used in equation 2, to evaluate savings during the heating season.

Cooling:

$$q = [(WTA * 0.75) * (Q_1 - Q_2) * 0.24 (T_0 - T_1)]/14.6$$

Variable definition is same as above. Specific volume of outdoor air at summer design condition is 14.6.

Equation No. 1 is used to determine seasonal savings.

Total Annual Savings = Heating saving + Cooling savings

Simple Payback = Installed cost of material/Annual dollar savings

6. Duct Installation: Insulation of air supply duct can have a substantial effect on overall energy use. Retrofitting a ducting system with insulation is practical for ducts located in either the attic space or a suspended floor crawl space. Ducts experience both heat loss and heat gain. Losses and gains are normally expressed as a percentage of the total loss or gain of the structure. The following tables give percentage values for Oklahoma.

Heat Loss - Heating Season
(For ducts located either in attic or suspended floor crawl space)

No insulation - 20%
1 inch insulation - 15%
2 inches insulation - 10%

Heat Gain - Cooling Season

Duct Location	% of Total
Attic Space	No insulation - 20%
Attic Space	1 inch - 15%
Attic Space	2 inches - 10%
Crawl Space	No insulation - .5%
Crawl Space	1 inch - 2.5%
Crawl Space	2 inches - 0%

By increasing duct insulation, change in total energy loss and gain can be obtained by using values given in the tables. Equations 1 and 2 can then be used to determine total annual savings.

Simple Payback = Total installed cost of insulation/Annual dollar savings.

7. Clock Thermostats: Thermostat settings affect total energy consumption in residences in both heating and cooling. Based on Oklahoma data, a decrease of 2.7% in energy consumption can be obtained for every degree reduction in thermostat setting during the heating season. A decrease of 4% can be expected for every degree increase in thermostat setting during cooling.

Cost savings due to thermostat set back will be estimated using above figures. Patterns of thermostat set back will vary with each homeowner. Therefore, savings due to thermostat setback will be highly dependent upon lifestyle.

Payback will be calculated as follows:

Simple Payback = Total cost/Annual dollar savings.

8. Replacement Central Air Conditioning: The primary purpose of investigating replacement central air conditioning is to show the homeowner advantages of increased efficiency. From equation 1, total cooling energy consumption is inversely related to the coefficient of performance. Coefficient of Performance is equivalent to the Seasonal Energy Efficiency Ratio divided by 3.413. Therefore, by increasing SEER, total energy consumption is decreased.

Existing SEER will be obtained from name plate ratings or from standard data. New units will be evaluated at an SEER of at least 10.0. Energy savings will be evaluated as follows.

Energy reduction = $(Q * C/3413) * [(1/COP_1)-(1/COP_2)]$
Annual Dollar Savings = Energy reduction x Cost of energy

Simple Payback = Replacement Cost/Annual Dollar Savings

9. <u>Water Heater Insulation</u>: Adding insulation to the jacket of an existing water heater can reduce heat loss from the jacket wall. Average annual closet temperature in Oklahoma is 70°F. Water temperatures range from 120°F to 140°F. The auditor will be responsible for determining average water temperature. Annual savings will be calculated by the following equation.

$$E = (A * (T_1-T_2) * 365 * 24)/(RV_2-RV_1)$$

E = Energy Savings

A = Jacket wall area

T_1 = Water temperature

T_2 = Ambient temperature

RV_1 = Present R-value (default values: 7 for electric, 3 for gas)

RV_2 = Increased R-value (10 for electric, 6 for gas)

By multiplying energy savings by cost of energy, annual dollar savings can be determined.

Simple Payback = Cost of insulation/Annual dollar savings.

10. <u>Solar Water Heating</u>: Hot water consumption and resulting energy consumption will be calculated using procedures developed by Oakridge National Laboratories. Consumption calculations are based on 20 gallons per person per day for the first two people and 15 gallons per person per day for any additional people. Energy consumption is calculated from the following equation.

$$Q = M * C_p * DT/E$$

Q = Annual energy consumption

M = Annual hot water consumption

C_p = Specific heat of water

DT = Temperature difference in incoming and outgoing water

E = Heating efficiency

After determining energy use, an analysis on solar water heating will be made. The auditor will be able to select the percent of hot water to be supplied by solar. Using this percentage, savings can be calculated.

Mechanical Equipment Efficiencies:

1. Heating -

The basic seasonal energy use equation used in the Oklahoma plan is as follows.

$$E = 24 * DD * Q/[(T_1-T_0) * H_v * N]$$

E = Energy Use

DD = Heating degree days

Q = Structural heat loss rate

T_1-T_0 = Design temperature difference

H_v = Heat value of fuel

(Natural Gas = 1,000 BTU/cu. ft.;

Propane = 92,000 BTU/gal.;

Electricity = 3,413 BTU (Kw-hr;

Oil = 139,000 BTU/gal.)

N = furnace efficiency

Most available methodologies use an equation similar to the above. However, normally a correction factor to the overall equation is used. The Oklahoma State methodology is based on approximately 2 years of study by the Agricultural Engineering Department at Oklahoma State University. We have found that it is more accurate to use the above equation as is and vary the degree day base temperature. Current methodology now uses a base temperature of 62.5°F. With this methodology, the following efficiencies are used:

a) Electric resistance furnaces - 100%

b) Electric Heat Pump - Seasonal Performance factor calculated as follows:

SPF = 2.3 - 0.00015 x DD, where DD is the degree days based on 65°F base temperature. SPF times 100 represents seasonal efficiency in percent.

c) Gas furnaces - For maximum prediction accuracy in Oklahoma, gas furnace efficiencies were broken into three categories based on the overall heat loss rate of the structure.

Heat Loss Rate	800 BTU/hr°F	N = 75%
Heat Loss Rate	600-800 BTU/hr°F	N = 70%
Heat Loss Rate	600 BTU/hr°F	N = 64%

d) Wood - Only wood burning stoves and modified fireplaces will be considered. Conventional fireplaces are not counted as heat supplying devices. The efficiency of wood burning stoves and modified fireplaces will be 35%.

e) L.P. Gas Furnaces - Use same efficiencies as natural gas furnaces.

f) Oil furnaces - Less than 1% percent of the homes in Oklahoma are heated with oil. However, provisions have been made to analyze oil furnaces.

Efficiency = 67%

<u>Cooling</u>

Air conditioning efficiencies can be stated in terms of Energy Efficiency Ratios (EER) or a coefficient of Performance (COP). The Oklahoma methodology utilizes the COP value. NOTE: COP = EER/3.413. The COP of existing units in Oklahoma is a function of equipment age. For example, units 3 years and older typically have seasonal COP's in the range of 1.8 to 2.1. New units (newer than 3 years) can have COP's as high as 3.2.

In the Oklahoma methodology, if the actual COP is known or can be calculated, it will be used. If the actual cannot be obtained, the following default values will be used.

	COP
Less than 2 years of age	3.0
2 years - 5 years	2.24
greater than 5 years	1.9

Replacement Heating System:

1. Electric Resistance Furnace to Heat Pump:

Efficiencies will be used as described in section on mechanical efficiencies.

2. Replacement Gas Furnaces.

It is possible to achieve energy savings by replacing old, low efficient gas furnaces with high efficiency units. New Gas furnaces are available with estimated seasonal efficiencies of 80%.

Savings due to replacement furnaces will be calculated by increased present furnace efficiency to the 80% level. The assumption must be made that new furnaces will be correctly sized.

Replacement Oil Burners

Savings due to replacement of oil burners will be reflected by increased seasonal efficiency. Seasonal efficiency can be increased by approximately 5% by the additions of improved burners.

Vent Dampers

Savings due to the addition of vent dampers will be calculated by increasing the seasonal efficiency of the heating system by 7%. This value corresponds with recommendations and guidelines presented in the model audit.

RENEWABLE RESOURCES
State of Oklahoma
RCS Program

1. Available Solar Radiation: Monthly average solar radiation data were derived from HUD minimum property standards. A correlation of K_t as a function of latitude was developed from the HUD data. This correlation was in turn used to develop an equation from R. R is a function of latitude, collector tilt, K_t and month of year.

Monthly average extraterrestrial radiation values were obtained from table A-108 HUD minimum property standards. Because Oklahoma falls between 30° and 40° latitude, an interpolation technique was developed to obtain the value of I_o for each month and each latitude. The average horizontal radiation is then calculated by:

$$H = K_t * I_o$$

The radiation available on a tilted surface is calculated by:

$$I_t = R * H$$

2. System Efficiency. System efficiency is a highly variable quantity in active solar systems. Collection efficiencies vary with collector design parameters such as number of layers of glazing material, type of glazing material, type of absorber, fluid temperatures, sun angles, and collector insulation. Other losses in the system occur primarily in storage and piping systems. Because of the variation of overall utilization efficiency, a constant value is assumed in the OSU methodology. The overall collection and utilization efficiency will be taken as 25 per cent. The overall 25% figure is based on a typical annual

collector efficiency of 38% and a system efficiency of 66%. The 38% figure is a typical value when considering variation in incident angles, ambient temperature, and available solar radiation. The 66% efficiency accounts for storage and piping losses.

3. Domestic Water Heating. Energy required to heat domestic water will be calculated using methodology described in the Oklahoma State Plan. To access the solar analysis of domestic water heating the auditor must supply the following data:

PSF - Prime Solar Fraction. Minimum values will be determined by Region Specific Solar Factors contained in Model Audit Procedures.

Square Feet of Collector - Domestic water heating systems are typically standard in their design differing primarily in collector area. The auditor will evaluate the home and assume an appropriate collector area.

After inputting PSF and collector area, the total available solar energy for water heating can be calculated. Available radiation will be evaluated according to the methodology found in Parts 1 and 2 of this report. The solar energy is evaluated on a monthly basis. Monthly water heating loads are calculated according to methodology described in Oklahoma State Plan. The proportion of monthly demand supplied by solar is evaluated for each month. Total annual demand supplied by solar is summed to obtain annual proportion supplied by solar system. Annual savings is calculated by multiplying percentage solar supplied times the calculated annual water heating cost based on current conventional energy source.

4. Solar Swimming Pool Heating - Calculation procedures for solar swimming pool analysis were taken from Model Audit procedures, E8, revised for Oklahoma HUD Zones May, 1980.

According to the model audit procedures and to common practices in Oklahoma, covered pools will not be evaluated. Very few pools in Oklahoma are covered. Those that are covered have very little solar energy savings potential.

Correlations were developed for the various quantities in the tables as a function of pool area. Resulting equations used in the Oklahoma analysis HUD Zone 4 are shown below. Equations for other HUD Zones were calculated accordingly.

Practically all pools in Oklahoma are at least moderately shielded from wind. Most are in residential areas and have sight hindrance fences. Because of this, annual energy consumption for pool heating is taken from the moderately shielded section for each HUD zone in Oklahoma. The auditor selects the appropriate solar savings fraction. The SSF is in turn applied to annual fuel use to obtain annual energy savings. This quantity is initially in terms of million BTU's. It is converted to units of fuel based on the heat value of the primary heating fuel. Multiplying units of fuel by cost gives annual dollar savings.

Correlations were developed for annual energy use as a function of pool area. The correlations were based on the tabular data in the model audit. Resulting equations used in the Oklahoma Analysis are shown below.

HUD Zone 3

Annual Energy Use (Million BTU's) = Pool area * (6.00×10^4)

HUD Zone 4

Annual Energy Use (Million BTU's) = Pool area * (17.14×10^4)

HUD Zone 5 & 6

Annual Energy Use (Million BTU's) = Pool area * (17.41×10^4)

In HUD Zones 4, 5, and 6, collector area as given by the moderately shielded columns in the Model Audit tables seemed to be low. Experience in Oklahoma has shown greater collector area requirements than that shown in the model unit. The difference may be in the quality and types of collectors used in the calculation procedures. In Oklahoma, typically low cost, low efficiency collectors are used. High temperatures are not needed for pool heating. Therefore, it was necessary to adjust collector areas. Again, correlations were developed for collector area as a function of pool area. equations were developed for each HUD zone and each solar savings fraction. Resulting equations used in the Oklahoma analysis for HUD zone 4 are shown below. Equations for other HUD zones were calculated accordingly.

HUD Zone 4

(a) 30% SSF: Collector Area (ft^2) = Pool Area * 0.38

(b) 40% SSF: Collector Area (ft^2) = Pool Area * 0.506

(c) 50% SSF: Collector Area (ft^2) = Pool Area * 0.633

5. Passive Solar Energy. Passive solar energy systems applicable to the Oklahoma Plan can be categorized into the following categories.

A. Indirect Gain Glazing Systems. The most applicable indirect gain glazing system for Oklahoma is the use of south facing double glass. Calculation methodology evaluates for various zones in Oklahoma the amount of solar radiation available on a south facing vertical surface. These values are taken from ASHRAE Fundamentals Handbook in the form of Solar Heat Gain Factors. Solar Heat Gain Factor represent the total energy transferred into a home with standard reference glass, based on clear day radiation.

To obtain the average seasonal heat gain due to direct glazing the following equation is used:

$$HG = (GA * SC * SHGF * CF) - (U * 24 * DD)$$

Where HG = Heat Gain

GA = Grass Area

SC = Shading Coefficient (0.83 for double glass)

SHGF = Solar Heat Gains Factor (Heating Season Values)

CF = Clearness Factor (0.6)

U = Overall Heat Transfer Coefficient

DD = Seasonal Heating Degree-Days

The seasonal heat gain is converted to seasonal energy savings. Because cooling represents a major energy use in Oklahoma, the additional cooling load due to the glazing must be evaluated to give the homeowner a fair analysis. The additional cooling load is calculated according to ASHRAE Equivalent Temperature Methodology given in Methodology Section of Oklahoma Plan. The additional energy use in cooling is subtracted from the savings in heating. The net savings is then reported to the homeowner.

PRIMARY ASSUMPTION: All energy received by the vertical glass can be utilized to offset heating need of the structure.

B. Solaria Sun Space. Analysis of the Solaria Sun Space is quite difficult because of the variance in shape, installation, and materials. Benefits from the sun space will also be affected by type of wall structure. Oklahoma analysis will treat the sun space as a vertical air type solar collector. Management of the sun space is critical in the actual realization of savings. For calculation purposes, it is assumed that the homeowner will ventilate and partially cover the space in summer conditions. This will eliminate any increased cooling load. It is also assumed that the homeowner will provide an air circulation technique to transfer the heat gain from the space to the home interior. For calculation purposes, it is assumed that the sun space will be primarily constructed of glass materials.

Glass area of collector will be taken as 10 square feet per linear foot of wall covered. Solar radiation will be evaluated on a south facing vertical surface. An overall collection efficiency of the sun space will be taken as 20%. In other words, 20% of the energy collected in the sun space will be transferred and utilized by the house.

C. Window Heat Gain Retardants. Heat gain retardants will be evaluated only on east and west facing fenestrations. Retardants are of no value on north facing windows and inhibit beneficial heat gain on south facing windows.

Procedures for estimating heat gains and cooling loads for fenestrations was taken from ASHRAE Fundamentals chapters 25 and 26. These procedures are described in the calculation procedures of the State Plan. To evaluate reduction in heat gain and cooling load due to addition of heat gain retardants measures, it was necessary to evaluate the reduction in the heat gain factors for east and west facing windows.

The basic equation for estimating heat gain due to fenestrations is as follows:

$$Q = A\,[SC\,(SHGF) + U\,(T_o - T_i)]$$

Where

Q = Heat Gain

A = Window Area

SC = Shading Coefficient

$SHGF$ = Solar Heat Gain Factor

U = Overall U-Value for the Window Glass Area

$T_o - T_i$ = Design Temperature Difference

The function of heat gain retardants measures is to reduce the shading coefficient. For calculations with no heat gain retardants a shading coefficient of 0.52 was used. This assumes medium density draperies and storm windows. We are making the assumption that the homeowner will add storm windows before applying the retardants. The shading coefficient with the heat gain retardants is 0.26.

In Chapter 25 of ASHRAE Fundamentals the basic equation stated above is reduced to:

$$Q = A * HGF$$

Where HGF = Heat Gain Factor

For the assumptions stated above the heat gain factor is 49. When the retardants measure is added to the window the heat gain factor is reduced to 31. The reduction in cooling load is therefore calculated by the following equation:

$$QRED = (49 - 31) * A_{E-W}$$

Where QRED = Reduction in Cooling Load

A_{E-W} = Window Area of East and West Windows

The reduction in cooling load is then converted to energy savings according to methods described in State Plan.

6. Wind Energy Analysis. Average annual wind speeds were developed for each county in Oklahoma. The wind speeds were obtained from tabulated weather data for Oklahoma. Providing the home meets the required applicability tests, annual production of energy is taken from SWECS Table in the Model Audit procedures.

Average wind speeds in Oklahoma will be adjusted according to information contained on page E10.2 in the model audit. The terrain shelter adjustment factor will be taken as 1.0 for all counties in Oklahoma. The tower height and surface roughness adjustment factor will be included. Roughness characteristics will range from high woods in southeastern counties to grass and crops in western counties of Oklahoma. Therefore, adjustment factors ranging from 0.8 to 1.3 will be included for each county. These factors will become part of the county data set used in the overall program.

NOTE: Because savings for renewable resource items are based on simplifying assumptions and are subject to homeowner management practices, a special booklet will be given to each homeowner receiving the audit. The booklet will provide a discussion of each renewable resource program measure.

THE ENERGY EVENT

SINGLE STORY RESIDENTIAL ENERGY AUDIT

In Coordination with the Oklahoma Department of Energy and the OSU Agricultural Engineering Department

Cooperative Extension Service • Division of Agriculture • Oklahoma State University

HOMEOWNERS NAME ______________________________ [1]

HOMEOWNERS ADDRESS ______________________________ [2]

______________________________ [3]

RETURN NAME ______________________________ [4]

RETURN ADDRESS ______________________________ [5]

______________________________ [6]

Where numbered choices are available, choose the answer that best describes your home and write the number on the corresponding line.

1. County where the house is located. __________ [7]
2. Total square feet living area. __________ [8]
3. What is the roof color? __________ [9]
   1. Dark
   2. Light (or wood shingles)
4. R-Value for ceiling areas. __________ [10]
5. Type floor construction. __________ [11]
   1. Suspended frame floor
   2. Concrete slab floor
   3. Combination of suspended frame and concrete slab
6. If a combination floor answer the following.
   1. Total area in square feet of the suspended frame portion. __________ [12]
   2. Total area in square feet of the concrete slab portion. __________ [13]
7. The R-Value for the suspended frame floor or portion of combination floor. *If the answer to #5 was 2 leave blank.* __________ [14]
8. Is the concrete slab floor or portion of combination floor insulated? *If the answer to #5 was 1 leave blank.* __________ [15]
   1. Yes
   2. No
9. Where are the air supply ducts for the heating and cooling system located? __________ [16]
   1. No duct system
   2. In concrete slab floor
   3. In attic space
   4. Under suspended frame floor
   5. Within conditioned space
10. If a duct system is present what type of insulation is used for it? *If no duct system is present leave blank.* __________ [17]
    1. Ducts not insulated
    2. 1" duct insulation
    3. 2" duct insulation
11. Complete the following for exterior doors. *(Treat sliding glass doors as windows.)*
    1. Door area without storms (sq ft) __________ [18]
    2. Door R-Value without storms __________ [19]
    3. Door area with storms (sq ft) __________ [20]
    4. Door R-Value with storms __________ [21]

12. Complete the following for windows.
(Treat completely shaded windows as north windows.)

Window Direction	Single Glazed No Storm (Sq Ft)	Single Glazed With Storms or Double Glazed (Sq Ft)	Double Glazed With Storms or Triple Glazed (Sq Ft)
South	22 ________	26 ________	30 ________
North	23 ________	27 ________	31 ________
East	24 ________	28 ________	32 ________
West	25 ________	29 ________	33 ________

13. Perimeter length of home in feet. (See Example Problem) ________ 34

14. Total exterior wall area in square feet, not including window or door area. (See Example Problem) ________ 35

15. Type of wall construction. ________ 36
    1. Brick veneer
    2. Frame
    3. Masonry

16. R-Value of exterior walls. (See Insulation Table) ________ 37

17. Estimate the infiltration characteristics. ________ 38
    1. Good condition - Tight fitting windows and doors, caulked and weatherstripped
    2. Fair condition - Average fit, partially caulked and weatherstripped
    3. Poor condition - No caulking or weatherstripping

18. Type of home heating system ________ 39
    1. Natural gas - Central forced air system
    2. Natural gas - Floor furnace or wall heater
    3. Propane - Central forced air system
    4. Propane - Floor furnace or wall heater
    5. Electric resistance - Central forced air system
    6. Electric resistance - Baseboard or ceiling cable
    7. Heat pump
    8. Other (explain) ________

19. Is home air conditioned? ________ 40
    1. Yes (Central forced air system)
    2. Yes (Window units)
    3. No.

20. Rates during the heating season, as applies to your system. } 41
    1. Average price of natural gas, $/MCF? ________
    2. Average price of propane, $/Gallon? ________
    3. Average price of electricity, $/KWH? ________

21. Average price of electricity during the cooling season? *If not air conditioned leave blank.* ________ 42

22. Number people living in your home? ________ 43

23. Do you wish a water heater analysis? ________ 44
    1. Yes
    2. No

24. Type of water heater? } 45
    1. Gas ________
    2. Electric ________

25. Water heater location } 46
    1. Conditioned space ________
    2. Unconditioned space ________

26. Normal thermostat setting for
    1. Day: Heating ____ Cooling ____
    2. Night: Heating ____ Cooling ____

27. If your heating system is a non-central forced-air furnace, do you heat only a portion or maintain different temperature levels in your home?

    If so explain: ________________

28. Age of the Home. ________
    1. Less than five years.
    2. Five to 10 years.
    3. Over 10 years.

Comments: ________________________________

THE ENERGY EVENT

TWO STORY AND SPLIT LEVEL RESIDENTIAL ENERGY AUDIT

In Coordination with the Oklahoma Department of Energy and the OSU Agricultural Engineering Department

Cooperative Extension Service • Division of Agriculture • Oklahoma State University

HOMEOWNERS NAME ______ [1]

HOMEOWNERS ADDRESS ______ [2]

______ [3]

RETURN NAME ______ [4]

RETURN ADDRESS ______ [5]

______ [6]

Where numbered choices are available, choose the answer that best describes your home and write the number on the corresponding line.

1. County where the house is located. ______ [7]
2. Total square feet living area. ______ [8]
3. What is the roof color? ______ [9]
   1. Dark
   2. Light (or wood shingles)
4. Square feet ceiling area of your home? (Do not include ceiling areas under conditioned spaces) ______ [10]
5. R-Value for your ceiling area. ______ [11]
6.
   A. Square feet floor area of your home? (Enter 0 for items that do not apply)
      1. Concrete slab-on-grade ______ [12]
      2. Suspended frame floor over crawl space ______ [13]
      3. Suspended frame floor over basement ______ [14]
      4. Suspended frame floor over garage ______ [15]
      5. Suspended frame floor over carport or other open space ______ [16]

   B. What level of insulation do the above floor areas contain?
      1. Concrete slab-on-grade
         1. Insulated______
         2. Not insulated______ } [17]
      2. Suspended frame floor over crawl space R = ______ [18]
      3. Suspended frame floor over basement R = ______ [19]
      4. Suspended frame floor over garage R = ______ [20]
      5. Suspended frame floor over carport or other open space R = ______ [21]

   C. If your home has a suspended frame floor over a garage, do you use supplemental heat in the garage?
      1. Yes______
      2. No______ } [22]

   D. If your home has a basement, is it
      1. Heated______
      2. Unheated______ } [23]
7. Where are the air supply ducts for your heating and cooling system located? ______ [24]
   1. No duct system
   2. In concrete slab floor
   3. In attic space
   4. Under suspended frame floor
   5. Within conditioned space
8. If a duct system is present what type of insulation is used for it? (If no duct system is present leave blank.) ______ [25]
   1. Ducts not insulated
   2. 1" duct insulation
   3. 2" duct insulation
9. Complete the following for exterior doors. (Treat sliding glass doors as windows.)
   1. Door area without storms (sq ft) ______ [26]
   2. Door R-Value without storms (See insulation table) ______ [27]
   3. Door area with storms (sq ft) ______ [28]
   4. Door R-Value with storms (See insulation table) ______ [29]

10. Complete the following for your windows.
(Treat completely shaded windows as north windows.)

Window Direction	Single Glazed No Storm (Sq Ft)	Single Glazed With Storms or Double Glazed (Sq Ft)	Double Glazed With Storms or Triple Glazed (Sq Ft)
South	______ 30	______ 34	______ 38
North	______ 31	______ 35	______ 39
East	______ 32	______ 36	______ 40
West	______ 33	______ 37	______ 41

11. Perimeter length of home. ______ 42

12. Total exterior wall area not including window or door area. (Sq Ft) ______ 43

13. Type wall construction. ______ 44
    1. Brick veneer
    2. Frame
    3. Masonry

14. R-Value of exterior walls. ______ 45

15. If home has knee-walls (walls adjacent to an attic-space) what is the knee wall area? (Sq Ft) ______ 46

16. If home has knee walls, what level of insulation is present? R = ______ 47

17. Estimate the infiltration characteristics. ______ 48
    1. Good condition - Tight fitting windows and doors, caulked and weatherstripped
    2. Fair condition - Average fit, partially caulked and weatherstripped
    3. Poor condition - No caulking or weatherstripping

18. Type heating system. ______ 49
    1. Natural gas
    2. Propane
    3. Electric
    4. Heat pump

19. Is home air conditioned? ______ 50
    1. Yes (Central forced air)
    2. Yes (Window units)

20. Answer the question that applies to heating system about rates during the heating season.
    1. Average price of natural gas, $/MCF. ______
    2. Average price of propane, $/gallon. ______
    3. Average price of electricity, $/KWH. ______ } 51

21. Average price of electricity during the cooling season. If not air conditioned leave blank. ______ 52

22. How many people live in home? ______ 53

23. Thermostat temperature

Day:	Heating ____	Cooling ____
Night:	Heating ____	Cooling ____

24. Do you wish a water heater analysis? ______ 54
    1. Yes
    2. No

25. Type of water heater.
    Gas ______________________
    Electric ______________________

26. Water heater location ______ 55
    1. Conditioned space
    2. Unconditioned space

27. If your heating system is a non-central forced-air furnace, do you heat only a portion or maintain different temperature levels in your home?
    If so explain: ______________________
    ____
    ____

28. Age of the Home.__________
    1. Less than five years.
    2. Five to 10 years.
    3. Over 10 years.

Comments:____
____
____
____

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THE ENERGY EVENT

R-VALUES FOR RESIDENTIAL CONSTRUCTION MATERIALS

In Coordination with the Oklahoma Department of Energy and the OSU Agricultural Engineering Department

Cooperative Extension Service • Division of Agriculture • Oklahoma State University

INSULATION R-VALUES

Insulation R-values are normally given as a value per inch of thickness. To obtain total insulation R-values, multiply the insulation thickness in inches by the R-value factor given in the following table.

Fiberglass	Batts	3.1/inch	Cellulose Loss*Fill	3.7/inch
Rock Wool	Batts	3.7/inch	Polystyrene	5.0/inch
Fiberglass	Loose Fill	2.2/inch	Urea-Formaldehyde	4.3/inch
Rock Wool	Loose Fill	2.8/inch	Vermiculite	2.2/inch

BASIC CONSTRUCTION MATERIALS

R-values of construction material are normally given for specific thickness. The following table contains some of the commonly used materials.

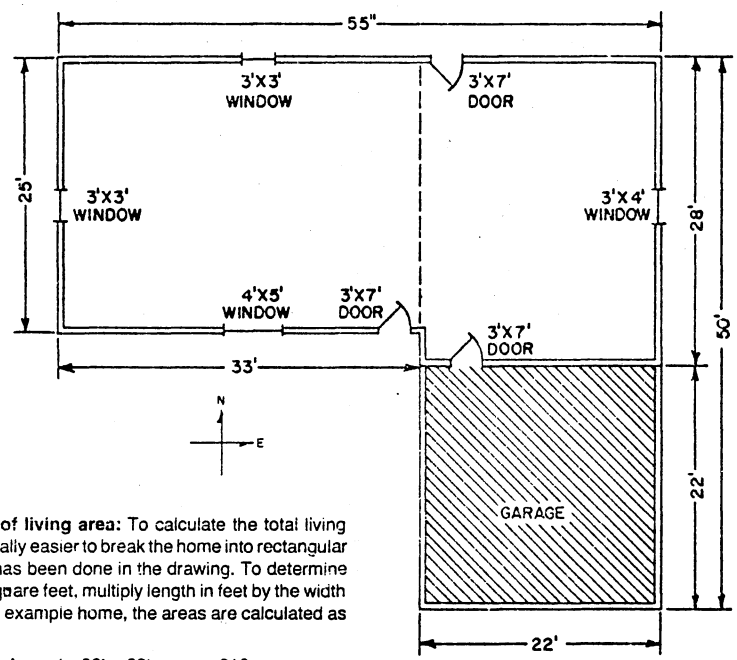
Gypsum Board (3/8) inch)	0.32	Plywood (1/2 inch)	0.62
Gypsum Board (1/2 inch)	0.45	Particle Board (5/8 inch)	0.82
Plywood (1/4 inch)	0.31	Soft Wood (1 inch)	1.25
Plywood (3/8 inch)	0.47	Hard Wood (1 inch)	0.91
Concrete Block (8 inch)	1.89	Conrete (1 inch)	0.19
Lightweight Block (8 inch)	3.03	Common Brick (4 inch)	0.44
Lightweight Block (8 inch Cores filled)	5.88	Wood siding	0.80

MISCELLANEOUS MATERIALS

Doors (1 1/2 hollow core)	2.05	Windows Single Glazed	0.89
Doors (Core filled)	6.25	Windows (double glass)	1.79
Storm Door	1.00	Windows (Triple)	2.67

SAMPLE CALCULATION PROCEDURES

The following drawing represents a typical single story home which is to be audited.



1. **Calculation of living area:** To calculate the total living area, it is usually easier to break the home into rectangular areas. This has been done in the drawing. To determine the area in square feet, multiply length in feet by the width in feet. In the example home, the areas are calculated as follows.

Area 1 - 28' x 22'	=	616
Area 2 - 33' x 25'	=	825
TOTAL	=	1,441 sq. ft.

2. **Calculation of perimeter length:** Perimeter length is the total linear distance around the perimeter of the heated portion of the home. Simply add the lengths of various sections to obtain the total perimeter length.

Perimeter length = 55 + 25 + 33 + 3 + 22 + 28 = 166 ft.

3. **Window area:** Total window area on each side of the home must be calculated. Add the area of each window for each side of the home. In the example, you will notice that each side contains only one window. When calculating window area, make sure you distinguish between types of windows. For example, storm window area should not be added to single pane windows even though they may be on the same side of the home.

South window area	= 4' x 5' =	20 sq. ft.
North window area	= 3' x 3' =	9 sq. ft.
East window area	= 3' x 3' =	9 sq. ft.
West window area	= 3' x 4' =	12 sq. ft.
	TOTAL =	50 sq. ft.

4. **Exterior door area calculations:** Exterior door areas must be obtained for both regular door and doors with storm door additions. In the example, all doors are regular. However, doors which open into enclosed spaces such as garages should be counted as storm doors.

Regular door area	= (3' x 7') + (3' x 7') = 42 sq. ft.
Storm door area	= 3' x 7' = 21 sq. ft.
TOTAL	= 63 sq. ft.

5. **Net wall area calculations:** To calculate wall area, multiply the wall height (usually 8 feet) by the perimeter length. This gives total wall area. To determine net wall area, total window area and door area must be subtracted.

Total wall area	= 166' x 8' = 1,328 sq. ft.
Net wall area	= 1,328 − 50 − 63 = 1,215 sq. ft.

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*** OKLAHOMA COOPERATIVE EXTENSION SERVICE RESIDENTIAL ENERGY ANALYSIS ***

THIS ANALYSIS PREPARED FOR:
EXAMPLE

THE FOLLOWING ANALYSIS IS BASED ON:

ACTUAL HEATING FUEL PRICE $5.00/MCF

ACTUAL COOLING FUEL PRICE $0.0600/KWH

AVERAGE HEATING DEGREE DAYS 3631

AVERAGE COOLING HOURS 1510

** HOME ENERGY ANALYSIS BASED ON PRESENT THERMAL EFFICIENCY **

ITEM	HEATING COST FOR THERMOSTAT SETTINGS: 66	72	78	COOLING COST FOR THERMOSTAT SETTINGS: 72	76	80	TOTAL COST FOR THERMOSTAT SETTINGS WIN-72 SUM-76
CEILING INSUL (R=12.9)	$25.39	$30.30	$35.21	$39.26	$33.85	$28.43	$64.15
DOORS (NORMAL)	$4.27	$5.10	$5.92	$4.56	$3.93	$3.30	$9.03
DOORS (STORM)	$2.87	$3.43	$3.98	$3.06	$2.64	$2.22	$6.07
FLOOR INSUL (BASM R= 0.0)	$27.49	$32.80	$38.12	$0.00	$0.00	$0.00	$32.80
INFILTRATION (AVG)	$68.43	$81.66	$94.88	$30.87	$26.61	$22.35	$108.27
MISCELLANEOUS	$18.47	$22.04	$25.61	$30.22	$26.06	$21.89	$48.09
SUP. DUCTS (0 IN INS)	$72.39	$86.39	$100.38	$84.16	$72.55	$60.94	$158.94
WALL INSUL (R= 0.0)	$184.44	$220.10	$255.75	$196.76	$169.62	$142.48	$389.72
WINDOWS (DOUBLE)	$49.07	$58.55	$68.04	$116.06	$100.05	$84.04	$158.60
	--------	--------	--------	--------	--------	--------	--------
TOTALS	$452.82	$540.36	$627.90	$504.95	$435.30	$365.65	$975.66

*** OKLAHOMA COOPERATIVE EXTENSION SERVICE RESIDENTIAL ENERGY ANALYSIS ***

** HOME ENERGY ANALYSIS BASED ON IMPROVED THERMAL EFFICIENCY **

	HEATING COST FOR THERMOSTAT SETTINGS:			COOLING COST FOR THERMOSTAT SETTINGS:			TOTAL COST FOR THERMOSTAT SETTINGS
ITEM	66	72	78	72	76	80	WIN-72 SUM-76
CEILING INSUL (R=30.0)	$12.45	$14.86	$17.26	$19.25	$16.59	$13.94	$31.45
DOORS (STORM)	$5.74	$6.85	$7.96	$6.13	$5.28	$4.44	$12.13
FLOOR INSUL (BASM R=19.0)	$4.38	$5.23	$6.07	$0.00	$0.00	$0.00	$5.23
INFILTRATION (MIN)	$50.15	$59.84	$69.54	$23.19	$19.99	$16.79	$79.84
MISCELLANEOUS	$7.20	$8.59	$9.98	$30.22	$26.06	$21.89	$34.64
SUPPLY DUCTS (2 IN INS)	$15.39	$18.36	$21.34	$22.91	$19.75	$16.59	$38.11
WALL INSUL (R=19.0)	$32.08	$38.28	$44.48	$34.22	$29.50	$24.78	$67.78
WINDOWS (DOUBLE)	$49.07	$58.55	$68.04	$116.06	$100.05	$84.04	$158.60
	--------	--------	--------	--------	--------	--------	--------
TOTALS	$176.45	$210.55	$244.66	$251.97	$217.22	$182.46	$427.77

*** OKLAHOMA COOPERATIVE EXTENSION SERVICE RESIDENTIAL ENERGY ANALYSIS ***

POTENTIAL SAVINGS THAT CAN BE ACHIEVED BY INCREASING THE THERMAL EFFICIENCY OF YOUR HOME TO THE RECOMMENDED LEVELS.

ITEM	PERCENT ENERGY REDUCTION	ANNUAL DOLLAR SAVINGS*
CEILING	3.7	$32.70
DOORS	0.3	$2.96
FLOOR (BASEMENT)	3.5	$27.58
INFILTRATION	3.5	$28.43 **
SUPPLY DUCTS	14.0	$120.83
WALLS	37.4	$321.94
WINDOWS	0.0	$0.00
	-----	------
TOTALS	62.4	$534.44

DOLLARS THAT CAN BE INVESTED TO INCREASE THE THERMAL EFFICIENCY OF YOUR HOME TO THE RECOMMENDED LEVELS BASED ON ABOVE DOLLAR SAVINGS SHOWN. ***

ITEM	PAY-BACK PERIOD 5 YRS	PAY-BACK PERIOD 7 YRS	PAY-BACK PERIOD 10 YRS
CEILING	$149.18	$206.32	$291.01
DOORS	$13.50	$18.67	$26.34
FLOOR (BASEMENT)	$125.81	$174.01	$245.43
INFILTRATION	$129.71	$179.39	$253.02
SUPPLY DUCTS	$551.24	$762.38	$1,075.31
WALLS	$1,468.71	$2,031.28	$2,865.06
WINDOWS	$0.00	$0.00	$0.00

* BASED ON CURRENT FUEL PRICES.

** A PORTION OF INFILTRATION SAVINGS IS ATTRIBUTED TO STORM WINDOWS.

*** BASED ON FUEL PRICE ESCALATION RATE OF 10% PER YEAR AND AN INTEREST RATE OF 6% PER YEAR

*** OKLAHOMA COOPERATIVE EXTENSION SERVICE RESIDENTIAL ENERGY ANALYSIS ***

** INPUT PARAMETERS **

HEATING SYSTEM	NATURAL GAS
NO. OF OCCUPANTS	3
CEILING AREA	1000 SQ FT
WALL AREA	1769 SQ FT
KNEE-WALL AREA	0 SQ FT
PERIMETER LENGTH	127 FT
DOOR AREA	
REGULAR	21 SQ FT
STORM	21 SQ FT

WINDOWS	SINGLE GLAZED NO STORMS	SINGLE GLAZED WITH STORMS OR DOUBLE GLAZED	DOUBLE GLAZED WITH STORMS OR TRIPLE GLAZED
SOUTH	0 SQ FT	50 SQ FT	0 SQ FT
NORTH	0 SQ FT	50 SQ FT	0 SQ FT
EAST	0 SQ FT	50 SQ FT	0 SQ FT
WEST	0 SQ FT	50 SQ FT	0 SQ FT
TOTAL	0 SQ FT	200 SQ FT	0 SQ FT

*** OKLAHOMA COOPERATIVE EXTENSION SERVICE RESIDENTIAL ENERGY ANALYSIS ***

** GAS WATER HEATER ANALYSIS **

WATER TEMPERATURE, F	ANNUAL ENERGY USE, MCF	ANNUAL WATER HEATING COST	MONTHLY WATER HEATING COST	SAVINGS DUE TO INSULATION WRAP R-3	R-7
120	23	$112.62	$9.39	$14.71	$20.59
130	26	$131.31	$10.94	$17.65	$24.71
140	30	$149.99	$12.50	$20.59	$28.83
150	34	$168.68	$14.06	$23.53	$32.95

ANALYSIS BASED ON AN AVERAGE DAILY HOT WATER USE OF 55 GALLONS.

** CENTRAL AIR CONDITIONING REPLACEMENT ANALYSIS **

ANNUAL SAVINGS AT END OF:	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
	$167.59	$184.35	$202.79	$223.06	$245.37

ANALYSIS BASED ON EER 6.5 FOR PRESENT UNIT AND 10.0 FOR REPLACEMENT UNIT.

THIS COMPUTERIZED HOME ENERGY AUDIT WAS DEVELOPED BY OKLAHOMA COOPERATIVE EXTENSION SERVICE
AGRICULTURAL ENGINEERS AT OKLAHOMA STATE UNIVERSITY

V

VITA

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Doctor of Philosophy

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