AN ABSTRACT OF THE THESIS OF

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Title: ENERGY CONSIDERATIONS IN REMODELING OF OWNER-OCCUPIED SINGLE FAMILY DWELLINGS, CORVALLIS, OREGON

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The investigation of energy considerations in the remodeling of single family owner-occupied dwellings was the central purpose of this study. Variables studied included relationships between demographic characteristics and the inclusion of energy conservation techniques, planning of the remodeling, and ranking of considerations in the remodeling.

A sample of 225 owner-occupants who had purchased building permits to spend $1,000.00 or more on remodeling between July 1, 1973 and June 30, 1977 was collected from the files of the Building Inspector's office, City of Corvallis, Oregon. A questionnaire concerning the remodeling practices was mailed to the sample. One hundred and eight usable questionnaires were returned and served as the data base for the study.

The respondents' mean age was 42.6 years with a median education level of 16 years. The mean size of the sample households was 3.5 persons. The mean of the total gross annual income was $25,850. Over 40 percent of the respondents were in occupations classified as professional. Among the respondents, 74.1 percent believed that an

energy crisis existed.

Sixty-nine percent of the houses in the study were less than 20 years old. The mean age of the houses was 21.5 years with a median age of 16.3 years. Sixty-five percent of the homes were purchased since 1971. The major type of fuel utilized in the majority of the homes (62 percent) was natural gas.

Sixty-nine percent of the remodelings were planned by the respondents and/or their partner. Of the 75 who did their own planning for remodeling, 34 used builders as a source of information. Other sources of information utilized by the respondents were magazines, newspapers, and friends.

Of the remodelings, 40 percent took place between July 1, 1976 and June 30, 1977. About two-thirds of the respondents spent less than $10,000 for their remodeling project. The mean cost of the remodelings was $7,670. The major consideration for remodeling was to increase living area in the homes. Over three-fourths of the respondents added space to their dwelling. The area increases ranged from 20 square feet to 1,800 square feet. Of the 108 respondents, 48 percent included energy saving features in their remodeling. Over 27 percent did make some energy conserving alterations to heating systems; however, 40 percent altered heating systems without energy saving considerations. In comparing fuel unit consumption before and after remodeling, 22.2 percent reported decreases in units consumed; 27 percent indicated increased consumption and the remainder reported no change or were not sure of a change in unit consumption.

Of the 108 respondents, 46 percent indicated they considered alternate energy sources in their remodeling. Of these, about 90 percent considered wood.

The .05 level of significance was selected as the criterion for identification of significant associations. The Chi-square statistical test was used. The findings of the study are:

1. No association was observed between the dates of remodeling and the inclusion of energy saving features in the remodeling.

2. An association was suggested between the type of fuel used in the homes and the inclusion of energy features in the remodeling. Homes using wood as a major fuel most often included energy features.

3. An association was suggested between the inclusion of energy saving features and the considerations of cost, custom decorating, maintenance, and increased livability.

4. An association was suggested between the type of person planning the remodeling and the inclusion of energy saving features. Contractors were most likely to include energy features in the remodeling.

5. An association was suggested between the age and education of the respondents and the inclusion of energy features in remodelings. Those under 35 years and over 65 years and/or with one to four years of college most often included energy saving features in their remodeling.

Energy Considerations in Remodeling of Owner-Occupied Single Family Dwellings, Corvallis, Oregon

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I. INTRODUCTION

With less than five percent of the world population, the United States consumed 30 percent of the world energy production in 1976 (United Nations, 1978). Using the same criteria for comparison, Canada and France, each with .6 percent of the world population, consumed three percent of the world energy, respectively. Sweden, with .2 percent of the world population, consumed less than one percent of the world energy. Asia, with over 57 percent of the world population, consumed 14 percent of the world energy consumption (United Nations, 1978).

Considering per capita energy consumption, the United States' consumption is five times that of the world average per capita consumption. In addition, all other countries fall below the United States' per capita energy consumption. Canada has a per capita consumption 20 percent less than that of the United States, Sweden 50 percent less, France 70 percent less, and Asian countries consume 80 percent less per capita than that of the United States (United Nations, 1978).

In 1920, the per capita energy consumption in the United States was 186 million British Thermal Units (BTU) (U.S. Dept. of Commerce, 1976). By 1973, this energy consumption had risen to 355 million British Thermal Units, almost double the United States' consumption of 1920.

A slight decline took place yearly after 1973 until 1977 when an increase occurred over the previous year with 351 million British Thermal Units per capita consumed (U.S. Bureau of the Census, 1978).

Energy consuming technology has been extended into every facet of American life (Hirst and Moyers, 1974). Higher incomes have allowed consumption of more goods and services in the category of energy intensive production items (Doss, 1972). At the same time, technology has created a multitude of products requiring high levels of energy in production as well as operation. The number of appliances and convenience items in today's homes supports this concept. An underlying factor of increased consumption of energy has been the availability of "cheap" energy for many years, resulting in technology and consumption patterns which now need to be reassessed given the realization that natural energy sources are finite and are being rapidly depleted (Hirst and Moyers, 1974).

Production and consumption patterns have shown a great deal of change since 1940. In that year the combined energy production of the United States exceeded consumption by eight percent. The first year consumption rates exceeded the United States production was 1955, (U.S. Dept. of Commerce, 1976), and by 1977 consumption surpassed production by 21 percent (U.S. Bureau of the Census, 1978).

This reversal to an energy deficit is primarily attributed to the increase in oil and petroleum products consumed in the United States. In 1940, there was status quo for production and consumption of oil, but in 1955 consumption first exceeded domestic production (U.S. Dept. of Commerce, 1976). By 1977, consumption had risen to exceed production by 41 percent. Only 49 percent of the oil consumed by the United States was being produced at home in that year. Contributing to that situation is the fact that the United States experienced between 1940 and 1977 a per capita oil consumption increase of over 300 percent (U.S. Bureau of the Census, 1978).

With more dependence on imported sources of fuel, primarily crude oil, the dependency on Arab nations for oil imports increases. In 1973, petroleum was used in the United States for 46 percent of the total energy needs, and almost half of that petroleum was being imported (Ruffin, 1974). From 1970 to 1973, the Arab imports increased four times with 14.3 percent of all imported oil coming from Saudi Arabia. This trend has continued with imports increasing to 20.9 percent from Saudi Arabia in 1977, or seven times that of 1970 import amounts (U.S. Bureau of the Census, 1978; United Nations, 1978).

The energy crisis of 1973 made the American public aware of the need for energy conservation. This crisis resulted from the Arab oil embargo which created short supplies of energy sources, and eventually led to great increases in energy prices.

A growing concern for all consumers has been the increasing cost of utility bills (Penno, 1977). Costs involved with construction of new facilities to provide additional energy, as well as increases of management costs due to inflation are factors in the higher base rates to consumers (Penno, 1977).

These higher costs appear to be a continuing trend. During the years 1973 and 1977 the Consumer Price Index indicated an overall rise for fuel and utility prices. The largest increase was seen between the years 1973 to 1974 when fuel and utility costs rose 17.5 percent in the index (U.S. Dept. of Labor, 1975). The increase was 12.7 percent between 1974 and 1975, nine percent between 1975 and 1976, and 10.4 percent between 1976 and 1977 (U.S. Dept. of Labor, 1976; 1977; 1978). The overall increase in prices during the years 1973 to 1977 for fuel and utilities was 59 percent. To the consumer the increase meant if their utility bill was $20.00 per month in 1973, it would be $31.80 per month in 1977 for the same number of energy units.

The increased costs of fuel and utilities can also be demonstrated through comparison of the fuel and utility price index of the all items category of the Consumer Price Index. This category represents the average increase in prices for all goods and services. Beginning in 1973 the fuel and utility index was five percent below that of the all items category (U.S. Dept. of Labor, 1975). In 1974 and 1975 the difference rose above the all items category two percent and four percent respectively (U.S. Dept. of Labor, 1976). In 1976 and 1977 the fuel and utility index was above the all items category by seven percent and ten percent respectively (U.S. Dept. of Labor, 1978).

Price increases by 1980 have been projected to be 30 percent for natural gas, 72 percent for oil, and 11 percent for electricity over 1975 prices for fuels supplied to the residential sector. Several studies in the United States suggest that the prices of substitute fuels must rise more rapidly than the price of electricity in order to achieve an increase in electricity consumption (U.S. Dept. of the

Interior, 1975).

Energy use in the millions of homes of America is substantial. Residences consume about one-fifth of the national total use of energy from all sources and about one-third of all electricity generated (Hirst and Moyers, 1974). The greatest energy use in the average American home is for space heating, accounting for more than half of the residential energy consumed and 11 percent of the total energy used in the United States. Water heating is the second largest energy use in the home followed by cooking and clothes drying. Space heating and cooling, water heating, refrigeration, and cooking represent more than 85 percent of the residential energy use (Landsburg, 1974).

In the west, 70 percent of the housing units use utility gas, but regardless of the source of energy delivered to the home, the actual construction of the house is important in determining energy consumptions (Hirst et al., 1978). The National Bureau of Standards estimates that improvements in insulation and construction can reduce the energy consumed in heating and air conditioning by 40 to 50 percent from present norms (Hirst and Moyers, 1974). By 1990 the nation's overall space heating and cooling requirements could be reduced by 30 percent from the projected demand levels. Additional energy savings in water heating, refrigeration, cooling and lighting systems and in air-conditioning equipment are also possible (Lincoln, 1974).

If 75 percent of all new construction used optimum insulation, if 25 percent of existing housing were upgraded with better insulation, and if 12 percent of older units had storm windows and doors installed, the nation's energy costs would be reduced by approximately nine percent in 1982 (Hirst and Moyers, 1974). The cummulative energy savings that would occur because of these programs amounts to the equivalent of six years of present day residential energy use. By the end of this century the economic benefits of the programs would amount to a savings of $600.00 per household (Hirst et al., 1978).

With decreasing resources of natural energy supplies, energy conservation in the residential sector is significant. Although research has been dedicated to determining what energy efficient techniques may be used in residential dwellings, little attention has been given to the actual behavior of homeowners toward energy conservation options. Research is needed to determine what are homeowners' attitudes and practices toward incorporating energy conserving features into dwelling alterations.

Statement of Problem

The main concerns of the study were to determine homeowners' awareness of conservation techniques in remodeling of single family dwellings, their attitudes toward an existence of an energy crisis and their consideration and use of alternate energy sources.

Objectives of the Study

The objectives of this study were:

1. To learn if energy was a major consideration in remodeling of single family owner-occupied dwellings.

2. To examine which variables influenced an energy consideration decision in remodeling.
3. To examine energy conservation features used in the remodeling of homes in this study.

Hypotheses

1. There is no association between the year of remodeling and the inclusion of energy saving features.
2. There is no association between the major types of fuel used in the home and the inclusion of energy saving features in remodeling.
3. There is no association between energy saving features and other considerations in remodeling:
   a. Addition of space
   b. Cost
   c. Custom Decorating
   d. Increase livability
   e. Increase market value
   f. Maintenance
   g. Modernization
4. There is no association between persons planning the remodeling and the inclusion of energy saving features in remodeling.
5. There is no association between the inclusion of energy saving features in remodeling and demographic characteristics of the respondents:
   a. Age
   b. Education

c. Occupation

d. Income

Assumptions

1. Persons remodeling their home were thought to have considerable control over energy conservation choices.
2. Questionnaires completed by one member of the family did not differ from those completed by more than one member.
3. Respondents met the criteria specified.
4. The respondents provided the requested information as completely and accurately as they were able to do.
5. There was no difference between those homeowners returning the questionnaires and those not.

Limitations

1. The study was limited to a sample of single family owner-occupied dwellings in Corvallis, Oregon for which building permits were issued for $1,000.00 or more to be spent on remodeling between July 1, 1973 and June 30, 1977.
2. The conclusions of the study were limited to those homeowners who returned completed questionnaires.

Definition of Terms

1. Alternative Energy Source is an energy source other than electricity, coal, liquid petroleum gas, or natural gas.
2. Energy Considerations are conscious choices of energy conserva-

tion techniques utilized in the home.

3. Energy Saving Features are technologies utilized in the dwelling and result in energy conservation.
4. Remodel is altering or rearrangement of existing space, or the construction of additional space to the house.
5. Types of Remodeling used in the study are categorized as follows:
   a. Addition of Space is the enlargement of living area by the addition of a room, porch, enclosure of a carport, addition of a second story or completing an attic or garage.
   b. Maintenance is an alteration to improve or maintain the quality of the house (Morris and Winter, 1977).
   c. Decorating/Modernization is an alteration of the interior organization or design or updating of the living environment.
   d. Energy Remodeling is an alteration or addition to decrease energy consumption or increase energy efficiency in the home.
   e. Exterior Remodeling is improvement or alteration made to areas outside the living area of the home.

II. REVIEW OF LITERATURE

Introduction

Topics included in the literature reviewed were: energy consumption by the United States and by the residential sector, an overview of remodeling activity in the United States between 1973 and 1976, and alterations and additions to single family dwellings for energy efficiency.

United States Energy Consumption

In 1976, the United States with less than six percent of the world population consumed 30 percent of the world energy production (United Nations, 1978). Total energy consumption in the United States has been steadily increasing. Since 1947, energy consumption has increased each year over the previous year with the exception of five years of lessened economic activity (Dupree and Corsentino, 1975).

From 1947 until 1973 gross energy consumption rose 125 percent. This represents a 3.2 percent average annual rate of growth for the 1947 to 1973 period. The largest annual rate increase was between 1965 and 1970 when the average rate reached 4.8 percent annually (Dupree and Corsentino, 1975).

The United States energy consumption per capita has increased at an average rate of 1.4 percent annually since the year 1900. From 1950 to 1969 the average annual per capita increase was 1.8 percent per year. Since 1970, the annual rate has increased to 2.6 percent annually per capita (United Nations, 1978). From 1970 to 1973, an eight percent per capita increase took place in the United States (U.S. Dept. of the Interior, 1975).

One further indicator of the trend toward increased energy consumption is the energy consumed per dollar of the Gross National Product (GNP) in which the measure is made using constant 1958 dollars. The energy to Gross National Product ratio had a long term downward trend from 1947 until 1966. This trend reversed in 1966 (85,700 BTU to dollar of GNP) and steadily rose until 1970 (92,900 BTU to dollar of GNP) to an increase of eight percent. Since 1974 this trend has shown a decline with some stabilization due primarily to a recession in the economy. This ratio is a rough measure of the "dollar" efficiency of energy utilization in the economy (Dupree and Corsentino, 1975).

The energy mix used in the United States was altered substantially between 1940 and 1977. In 1940, coal use furnished over 50 percent of the total energy consumed. By 1977, less than 20 percent of the energy consumed came from coal (U.S. Bureau of the Census, 1978). Petroleum usage increased from 31 percent to approximately 50 percent of the total consumption, an increase of 55 percent for that time span. Natural gas use more than doubled between 1940 and 1975 while electricity use increased by 80 percent (Dupree and Corsentino, 1975).

The production of all energy sources except natural gas is projected to increase in the United States. By 1990 the greatest increase in production will be in nuclear and coal resources.

However, even with the increased production of petroleum in this country, imports are projected to increase by 64 percent from the 1973 totals (13.5 quadrillion BTU) by 1990 (over 21 quadrillion BTU). It is projected that by 1990 over 49 percent of the United States energy consumption will come from petroleum sources compared to the 32 percent during 1973 (U.S. Dept. of the Interior, 1976).

Residential Energy Consumption

Energy use by the residential sector is substantial in the United States. In 1970, 17 percent of all United States energy consumption was directly consumed by the residential sector (U.S. Dept. of Housing and Urban Development, 1973). By 1974 the residential sector used one-fifth of the total United States energy consumption (U.S. Dept. of Housing and Urban Development, 1975). From 1950 to 1975 the overall annual growth rate for residential energy use was 3.5 percent, nearly double the growth rate for household formation. This rate has shown a slight decline since 1972 (Hirst and Jackson, 1977).

The majority of the residential energy consumption is for space and water heating. In 1976, space heating represented 69 percent of the total energy consumed by all residences. Water heating accounted for another 16 percent, cooking took five percent, refrigeration three percent, and clothes drying and air-conditioning two percent, respectively. The remaining five percent was used for other purposes such as lighting and small appliance operation (U.S. Dept. of the Interior, 1976).

In 1950, coal accounted for more than one-third of the household fuel supply. However, by 1975 it furnished only two percent of the total residential energy. Petroleum's share of the total also declined from 26 percent to 18 percent while natural gas use increased from 22 percent to 34 percent in 1950, and to over 43 percent by 1975 (Hirst and Jackson, 1977). Some of this increase can be attributed to an increase in new housing units which utilize only electricity. Ironically, a home heated by electricity requires about twice as much fuel per unit of heat production as a similar gas or oil heated home (Newman and Day, 1976). Electric resistance heating increases annual primary energy consumption by 31.4 percent (U.S. Dept. of Housing and Urban Development, 1977).

In 1976, for all occupied housing units in the United States, 56 percent used utility gas for space heating, 22.5 percent oil, 12.6 percent electricity, five percent liquid gas, less than one percent coal, and one percent wood or other sources (U.S. Bureau of the Census, 1977). For all occupied housing units (owned and rented) in the West in 1976, 70 percent used utility gas as a source of heating fuel, 17 percent electricity, six percent fuel oil, three percent liquid petroleum gas, and less than one percent wood (U.S. Dept. of Housing and Urban Development, 1978).

During 1976, in the West, 65 percent of all owner-occupied housing units utilized warm-air furnaces for space heating while 26 percent utilized floor, wall or pipeless furnaces. Seven percent used built-in electric units and only two percent used fireplaces, stove or portable heaters as a major source of space heating (U.S.

Bureau of the Census, 1977; U.S. Dept. of Housing and Urban Development, 1978).

Prices for fuels were generally stable until 1970 when prices, especially those for petroleum products, rose (Hirst and Jackson, 1977). Household expenditures on fuels (as a percent of total personal consumption expenditures) remained constant until 1973. However, between 1973 and 1974, an increase from three to four percent resulted due to the sharp increase in fuel prices (Dupree and Corsentino, 1975).

A study sponsored by the Ford Foundation reported that as income increases, the increase in consumption of natural gas is gradual, electricity intermediate, and gasoline sharp. The upper income family uses about one and one-half times as much natural gas as families in the lowest income quartile, two and one-quarter times as much electricity, and five times as much gasoline (Hogan, 1978). The more money a family has, the more energy they consume (Newman and Day, 1976).

Parodoxically, the higher the income, the more likely the household will possess equipment to save energy (Newman and Day, 1976). While low income families live in smaller homes and are more likely to live in apartments, their energy bills for heating are not proportionally less (Hogan, 1978). The homes of low income families are often not weatherized. While 75 percent of all United States single family homes have some insulation, only 40 percent of the houses of the poor compared to 90 percent of the upper income have insulation (Hogan, 1978).

National Remodeling Activity 1973 to 1976

Total expenditures for maintenance and repairs, and construction improvements for owner-occupied single family dwellings ranged from 11.3 billion dollars in 1973 to 18.9 billion dollars in 1976 (Rubinstein, 1977). Maintenance and repair expenditures included costs for the upkeep of the property while construction improvements represented capital investiments and were categorized to include: 1) additions to a residential structure; 2) alterations within the residential structure; 3) additions and alterations on property outside the residential structure; and 4) major replacements permanently attached to the house (U.S. Bureau of the Census, 1976).

Expenditures for owner-occupied single family dwellings ranged from 11.3 billion dollars in 1973 to 18.9 billion dollars in 1976. Table 2.1 summarizes the expenditures by the type of work performed. Addition and alteration expenditures ranged from 5.7 billion dollars in 1973 to over 10 billion dollars in 1976 (U.S. Dept. of Housing and Urban Development, 1976). Additions, alterations, and major replacements are categorized as part of improvements.

Table 2.1 Expenditures for maintenance and repairs and improvements for owner-occupied single housing units (in billions of dollars)

Year	Total	Maintenance & Repairs	Improvements
1973	11.3	3.6	7.7
1974	13.5	4.0	9.5
1975	15.6	4.5	11.1
1976	18.8	5.2	13.6

Source: U.S. Dept. of Housing and Urban Development, 1976, p. 709
U.S. Dept. of Housing and Urban Development, 1977, p. 735

Expenditures for all owner-occupied households ranged from an average of $340.00 in 1974 to $450.00 in 1976 (U.S. Dept. of Housing and Urban Development, 1976). For maintenance and repairs in the Western region of the United States, the range was from $312.00 in 1974 to $421.00 in 1976 (U.S. Dept. of Housing and Urban Development, 1977).

Owners of expensive homes tended to spend more for improvements than those of modest homes. For families with homes valued at $20,000 or more in the year 1972, expenditures averaged $397.00. Expenditures on houses valued between $10,000 and $20,000 averaged about $241.00 and on houses valued lower than $10,000, $174.00 (Krassa, 1975). Table 2.2 reports expenditures by household incomes.

Table 2.2 Average expenditures by owner-occupants of single family dwellings for maintenance and repairs, and improvements (in dollars)

Incomes	1975		1976	
	U.S.	West	U.S.	West
Total	382	463	450	421
Under 5,000	163	182	203	163
5,000 - 9,999	266	241	298	312
Over 10,000	1688	2141	1850	1454
Not Reported	316	153	361	513

Source: U.S. Dept. of Housing and Urban Development, 1977,

Information on repairs and improvements that may be directly related to rising fuel costs is not available. If the installation of some of these items occurs incidental to other work, the expenditure is listed under the category for the most extensive work

(Krassa, 1975).

Total heating and central air-conditioning work amounted to 2.1 billion dollars in 1976, an increase of 26 percent over 1975 expenditures. Owner-occupied single housing units account for 43 percent of the 1976 expenditures. This type of work basically includes maintenance of the systems. Expenditures for major replacements for heating and central air-conditioning totaled 1.7 billion dollars in 1976, 43 percent more than in 1974 (Rubinstein, 1977).

Work categorized as remodeling by the United States Bureau of the Census amounted to 3.7 billion dollars from 1971 through 1973. For 1974 to 1976 years, the total was 4.6 billion dollars (Rubinstein, 1977). Remodeling expenditures in 1976 were over 300 percent greater than during 1967. Expenditures for remodeling by owner-occupants of single unit dwellings ranged from nine billion dollars in 1973 to 11.6 billion dollars in 1976 (Rubinstein, 1977). This category includes rearrangement of interior space and construction of new facilities such as baths and kitchens. Also included are items such as painting, roofing, and plumbing. Of the categories discussed earlier, remodeling is a part of the construction or the addition and alterations category.

Construction expenditures for residential additions amounted to 3.5 billion dollars in 1976, 77 percent greater than in 1975 (Rubinstein, 1977). About 84 percent of these additions were made by owner-occupants of single unit dwellings.

Expenditures for all categories of additions and alterations increased. Rising costs of materials and labor contributed to this trend. More improvements result from increases in new housing costs and reduced building during 1974 and 1975 (Rubinstein, 1977).

Many families do not pay cash for home improvements but obtain loans (Krassa, 1975). In 1976, the median loan for all improvements to single family housing was $2,739 with a mean loan of $3,125. Over 87 percent of the loans were for amounts over $1,000. For heating system improvements to all types of dwellings, the mean loan was $1,081. A loan of $806 was the mean reported for insulation. Additions and alterations accounted for 25.3 percent of all loans made for improvements. Of the loans made for additions and alterations, 9.4 percent were for heating system improvements and 3.7 percent for insulation (U.S. Bureau of the Census, 1976).

Additions and Alterations for Energy Efficiency

With increased technologies, there are more means by which energy can be conserved in residential dwellings. Many of these techniques may be adapted to existing housing to increase the efficiency of energy utilization and conserve resources.

Insulation

Because space heating accounts for over 65 percent of the energy utilized in the residential sector, insulation could have an impact on conservation. Approximately 25.5 million existing housing units could be improved with additional insulation (Penoyar and Williams, 1977). A 12 percent increase in insulation in wall areas could equal a five percent decrease in annual energy consumption by the household

(U.S. Dept. of Housing and Urban Development, 1977). The greatest potential for energy savings through insulation is found in the upgrading of extant housing (Fitch, 1974).

Results from one study indicate that the heating load of the average single family dwelling with two and one-half inches of ceiling insulation can be reduced up to 35 percent by: 1) the addition of insulation to equal ten to twelve inches; and 2) the installment of storm windows and doors (Magnas et al., 1976).

The economics of adding ceiling insulation is dependent upon the current level of insulation and the expected life of the dwelling. In a house with no ceiling insulation at present, eight inches of insulation will pay for itself in less than two years. However, if a house already has two inches of insulation the addition will be paid back more slowly. The pay back period is also related to the type of heating system used in the house and the rate of fuel price increases (Fitch, 1974).

A Stanford Research Institute report prepared for Pacific Power and Light Company concluded that all insulations were economically justified over a 30 year life of a dwelling. Optimum insulation pays for itself in three to six years depending on the geographic location. The total calculated savings per dwelling on a 30 year life ranged from $1,500 to $9,000 according to the same study (Pacific Power and Light, 1974).

In 1976, for all occupied single family housing units in the West, 70 percent of the residents reported attic or roof insulation in some amount, 18 percent none, and the remainder were not sure or did not report (U.S. Dept. of Housing and Urban Development, 1977). Estimates indicate that eight to nine million units have already been voluntarily improved since the 1973 oil embargo. Most of these improvements involved ceiling but not wall installations due to the relative ease and low costs involved in insulating ceiling areas (Penoyar and Williams, 1977).

Because space heating accounts for an estimated 77 percent of residential energy consumption in the Northwest, the choice of heating and insulation systems has a potential impact on overall energy use (Fitch, 1974). Space heating accounts for over 13 percent of the total energy used in Oregon. Combined savings from improvements of insulation could reduce energy consumption in Oregon by 1.3 percent by 1980 (Fitch, 1974).

The current stock of single unit dwellings in the Oregon Willamette Valley, estimated in 1973 to be 393,400, far exceeds the number of new units being built each year. If 50 percent of these established units were upgraded with insulation, the potential savings would be 3.2 to 6.7 percent reduction in total space heating requirements for Oregon. This potential savings per year in total residential space heating could reach over nine percent by 1980 (Fitch, 1974).

A study conducted in 1973 in the Oregon Willamette Valley regarding insulation feasibility of housing had the following conclusions:

1) There is economic justification for installing three and one-half inches of insulation batts in walls and eight inches in the ceiling spaces of wood-frame houses.

2) All units built over vented crawl spaces should have under-floor insulation.

3) In the immediate future, greater energy savings could be derived from upgrading insulation in existing housing than from raising standards in new construction.

4) Combined savings from improved insulation in both new and existing housing could total to as much as 7.3 percent of the energy used for space heating in 1975 and 9.4 percent by the year 1980 (Fitch, 1974, 35).

Storm Windows and Doors

If a house is well insulated the heat loss through glass surfaces will be about 30 percent of the total heat loss for the dwelling (Cobb, 1976). Like insulation, the potential for energy savings as a result of the addition of storm windows and/or doors is substantial.

With the addition of storm windows and doors, as much as 15 to 30 percent of heating costs may be saved (How to Cut, 1973). After completion of a study in 1973 in the Willamette Valley of Oregon, Fitch (1974) concluded that it was economically feasible for electrically heated homes to be fitted with insulated (double pane) glass windows. The degree of savings is associated with the type of heating system and climatic conditions.

Quality storm windows will generally pay for themselves in less than ten years and provide for 13 percent savings in energy use each year after (Storm Windows, 1974; Cobb, 1976). With proper installation, plastic, double pane glass, or triple track storm windows have the same effectiveness (U.S. Dept. of Housing and Urban Development, 1975).

In 1976, about one-third of all single family dwellings were equipped with storm doors and windows (U.S. Dept. of Housing and Urban Development, 1977). In 1976, 12.6 percent of all occupied housing units in the West had all windows fitted with storm windows; however, 79 percent had no storm windows at all. Slightly over ten percent had all doors fitted with storm doors (U.S. Bureau of the Census, 1977).

The total in-structure heating energy savings from all storm door and window applications in use are five percent of the annual heating and cooling energy used in the residential sector. Increasing storm window and door installations could save an additional one to two percent. Since 30 to 60 percent of all single family houses, even in colder regions, do not have storm windows and doors, the potential for energy conservation is considerable (U.S. Dept. of Housing and Urban Development, 1975).

Heating Systems

In the residential sector, space heating is the largest consumer of energy. Because space heating accounts for an estimated 77 percent of residential energy consumption in the Northwest, the choice of heating systems has a potential impact on overall energy use (Fitch, 1974).

The choice of a heating system and fuel will have an impact on where future energy must come from, whether it is from electricity for which the Northwest must create additional generating capacity or from oil and natural gas which must be imported into the region. The most common type of heating fuel in all occupied units in the West is utility gas. The second most common source of energy is electricity. In comparing the number of units using electricity in 1970 and 1976, an increase change of 42 percent took place with 17 percent of all housing units using electricity as a source of heating fuel. Other fuels used in 1976 included fuel oil, bottled gas, coal, and others (U.S. Dept. of Housing and Urban Development, 1977).

Electric resistance heating is less efficient than gas or oil as a fuel in the home (U.S. Dept. of Housing and Urban Development, 1977). Electric resistance heating in a home requires approximately twice as much fuel per unit of heat as a similar gas or oil heated house (Newman and Day, 1976). There has been an increase in housing units constructed with electric resistance heating. Electric heating systems may be supplied with a device known as a heat pump. Heat pumps result in a system twice as efficient as resistance heating for the home (U.S. Dept. of Housing and Urban Development, 1977).

Oil and gas furnaces have comparable efficiency. New systems deliver about 60 percent of the energy in the fuel to the living areas of the house. Much of the fuel goes up the chimney as waste heat (U.S. Dept. of Housing and Urban Development, 1977). In the characteristic house, 12 percent of the waste heat from the flue gas could be recovered and returned to space heating through an air supply in the furnace return duct, thereby resulting in a savings of ten percent annually (U.S. Dept. of Housing and Urban Development, 1973). Another approach to minimize furnace energy use would be the use of a damper system to close the flue during the off cycle periods of the furnace. One manufacturer suggests a savings of 20 to 30 percent or an annual savings of five percent of fuel through the use of the damper system (U.S. Dept. of Housing and Urban Development, 1973).

Several concepts may be used for energy efficiency in gas furnaces: heat exchangers which extract flue energy from the flue and deposit it in the return air ducts; new high efficiency furnaces located outside the dwelling; and, automatic flue shut-off devices which close the flue when the furnace is not operating. Such innovations could save about 8.4 percent of the annual energy consumed in the characteristic house (U.S. Dept. of Housing and Urban Development, 1977).

According to one study, the average fireplace has a heating efficiency of only ten percent. This means almost ten times more heat goes for waste heat than into the home for space heating. If the masonry fireplace is poorly constructed the fireplace can have a negative efficiency by pulling the heat out through convection currents (Oddo, 1975).

Masonry fireplaces are generally expensive and inefficient. For slightly more cost, the fireplace may be constructed around a prefabricated steel firebox. The metal back and sides generate more heat than the masonry surfaces (Oddo, 1975). Air drawn into the unit is warmed by contact with the back and the hot metal box and then convected upward into the room (Make Your Fireplace, 1975). Free standing metal fireplace stoves heat by both radiation from the fire and some contact heating of the air by the metal exposed. There is also the advantage of heating from all sides (Oddo, 1975).

For an existing masonry fireplace there are several options for improvement of heating. A small forced-air unit may be installed into the existing fireplace. There are several designs but the basic operation is drawing the cool air into one end of the network, circulating the air through the fireplace, and blowing the warm air out the other end (David, 1975). Although manufacturers claim these units can be responsible for heating an entire house, there is no research to support such a claim (Leckey, 1974).

Twenty year life cycle cost analyses show that for water and space heating a solar collector system competes favorably with conventional electrical heating systems, but not with conventional gas or oil heating systems except in regions of the country where there are extreme fossil fuel prices. The current high initial costs along with the public's unfamiliarity with solar collector performance over a period of years present major obstacles to wide spread adoption of solar heating systems (Magnas et al., 1976).

Retrofitting a solar space heating system is difficult because the design options are much fewer. Not all existing houses are adaptable for solar space heating. Some problems are high heat losses, wrong orientations, winter shading, or lack of space for the solar components (Sunset, 1978; Dubin, 1975).

A house must meet several criteria for retrofit, It must have an area suitable for the heat collection. The area must be large enough to gather adequate heat needed for space heating, and the area should have a southern orientation (Sunset, 1978).

In the case of a passive heating system, the collection area must be an actual part of the house structure. The significant costs and difficulties of structural changes necessary to add most passive systems makes retrofits of this type unlikely.

Active systems have more flexibility than passive systems in retrofitting plans. The collectors may be installed on a roof, a vertical wall, or fence. A collector area may be divided between several locations. With active systems, space needs to be available for the distribution system and the storage of energy (Dubin, 1975; Sunset, 1978).

The heat distribution for an active liquid system is relatively easy to retrofit for a house since the pipes and pumps involved occupy little room. The air ducts and fans needed for an active air system demand more space considerations (Sunset, 1978). With regard to the storage necessary, neither the liquid or air systems require considerable space for storage. The space for an active air system demands three times the volume of the space requirements of a liquid system, the air system usually utilizing rock storage and the liquid system a water mixture (Dubin, 1975; Sunset, 1978).

Water Heating Systems

After space heating, water heating is the largest and least apparent use of energy in the home (Mutch, 1974). Water heating ranks second to space heating systems for residential energy use. It has been estimated that residential water heaters currently demand one-third of the total energy used for all appliances and over three percent of the United States energy consumption (Wilson, 1978).

The increasing energy use for water heating is explained by an increase of units and consumption per unit. For example, the average energy consumption of a standard electric water heater increased 15 percent between 1950 and 1969 (Mutch, 1974).

Standby losses amount to approximately 17 percent of the input for electric and 27 percent for gas-fired water heaters. The overall standby loss is due to: 1) loss through insulation; 2) leaks through fittings; 3) stack losses of the main burner when the heater is used to reheat water after a cooling period; and 4) heat loss from the exposed metal flue during standby (Wilson, 1978).

Since late 1974, manufacturers have recognized energy saving options and their potential as a new sales tool. Changes which result in energy savings have been made to many of the existing models. Among the features included for energy reduction are: 1) greater insulation thickness and lower conductivity; 2) reduction of conduction leaks; 3) reduction in thermostat settings; 4) increases in flue baffling; 5) reduction in pilot rates; and 6) reduction in main burner input. The energy savings possible with these changes or any combination of them is up to 20 percent for gas-fired heating units (Wilson, 1978).

In the Pacific Northwest 69 percent of water heaters use natural gas, 26 percent electricity, three percent liquid petroleum and the remainder other types of fuel. This distribution is typical for other regions of the United States (Mutch, 1974).

Supplementing conventional energy input to water heaters with solar heat is another means of energy conservation. A solar water heater will consist of a solar collector, a heat storage tank, and the necessary auxiliary equipment and controls to couple these elements into an operating system. The solar design enables water to be preheated before entering a conventional water heater which brings the water to a final desired temperature (Wilson, 1978).

Solar water heaters have been extensively used in Australia, Japan, and Israel for up to several decades (Mutch, 1974; Wilson, 1978). A solar water heating industry was established in Florida during the 1930 to 1940 period, but vanished in the proliferation of low cost natural gas (Wilson, 1978).

Economically feasible solar water heaters for the near future could be designed for supply of 40 to 70 percent of the entire water heating load. Larger systems approaching 100 percent solar heating will be less economically possible since the collector and storage capacities would be poorly utilized throughout most of the year (Wilson, 1978).

Appliances

After space heating and water heating, major appliances are the third largest consumers of energy in the average household (Citizens Action Guide, 1973). Refrigeration, clothes drying and cooking use the most amounts of energy of the major appliances.

In 1976, for all occupied housing units in the West, electricity was the most common source of energy for cooking purposes and was utilized in 53 percent of the housing units. Utility gas, found in 43 percent of the housing units, was the second most used energy source, and bottled gas was used by three percent of the homes for cooking fuel. The remainder of the households (one percent) used wood or other sources (U.S. Dept. of Housing and Urban Development, 1977). With respect to energy use of different types of cooking models, self-cleaning ovens were found to use approximately 21 percent more energy than conventional cooking equipment (Citizens Action Guide, 1973).

Energy consumption for refrigeration is a result of electricity being used to operate the compressor which drives the refrigeration cycle and also powers the heaters and fans. Refrigerator energy use depends primarily on the design of the unit, size, door configuration, and defrost options (Hoskins et al., 1978). Frost free refrigerators consume 50 percent more energy than a non-frost free model. The side by side refrigerator/freezer models consume up to 45 percent more energy than conventional models (Citizens Action Guide, 1973).

Energy use of refrigeration units is also influenced by operational characteristics such as room temperature, food load, and the number of door openings (Hoskins et al., 1978).

Lighting

Approximately 25 percent of all electricity sold is consumed for providing lighting indoors and outdoors throughout the United States (Lighting; Energy Waster, 1974; Hayes, 1976). Lighting accounts for about three and one-half percent of a residential dwelling's total energy bill and from eight to 16 percent of the total electric bill in homes heated by other than electricity as a fuel source (Brown, 1978).

The efficiency of lamps in converting electrical energy into illumination vary over an extremely wide range from less than ten lumens per watt to over one hundred (Adams, 1975). Incandescent lighting is inefficient; only about 15 percent of the energy input becomes visible light with the remainder generating heat. Fluorescent tubes use electrical energy more efficiently than incandescent bulbs (Brown, 1978). A forty watt fluorescent lamp has approximately four times the efficiency of a one hundred watt incandescent lamp (Adams, 1975).

III. METHODOLOGY

Introduction

This chapter includes the selection of the sample, the development of the instrument, and the collection and analysis of the data.

Selection of the Sample

The purpose of this study was to gain knowledge about the homeowners' awareness of energy saving features in the remodeling of their present dwellings. Persons who remodeled their homes were thought to have considerable control over energy conservation choices.

Persons planning to make alterations and/or additions to their present dwellings are required to purchase building permits. These permits are on file in the Corvallis City Hall and are part of public records. The Corvallis, Oregon building permits were used as the source of reference for single family dwellings remodeled between July 1, 1973 and June 30, 1977.

1. The address and the name of each person purchasing a building permit for a remodeling job of $1,000 or more on a residential dwelling were obtained by the researcher from the Building Inspector's Office, Department of Public Works, City of Corvallis.

2. The file for each of the addresses was reviewed to verify the owner of the dwelling at the time the building permit was issued. This process was necessary since many permits are issued under the name of the person responsible for the remodeling work.

3. Polk's Corvallis (Benton County, Oregon) City Directory (1978)

was used to determine if the address was:

a. a rental

b. owner occupied, and

c. the owner was the same person determined to be the owner occupant at the time the building permit was issued.

4. The names and addresses of the homeowners were verified by checking the 1978/1979 Corvallis telephone directory. This reference was used to verify spelling and correctness of names and addresses. The persons not listed in the telephone directory were not eliminated from the sample. For the study, 225 names met the criteria.

5. Upon completion of these steps, a list of single family dwellings, owned and occupied by the same person(s) from the time a building permit was purchased to the time of this study compiled.

Development of the Instrument

A questionnaire was developed to collect demographic and remodeling data.

1. The proposed research study, including the questionnaire, was presented to the graduate students and faculty of the Family Resource Management Department. Their suggestions were used to make revisions.

2. A list of the first ten residential addresses with permits issued for $1,000 or more value after July 1, 1977 was collected for the trial test sample. The addresses were processed as above with seven households meeting the criteria.

3. The revised questionnaire, cover letter, and self-addressed

stamped envelope were mailed to seven respondents for a trial test of the instrument.

4. Five out of seven questionnaires were returned with suggestions for the researcher.

5. These suggestions were used to make final revisions of the questionnaire.

Collection of the Data

1. The 225 questionnaires with cover letter (Appendix) were mailed to the sample on February 22, 1978. A self-addressed stamped post card was included for the respondent to mail at the time the questionnaire was returned in order to ascertain which questionnaires had not been returned.

The respondents were asked to return the questionnaires and post cards by March 8, 1978.

2. Of the 113 questionnaires returned 108 (96 percent) were usable.

Analysis of the Data

The responses of the questionnaires were coded, tabulated, and summarized by the researcher. A computer program using the Statistical Package for the Social Sciences (Nie, 1975) was used for the statistical analysis; number and percentage distributions, means, ranges, and medians. The Chi-square test was used to test the hypotheses (Downey, 1975). The .05 level of confidence was selected as the criterion for determining an association between variables.

IV. FINDINGS

This study sought to identify energy considerations made in the remodeling of single family owner-occupied dwellings. The data summarized from the 108 questionnaires are reported in this chapter. This chapter includes the topics: 1) description of the sample; 2) characteristics of the dwellings remodeled; 3) plans for the remodeling; 4) characteristics of the remodeling; 5) energy factors considered in remodeling; and 6) other related energy concerns in the remodeling.

Description of the Sample

Data for the study were collected through questionnaires mailed to 225 homeowners who had obtained a building permit to perform a minimum of $1,000 remodeling work to their homes. Completed questionnaires from the 108 respondents served as the basis for this research study.

Age of the Respondents and Partners

The respondents in the study ranged in age from 21 years to 70 years. The mean age was 42.6 years and the median age was 35 years. The partners' ages ranged from 23 years to 68 years with a mean age of 41.5 years and a median of 39 years. Table 4.1 summarizes the reported ages of the respondents and their partners. Three-fifths of the respondents and two-thirds of their partners were in the 26 to 45 year age group.

Table 4.1 Age characteristics of respondents and their partners

Age	Respondents N	Respondents %	Partners N	Partners %
25 or under	4	3.7	4	4.3
26 - 35	28	26.0	24	25.8
36 - 45	37	34.3	38	40.9
46 - 55	24	22.2	16	17.2
56 - 65	13	12.0	8	8.5
over 65	2	1.8	2	2.2
no response	0	0.0	1	1.1
Total	108	100.0	93	100.0

Size of Households

The size of households reported in the study ranged from one to 12 persons. The mean size of households was 3.5 people. The distribution of household size is summarized in Table 4.2. About 80 percent of the households had four or less members.

Table 4.2 Size of household of the respondents

Number of Persons	N	%
1 - 2	30	28.0
3 - 4	55	51.0
5 - 6	20	18.5
7 and over	3	2.5
Total	108	100.0

Occupations of Respondents and Their Partners

Hollingshead's occupational classifications were utilized as a guide for developing occupation categories for this study (Hollingshead, 1957). Table 4.3 summarizes the occupations reported for the respondents and their partners. Of those reporting, 87.5 percent of the respondents and 72 percent of their partners were employed. Slightly over one-fifth of the partners were full-time homemakers.

Table 4.3 Types of occupations reported for the respondents and their partners

Occupational Category	Respondents		Partners	
	N	%	N	%
Executive/Major Professional	7	6.5	0	0.0
Business Managers/ Professional	39	36.0	21	22.5
Administrative Personnel & Small Business Owners	15	14.0	4	4.3
Clerical & Technical	14	13.0	20	21.5
Skilled Manual	7	6.5	4	4.3
Semi Skilled	2	2.0	3	3.2
Unskilled	0	0.0	3	3.2
Retired	6	5.5	1	1.0
Homemaker, full-time	6	5.5	20	21.5
No Response	12	11.0	17	18.5
Total	108	100.0	93	100.0

Education Level of the Respondents and Their Partners

A summary of the education levels attained by the respondents and their partners is shown in Table 4.4. The education levels of the respondents and their partners ranged from less than eight years to 19 years, or the completion of a doctoral degree. The mean education for the respondents and their partners was 16 years, or completion of a bachelor's degree.

In 1976, the mean for the education level was 12.7 years for all heads of owner-occupied housing units (United States Dept. of Labor, 1977). About two-thirds of the respondents and slightly over half of the partners held a bachelor or higher degree. Almost 22 percent of the respondents and 10.8 percent of the partners held doctoral degrees.

Table 4.4 Education level reported for the respondents and their partners

Education Completed	Respondents		Partners	
	N	%	N	%
1 - 8 years	2	1.9	1	1.1
9 - 12 years	11	10.2	17	18.3
Vocational Training	5	4.6	4	4.3
1 - 4 years college (no degree)	18	16.7	17	18.3
Bachelor's Degree	25	23.1	29	31.2
Master's Degree	23	21.3	8	8.5
Doctoral Degree	23	21.3	10	10.8
Other	1	.9	1	1.1
No Response	0	0.0	6	6.4
Total	108	100.0	93	100.0

Income of Households

Respondents were asked to report total gross annual household income. Those incomes reported by the respondents ranged from under $8,000 to over $50,000 per year. The mean income for the sample was $25,850 per year with a median of $27,500 per year. About half of the households reported incomes over $25,000 per year (Table 4.5). The median income in 1976 for all families in owner-occupied housing in the West was $16,200 (U.S. Bureau of the Census, 1977). The high income levels for this study may be due to the criteria of the study for major remodeling. This would lend itself to higher income homeowners.

Table 4.5 Total gross annual household incomes reported by respondents

Income Categories	N	%
Under $8,000	3	2.8
$8,000 - $11,000	11	10.0
$12,000 - $14,999	5	4.7
$15,000 - $19,999	14	13.0
$20,000 - $24,999	18	16.7
$25,000 - $29,999	16	14.8
$30,000 - $34,999	20	18.5
$35,000 - $39,999	4	3.7
$40,000 - $44,999	5	4.7
$45,000 - $49,999	4	3.7
Over $50,000	4	3.7
No Response	4	3.7
Total	108	100.0

Attitudes Toward an Energy Crisis

Among the respondents, 72.7 percent believed an energy crisis existed. Eleven percent reported that they did not believe an energy crisis existed, and 12 percent indicated they did not know if an energy crisis existed. Table 4.6 summarizes the respondents' education levels by their belief in an energy crisis. Of the 106 reporting with at least a bachelors' degree, 86 percent felt there was an energy crisis.

Table 4.6 Respondents' education levels by their attitude toward an energy crisis

Education		Belief that Energy Crisis Exists			
	N	% Yes	% No	% Not Sure	Total
Under 8 years	2	50.0	50.0	0.0	100
9 - 12 years	11	36.4	25.0	34.6	100
Vocational	5	40.0	20.0	40.0	100
1 - 4 years College (no degree)	18	61.1	16.7	22.2	100
Bachelors'	24	92.0	8.0	0.0	100
Masters'	23	73.9	17.3	8.7	100
Doctoral	23	91.3	0.0	8.6	100
Total	106	72.7	15.4	11.6	100

A summary of 94 respondents reporting gross annual household income by their belief in an energy crisis is found in Table 4.7. Of the respondents with incomes over $12,000, 82 percent believed that an energy crisis existed. Findings would suggest that respondents' belief in an energy crisis was strongly associated with their income and education levels.

A Michigan State study reported that 50 percent of the public did not believe there was an immediate energy crisis. However, belief in the energy problem was strongly related to measures of family socioeconomic status and the income and education attainment (Morrison and Gladhart, 1976).

Morrison and Gladhart (1976) showed that family income was the single best indirect predictor of residential energy consumption with higher incomes using more energy than lower incomes. Newman and Day (1976) reported that the higher the income, the more energy the household consumes.

Table 4.7 Annual gross household income by respondents' attitude toward an energy crisis

Income	N	Belief that Energy Crisis Exists			Total
		% Yes	% No	% Not Sure	
Under $12,000	14	57.1	14.2	28.4	100
$12 - $19,999	14	78.5	14.2	7.0	100
$20 - $29,999	34	64.7	11.7	8.8	100
$30 - $39,999	22	82.0	4.0	13.6	100
$40 - $49,999	8	87.5	0.0	12.5	100
Over $50,000	2	100.0	0.0	0.0	100
Total	94	70.2	9.5	12.7	100

Characteristics of the Dwellings

Age of the Houses in the Study

The ages of the houses remodeled in the study are given in Table 4.8. Sixty-nine percent of the dwellings were less than 20 years old, or built after 1958. The houses ranged in age from one to 78 years.

The mean age of the houses was 21.5 years and the median age was 16.3 years.

Table 4.8 Age characteristics of the houses remodeled by 108 respondents

Age in Years	Responses N	%
Under 5	4	3.5
5 - 14	39	37.0
15 - 24	32	29.0
25 - 34	16	15.0
Over 35	17	15.5
Total	108	100.0

Length of Ownership of the Dwellings

Table 4.9 indicates the length in years of ownership of the dwellings in the study. Only four percent of the houses were owned by the respondents for more than 18 years, while 55 percent had been owners less than seven years. The years of ownership by the respondents ranged from two to 35 years. The mean year of purchase for the dwellings was 1968 with the mean length of ownership at ten years.

Table 4.9 Length of ownership for houses in the study

Length of Ownership In Years	Responses N	%
Under 3	14	13.0
3 - 7	45	42.0
8 - 12	27	25.0
13 - 18	17	16.0
Over 18	5	4.0
Total	108	100.0

Major Fuels Utilized in the Remodeled Dwellings

Four fuels were identified as being utilized in the dwellings remodeled: electricity; natural gas; oil; and wood. Table 4.10 summarizes the information on fuel use for the sample. Natural gas was used as a major fuel by 57.4 percent of the households. Compared to statistics for fuel usage in the homes of the Western United States, the responses are representative. However, the number indicating wood as a fuel source was five times the percentage for the Western United States (U.S. Dept. of Commerce, 1976; Penoyar and Williams, 1977).

Table 4.10 Major type of fuel used in houses remodeled by 108 respondents

Fuel	Responses N	%
Electricity	28	25.9
Natural gas	62	57.4
Oil	11	10.2
Wood	7	6.5
Total	108	100.0

Person Responsible for Planning the Remodeling

Table 4.11 categorizes the persons responsible for the major portion of the remodeling plans. A majority (69.5 percent) of the remodelings were planned by the respondent and/or their partner. The next most common planners were architects and contractors with 10.2 percent and 8.3 percent respectively.

Table 4.11 Person planning the remodeling for 108 respondents

Planner	Responses N	%
Architect	11	10.2
Builder	5	4.6
Contractor	9	8.3
Professional Remodeler	7	6.5
Respondent or Partner	75	69.5
No Response	1	0.9
Total	108	100.0

Sources Used in Planning the Remodeling

The 75 respondents who indicated they or their partners made their own remodeling plans listed the sources of information used. Table 4.12 summarizes the sources used and gives the frequency of use. The number of sources used for any one remodeling ranged from one to six. Builders were most frequently listed as a source of information in planning the remodeling. Magazine and newspaper articles were the next most frequent source identified.

Table 4.12 Sources of information used by 75 respondents who planned their own remodeling

Type of Source of Information	Responses N	Responses %
Advertisements	5	4.4
Books	7	6.2
Builder	34	30.0
Classes	1	.9
Friends	6	5.3
Magazine & Newspaper Articles	28	24.8
Own Ideas & Experience	22	19.6
Television	2	1.8
Other	8	7.0
Total	113	100.0

Considerations in the Remodeling

The respondents were asked to choose and rank the items they considered in remodeling their dwellings. Table 4.13 gives the items considered by the ranking of each. The addition of space, increased

Table 4.13 Rank order of the considerations in remodeling reported by 108 respondents

Considerations	Rank in Percent 1	2	3	4	5	6	7	8
Addition of Space	43.6	23.6	2.7	2.7	1.8	-	-	-
Cost	5.5	14.5	22.7	8.2	8.2	1.8	-	-
Custom Decorating	0.0	1.8	4.5	4.5	2.7	.9	-	.9
Energy Conservation	1.8	6.4	14.5	12.7	8.2	-	.9	-
Increase Market Value	6.4	3.6	15.5	15.5	5.5	1.8	-	-
Increase Livability	32.7	34.5	11.8	5.5	.9	-	-	-
Modernization	0.0	2.7	7.3	6.4	3.6	2.7	-	-
Maintenance	0.0	2.7	4.5	3.6	3.6	3.6	.9	-
Not Ranked	5.5	8.4	16.5	40.9	65.5	87.4	98.2	99.1
Other	4.5	1.8	-	-	-	1.8	-	-
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

livability, and cost were ranked as the three most important considerations in remodeling. The least ranked items were custom decorating and maintenance.

Characteristics of the Remodeling

Data collected about cost, type of remodeling, square footage increased and year of remodeling are included in this section.

Dates of the Remodeling for Dwellings Studied

A total of 102 respondents reported the dates of their remodeling. Table 4.14 summarizes the years the respondents indicated their remodeling took place. Over 70 percent of the remodelings were performed between July 1, 1975 and June 30, 1977. The trend toward more remodelings in recent years may be due to the criteria of the sample. The most recent remodelers are less likely to have moved from the dwellings remodeled.

Table 4.14 Dates of remodeling reported by 102 respondents

Dates	Responses	
	N	%
July 1, 1973 - June 30, 1974	13	12.7
July 1, 1974 - June 30, 1975	16	15.7
July 1, 1975 - June 30, 1976	32	31.3
July 1, 1976 - June 30, 1977	41	40.3
Total	102	100.0

Remodeling Costs

The respondents were asked to give the cost of remodeling their houses. These figures were grouped into six categories (Table 4.15). About two-thirds of the respondents spent under $10,000 for their remodeling. The expenditures ranged from $1,000 to $30,000. The mean cost of the remodelings was $7,670. The high mean in the study may be attributed to the criteria for expenditures of over $1,000.

Krassa (1975) suggests that the owners of more expensive housing spend more for remodeling. In addition, the higher the income of the owners, the more money is spent on remodeling. High income levels of the respondents could also be a factor to explain the high expenditures of this sample.

Table 4.15 Expenditures reported by 108 respondents for remodeling

Expenditure Categories in Dollars	Responses N	%
1,000 - 4,999	37	34.0
5,000 - 9,999	34	31.0
10,000 - 14,999	18	17.0
15,000 - 19,999	6	5.5
20,000 - 24,999	6	5.5
Over 25,000	2	2.0
No Response	5	5.0
Total	108	100.0

Type of Remodeling

From the information supplied, the researcher categorized the type of remodeling performed. Table 4.16 summarizes the types of remodelings. About three-fourths of the remodeling was done to add space. Only four percent remodeled specifically for energy conservation. Examples of the energy conservation remodeling techniques include the addition of wood burning stoves, storm windows and doors, insulation of duct work, and design for optimum natural solar heating.

Table 4.16 Types of remodeling performed to dwellings

Type of Remodeling	Responses N	%
Decorating/Modernization	12	11.0
Energy Conservation	4	4.0
Exterior Alterations	8	7.0
Maintenance	6	6.0
Space Addition	78	72.0
Total	108	100.0

Area Additions

Of the 78 respondents adding square footage to their dwellings, 62 percent increased area by less than 450 square feet. Increases ranged from 20 square feet to 1,800 square feet. The mean increase was 296.8 square feet. Table 4.17 summarizes the space increases.

Table 4.17 Increase in square footage to 78 dwellings during remodeling

Increased Square Footage	Responses N	%
Less Than 100	4	5.1
100 - 149	7	9.0
150 - 249	17	21.8
250 - 449	20	25.6
450 - 649	11	14.1
650 - 849	12	15.4
850 - 1049	6	7.8
1050 and Over	1	1.2
Total	78	100.0

Energy Considerations in the Remodeling

The energy considerations of owners of single family dwellings were examined to learn if: 1) energy saving features were incorporated in the remodeling; 2) alterations were made to heating systems; 3) considerations were made in the selection of appliances and hot water heaters; 4) fluorescent lighting fixtures were installed; and 5) alternative energy sources were considered in the remodeling.

From the information supplied by the respondents, the researcher determined if energy conserving features were a part of the remodeling performed. Analysis of the description of the remodeling, ranking of considerations for remodeling and the selection of equipment, alterations to heating systems, and the installation of fluorescent fixtures were used as a basis for these decisions. Only 42 of the 108 respondents included energy saving features in their remodeling. Two respondents did not provide enough information to determine if energy conservation was part of the remodeling.

Alterations to Heating Systems

Based on the information provided by the respondents, the researcher determined if alterations to the heating systems had been made with or without energy consideration. Table 4.18 summarizes the findings from 73 respondents altering their heating systems. Over 40 percent of those altering their heating systems made energy-conserving alterations. Some examples of energy alterations to heating systems included heatilators installed in fireplace units and insulation of duct work. Other changes included the addition of wood burning stoves and the expansion of heating systems in which the square footage of a room was substantially increased. Overall, 16 wood stoves, six fireplace units, and two heatilators were added in remodeling.

Table 4.18 Heating system alterations reported

Alterations	Responses	
	N	%
Alterations with energy considerations	30	41.0
Alterations without energy consideration	43	59.0
Total	73	100.0

Considerations in the Selection of Appliances and Hot Water Heaters

Of the 108 respondents, 10 chose hot water heaters and 15 chose other appliances as part of their remodeling activity. For the appliances, cost and availability were the two most important factors in their selection. Style, color, and energy use were most often ranked third. In the selection of hot water heaters, cost, type of fuel, and energy use were ranked as the important factors in their selection.

Addition of Fluorescent Lighting

The 26 respondents reporting the installation of fluorescent fixtures listed rooms in which incandescent lighting was changed to fluorescent, or where fluorescent lighting was added. Fluorescent lighting was incorporated in 34 rooms remodeled. Table 4.25 summarizes the type of rooms in which changes were made. Kitchens and family rooms most often had lighting changed to fluorescent.

Table 4.19 Rooms in which fluorescent lighting was installed in 26 remodeled dwellings

Type of Room	N	%
Kitchen	10	29.4
Family Room	10	29.4
Bathroom	3	8.8
Laundry/Utility	4	12.0
Living Room	1	3.0
Basement/Garage	2	5.8
Bedroom	2	5.8
Other	2	5.8
Total	34	100.0

Energy Consumption Changes

In comparing energy consumption before and after remodeling, 22.2 percent reported decreases, 27 percent increases, and 29.6 percent no change in the amount of fuel units utilized. The remaining 21.2 percent of the respondents were not sure if their fuel unit consumption had changed. In some cases the decreased unit consumption was the result of a change to an alternate source of fuel such as wood. In some instances fuel unit consumption increases corresponded to the addition of space to the home.

Consideration of Alternate Energy Sources

Of 108 respondents, 45.5 percent (49) indicated they considered alternate energy sources in their remodeling, and 52.8 percent (57) indicated they did not, while 1.8 percent (2) did not respond to the question. Of the respondents considering alternate sources, 89.3 percent considered wood, 8.5 percent solar energy, and two percent considered using electricity as an alternate form of energy.

In response to what might motivate the homeowners to adopt an alternate energy source, saving money on utility costs, saving energy, and increasing the resale value of their home were the most reported factors. Table 4.20 summarizes the motivating factors for the 76 respondents.

4.20 Motivations for considering alternate energy sources by 76 respondents

Motivation	Ranked 1		Ranked 2	
	N	%	N	%
Lower Interest Loans	1	1.3	4	5.3
Increase Resale	13	17.3	10	13.2
Save Money	42	55.2	21	27.6
Save Energy	18	23.6	26	34.2
Tax Advantages	2	2.6	8	10.5
No Response	0	0.0	7	9.2
Total	76	100.0	76	100.0

When asked what the major deterrants were to adopting an alternate energy source, 50 of the 108 respondents listed cost and problem installations as deterrants. Table 4.21 show the ranking of the deterrant factors.

Table 4.21 Deterrants for adoption of alternate energy sources as reported by 50 respondents

Deterrants	Ranked 1		Ranked 2	
	N	%	N	%
Aesthetics	2	4.0	4	8.0
Costs	22	44.0	9	18.0
Lack of Knowledge	7	14.0	7	14.0
Lack of Faith	3	6.0	5	10.0
Problem Installations	16	32.0	17	34.0
No Response	0	0.0	8	16.0
Total	50	100.0	50	100.0

Current relatively high costs, along with the public's unfamiliarity with solar system performance, present major obstacles to the adoption of solar heating systems by the residential sector (Magnas et al., 1976). Also, the retrofit of active solar systems is difficult in some cases given the structural and space requirements (Sunset, 1978). These concerns are evident in the findings of this study.

Hypotheses

The Chi-square statistical test was used. The .05 level of significance was selected as the criterion for identification of significant associations between variables.

Hypothesis 1. There is no association between the year the remodeling took place and the inclusion of energy saving features.

On the basis of the Chi-square test, Hypothesis 1 could not be rejected. There was no significant association found between the year the remodeling took place and the inclusion of energy saving features at the .05 probability level.

Table 4.22 shows the dates of remodeling and the inclusion of energy saving features. Seventy-one percent remodeled between July 1, 1975 and June 30, 1977. Of the respondents remodeling during that time, 42.2 percent included energy saving features in their remodeling. Of the 29 percent remodeling prior to July 1, 1975, 34.5 percent included energy saving features.

Table 4.22 The inclusion of energy saving features in the remodeling by date of remodeling

Dates	Energy Features Included	Energy Features Not Included	Total
July 1973 - June 1974	3	10	13
July 1974 - June 1975	7	9	16
July 1975 - June 1976	12	19	31
July 1976 - June 1977	18	22	40
Total	40	60	100

X^2= 2.0832, 3 d.f.< X^2= 7.81473 at the .05 level of significance

Hypothesis 2. There is no association between the major type of fuel used in the home and the inclusion of energy saving features in remodeling.

Based on the Chi-square test, Hypothesis 2 was not rejected. Based on the data in Table 4.23 there was no association between the major type of fuel used in the homes and energy saving features included in the remodeling. The datum does suggest homes using wood as a major fuel most often included energy saving features in their remodeling.

Table 4.23 The inclusion of energy saving features in remodeling by major type of fuel used in the dwelling

Fuel Type	Energy Features Included	Energy Features Not Included	Total
Electricity	13	14	27
Natural Gas	19	42	61
Oil	5	6	11
Wood	5	2	7
Total	42	64	106

X^2= 5.76822, 3 d.f.< X^2= 7.81473 at the .05 level of significance

Hypothesis 3a. There is no association between the ranking of importance of energy saving features and the addition of space as considerations in remodeling.

Based on the Chi-square test, Hypothesis 3a could be rejected at the .0031 significance level (Table 4.24). There was an association between the two variables since most respondents who ranked the addition of space as a consideration also ranked energy saving features as important in remodeling.

Hypothesis 3b. There is no association between the ranking of importance of energy saving features and cost as considerations in remodeling.

On the basis of the Chi-square test, Hypothesis 3b could be rejected at the .0142 significance level (Table 4.24). A total of 67 respondents ranked cost as a consideration with 49 also reporting energy as a consideration in the remodeling. There is an association between the two variables since those respondents concerned with cost are also concerned with energy features. Twelve respondents out of 49 (24%) ranked energy features as a more important consideration than cost in their remodeling.

Hypothesis 3c. There is no association between the ranking of importance of energy saving features and custom decorating as considerations in remodeling.

Hypothesis 3c could be rejected at the .0000 level of significance based on the Chi-square test. As summarized in Table 4.24, the test determined that those respondents considering custom decorating also considered energy features in their remodeling.

Hypothesis 3d. There is no association between the ranking of importance of energy saving features and increased livability as considerations in remodeling.

Based on the Chi-square test, Hypothesis 3d could not be rejected. There was no association (Table 4.24) between the two variables. Those respondents concerned with increased livability for their home did not rank energy as an important consideration in their remodeling.

Hypothesis 3e. There is no association between the ranking of importance of energy saving features and increasing market value as a consideration in remodeling.

Hypothesis 3e could not be rejected based on the Chi-square test (Table 4.24). There was no association between the two considerations. Respondents who indicated increasing the market value of their house as a consideration did not often rank the inclusion of energy saving features as a consideration.

Hypothesis 3f. There is no association between the ranking of importance of energy saving features and maintenance as considerations in remodeling.

Based on the Chi-square test, Hypothesis 3f could not be rejected (Table 4.24). There was no association between the ranking of maintenance as a consideration and the inclusion of energy saving features. Those respondents considering maintenance in their remodeling did not often rank energy as a consideration.

Hypothesis 3g. There is no association between the ranking of importance of energy saving features and modernization as considerations in remodeling.

Hypothesis 3g could not be rejected based on the Chi-square test (Table 4.24). There was no association found between considering modernization in the remodeling and the consideration of energy.

Table 4.24 Chi-square test scores for the ranking of energy saving features and other considerations in remodeling

Considerations	Degree of Freedom	Chi-Square
Addition of Space	6	19.68674*
Cost	6	15.90979*
Custom Decorating	6	113.52933*
Increased Livability	6	5.23210
Increased Market Value	6	6.71608
Maintenance	6	12.37061
Modernization	6	8.86352

* Significant at the .05 significance level

Hypothesis 4. There is no association between persons planning the remodeling and the inclusion of energy saving features in the remodeling.

Based on the Chi-square test, Hypothesis 4 could not be rejected. Based on the data shown in Table 4.25 there was no association between the type of person planning the remodeling and the inclusion of energy saving features. The datum suggests that contractors were most likely to include energy saving features in their plans.

Table 4.25 Person planning the remodeling and the inclusion of energy saving features

Energy Features	Person Planning the Remodeling					
	Architect	Builder	Contractor	Remodeler	Self	Total
Yes	2	2	5	1	32	42
No	9	3	4	5	42	63
Total	11	5	9	6	74	105

$X^2 = 4.7746$, 4 d.f., $< X^2 = 9.48773$ at the .05 level of significance

Hypothesis 5a. There is no association between the inclusion of energy saving features in remodeling and the age of the respondent.

Hypothesis 5a could not be rejected based on the Chi-square test. Table 4.26 shows the data for the respondents' ages by the inclusion of energy saving features in the remodeling. There was no association between age and the inclusion of energy saving features in remodeling. However, the data suggested that respondents 65 years and older and those 26 to 35 years were most likely to include energy saving features in their remodeling.

Table 4.26 The inclusion of energy saving features in the remodeling by the age of the respondent

Energy Features	Age of the Respondent						
	25 or under	26-35	36-45	46-55	56-65	65+	Total
Yes	2	13	13	7	5	2	42
No	2	15	24	15	8	0	64
Total	4	28	37	22	13	2	106

X^2= 4.64874, 5d.f., < X^2= 11.0705 at the .05 level of significance

Hypothesis 5b. There is no association between the inclusion of energy saving features in remodeling and the education of the respondent.

Table 4.27 shows the inclusion of energy saving features by the education of the respondent. Based on the Chi-square test, Hypothesis 5b was not rejected. There was no association between the two variables, but the datum suggests that respondents with an education of one to four years of college most often included energy features in their remodeling.

Table 4.27 The inclusion of energy saving features in the remodeling by the education of the respondent

Energy Features	Education of Respondent								
	1-8	9-12	Voc.	1-4*	B.S.	M.S.	PhD.	Other	Total
Yes	1	3	2	11	9	8	8	0	42
No	1	7	3	7	16	15	14	1	63
Total	2	10	5	18	25	23	22	1	106

X^2= 5.06796, 7 d.f., < X^2= 14.0671 at the .05 level of significance
* indicates years of college but no degree

Hypothesis 5c. There is no association between the inclusion of energy saving features in remodeling and the occupations of the respondent.

Based on the Chi-square test, Hypothesis 5c could not be rejected. However, the retired respondents and those in a clerical or technical field most often included energy saving features in the remodeling. Table 4.28 summarizes the data for the two variables and the Chi-square test.

Table 4.28 The inclusion of energy saving features in the remodeling by the occupations of the respondents

Occupation	Energy Features		
	Yes	No	Total
Major Professional	2	5	7
Business Managers	14	25	39
Administration	6	8	14
Clerk/Technical	7	7	14
Skilled	2	4	6
Semi-skilled	0	2	2
Retired	4	2	6
Housewife	2	4	6
Total	37	57	94

X^2= 4.628197, 7 d.f., < X^2= 14.0671 at the .05 level of significance

Hypothesis 5d. There is no association between the inclusion of energy saving features in remodeling and the income of the households.

Table 4.29 shows the data for household incomes by the inclusion of energy features in remodeling. Based on the Chi-square test, Hypothesis 5d could not be rejected. The income category of $8,000 to $11,999 was the only category in which more people included than did not include energy saving features in their remodeling.

Table 4.29 The inclusion of energy saving features in the remodeling by the income of the households

Income	Energy Features Included		
	Yes	No	Total
Under $8,000	1	2	3
$8 - $11,999	6	5	11
$12 - $14,999	2	3	5
$15 - $19,999	6	7	13
$20 - $24,999	7	11	18
$25 - $29,999	7	9	16
$30 - $34,999	5	14	19
$35 - $39,999	0	4	4
$40 - $44,999	2	3	5
$45 - $49,999	2	2	4
$50 - $54,999	0	2	2
Over $55,000	2	0	2
Total	40	62	102

$X^2 = 10.02446$, 11 d.f., $< X^2 = 19.6751$ at the .05 level of significance

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to investigate energy considerations in the remodeling of owner-occupied, single family dwellings. Energy conservation techniques, attitudes toward an energy crisis, the use of alternate energy sources, characteristics of the remodeling planning, as well as relationships between demographic information and energy conservation in remodeling were investigated.

Questionnaires were sent to all homeowners who had purchased building permits from the City of Corvallis, Oregon for a remodeling project costing $1,000 or more. Of the 225 mailings, 108 (48 percent) homeowners returned completed questionnaires.

Demographic Data

The 108 respondents in the study ranged in age from 21 to 70 years with a mean age of 42.6 years. Their partners ranged in age from 23 to 68 years with a mean age of 41.5 years.

The size of the households reported in the study ranged from one to 12 persons with the mean size of the household being 3.5 persons. Eighty-seven percent of the respondents and 72.4 percent of their partners were employed. The most common occupations for the respondents were in the category of business managers and professionals with 36 percent of the respondents and 21 percent of their partners in that classification. The mean level of education for both respondents and their partners was 16 years. The education level ranged from less than eight years to completion of a doctoral degree. Of the 106 respondents and 93 partners reporting education levels attained, 16 percent had completed a doctoral degree.

The total gross annual household income ranged from under $8,000 to over $50,000 per year. Over half of the households reported incomes above $25,000 per year.

Seventy-five percent of the respondents believed in the existence of an energy crisis, 12 percent did not, and 13 percent were not sure. Over 50 percent of the respondents with some college education felt there was an energy crisis. Of the respondents with incomes over $12,000 per year, over half believed an energy crisis existed.

Characteristics of the Dwellings

Sixty-nine percent of the dwellings studied were less than 20 years old. The houses ranged in age from one to 78 years with a mean of 21.5 years. Only four percent of the dwellings were purchased since 1976. The years of purchase ranged from 1943 to 1976 with a mean year of purchase being 1968. Fuels used in the houses included electricity (25.9 percent), natural gas (57.4 percent), oil (10.2 percent), and wood (6.5 percent).

Characteristics of the Remodeling

Over 69 percent of the remodeling plans were made by the respondents or their partners. Architects were responsible for 10.2 percent of the remodeling plans while contractors were responsible for 8.3 percent of the plans. Of the 75 respondents responsible for the planning of their remodeling, builders were most often used as a source of information on remodeling with magazine and newspaper articles as the next most common source of information used.

The three most important considerations in the remodeling were ranked as 1) addition of space, 2) increased livability, and 3) cost. Custom decorating and maintenance were ranked as the least important considerations in remodeling.

Over 71 percent of the remodelings in the study were performed between July 1, 1975 and June 30, 1977. About two-thirds of the remodelings cost under $10,000. The expenditures ranged from $1,000 to $30,000 with a mean expenditure of $7,670.

From the information supplied, the researcher categorized the types of remodeling performed. About three-fourths of the respondents added space to their dwellings. Of the 78 respondents adding space, 62 percent added an area of 450 square feet or less. Increases ranged from 20 square feet to 1,800 square feet. The mean increase in area was 296.8 square feet. Decorating and modernization accounted for 11 percent of the work with exterior alterations and maintenance seven percent and six percent respectively. Four percent specifically remodeled for energy conservation.

Energy Features of the Remodelings

Forty-two percent of the 108 respondents included energy saving features in their remodeling. Of the 73 respondents who altered the heating system of their dwellings, 41 percent indicated they made energy saving alterations which included one of the following: 1) insulation of duct work; 2) wood stove installation; 3) addition of fireplace units; and 4) the installation of heatilators in existing fireplace units. In comparing fuel consumption before and after remodeling, 22.2 percent reported decreases, 27 percent increased consumption, 29.6 percent reported no change, and 21.2 percent were not sure of consumption patterns.

Fifteen respondents chose appliances, ten chose hot water heaters, and 26 installed fluorescent lighting fixtures in their remodeling. For appliance selection and hot water heaters, the primary considerations were cost and type of fuel. Those who reported the installation of fluorescent fixtures indicated kitchens and family rooms most often equipped with fluorescent fixtures.

Over 45 percent of the respondents indicated considering alternate energy sources in their remodeling. Wood was the alternate source most often considered. Motivations for choosing an alternate source of energy were to save money, to save energy, and to increase the resale value of their dwellings. Costs and problem installations were the deterrants to the use of alternate energy sources for the respondents.

Hypotheses

Hypothesis 1. There is no association between the year the remodeling took place and the inclusion of energy saving features.

Based on the Chi-square test the first hypothesis could not be rejected.

Hypothesis 2. There is no association between the major type of fuel used in the home and the inclusion of energy saving features in remodeling.

No association was indicated in the type of fuel used in the dwelling and the inclusion of energy features in remodeling. The data suggested homeowners using wood as a major fuel source were most likely to include energy features in their remodeling. Hypothesis 2 was not rejected on the basis of the Chi-square test.

Hypothesis 3. There is no association between energy saving features and other considerations in remodeling: a) addition of space; b) cost; c) custom decorating; d) increase livability; e) increase market value; f) maintenance; and g) modernization.

There was no association between the considerations of increased livability, modernization, maintenance and increased market value and energy saving features in the remodeling. The Chi-square test resulted in the rejection of hypothesis 3a, 3b, and 3c. An association was found between each of the consideration of cost, custom decorating, and space additions and the consideration of energy saving features.

Hypothesis 4. There is no association between persons planning the remodeling and the inclusion of energy saving features in remodeling.

The data suggested contractors most often incorporated energy features into remodeling plans. Based on the Chi-square test hypothesis 4 could not be rejected.

Hypothesis 5. There is no association between the inclusion of energy saving features in remodeling and demographic characteristics of the respondents: a) age; b) education; c) occupation; and d) income.

Hypothesis 5 could not be rejected on the basis of the Chi-square test. The results of the test indicated no association between the respondents age, education, occupation or income and the inclusion of energy saving features in the remodeling.

Conclusions

On the basis of the Chi-square test findings from this study suggest the following conclusions:

1. A majority (58%) of the people remodeling their homes and spending over $1,000 are not including energy conserving features in their remodelings at this time. Over 40 percent of the sample did incorporate some energy saving features in their remodeling.

2. There was no association between the homeowners including energy features in their remodeling and the year the work was performed. The lack of an association would suggest no trend toward more energy saving features being incorporated into remodeling since 1973.

3. The data from this study suggest homeowners who use wood as a major fuel were most likely to include energy features in their remodeling projects.

4. Energy was ranked overall as the fifth most important consideration in the remodeling. Two considerations, costs and increasing market value, were significantly associated with the consideration of energy.

5. Cost was one of the most important considerations in remodeling.

6. Alternate energy sources such as solar energy were not being considered in the remodeling.

In this study the majority of homeowners did not incorporate energy saving features in their remodeling projects. The greatest concern was the addition of space for the home while energy was not a major consideration.

The Department of Energy for the State of Oregon states that 90 percent of the homes in Oregon could be retrofitted for additional energy efficiency (Harris, 1978). If homeowners who are remodeling their homes could be stimulated to include energy features, energy savings in the residential sector could be substantial. The study indicates that a majority of these homeowners added space to their dwellings, and in most cases increased fuel usage. When energy conservation becomes more cost effective for the homeowner, it may create more of an incentive for energy savings.

Perhaps, due to the income level of the sample, the economic impact of the increases in utility costs was not sufficient to stimulate energy remodeling activity. It may be possible that homeowners of lower incomes and those making lower expenditures on remodeling more often include energy saving features in their remodeling.

Implications

The results from this study have several implications for the housing educator. The findings show that a belief in the existance of an energy crisis was typical of the sample, yet this belief was not reflected in the respondents' remodeling activity. The majority of the respondents did plan their own remodeling. Given these facts it may be implied that if the homeowners could be stimulated through education with respect to energy conservation techniques and alternate energy supply utilization, greater energy savings might be realized in the residential sector.

Because of the potential for energy conservation through retrofit of existing housing and because of the amounts of money invested in remodeling activity, there are implications for public policy which could stimulate more energy conservation applications. Such policies as increased tax credits or lower interest loans could be motivations for homeowners to include conservation techniques in remodeling. A policy of continued funding for research into new conservation techniques as well as the production of more inexpensive procedures could also prove to be incentives for the homeowners to incorporate energy saving features into their remodeling activity.

Recommendations for Future Study

The findings of this study suggest the need for the following additional research:

1. Replicate the study using all building permits issued for all costs of remodeling.

2. Replicate the study in other geographic areas and compare these studies to this study in Corvallis, Oregon.

3. Investigate the valuation change for houses including energy efficient features and those not, given the same expenditures for remodeling.

4. Investigate increases in valuation of dwellings with respect to expenditures for remodeling.

5. Explore in depth motivations for homeowners to include energy saving features.

6. Investigate through case study the costs and savings for those including energy conservation techniques in their remodeling.

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APPENDIX

School of
Home Economics

Oregon
State
University

Corvallis, Oregon 97331 (503) 754-3551

February 21, 1978

Dear

I am a graduate student at Oregon State University in the Family Resource Management Department and I would like to ask for your help. As part of the requirements for my Master's degree I am conducting a study in the remodeling practices of owners of single family homes.

The enclosed questionnaire has been designed to obtain information about the remodeling practices of families of owner-occupied homes.

Your name was obtained from applications for building permits filed in the Corvallis City Hall between July 1, 1973 and June 30, 1977.

The information collected in the questionnaire is solely for the purpose of this research study. You will remain anonymous as the responses will be coded and summarized and you will never be identified in any way.

Both my major professor and I hope that you will take the time and have the interest to respond to the questionnaire and return it in the envelope provided by March 8, 1978. Please mail the enclosed post card at the same time as your response to enable me to know if your questionnaire has been returned.

Yours sincerely,

Mary L. Granite, Graduate Student

and

Martha A. Plonk, Major Professor

QUESTIONNAIRE for the STUDY of CONSIDERATIONS
in REMODELING by HOMEOWNERS in CORVALLIS, OREGON, 1973-1977

In this questionnaire remodeling is considered to be any addition or alteration of $1000.00 or more value to a single family home between July 1, 1973 and June 30, 1977. If more than one remodeling job of this value took place, answer the questions with the most expensive remodeling in mind.

1. How many times have you remodeled your home since July 1, 1973, spending more than $1000.00? ____________

2. What month and year was the permit issued for the most expensive remodeling? ________________ Actual cost of the remodeling? ___________

3. Explain the type of remodeling done, and why. ________________________

____

____

____

4. Please give the approximate square footage of your home.
Before remodeling ________sq. ft. After remodeling ________sq. ft.

5. Who was responsible for the major part of the planning?
( ) architect ( ) contractor ( ) self or partner
( ) builder ( ) professional remodeler ( ) other, ____________

6. If you or your partner were responsible for the planning of the remodeling, indicate any sources of information used.
( ) businesses ( ) advertisements ( ) television
( ) builder/contractor ( ) magazine articles ( ) other, ___________
( ) classes ( ) newspaper articles

7. Check all the considerations in your remodeling and then rank those selected in order of importance.

check	rank		check	rank	
( )	( )	addition of space	( )	( )	increase market value
( )	( )	cost of remodeling	( )	( )	increase livability
( )	( )	custom decorating	( )	( )	modernization
( )	( )	energy conserving features	( )	( )	maintenance of home
( )	( )	other, specify _______________			

8. What year did you purchase your home? ___________

9. What is the approximate age of your home? __________

10. What is the major fuel used for heating in your home? ____________

11. Did you alter or make additions to the heating system in your remodeling?
( ) yes ( ) no If yes, explain what changes were made. _______________

____

12. Was there any noticeable change in the amount of fuel units (i.e. KWH) consumed before and after the remodeling? ( ) decrease ( ) no change
( ) increase ( ) not sure

13. Were lighting fixtures changed from incandescent to flourescent, or were additions of flourescent fixtures made? ( ) yes ( ) no
If yes, in what rooms? ______________________________

14. If appliances were part of your remodeling rank from 1 to 3 the most important factors in their selection.
( ) availability ( ) cost ( ) style/color ( ) dealer reputation
( ) brand name ( ) energy consumed ( ) hot water use ( ) other

15. If a hot water heater was purchased in your remodeling, rank from 1 to 3 the most important factors in the selection.
( ) brand name ( ) energy consumed ( ) installation
( ) cost ( ) type of fuel used ( ) other

16. a. Were alternative energy sources (wood, solar, etc.) considered in your remodeling? ( ) yes ( ) If yes, what source? ______________

b. Rank 1 and 2 the factors which might motivate you to consider these sources.
( ) lower interest loans ( ) saving energy
( ) increase resale of home ( ) tax advantage
( ) savings in utility bills

c. Rank 1 and 2 the reasons for not considering these sources.
( ) aesthetics (appearance) ( ) lack of faith
( ) costs ( ) problem installations
( ) lack of knowledge about the sources

17. Do you feel there is currently an energy crisis? ( ) yes ( ) no ( ) hot sure

18. Age of Respondent ____________ Partner ____________

19. Please give the ages of others currently living in your household.
a. Males ________________ b. Females ________________

20. Indicate the last year of school completed by you and your partner. Use a "R" for respondent and a "P" for your partner.
( ) ( ) 1-8 ( ) ( ) 1-4 years college ( ) ( ) Doctorate
( ) ( ) 9-12 ( ) ( ) Bachelor's degree ( ) ( ) other
( ) ( ) Vocational ( ) ( ) Master's degree

21. Employment: Respondent ______________ Partner ______________

22. Check the following catagory in which you and your partner's total gross annual income fall.
( ) under 8,000 ( ) 20,000-24,999 ( ) 40,000-44,999
( ) 8,000-11,999 ( ) 25,000-29,999 ( ) 45,000-49,999
( ) 12,000-14,999 ( ) 30,000-34,999 ( ) 50,000-54,999
( ) 15,000-19,999 ( ) 35,000-39,999 ( ) over 55,000