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NORTHWEST HOME BUYERS' FUEL AND ENERGY-EFFICIENCY PREFERENCES

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SUMMARY

This study for the Bonneville Power Administration (Bonneville) investigated home buyers' heating fuel and energy-efficiency preferences, and the influence of incentives on their choices. The study was conducted in four regions of Washington State: Spokane and Pierce Counties, where the Model Conservation Standards (MCS) for new electrically heated homes have been adopted as local code, and King and Clark Counties, where the MCS has been implemented only through a voluntary marketing program.

Focus groups in Tacoma (Pierce County) and Spokane (Spokane County) were used to identify dominant issues that affected home buyer attitudes and choices in the purchase of a new home. The focus groups also provided information used to design a tradeoff analysis. The tradeoff, or conjoint, analysis was conducted in all four areas to provide quantitative information about home buyer tradeoffs in new-home purchases.

Not surprisingly, aesthetic factors influenced the purchase decisions of the focus group participants more than other factors. When the moderator mentioned energy-efficiency, most focus group participants acknowledged that they had considered this aspect when looking for a home. Many associated energy-efficiency with construction quality. Focus group participants who had natural gas heat had stronger preferences for their fuel type than participants who had electrical heat. Generally, participants approved of incentive programs for energy-efficient homes that would provide cash rebates, interest rate discounts, or utility rate discounts. Incentive programs that would increase the mortgage amount for which a buyer would qualify were not well received, primarily because some focus group participants feared that buyers would overextend themselves.

The conjoint analysis showed the relative importance of seven factors in a buyer's new-home purchase decision. Of the factors considered, buyers ranked heating fuel type (natural gas, electricity, or wood) and house size as the two major factors affecting their preferences. In all four counties, buyers ranked cash rebates as more important than utility rate discounts. Energy-efficiency was ranked relatively low, with the highest ranking in Spokane (with the coldest climate).

Without any type of incentive program, simulations showed that requiring all new electrically heated homes, but not gas-heated homes, to be built to the MCS added between 2 and 15 percentage points to the market shares for electrically heated homes. The simulations also showed that modest cash incentives ($400 to $600) would increase the share of electrically heated homes from 1 to 7 percentage points beyond the effect of MCS alone.

The results of this study provide useful information about energy-efficiency, space heating fuel type, and alternative incentive programs. They provide initial evidence that fuel-specific energy-efficiency standards may significantly affect the shares of different heating fuels in the new home market. They also suggest that cash rebates and utility rate incentives may have a modest effect on the shares for different heating fuels. Because these results are based on a technique relying on hypothetical choices and because they reflect only four metropolitan areas, further study must be conducted to determine whether the results apply to other locations and whether other analytic approaches produce similar findings.

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1.0 INTRODUCTION

In 1983 the Northwest Power Planning Council issued the Model Conservation Standards (MCS), which were designed to improve the efficiency of electrically heated buildings. Since then the Bonneville Power Administration (Bonneville) has operated several programs to encourage building homes that meet MCS. A marketing program called the Super Good Cents (SGC) program provides cash incentives for homes built to meet MCS. In addition, jurisdictions in Bonneville's service territory have adopted the MCS as their local building code through the Early Adopter Program or the Northwest Energy Code Program. Since the standards apply only to new electrically heated buildings and are likely to increase initial building costs, questions have arisen about the effect MCS and the MCS programs may have on the choice of heating fuels for new residences.[a]

This study is one of several efforts sponsored by Bonneville to investigate issues relating to the selection of heating fuels. A previous study conducted by the Pacific Northwest Laboratory (PNL)[b] for Bonneville used a Pacific Northwest household survey of perceptions and preferences for heating fuels (Harkreader, Hattrup, and Weijo 1988). The present study uses information gathered in focus groups in Tacoma and Spokane, Washington; and four regional surveys carried out in Pierce, Spokane, Clark, and King Counties in Washington State.[c]

This study uses a tradeoff analysis to investigate the relative importance of the heating fuel choice in the purchase of a home. Also examined are the effects of two different types of incentives on the selection of heating

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(a) In 1991, a new residential building code goes into effect in Washington that requires all new electrically heated homes to be built to the MCS. Homes heated with natural gas will be required to meet lesser requirements, but requirements stricter than the existing state code. The results in this study should be useful for assessing the impacts of statewide implementation of the MCS on fuel choice, but the reader should be aware that the new code for gas-heated homes has not been addressed here.

(b) Pacific Northwest Laboratory is operated by Battelle Memorial Institute for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830.

(c) Pierce County is represented primarily by Tacoma; Spokane County, by Spokane; King County, by Seattle; and Clark County, by Vancouver.

fuels. The technique used, conjoint analysis, employs a hypothetical home selection to force homeowners to make tradeoffs among several factors influencing the purchase of a home. An analysis of these tradeoffs indicates which factors are more important in the decision.

In preparation for designing the conjoint analysis, four focus groups were held with Spokane and Tacoma homeowners who had purchased a home during or after 1986. These groups provided qualitative information about the factors that buyers considered before purchasing a home. The homeowners also provided information concerning their preferences for types and levels of incentives designed to influence their energy-efficiency and fuel choices.

This report consists of five sections and an appendix. Section 2 discusses the focus group interviews. Section 3 presents the methodology used to collect data for the conjoint analysis, the survey response rate, and the data analysis results. Section 4 discusses the findings of this report in light of previous research efforts. Section 5 presents the references. The appendix presents a simplified overview of conjoint analysis techniques and issues.

2.0 HOMEOWNERS DISCUSS THE HOME PURCHASE DECISION

Focus group interviews were held to gather preliminary information on the factors that influence new-home buyers to purchase a specific home. Focus groups are semi-structured discussions led by a moderator. The moderator introduces discussion topics, probes comments, and keeps the discussion on track. Focus groups are a means to gather qualitative information. Due to group interactions and the small non-representative sample, information gathered in a focus group format is not statistically representative and findings typically cannot be generalized to a population.

The researchers used the information obtained in the focus groups to better formulate the design of the quantitative conjoint analysis presented in Section 3. Another purpose of the focus groups was to provide a richness in descriptive information that can seldom be obtained through normal quantitative techniques. By paraphrasing and quoting the participants, the information presented on the home purchase decision is intended to give the reader a better insight into this important decision.

2.1 DESCRIPTION OF FOCUS GROUPS

Four focus groups were held with new-home buyers who had purchased single-family detached homes during or since 1986.[a] Two groups were held in one evening in Spokane and then two were held in Tacoma. The first group in each location consisted of homeowners who heated primarily with electricity. The second group consisted of homeowners who heated primarily with non-electric heating fuels. Approximately equal numbers of males and females were recruited for each group. A total of 27 homeowners participated in the groups. Ten of the participants heated their homes with electricity, 13

(a) Section 3 discusses the characteristics of two much larger samples of home buyers who were surveyed for the conjoint analysis. As noted, the focus groups were used in part to design the conjoint analysis. The characteristics of the participants in the focus groups matched those of the survey respondents quite well in most areas. One difference was that the focus groups tended to consist of a larger proportion of first-time home buyers.

heated their homes with natural gas, and 4 heated their homes primarily with wood, but had backup electrical systems.

The participants represented a wide variety of experiences owning homes and using different heating fuel types. Just under half the participants were first-time home buyers. The large majority of these first-time home buyers purchased homes heated with electricity. Very few of the first-time home buyers who participated had bought homes that used natural gas. In contrast, most of the participants of the non-electric-heat groups had owned more than one home. Most of the homes owned by these people were custom-built homes.

Most of the participants had some prior experience with different heating fuels. Most of the participants' experiences were with electricity or natural gas. However, in the electric-heat group held in Spokane, more than half had used wood heat at one time and several in the group presently had a wood heat system along with their electric system. One participant from the four groups had used fuel oil to heat a previous home.

Each discussion group began with the participants being asked to write down three factors, besides location, that influenced them to purchase their home. The moderator facilitated the discussion by asking questions and probing comments concerning these factors. Discussing these factors led to other key issues of interest. When the discussion waned, the moderator introduced any remaining key issues. The major topics for discussion were

- factors that influenced the purchase of their home
- perceptions of and preferences for various heating fuels
- awareness of the MCS and Bonneville's MCS programs
- preferred incentives promoting energy-efficient homes.

The focus group meetings lasted from 1 1/2 to 2 hours. When all of the topics had been thoroughly addressed, the moderator dismissed the participants and they were paid a cooperation fee.

2.2 FOCUS GROUP RESULTS

Results of the focus groups are presented here organized by issue. Where differences occurred among the responses of different owner sub-groups, they are noted.

2.2.1 Factors Influencing the Purchase of a Home

Obviously, home buyers have many reasons for purchasing their homes. Consistently across all four groups, the most mentioned reason for purchasing the home that the homeowners had bought was floor plan features or aesthetic qualities of the home:

> "The traffic pattern of the floor plan was the primary thing we were looking for . . . the right number of rooms and the traffic pattern . . . and then once we had the floor plan we went from there."

> "Wonderful kitchen cabinetry . . . and all kinds of nice decor kinds of things."

These features included oak cabinetry, a lot with trees, large living area, garage, and large bathrooms, to mention a few. The appearance of the home was what first attracted the home buyer:

> "We looked at a house and didn't like the color and we didn't even go inside of it . . . the outside appearance of the house affected our decision whether we even wanted to look at the house."

> "If you have to live in it, you have to have it look nice."

> "You have to be proud of it."

First-time home buyers were more likely to mention financial reasons for purchasing their homes than were the other participants. Financial reasons included an affordable price and special low-interest rates for their particular home. Several participants mentioned they were tired of renting and the purchase of their home was an investment:

> "We were tired of renting other houses. Tired of not getting the tax break we saw others getting . . . Tired of paying someone else's mortgage."

The more practical matters of affordable housing and financing were the second most often mentioned factors in the decision to purchase a home, especially with the first-time home buyer.

Energy-efficiency was initially mentioned by only one focus group participant. However because this feature was one of the main concerns of this study, this topic was explored by the moderator in each group. After it was brought up by the moderator, almost all of the participants agreed that they had considered this aspect when looking for a home to buy. Many associated energy-efficiency with the quality of the construction of the home. The quality of the home and confidence in the builder's expertise were important. The participants generally felt that their homes were well-built and energy-efficient. However, when discussing quality, only a few participants mentioned items such as insulation, doors, and windows as being of high quality. Most described quality in terms of the overall appearance of the home. The energy-efficiency of a new home is considered in the purchase decision, but other factors appear to be more important.

The type of heating fuel the home used was initially mentioned by only a few people. But when the groups were probed about the importance of the fuel decision, a distinct pattern appeared. Most participants in the non-electric heat groups, both in Spokane and Tacoma, stated that they had selected their heating fuel or had selected a home that used natural gas. Participants in these groups were very pro-natural gas. Only one participant in the electric heat groups mentioned heating with electricity as a reason for purchasing the home. Several of these participants were satisfied with their electric heat, but it was not a reason for purchasing the home. In the Spokane electric-heat group, half of the group was planning or had already installed a wood heat system in their new homes. Purchasing a home that had wood heating equipment was not important because the buyer could easily install it later.

2.2.2 Perceptions and Preferences for Different Heating Fuels

Discussing the role of the heating fuel choice in buying a home led to discussing the participants' perceptions of and preferences for the different heating fuels. Of those participants expressing a preference for a heating fuel, the majority preferred natural gas. The number of participants who preferred electricity or wood was about the same. Solar heat was discussed to some degree but none of the participants had much experience with solar heat. Solar heat appeared to be a novelty or pipe dream to many in the groups.

All but one person in the two non-electric-heat groups were very pro-natural gas. All but three homeowners in the non-electric-heat groups selected natural gas as their heating fuel. The fuel choice was very important to these homeowners in their decision to purchase their home. The majority of these homeowners had purchased more than one home and their present home was custom-built. Even a couple of participants in the electric-heat groups preferred natural gas over electricity.

In general, these homeowners felt that natural gas was very cost-effective, efficient, and clean. It had very few disadvantages compared with electricity and wood:

> "It (gas) is quick, low cost, and you can't get them any cleaner than that."

> "Gas should be less expensive now, for the foreseeable future. That's not to say it's going to remain that way forever, ever since this WPPSS fiasco we had here, well that's pretty much set the trend of what is going to happen with the electrical industry for quite awhile."

> MODERATOR: "If you had to build or buy a new house tomorrow would it have gas heat or electric heat?"
> GROUP: "Gas!" (in unison)
> MODERATOR: "What if you had to pay more for it?"
> LADY: "I did pay more! The house came with electric heat and I had to pay extra to get gas."

There was very little concern over the safety of natural gas. Advances in the technologies using natural gas appear to have almost eliminated concerns about safety problems with the fuel. Also helping the image of natural gas are the natural gas companies who are perceived to be service-oriented and respond quickly to problems:

> MODERATOR: "Is safety a problem with gas?"
> GENTLEMAN: "Not to me, not nowadays. Not with the electronic ignitions and no pilot light."

> "In this area if you have something wrong where you smell gas, call a gas company and they'll send someone out right away . . . and in most cases it won't cost you anything . . . they're off in a bang. They're (the gas company) there real quick."

Within the non-electric-heat groups there was an implied perception of natural gas being more reliable than electricity. In both non-electric-heat groups, participants stated that the advantage of having natural gas heat is that you still have heat when the electricity goes off. Evidently these people perceive that electric service is interrupted more often than natural gas service. Natural gas was also mentioned to be the preferred fuel for water heaters (faster recovery) and cooking (better temperature control).

The preferences of the participants in the electric-heat focus groups were split mostly between electricity and wood. A few group members preferred to have natural gas as a heating fuel. Those preferring electricity perceived electricity to be clean and to provide comfortable heat. None of the participants in the electric-heat groups perceived electricity to be the least expensive heating fuel. However, it was mentioned that costs for electricity in the Northwest were considerably lower than in other parts of the nation; and having once lived in other areas, the cost of Northwest electricity was of little concern. The convenience of paying only one fuel bill instead of two was also mentioned. The type of electric heating system was important for the preference for electricity. Those electric users who were sold on the benefits of electricity used radiant ceiling heat or a system using separate individually controlled room heaters. These systems were thought to provide quick, comfortable heat and to allow the flexibility of zonal heating. Users of electric baseboard heat did not like their systems. These systems were perceived as inefficient, unsightly, and inconvenient:

> "We can't figure out why they have it. You can't arrange furniture around it, it's expensive."

> "I'm the envy of my neighborhood. My neighbors say they've got electric baseboard heating and they're paying this and this for electric bills. They think my system is fabulous."

For the participants in the Spokane electric-heat group, wood appeared to be the most preferred heating fuel. Like the majority of participants in all the groups, wood was perceived to be the most inexpensive fuel in the Spokane electric heat group. Many in this group stated the availability of wood and the warm, comfortable heat it provides as reasons for their preference. All the groups mentioned the uncleanliness and inconvenience of wood heat as

disadvantages for wood use. However, there was a lot of discussion concerning the new wood pellet stoves. These stoves were perceived to be more efficient, cleaner, and more convenient to use than conventional wood stoves. Several Spokane participants presently had a pellet stove or had some experience with them.

2.2.3 Awareness of the Model Conservation Standards and Bonneville's Model Conservation Standards Programs

As stated in Section 1, the Northwest Power Planning Council issued the MCS to promote energy-efficiency in new buildings. Bonneville actively encourages the adoption of the MCS for residential buildings through the Northwest Energy Code Program and construction to the MCS through the Super Good Cents (SGC) program. The MCS for residential buildings requires upgraded windows, doors, and insulation. The homes are also built with other special construction techniques and requirements that improve the "tightness" and energy-efficiency of the home. In many areas, specific heating and ventilation equipment is required to meet the standards.

Spokane and Tacoma (Pierce County) are "early adopter" regions that have adopted MCS as the local building code for electrically heated homes. In Tacoma, Vancouver (Clark County), and parts of Spokane, the SGC program is available for new homes. The focus group participants were asked if they knew what the SGC and MCS were.

In the Spokane groups, only a few people were familiar with the SGC. These participants knew the program promoted constructing homes with higher than normal levels of energy-efficiency. A couple of the participants knew the program was sponsored by Bonneville through the local electric utility. Other than these two, the ones familiar with the program did not relate the program to electrically heated homes. No one in any of the Spokane groups knew what the MCS was.

The participants in the Tacoma groups were familiar with SGC through the television advertisements. Those participants in the electric-heat group knew the homes were highly energy-efficient and used electricity. Individuals in the non-electric heat group knew fewer specifics about the program. They

mostly recognized the name of the program. None of the participants was aware of the MCS.

The Tacoma participants with electrically heated homes had purchased them homes through the SGC program. In general, these homeowners were satisfied with and proud of their homes. They felt the SGC homes were quality homes. They noticed very little difference in the price of the SGC homes compared with other homes which they had considered. The advantages of program homes mentioned in the Tacoma groups were energy-efficiency, quality construction, and quiet interiors. One participant who owned a custom-built program home mentioned several disadvantages of the program. He felt the requirements for the allowable square footage of window area were too restrictive and that the types of windows and doors required to meet the standards were too expensive. Also, he thought the required air-to-air heat exchanger was expensive, noisy, and useless:

GENTLEMAN: "You have a switch, you have the option of using it (heat exchanger) in the night-time or the day-time or all the time but we don't. We don't use ours at all anymore."
MODERATOR: "Why did you quit using it?"
GENTLEMAN: "The noise, the running of the motor all the time. Even with a furnace I can't stand that noise or the gush of wind."

This person felt that program homes were well-built and energy-efficient, but too expensive and the requirements too restrictive.

In Tacoma, participants heating their homes with natural gas felt their homes were just as well-built and energy-efficient as SGC homes. The non-electric-heat group participants generally felt that the local building codes had been improved and homes had to be built with energy-efficiency in mind:

> "... how much you used to have to put in (insulation) and how much you have to now. It's more . . . it stays cool all day and I know that's because we've got a lot of insulation. . ."

> "I think that's the magic word. It's the building code now . . . energy-efficiency has become part of the building code."

2.2.4 Homeowner Reactions to Incentives Promoting Energy-Efficient Homes

The groups were also asked to discuss some hypothetical incentive programs for encouraging the purchase of highly efficient homes. The participants were presented with six types of local utility incentive programs

and asked for their opinions on each. The hypothetical incentives would be given for purchasing a home that met a standard of energy-efficiency set by the local utility. The participants were also asked to discuss what incentive amounts would be attractive. Three of the incentive programs were variations of a cash rebate program. Two of the programs provided incentives directed towards home mortgages and one program was directed towards utility rates. The possible incentives considered were as follows:

- a cash rebate paid directly to the homeowner
- a cash rebate paid towards the down payment
- a cash rebate paid towards the mortgage closing costs
- a discounted mortgage interest rate
- an increase in the home loan amount for which one can qualify
- guaranteed discounts on utility rates.

In general, the reactions to the cash rebate programs were very positive. Almost all of the participants felt that some type of cash rebate program would be accepted. The preference, by far, was for cash rebates paid directly to the home buyer as opposed to the down-payment or mortgage closing costs. Most of the participants did not like the idea of a cash rebate with strings attached stipulating where it must be applied:

> "I'd rather have one (cash rebate)."
>
> "I'm a little paranoid about a string attached. In this case it's a subtle string . . ."
>
> "They might be in cahoots with the bank or something."

A few participants did not like the idea of programs providing cash rebates, in any form, for energy-efficient homes. These people felt that you do not get anything for free and the rebates would ultimately drive housing prices up. The rebates also seemed like a quick fix to a long-term problem of improving the energy-efficiency of the building stock. Most of the rebate critics preferred incentives that would take a long-term approach.

The two incentive programs directed toward home mortgages received the most and the least amounts of praise. The discounted interest rates incentive

for purchasing an energy-efficient home received the most praise of the six programs presented. Only one participant stated he would not participate in such a program.[a]

The most negative reaction was directed against the program that would increase the amount of a home mortgage for which a buyer could qualify if he purchased an energy-efficient home. Most of the participants felt that this was a "credit card" approach and would allow people to get into financial troubles. A few thought such a program would allow those who were just short of qualifying to purchase a home. These participants felt the program would be more attractive to the first-time home buyer:

> "Trying to qualify for a house is not easy. It's real difficult now . . . to get a better house for a young couple, especially when they're first starting out, they could, you know, have a better investment it might help them."

Like the program using discounted interest rates, discounts on utility rates were well received by almost everyone. This program was perceived as promoting energy-efficiency with a long-term incentive. However, many in the groups were skeptical that utilities would offer such a program or skeptical about the motivations for offering such a program. It was stated that utilities have to make a profit and discounted utility rates may be a disguised attempt to lock homeowners in to a costly heating fuel type. Also, it was felt that discounted utility rates would encourage energy consumption under the guise of saving energy. A program giving discounts for using less energy instead of the efficient use of energy was thought to be more beneficial. Even with this skepticism, the program offering discounted utility rates was viewed positively overall.

In discussing the different incentive programs, the moderator probed for the levels of energy-efficiency incentives that would be attractive to the participants. When discussing cash rebates, the minimum acceptable incentive was around $1,000. Any amount below $1,000 would not be much of an inducement

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(a) This participant was against any incentive programs to promote energy efficiency due to his involvement in the SGC program. He felt that the regulations were too strict and following them by the letter was too expensive.

to purchase a highly energy-efficient home. Most of the participants felt they would pay an extra $2,500 to $5,000 for a highly efficient home and an incentive promoting energy-efficiency should be in this range. For the incentive programs directed towards monthly savings (discounted interest rates and utility rates), the participants felt that, in general, the programs would have to save them between $15 and $30 a month for them to want to participate.

3.0 THE RESIDENTIAL HEATING FUEL CHOICE: A CONJOINT ANALYSIS

The focus groups identified several key factors that influence the decision to purchase a home. Information from the focus groups, realtors in the study areas, and Bonneville MCS program documents was used to develop a questionnaire to collect data for a conjoint analysis of the factors home buyers consider when purchasing a new home. Analyzing the preferences of homeowners who have recently purchased new homes allowed an assessment of the relative importance of fuel and energy-efficiency choices in the overall purchase decision and the preferences of recent home buyers.

This section is not intended to provide a complete description of the conjoint analysis techniques or the statistical tests used. Instead, this section discusses the methodology used to collect the data and the response rate of the survey, and presents the results of the data analysis. The appendix provides a more in-depth overview of conjoint analysis techniques.

3.1 METHODOLOGY

In addition to the focus groups described in Section 2, we used conjoint analysis to address how fuel type and energy-efficiency affected the decision to purchase a new home. Conjoint analysis forced survey respondents to make tradeoffs between different levels of important characteristics of a product in a hypothetical purchase situation. The respondents were presented with profiles of different home purchase situations and were asked to rank the profiles according to the likelihood of their purchasing the homes described by each profile. From these rankings, the relative importance of the characteristics were estimated. Also estimated were the values the respondents placed on the different levels of the characteristics.

The characteristics of the home purchase situation are termed factors. The possible alternatives within each factor are the levels of the factor. For instance, an important factor in purchasing a home is the type of home, which might have "levels" such as tract, semi-custom, or custom.

The conjoint analysis could not include all the factors influencing the home purchase decision. The focus groups indicated that the location,

financing, price, amenities, and floor plan features were probably the most important factors. Factors such as location, availability of financing, type of financing, and the price range of the home were designed to be extraneous to the profiles since these factors were not expected to be correlated with fuel type or energy-efficiency. In addition, the respondents were asked to keep in mind the factors and constraints that influenced their decision to purchase their present home (e.g., price, financing, location).

Although interactions among the factors could have been handled, it was preferable to select independent factors. In other words, a respondent's preference for a level of one factor should not depend on his or her preference for another factor. Our approach, therefore, focused on the main effects of the factors of interest, and not on the interactions. As an example, the profile comparisons did not restrict a person's choice of a highly energy-efficient home to only electrically heated homes.

By correctly selecting the factors and their levels, conjoint study designers can improve the content validity of the design. We used the focus groups to compile a list of several important factors. These factors were examined for dependence on each other and the final factors were selected. The levels of the selected factors were decided using information from the focus groups, from realtors in the study areas, and from Bonneville's present MCS programs. The appendix contains more information concerning factor selection. To satisfy the condition of factor independence (see appendix), factors which were highly dependent on each other (e.g., level of amenities, type of home, price of home) were represented by the factor that best exemplified that group of factors (e.g., type of home).

The factors included in this study and their levels are shown in Table 3.1. The factors of the most concern in this study were the type of heating

TABLE 3.1. Home Purchase Factors and Levels Included in the Conjoint Design

Factors	Levels	Factors	Levels[a]
Type of Home	Tract-built Semi-custom Custom-built	Primary Heating Fuel	Electricity Natural Gas Wood
Levels in Home	Single level Multi-level	Utility Rate Discount	$15/$20 per month None
Size of Home	> 2,300 ft^2 1,700 - 2,099 ft^2 1,300 - 1,699 ft^2 < 1,300 ft^2	Cash Rebate	$1,250/$1,900 $800/$1,250 $400/$600 None
Energy-efficiency	Average efficiency High efficiency		

(a) When two levels are shown separated by a slash (/), the first value was used for Pierce, King, and Clark Counties and the second value was used for Spokane County.

fuel, the purchase incentives, and the level of energy-efficiency of the home.[a] The high energy-efficiency level was intended to be a proxy for MCS. Since most buyers were not likely to be aware of the requirements of the MCS, we included the following language in our instructions to the participants:

> Due to upgraded windows and insulation levels, the homes built to [the high efficiency level] cost about $1,500 more to build, but will save on energy bills.

The intent of this language was to convey to the respondents that the higher energy-efficiency level would reduce their energy bills, but that the builder

(a) The levels of the cash rebate and utility rate discount that we included in the analysis varied between Spokane and the other three counties because Spokane is in a colder climate zone. The cash rebate levels varied as shown in Table 3.1 to be consistent with the variation in the MCS program incentives between the two climate regions. The monthly utility bill discounts were at the levels shown because participants in the focus groups indicated these amounts would be required for them to even take the incentives into account. The levels were slightly higher in Spokane to reflect the higher heating bills expected in this colder climate.

would have to spend more to build the home. Whether or how the additional cost to the builder might be passed on to the buyer and how much utility bills might be reduced were left to the respondents' judgment.

The number of factors and levels chosen allowed for a manageable number of profiles for the respondents to rank. Besides ranking the profiles, the respondents were asked to provide demographic and other information.

The data were collected via mail surveys in the four Washington counties.[a] The target population was homeowners who had purchased a new home during or after 1986 because the study addressed the fuel choice in new homes. Also, it was thought that more representative responses would be obtained from those homeowners who had recently gone through the process of buying a new home. For all four counties, a random sample of about 300 addresses was drawn from a list of residences built after 1985. The lists were obtained from county assessors' databases. Where occupant names were not available in the assessors' data, we attempted to obtain them from reverse telephone directories. For all four counties, for those addresses where the names of the occupants could not be obtained, the surveys were addressed to the Homeowner, Occupant, or Home Purchase Decisionmaker.

Mail surveys typically have low response rates, so several precautions were taken to increase the response rate. In all four counties, several contacts were made with the respondents. Surveys were accompanied by a cover letter explaining the purpose of the research and introducing the research firm and the sponsor. The letter stressed the importance of returning the survey to obtain a representative sample. The cover letter was personally signed by the researcher. A second survey was sent to those who had not returned the first mailing; it too was accompanied by a personally signed cover letter encouraging the return of the survey. Two weeks following the second mailing, the households that had not returned the survey were contacted by telephone if their numbers were listed. They were encouraged to return the survey and sent another copy if necessary.

(a) The surveys were conducted in Pierce and Spokane Counties about one year before they were conducted in the other two counties because of the timing of this study.

3.2 RESPONSE RATE

The response rate of a survey indicates how well the survey results represent the population they are supposed to represent. The higher the response rate from a random sample of a population surveyed, the higher the level of confidence that can be placed on the estimates derived from the survey.

Survey response rates can be affected by factors such as how strongly people feel about the issue. Survey methodology will also be a factor; for instance, telephone surveys usually have higher response rates than mail surveys, but in-person interviews usually have the highest response rates of all methods. Repeated surveying of respondents in a region can also hurt the response rates for later surveys. For example, residents of Pierce County, especially the City of Tacoma, have been heavily surveyed on topics similar to the topic of this study.

Having the names of the respondents, and not just their addresses, can increase the response rate for mail surveys. Mail surveys addressed to "Resident" or "Occupant" usually are not returned as often as surveys with complete addresses. Combining the assessors' data and reverse phone directory listings, names were available for only about half the households in our sample.

Table 3.2 presents information about the response rates in all four counties. The rate for Spokane County was nearly 66%, a very respectable level. The rate for Pierce and Clark counties was about 55%, which is still fairly good for mail surveys. King county had the lowest response rate with 46%.[a]

(a) The subcontractor, MACS, Inc., who conducted the surveys of King and Clark Counties indicated that 1) mail survey response rates are typically between 3% and 10% and have been declining; 2) Seattle City Light has noticed a steady decline in response rates for their customer surveys; and 3) the second mailing coincided with the Fourth of July holiday. Given these factors, the rates achieved are actually quite good for the approach used.

TABLE 3.2. Survey Response Rates by County

	Pierce	Spokane	King	Clark
1. Surveys Sent	300	300	300	322
2. Returned to Sender (vacant, addressee moved, no such address)	54	33	47	26
3. Non-Qualified Respondent (renter, purchased a previously owned home)	6	6	6	18
4. Completed Surveys	133	172	113	152
5. Response Rate 4. / (1. - 2. - 3.)	55.4%	65.9%	45.7%	54.7%

As noted, a series of steps was taken to increase the response rate. The biggest increase occurred on the second mailing in Pierce and Spokane Counties when a monetary incentive was included. Supplementing the written requests with a phone call produced very few additional responses, although most people contacted by phone promised to return their survey.

Without having extensive data on people who did not respond, it was difficult to say if or how the data were biased because of non-responses. With the response rates achieved for the surveys, the data might under-represent certain segments of homeowners who recently purchased new homes, but the response rates were fairly close, particularly in Spokane, to levels typically considered acceptable.

One possible source of bias we investigated was the difference between the response rates of households for which we had names and those for which we did not. We speculated that certain homeowner types were more likely to have unlisted phone numbers and, if the response rate depended on whether the occupant's name appeared on the envelope, a systematic bias might have been introduced since owners with unlisted numbers would be underrepresented in our sample. For Spokane, the response rates were identical for the two groups. For Pierce County, the response rate was higher (58%) where occupant names were available than where they were not (47%). Based on these results, we

concluded that no bias was being introduced in Spokane by the presence or absence of occupant names and a small amount of bias might be present in the Pierce County data from this phenomenon. In King and Clark Counties no data were analyzed to determine whether any bias existed.

3.3 DESCRIPTION OF THE RESPONDENTS

Besides the profile rankings, information on key characteristics of the respondents and their homes was collected through a series of questions on the survey. Table 3.3 shows this information. This section describes the homeowners and investigates the relationships between the characteristics of the homeowners and their homes.

Over 60% of new homes in Clark and Pierce Counties had electricity as their primary heating fuel. The shares for electricity and natural gas heating were about equal in Spokane County. In King County, natural gas heating was about three times as common as electricity. Where a secondary heating fuel existed, wood was most common. In all counties, tract homes were the least common. These data showed that 36% of the Pierce County homes, 32% of Clark County homes, and 21% of King County homes were custom-built homes, while in Spokane over half the homes were custom-built.[a] The age distributions were fairly similar across all counties.

We also have examined relationships among the characteristics shown in Table 3.3. Most of the relationships did not vary significantly by county. Not surprisingly, for all counties, those people who reported purchasing semi-custom or custom homes tended to choose the primary heating fuel for the home. While most people purchased custom or semi-custom homes, first-time buyers usually purchased a tract or a semi-custom home. Accordingly, first-time homeowners were currently living in less expensive homes and tended to be younger, usually less than 35 years old.

(a) We suspected that the large share of respondents reporting custom-built homes in Spokane might have been due to differences in the response rates for households where we did and did not have occupant names. As Section 3.2 discussed, however, there was no difference in the response rates between these two groups in Spokane.

TABLE 3.3. Demographics of Survey Respondents by County, %

	Clark	King	Pierce	Spokane
Primary Heating Fuel				
Electricity	62.7	21.2	62.0	42.0
Natural Gas	36.0	75.2	30.0	44.0
Wood	1.3	2.7	8.0	12.0
Other	0.0	0.9		2.0
Secondary Heating Fuel				
None	46.6	43.8	42.0	44.0
Electricity	7.5	7.1	11.0	14.0
Natural Gas	4.7	1.8	0.0	2.0
Wood	37.1	45.6	46.0	38.0
Other	4.1	1.8	0.0	3.0
Heating Fuel Selection				
Chose home's fuel	40.1	29.2	47.0	62.0
Chose home with preferred fuel	21.1	30.1	19.0	14.0
Someone else made fuel choice	38.8	40.7	34.0	24.0
Number of Homes Owned				
1	18.6	27.8	38.0	16.0
2	22.8	27.8	22.0	30.0
3 - 4	35.1	29.6	24.0	36.0
5 or more	23.4	14.8	16.0	17.0
Type of Home				
Custom	32.2	20.7	36.0	54.0
Semi-Custom	47.9	55.0	34.0	37.0
Tract	19.9	24.3	30.0	9.0
Age				
Under 35	29.7	34.5	34.0	34.0
35 - 54	48.6	55.5	51.0	57.0
55 and over	21.6	10.0	16.0	9.0
Sex				
Male	54.1	60.4	67.0	62.0
Female	45.9	39.6	33.0	38.0
Purchase Price of Home				
Under $100,000	54.9	36.6	68.0	60.0
$100,000 - $159,999*	38.9	53.6	18.0	29.0
$160,000 and over*	6.2	9.8	14.0	11.0

*Note: Because higher housing prices were expected in King and Clark Counties the ranges were "$100,000 - $229,999" and "$230,000 and over."

Respondents who did not decide on the type of primary heating fuel for their home more often than not owned an electrically heated home, except in King County where natural gas was most often used. In Pierce County, those homeowners who did not choose their fuel tended to be first-time homeowners. King County had the lowest percentage of respondents who chose their own fuel; whereas, in Spokane County, a larger percentage of people reported deciding on their primary heating fuel, regardless of the number of homes they had purchased or their age. Also, Spokane, Pierce, and King County respondents with more expensive homes had a slight tendency to have non-electric primary heating fuels. In Spokane County, first-time home buyers predominantly bought electrically heated homes, whereas other buyers predominantly bought gas-heated new homes. However, both first-time buyers and those who were buying their second or subsequent home in Pierce and Clark counties tended to heat with electricity. In King County most buyers in all categories heated with natural gas.[a]

3.4 CONJOINT ANALYSIS RESULTS

The conjoint analysis involved asking the survey respondents to rank 18 profiles of different home purchase situations. These rankings were used to determine the relative importance of the different factors considered and the values the respondents placed on the different levels of the factors.

The primary output from a conjoint analysis is a set of values indicating the utility that respondents attach to each level of the factors considered. These utility values are estimated for each respondent and the group utility values are the average of the individual utility values. The total utility value is the sum of the utility values for the factor levels. The group utility values are used to estimate the total value that respondents would place on a hypothetical home purchase situation. The relative importance of each factor in the purchase decision can also be calculated from the conjoint analysis based on the utility values for each factor.

(a) The share of respondents who considered wood to be their primary heating fuel was largest in Spokane County, possibly because the county is more rural than the other counties. Only three respondents in King County and only two respondents in Clark County used wood as a primary heating fuel.

Table 3.4 indicates the estimated relative importance of each factor included in this conjoint analysis. The relative importance gives an indication of how strongly each factor affects the home purchase decision. The relative importance of each factor is calculated by taking the difference between the highest and lowest utility values for the levels of the factor and dividing this difference by the sum of the differences for all the factors. The relative importance of the factors takes into account only factors included in the design.[a]

The relative importance of the factors is fairly consistent across the four counties. The most important factor in each county is the primary heating fuel. In King County, fuel type is nearly as important as all other factors combined. In all other counties, factors that represent aesthetic qualities or floor plan features (home type, size, and number of levels) account for approximately 50% of the total range in utility values. In all counties, aesthetic qualities are more important than the purchase incentives or the level of energy-efficiency.

TABLE 3.4. Relative Importance of Factors by County

Factor	Clark	King	Pierce	Spokane
Fuel Type	38.7%	48.6%	34.8%	33.2%
Home Size	29.3	31.9	32.9	32.9
Home Type	12.3	5.8	15.9	18.2
Cash Rebate	5.8	6.1	6.7	6.6
Rate Discount	4.9	5.1	3.0	1.7
Efficiency Level	2.5	1.7	3.6	4.9
Levels in Home	6.5	0.7	3.1	2.4

(a) As noted earlier, factors such as location and financing, which might be more important to the home buyer than some of the factors considered here, were not included in the analysis.

Table 3.5 contains the group utility values for each factor level. For each specific factor, the most preferred level has the highest positive utility value. Because of the statistical techniques used to estimate the utility values, the utility values sum to zero for categorical factors. Consequently, a negative utility does not mean that the respondents place no value on the particular level; it just means that the respondents value that level less than other levels. For the factors that have quantities associated with them (such as the level of a cash rebate), the utility values are a function of a vector (linear) coefficient and, for home size, a quadratic term (see the appendix). For the home size factor, the utility is calculated by dividing the floor area (in ft^2) by 100 and then multiplying this value by the vector coefficient and adding it to the product of the quadratic coefficient times the square of the floor area divided by 100. The cash rebate utility values are calculated by simply dividing the cash rebate amount by 100 and multiplying the resulting value by the vector coefficient.

Table 3.5 shows that in all counties, custom or semi-custom homes were the most valued. Tract homes consistently had lower utility values than the other two housing types. In all counties except Spokane, single-level homes had a higher utility value than multi-level homes. As noted later, preferences for levels in a home tended to vary with respondent age so these results reflected the age distribution of new-home buyers.

In all cases, the utility of home size followed a quadratic relationship. Additional floor area was desirable up to some maximum size. The most preferred size ranged from about 2,000 to 2,300 ft^2.

In all counties, wood was the least preferred heating fuel. In contrast, natural gas received the highest utility value in all locations and, therefore, was the preferred fuel. In King County, the difference between utility values for electricity and gas heat was the largest, indicating that buyers in King County placed considerably higher value on natural gas heat.

The utility value for cash rebates varied linearly with the amount of the rebate in all counties. Utility values were fairly consistent across the counties. The utility value for a rate discount also was reasonably

TABLE 3.5. Utility Values for the Factor Levels by County

	Clark	King	Pierce	Spokane
Home Type				
Tract	-1.22	-0.62	-1.49	-1.69
Custom	0.59	0.31	0.66	0.99
Semi-Custom	0.63	0.31	0.83	0.71
Levels in Home				
Single	0.49	0.06	0.23	-0.18
Multi	-0.49	-0.06	-0.23	0.18
Home Size				
1,100 ft^2	15.19	14.70	19.47	19.57
1,500 ft^2	18.08	17.70	22.83	22.96
1,900 ft^2	19.55	19.46	24.21	24.38
2,300 ft^2	19.61	19.96	23.60	23.81
Vector	1.86	1.77	2.45	2.46
Quadratic	-0.04	-0.04	-0.06	-0.06
Primary Heating Fuel				
Wood	-3.71	-4.18	-3.20	-2.68
Electricity	1.62	0.58	1.32	0.45
Natural Gas	2.10	3.60	1.89	2.23
Cash Rebate*				
None	0.00	0.00	0.00	0.00
$400/$600	0.28	0.32	0.32	0.31
$800/$1,250	0.56	0.63	0.63	0.65
$1,250/$1,900	0.88	0.99	0.99	0.99
Vector	0.07	0.08	0.08	0.05
Rate Discount $15/$20*				
No	-0.37	-0.40	-0.22	-0.13
Yes	0.37	0.40	0.22	0.13
Efficiency				
Average	-0.18	-0.14	-0.26	-0.36
High	0.18	0.14	0.26	0.36
Correlation Coefficient	0.82	0.87	0.86	0.84
Absolute Difference	2.48	2.27	2.44	2.47

* First value shown is for all counties except Spokane; second value is for Spokane County.

consistent across the counties. Even with the higher rate discount considered for Spokane County, however, the utility value to the homeowners was lower than in the other counties.

Finally, increased energy-efficiency was considered to provide higher utility than standard efficiency levels. This meant that respondents considered the higher efficiency desirable even though home prices were likely to increase. The effect was most pronounced in Spokane, where heating loads would be the highest.

To examine differences across population subgroups, we looked at how utility values varied with demographics. Those results are summarized below.

As would be expected, owners had the highest utility value for the type of home they owned. For example, owners of custom-built homes consistently had higher utility values for custom homes than they did for tract or semi-custom homes.

Similarly, homeowners consistently had the highest utility values for the type of heat in their current home. Wood heat users, in all counties except Clark, had a higher utility value for natural gas heat than electric heat.

In all cases, homeowners 55 years and older placed a higher utility value on single-level homes than they did multi-level homes. This seemed reasonable given that older homeowners would probably have more difficulty negotiating stairs.

Other differences emerged that involved the selection or preference for electric heating. In Pierce and Clark counties, older buyers attached a significantly higher value to electric heating than did other buyers. Buyers who did not select their fuel, typically buyers of tract homes, predominantly had electric heat.

Responses to incentives varied by characteristics of buyers or households. For example, in Pierce County older buyers valued a cash rebate less than did other buyers. Also in Pierce and King counties, owners of tract homes found a cash rebate significantly more valuable than did owners of other home types.

First-time home buyers appeared to be a distinct subgroup. The focus groups indicated that first-time buyers preferred electric heat; and the conjoint analysis survey data showed that about 59% of the first-time home buyers in the complete sample had electric heating, whereas only about 43% the buyers who had owned more than one home currently had electric heat. The survey data also showed that only about 18% of the first-time buyers purchased custom homes, whereas about 43% of the buyers who had bought two or more homes were currently living in custom-built homes.

For testing the reliability of our results, 2 of the 18 profiles the respondents were asked to rank were hold-out cards. The group utility values were estimated using only the other 16 profiles, and the two hold-out profiles were "held out" of the analysis. The group utility values were then used to predict the ranking of the two hold-out cards. At the bottom, Table 3.5 includes two measures of the reliability of the conjoint results: the hold-out card correlation and the absolute difference between the predicted ranks and the actual ranks of the hold-out cards. The two measures of reliability indicate how well the rankings of the hold-out cards were predicted for the sample as a whole based on the group results.

All counties showed a high correlation between the predicted and actual ranks of the hold-out cards: the simple correlation coefficient was greater than 0.8. This indicated that the individual utility values predicted actual ranks of the hold-out cards accurately. The absolute difference between rankings indicated that the group utility values were able to predict the actual ranks of the hold-out cards within approximately plus or minus two and a half ranks.

3.5 SEGMENTING HOMEOWNERS ACCORDING TO UTILITY VALUES

The selected results in the previous section indicated that specific groups of homeowners value certain characteristics of a home more than other groups of homeowners. Such information could be useful for targeting programs to different market segments. The relative sizes of the segments, the importance segment members place on the factors, and the utility values members have for the factor levels are important pieces of information. Demographic descriptions of the segments are also useful for targeting

information.[a] This section discusses segmenting homeowners into groups with similar utility values; segment utility values and relative sizes are discussed.

The method used for segmenting the respondents was a K-means cluster analysis of the respondents' utility values. This clustering technique split the sample into a specified number of groups such that the between-groups variation in the group means was as large as possible relative to within-group variation of the utility values. We used this method of segmentation to produce two distinct segments, or clusters, of homeowners in each of the four counties.

The utility values for the clusters in all counties are shown in Table 3.6. The table also indicates the relative importance of each of the factors for the groups.

In general, the importance rankings were similar for Group 1 in each county and also for Group 2 across counties. In all four counties, homeowners in Group 1 placed more importance on the primary heating fuel than homeowners in Group 2. On the other hand, home size was less important to Group 1 members in all counties. Another distinguishing factor was home type, which Group 2 valued more in all counties except Clark.

Table 3.7 presents demographic information on members of each cluster. For Pierce County, Group 1 consisted of 58.8% of the homeowners. Most of the homeowners in Group 1 (60.0%) used electricity as their primary heating fuel. Approximately 39% used natural gas to heat their homes. Approximately 53% also had a secondary heating fuel, almost always wood. By comparison, a larger percentage of Pierce County Group 2 homeowners (18%) used wood as a primary heating fuel. Fifty-nine percent used electricity and 22.5% used

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(a) Accurate descriptions of segments, however, would require better demographic information than we collected and larger sample sizes for each segment. Statistically speaking, the relatively small sample sizes of the segments did not allow narrow confidence intervals to be placed around the demographic category percentages. For most of the reported percentages, the 95% confidence interval is approximately plus or minus 8%.

TABLE 3.6. Relative Importance and Utility Values for Homeowner Segments

	Pierce		Spokane	
	Group 1	Group 2	Group 1	Group 2
Home Type				
Relative Importance, %	11.11	28.74	12.22	29.06
Tract	-1.14	-2.05	-1.32	-2.12
Custom	0.35	1.16	0.61	1.42
Semi-Custom	0.79	0.89	0.72	0.70
Levels				
Relative Importance, %	2.88	3.94	0.12	5.58
Single	0.25	0.22	-0.01	-0.34
Multi	-0.25	-0.22	0.01	0.34
Home Size				
Relative Importance, %	23.49	49.42	21.09	41.38
1,100	18.15	22.22	19.47	19.47
1,500	21.15	26.10	22.35	22.95
1,900	22.23	27.74	22.99	24.51
2,300	21.39	27.14	21.39	24.15
Vector	2.31	2.79	2.54	2.43
Quadratic	-0.06	-0.07	-0.07	-0.06
Fuel				
Relative Importance, %	46.17	10.74	54.76	12.32
Wood	-5.25	-0.44	-5.38	-0.22
Electricity	2.48	-0.32	1.62	-0.64
Natural Gas	2.77	0.76	3.76	0.86
Cash Rebate*				
Relative Importance, %	7.94	4.48	4.49	4.11
None	0.00	0.00	0.00	0.00
$400/$600	0.44	0.16	0.24	0.16
$800/$1,250	0.88	0.32	0.48	0.32
$1,250/$1,900	1.38	0.50	0.75	0.50
Vector	0.11	0.04	0.06	0.04
Rate Discount*				
Relative Importance, %	3.91	1.43	3.38	0.82
None	-0.34	-0.08	-0.32	0.05
$15/$20 per month	0.34	0.08	0.32	-0.05
Efficiency Level				
Relative Importance, %	4.49	1.25	3.48	6.73
Average	-0.39	-0.07	-0.29	-0.41
High	0.39	0.07	0.29	0.41

* First value shown is for all counties except Spokane; second value is for Spokane County.

TABLE 3.6. (contd)

	King		Clark	
	Group 1	Group 2	Group 1	Group 2
Home Type				
Relative Importance, %	7.56	7.82	13.95	8.70
Tract	-0.76	-0.42	-1.63	-0.48
Custom	0.15	0.54	0.88	0.06
Semi-Custom	0.61	-0.12	0.75	0.42
Levels				
Relative Importance, %	0.66	3.58	6.45	6.38
Single	-0.06	0.22	0.58	0.33
Multi	0.06	-0.22	-0.58	-0.33
Home Size				
Relative Importance, %	19.86	45.93	22.68	53.33
1,100	15.40	12.76	13.86	17.71
1,500	18.00	15.60	16.50	21.15
1,900	19.00	17.48	17.86	22.99
2,300	18.40	18.40	17.94	23.23
Vector	1.95	1.49	1.70	2.16
Quadratic	-0.05	-0.03	-0.04	-0.05
Fuel				
Relative Importance, %	59.13	28.66	46.30	11.88
Wood	-5.91	-1.67	-5.32	-0.79
Electricity	1.11	-0.18	2.32	0.34
Natural Gas	4.81	1.85	3.01	0.44
Cash Rebate				
Relative Importance, %	5.52	8.14	4.17	9.66
None	0.00	0.00	0.00	0.00
$400	0.32	0.32	0.24	0.32
$800	0.64	0.64	0.48	0.64
$1,250	1.00	1.00	0.75	1.00
Vector	0.08	0.08	0.06	0.08
Rate Discount				
Relative Importance, %	5.18	4.89	3.78	8.31
None	-0.47	-0.30	-0.34	-0.43
$15/month	0.47	0.30	0.34	0.43
Efficiency Level				
Relative Importance, %	2.10	0.98	2.67	1.74
Average	-0.19	-0.06	-0.24	-0.09
High	0.19	0.06	0.24	0.09

TABLE 3.7. Demographics by Segment in Each County, %

	Pierce		Spokane	
	Group 1	Group 2	Group 1	Group 2
Primary Heating Fuel				
Electricity	60.00	59.18	44.00	40.24
Natural Gas	38.57	22.45	56.00	32.93
Wood	1.43	18.37		21.95
Other				4.88
Secondary Heating Fuel				
None	47.14	40.82	57.33	32.93
Electricity	1.43	20.40	2.67	19.51
Natural Gas			2.67	1.22
Wood	32.86	28.57	26.67	29.27
Other	18.57	8.16	10.67	15.86
Heating Fuel Selection				
Chose Home's Fuel	38.57	51.02	56.00	67.07
Chose Home with Preferred Fuel	21.43	20.41	18.67	10.98
Someone Else Made Fuel Choice	40.00	28.57	25.33	21.95
First-time Homeowner	37.14	40.82	16.00	18.29
Type of Home				
Custom	32.86	36.73	46.67	58.54
Semi-Custom	34.29	32.65	42.67	31.71
Tract	32.86	28.57	8.00	9.76
Age				
Under 35	28.57	40.81	25.34	41.47
35 - 54	51.43	46.94	61.33	51.22
55 and Over	20.00	12.24	13.33	7.32
Sex				
Male	64.29	75.51	68.92	53.16
Female	35.71	24.49	31.08	46.84
Purchase Price of Home				
Under $100,000	71.43	67.34	58.67	62.20
$100,000 - $159,999	15.71	16.33	28.00	28.06
$160,000 and Over	11.43	14.28	13.33	8.54
Percentage of Respondents in Group	58.80	41.20	47.80	52.20

TABLE 3.7. (contd)

	King		Clark	
	Group 1	Group 2	Group 1	Group 2
Primary Heating Fuel				
Electricity	17.24	25.00	58.33	69.57
Natural Gas	79.31	70.00	41.67	23.91
Wood	1.72	5.00		4.35
Other	1.72			
Secondary Heating Fuel				
None	50.88	32.50	49.40	35.56
Electricity	3.51	15.00	6.02	8.89
Natural Gas	3.51		4.82	6.67
Wood	40.35	50.00	36.15	46.67
Other	1.75	2.50	3.60	2.22
Heating Fuel Selection				
Chose Home's Fuel	27.59	30.00	41.46	37.78
Chose Home with Preferred Fuel	36.21	25.00	19.51	22.22
Someone Else Made Fuel Choice	36.21	45.00	39.02	40.00
First-time Homeowner	24.14	27.50	11.90	21.74
Type of Home				
Custom	22.41	15.00	32.14	32.61
Semi-Custom	48.28	60.00	47.62	45.65
Tract	29.31	20.00	19.05	17.39
Age				
Under 35	37.93	30.00	23.81	39.13
35 - 54	46.55	62.50	52.38	41.31
55 and Over	13.79	2.50	22.61	17.39
Sex				
Male	57.89	66.67	60.98	40.91
Female	42.11	33.33	39.02	59.09
Purchase Price of Home				
Under $100,000	36.20	42.50	46.43	65.22
$100,000 - $229,999	51.73	47.50	42.86	26.09
$230,000 and Over	12.07	7.50	5.95	6.51
Percentage of Respondents in Group	59.20	40.80	64.60	35.40

natural gas to heat their homes. Forty-one percent of Pierce County Group 2 homeowners had a secondary heating fuel, mostly wood, but 20.4% used electricity as a secondary fuel.

The respondents were asked whether they had played a role in selecting the primary heating fuel for their home. Approximately 60% of the Group 1 homeowners in Pierce County either chose their primary heating fuel or selected a home with their preferred fuel. This percentage was 72% for Group 2 homeowners. The homeowners in Group 1 and Group 2 were very similar with respect to number of homes owned, type of home, and purchase price; however, members of Group 1 tended to be a little older.

The membership of Group 1 in Spokane County accounted for 47.8% of the homeowners in the county. Fifty-two percent of the homeowners were segmented into Group 2. Group 1 predominantly (56%) used natural gas for heating. Approximately 43% of Group 1 used a secondary heating fuel, mostly wood. The primary heating fuels used in Group 2 were closely split between natural gas (33%), electricity (40%), and wood (22%), with other fuels accounting for 5% of the total. Group 2 respondents played a slightly greater role in selecting a primary heating fuel than did respondents from Group 1. As in Pierce County, Group 2 members tended to be younger than Group 1 members. About 59% of the respondents in King County fell into Group 1. The majority (79%) of those heated with natural gas and half had a backup heating system. Although most respondents within Group 2 heated with natural gas, the proportion was smaller than in Group 1. Seventy-eight percent did not have a backup heating system. Members of Group 2 tended to be younger than those in Group 1.

In Clark County, 65% of the respondents were in Group 1. Natural gas heating was more common in Group 1. Members of Group 2 tended to be younger.

By combining the utility values and demographics, some patterns can be identified for the different groups across the counties. Group 1 in all four counties placed a high importance on the primary heating fuel type and had a larger share of homes heated with natural gas than Group 2. Members of Group 1 in both counties appeared to disapprove of wood heat. Group 2 members in all counties were younger and rated home size significantly more important than did Group 1 members. The majority of Group 1's members lived in custom

homes, and these groups had the highest use of wood heat as the primary heating fuel. It might also be noted that, except for Clark County, home type was more important to Group 2 than to Group 1.

There were important consistencies between the demographic characteristics of the cluster groups and their responses in the conjoint analysis. This type of information and analysis could be explored further for segmentation and marketing purposes.

3.6 MARKET SIMULATIONS

One strength of conjoint analysis is the ability to use the utility values to simulate the respondents' choice behavior in hypothetical situations. In this section, the respondents' utility values are used to demonstrate the possible effects of a program encouraging the buying of highly energy-efficient electrically heated homes.

As mentioned previously, the Northwest Energy Code Program encourages municipalities to adopt the MCS as the building code for homes heated with electricity. Recently, Washington State adopted the MCS to go into effect in 1991 for all new electrically heated homes, along with incentives for these homes. Important questions relating to such programs are: "Will the adoption of the MCS encourage or discourage the purchase of electrically heated homes?"; "Are incentives needed to encourage the purchase of these highly energy-efficient electrically heated homes?"; and, if so, "What levels of incentives are appropriate?".

The simulations shed some light on these questions by providing estimates of market shares for different homes and program characteristics. Given a specific combination of home characteristics and incentives, the utility values for the levels of the factors in the situation were summed to produce a total utility value for that combination.[a]

(a) Although two models were used in our analysis to estimate market shares, we present only the results from using the first-choice model here because it provided better corroborated results. The appendix discusses this model and the Bradley, Terry, and Luce (BTL) model.

The first-choice model we used is the mainstay of conjoint simulators. For each respondent, it assumed that the situation with the highest total utility value would be selected by the respondent. It aggregated the results from all the respondents and indicated what percentage of the respondents preferred each combination of housing characteristics.

We simulated the decision to purchase either an electrically heated or natural-gas-heated home by starting with six typical homes. These six consisted of various combinations of home type (custom or tract) and floor area (1,100, 1,900, or 2,300 ft^2). The homes were assumed to be multi-level. Simulations were then used to estimate market shares for each basic home type under situations with varying efficiency levels and incentives. All six home types were included in each simulation, but the primary heating fuel, the purchase incentives, and the level of energy-efficiency were varied. The effect on fuel choice was determined by adding up the shares of homes with electric heat and the shares with gas heat.

The base case simulation included electrically heated homes with the same level of energy-efficiency as the alternative gas-heated homes and with no purchase incentives. This simulated the situation where the MCS was not required for electrically heated homes and no incentives were provided. In the second simulation, the electrically heated homes were energy-efficient homes with no purchase incentives.[a] For our purposes, the efficiency level of the energy-efficient homes was assumed to be comparable to MCS. Each simulation thereafter added alternative purchase incentives for the energy-efficient (MCS), electrically heated homes. Table 3.8 displays the results for each of the four counties.

Under the base case, i.e., equal energy-efficiencies and no purchase incentives, the simulations indicated a larger market share in each county for natural gas heating than electric heating. The base-case electric heating shares estimated for electricity ranged from 13.3% in King County to 44.2% in Pierce County.

(a) The data upon which these simulations were based assumed that homes not built to the MCS, i.e., of standard energy-efficiency, were built to the Washington State building code in effect in 1990.

TABLE 3.8. Market Simulation Results

Pierce County

	Base	MCS	MCS, Rate Discount	MCS, Cash Rebate $400	MCS, Cash Rebate $800	MCS, Cash Rebate $1,250
Electric Home	44.2	45.8	50.0	52.5	58.3	60.8
Nat. Gas Home	55.8	54.2	50.0	47.5	41.7	39.2

Spokane County

	Base	MCS	MCS, Rate Discount	MCS, Cash Rebate $600	MCS, Cash Rebate $1,250	MCS, Cash Rebate $1,900
Electric Home	22.8	37.3	41.1	39.9	44.3	46.8
Nat. Gas Home	77.2	62.7	58.9	60.1	55.7	53.2

King County

	Base	MCS	MCS, Rate Discount	MCS, Cash Rebate $400	MCS, Cash Rebate $800	MCS, Cash Rebate $1,250
Electric Home	13.3	23.5	30.6	24.5	29.6	33.2
Nat. Gas Home	86.7	76.5	69.4	75.5	70.4	66.8

Clark County

	Base	MCS	MCS, Rate Discount	MCS, Cash Rebate $400	MCS, Cash Rebate $800	MCS, Cash Rebate $1,250
Electric Home	38.5	43.8	55.8	48.5	50.0	56.9
Nat. Gas Home	61.5	56.2	44.2	51.5	50.0	43.1

When MCS was introduced for electrically heated homes, without any incentives, the estimated market shares for electricity increased in all counties. In King and Spokane counties the change was most dramatic. Spokane went from a 22.8% estimated share for electrically heated homes to 37.3% for electrically heated homes built to MCS specifications. King County shares

increased from 13.3% to 23.5%. The remaining columns in the table show how different incentives and levels tied to MCS electrically heated homes affected estimated market shares.

The rate discount ($20 per month in Spokane and $25 per month elsewhere) increased the share for electrically heated MCS homes in all counties. The increase ranged from about 4 to 12 percentage points.

The last three columns show the effect of cash rebates. In all counties except Pierce, the estimated share for electrically heated homes with the lowest cash rebate ($600 in Spokane County and $400 elsewhere) was less than the estimated share for the same homes with the rate discount. With an intermediate rebate level ($1,250 in Spokane and $800 elsewhere), the share for electrically heated homes increased between 1.5 and about 6 percentage points. At the highest rebate level analyzed ($1,900 in Spokane and $1,250 elsewhere), the cash rebate was enough to increase the share for electrically heated homes in all counties to a level greater than the share for the same homes with the rate discount. At the highest rebate level, Pierce County had the highest market share for electrically heated MCS homes, 60.8%. The lowest share for electrically heated homes with a maximum cash rebate was 33.2% in King County.

In three of the counties, each additional $100 of cash rebate resulted in a market share increase of about one percentage point for electrically heated MCS homes. In Spokane, the effect was about half this amount. In all counties except Clark, the initial increases in the rebate amount tended to have the most effect on market shares.

The utility rate discounts appeared to have a significant effect on electrically heated, MCS home market shares estimates. The rate discount examined amounted to $180/year in all counties but Spokane, where it was $240/year. The response to the rate discount and cash rebate can be compared by calculating how many months of a given rate discount would be required to have the same effect on market shares as a cash rebate. Results for Pierce and Clark Counties were at the extremes. In Pierce County, the 52.5% market share achieved with a $400 rebate was roughly the same as the market share produced by a $15/month rate discount. Thus, respondents in Pierce County

would require the rate discount to "pay back" in about 27 months ($400 at $15/month). On the other hand, the $15/month utility rate discount increased estimated market shares in Clark County about as much as a $1,250 rebate. Therefore, in Clark County respondents reacted more favorably to a utility rate discount, accepting a much longer "payback" of 83 months ($1,250 at $15/month). These results were consistent with the differences in relative importance placed on rate discounts and cash rebates by respondents in the two counties (see Table 3.4).

Although we were unable to test the market simulation results systematically, we were able to take advantage of available data to compare our results with actual market shares. Table 3.9 presents the comparisons.

In Pierce County, we had data from a previous study (Lee, Englin, and Harkreader 1989) that showed the share of new homes having electrical heat had declined from 95% to 55% during the period 1981 through 1987. The MCS program went into effect in Tacoma in mid-1983 and has continued. Though the

TABLE 3.9. Comparison of Simulation Market Share Estimates and Other Data

County	Estimated Shares of New Homes Heated with Electricity, %		Comments
	Simulation Based	Other Source	
Pierce	61	55	Simulation value based on $1,250 rebate; other based on utility data
Spokane	47	42	Simulation value based on $1,900 rebate
King	13	21	Simulation value from base case; survey data includes areas with MCS programs
Clark	57	63	Simulation value based on $1,250 rebate, SGC program in effect since 1987

incentive level has varied, it has been typically at the high end of the range we analyzed. Therefore, we used 61% as our simulation-based estimate of new electrically heated, MCS home share in Pierce County. This compared quite well with the estimate of 55% based on utility hook-up data.

In the other three counties, we relied on the demographics data collected through our survey to estimate new housing market shares by fuel type. The numbers in Table 3.9 were based on the primary heating fuel data presented in Table 3.3, including only respondents who reported having electricity or natural gas as their primary heating fuel. The biggest difference between the estimates from the simulations and those from the survey or utility data occurred in King County, where our simulation estimate was based on the assumption that no electrically heated MCS homes were offered. While this assumption would be appropriate for Seattle, since no Bonneville programs were in place there, other parts of King County had SGC programs during the period analyzed. The difference between our simulation estimate and the demographics data would have decreased if we had restricted our demographics to respondents in Seattle only.

Overall, the simulation-based market shares estimates agreed well with the observed shares. These results increased our confidence in the ability of the simulation model to estimate the effects of the MCS and various incentive approaches on market shares.

Because the effects of the MCS and incentives on market shares are very important to quantify, further research should be devoted to establishing reliable and valid estimates. Further analysis of the data collected here and extensions of the analysis to other sites could improve the current estimates.

4.0 CONCLUSIONS

This section summarizes the information presented in this report, highlighting important findings from the current research and linkages to related past research. This section also identifies implications of our findings and additional research required to resolve the issues examined. Since this report focuses on the interactions among fuel types, the MCS, incentives programs, and consumer choice, the conclusions presented here are grouped into three relevant categories: factors affecting the home purchase decision; the effects of alternative incentives; and market segmentation and market shares.

4.1 FACTORS AFFECTING THE HOME PURCHASE DECISION

Based on the conjoint analyses of homeowners in four Washington counties, a fairly consistent ranking emerged of the factors we examined in the new-home purchase decision. Averaging across the four geographic areas (Figure 4.1), fuel type was considered the single most important factor in the purchase decision. Combined, however, the floor area and home type, ranked second and third, respectively, were more important, accounting for about half the relative importance. The cash rebate linked to fuel type was fourth in the rankings. The utility rate discount was fifth, while energy-efficiency was tied with the number of levels in a home for last place in the rankings.

The relative importance of fuel type in the purchase decision was a significant finding. Little additional information was available to test this finding. Other results in this report and previous work, however, tended to corroborate this finding. For example, Lee, Englin, and Harkreader (1989, Table 4.2) showed that fuel type has had a statistically significant effect on home sale prices in Tacoma in recent years. In 1985 and 1987, buyers paid about $4,000 more for gas heated homes than electrically heated homes. Though the participants in the focus groups conducted for the current study did not usually bring up fuel type as a major factor in their home purchase decision, when the moderator raised the topic an important pattern of attitudes emerged. Owners who heated with natural gas typically had a strong preference for gas. Consistent with the results reported in Lee, Englin, and Harkreader (1989),

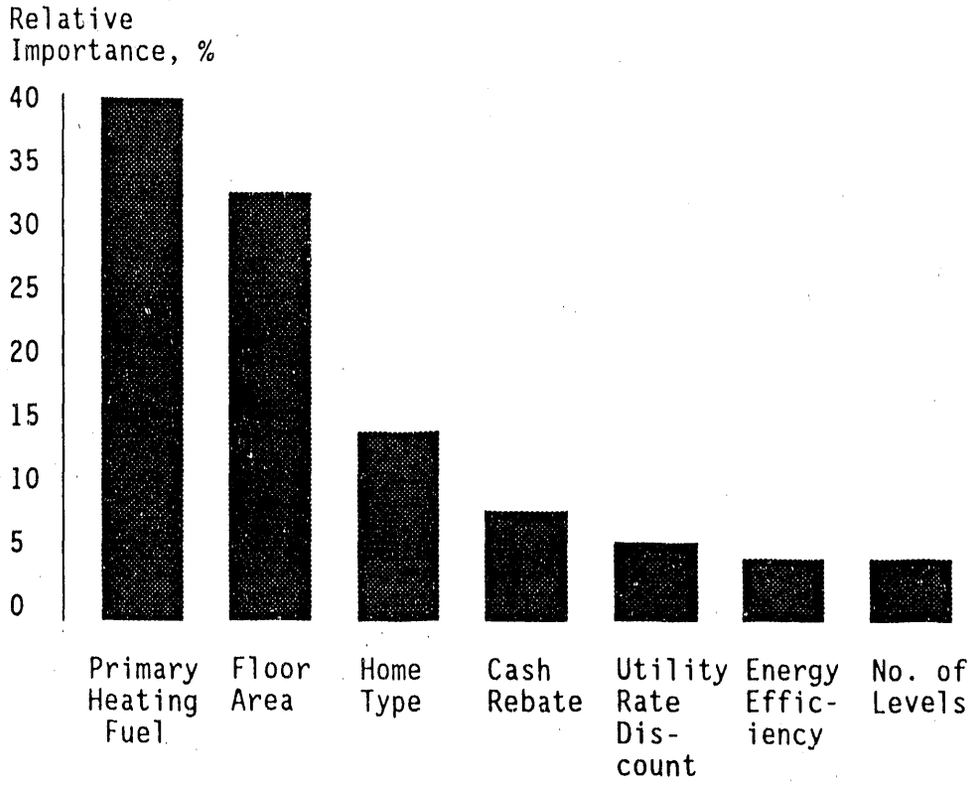

FIGURE 4.1. Average Relative Importance of Key Factors in Home Purchase Decision

one focus group participant even indicated that she had paid more for her new home to have the heating switched to natural gas. This evidence supported our conjoint analysis finding that fuel type was quite important to home buyers, even to the point that buyers would pay a premium to get their preferred fuel.

Besides being concerned about the economics of different fuels, buyers also had fairly strong views about the service provided by different utilities. Focus group participants expressed the view that gas utilities were more service-oriented than their electric counterparts. There also was the opinion that electricity supplies were less reliable than gas supplies. In addition, gas was considered a more satisfactory cooking and water heating fuel. A previous survey of 1,000 households in the Northwest partially supported these findings (Harkreader et al. 1988, Table 4.3); households rated gas more dependable than electricity. The previous study, however, did not reveal a significant preference for gas for cooking and water heating.

While fuel type was a very important factor, energy-efficiency constituted only about three percent of the total relative importance in the purchase decision. Like fuel type, this factor was usually not mentioned by participants in the focus groups, but, also like fuel type, once the moderator introduced it most participants indicated that they had considered energy-efficiency in their decision. An important finding from the focus groups was that buyers tended to associate energy-efficiency with home quality.

The focus group participants indicated that they would be willing to pay between $2,500 and $5,000 more for an energy-efficient home. This is fairly consistent with estimates from Lee et al. (1989, p. 4.17), which showed Tacoma buyers had been willing to pay between $5,500 and $7,600 more for a 1,500 square foot MCS home between 1985 and 1987. Tacoma focus group participants noted, however, that they had seen little difference between the price of MCS homes and other homes they had considered. At first glance, this seemed to contradict the results presented in Lee et al. (1989). However, if the buyer were comparing the prices of new gas-heated and electrically heated MCS homes, the positive MCS premium would be offset by the negative value associated with electric heating (Lee et al. 1989, p. 4.21), resulting in a relatively small overall price difference.

With respect to the MCS and programs to promote increased energy-efficiency, the focus group participants from Tacoma indicated good name recognition for the Super Good Cents program, but no familiarity with the MCS. Awareness of the SGC in Spokane was considerably less. Tacoma participants associated program homes with energy-efficiency, quality construction, and quiet.

4.2 THE ROLE OF INCENTIVES

Incentives can be used to encourage the purchase of energy-efficient homes or homes using a particular fuel type. Because the MCS applies only to new electrically heated homes, incentives tied to the MCS interact indirectly with fuel choice in new homes. This study examined the effects of several incentive types and magnitudes.

Participants in the focus groups reacted positively to all incentive types except the one that would make it easier to qualify for the purchase of an energy-efficient home. Participants feared that this was a "credit card" approach that would allow unqualified buyers to become overextended financially. Direct rebates were considered very attractive and the fewer strings attached the better. The best received incentive was discounted interest rates on energy-efficient homes. The longer-term nature of this approach was a major factor in its appeal. Utility rate discounts were also considered to be attractive, in part because of their long-term role. Some participants were skeptical of this approach, however, because of a general distrust of utilities and a concern that the discounts might promote, rather than discourage, energy consumption.

For cash rebates, the consensus view from the focus groups was that the incentive would have to be around $1,000 to have a significant effect. The results from our conjoint analysis indicated that a $1,000 rebate would increase the market share of electrically heated MCS homes about 10 percentage points. For smaller rebates, the effect appeared to be, on the average, an increase in market shares a little under one percentage point per $100 of rebate.

Utility rate discounts also appeared to be effective ways to influence market shares. Focus group participants indicated that utility rate discounts amounting to monthly savings of at least $15 would be required to have much of an impact on their home purchase decisions. The conjoint analysis revealed a substantial effect of such rate discounts in all four counties. On the average, a $15/month rate discount was equivalent to about an $800 cash rebate.

4.3 MARKET SEGMENTATION AND MARKET SHARES

The behavior of different home buyers in the new home purchase decision depends on a number of characteristics of the potential buyers. The data collected in this study allowed us to identify groups of buyers who exhibited similar preferences and, to some extent, to relate those preferences back to buyer characteristics. Our analysis also produced estimates of market shares for different heating fuels under alternative conditions.

Two segments were identified in all four counties that were fairly comparable across the counties. In all counties, Group 1's members placed a very high importance on fuel type in their home purchase choice. This result appeared to be driven by a strong disposition against wood heat by this group's members. In all counties except Spokane, members of this group considered energy-efficiency to be relatively important compared with the second segment, Group 2. In all four counties, Group 1 was more likely to have no backup heating system. A smaller share of Group 1 members were first-time homeowners and a larger share were 55 years old or older.

Members of Group 2 in all four counties considered home size to be the most important factor in their purchase decision. This group also tended to have less of an aversion to wood heating and more frequently considered it to be their primary heating fuel. In all but King County, a larger proportion of the members of this segment were under 35 years old.

Besides identifying homeowner segments and their preferences, we noted important features of owner preferences and identified several owner characteristics that were correlated with preferences. Overall, as would be expected, the respondents preferred custom or semi-custom homes to tract homes. The conjoint analysis data showed that more floor area was preferred, but only up to a point. The value of additional floor area tended to peak around 2,000 square feet.

First-time home buyers appeared to be a distinct subgroup. Both the focus groups and conjoint analysis survey indicated that first-time buyers preferred electric heat over natural gas. Only about one-fifth of the first-time buyers purchased custom homes, whereas almost half the buyers who had bought two or more homes were currently living in custom-built homes.

Certain buyers appeared to be more likely to prefer electric heat. For example, older buyers tended to attach a significantly higher value to electric heating than did other buyers. Buyers who did not select their fuel, typically buyers of tract homes, predominantly had electric heat.

Older buyers in Pierce County valued a cash rebate a significant amount less than did other buyers. In Pierce and King counties, owners of tract

homes found a cash rebate significantly more valuable than did owners of other home types.

Our analysis of how the MCS and alternative incentives affect market shares for electric and gas heating provided preliminary insights into the interplay between the MCS, fuel type, and market shares. Indications from this analysis were that, by itself, requiring the MCS as the building code for only new electrically heated homes would increase the share of new homes bought that are electrically heated. This observation suggested that buyers 1) recognize the benefits of energy-efficiency, 2) factor higher first-costs and lower energy costs into their selection, and 3) believe that the energy cost savings more than compensate for the higher first-costs. The effect would be largest in the coldest location, Spokane, where the energy cost reductions would be the greatest.

Our results indicated that cash rebates tied to the MCS would increase market shares. The effect was approximately linear over the range of rebates examined. Rebates had the largest effect in Pierce County and the smallest in Spokane County. Over the range studied, each $100 increase in the rebate increased the market share of electrically heated MCS homes about one percentage point.

Utility rate rebates also appeared to have a substantial effect on market shares. The monthly rates of $15 to $20 we examined produced market share effects comparable to those produced by the cash rebate levels we considered. The relative effects varied considerably from one location to another, however.

Because these results have significant potential implications for program design, policies, and forecasting, they have to be considered very carefully. Because they draw on data from only four metropolitan areas, they have to be treated as preliminary and indicative. Methodologically, they are based on data from hypothetical decision situations faced by buyers, rather than empirical data documenting actual decisions. Nevertheless, the fairly good consistency between the estimated and actual market shares in all locations validates the estimates presented here.

4.4 IMPLICATIONS AND EXTENSIONS

This study was limited to only four geographic regions in a single state, Washington. Consequently, the findings should not be interpreted to apply to Bonneville's entire service territory. The fact that most results were consistent across the four counties, nevertheless, does support the validity and universality of the results. It is important, however, to extend the current analysis to other locations representing more of the region's population centers.

Most of the results of the conjoint analyses were consistent with expectations and common sense. Conjoint analysis appeared to produce reasonable results and its application should be extended to other regions and refined.

Additional demographic and characteristics data should be obtained in future applications of the technique. These additional data would help relate the findings back to particular population groups and identify relationships among household characteristics and the results.

The conjoint analyses results helped identify distinct market segments. MCS programs could benefit through reduced program costs and increased effectiveness by targeting particular market segments. The collection of additional household characteristics data would permit improved classification of market segments and the market segmentation could help Bonneville focus its program efforts.

One major finding of this study was the significant effect that the link between the MCS and electrical heat appeared to have on market shares. It appeared that buyers recognized the benefits of the MCS and more buyers would opt for a new electrically heated home, rather than a gas heated home, if the electrically heated home were built to higher energy-efficiency standards.

Rebates attached to MCS electrically heated homes appeared to increase the market shares of such homes, but not by a large amount in most cases. Utility rate discounts appeared to be an effective way to influence market shares also. Given these results and the generally favorable responses to such incentives by focus group participants, it might be worthwhile for

Bonneville and regional utilities to examine the option of using rate discounts rather than just standard rebates.

In summary, the response of the housing market to incentives is a major factor in MCS program design and costs. Further study is necessary in other locales and with different market shares analysis designs to enhance the reliability of the current results.

5.0 REFERENCES

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APPENDIX

CONJOINT ANALYSIS

APPENDIX

CONJOINT ANALYSIS

This appendix is a simplified overview of conjoint analysis issues and techniques. It explains what techniques were used for this study. For more detailed explanations of conjoint analysis, the reader is urged to consult the references provided.

This study uses conjoint analysis to address the issue of fuel choice in new homes. By analyzing the preferences of homeowners who have recently purchased new homes, this technique assesses the relative importance of the fuel choice as compared with other factors thought to influence the home purchase decision. Also, by comparing home profiles with different characteristics and using the estimated values of important factors, this technique provides insight into the effect of adopting the MCS as a building code.

Conjoint analysis is a method for analyzing and modeling the decision-making process. The term "conjoint analysis" came from the attempt to create interval level scales to measure human preferences. Interval level scales, such as scales used to measure time, weight, and length, allow for the arithmetic operations of adding, subtracting, multiplying, and dividing. While relatively easy to generate for physical quantities, interval scales measuring attitudes or preferences are difficult to construct. "The difficulty arises because we know what it means to say that we like potatoes better than rutabagas, but generally not what it means to say that our liking for potatoes over rutabagas is greater than our liking for artichokes over eggplant" (Huber 1987).

Behavioral scientists reasoned that while expressed preferences do not directly produce interval scales, certain choices had to be based on judgments of value for specific characteristics that do. For example, a person stating that he prefers a 25 cent blue pen over a 15 cent black pen implies that being able to use blue ink is worth at least 10 cents more to him. By putting together a number of such preference situations, it was demonstrated that it

is possible to derive values that underlie preferences that have some interval properties and are additive. Conjoint measurement provided a theory for creating a measurement scale from preference judgments on different decision alternatives (Huber 1987).

In choosing between two or more alternatives, decision-making research indicates that the decision-maker tends to focus on a small number of the salient characteristics of the alternatives, usually no more than five or six (Engel 1982). The most important of these salient characteristics is said to be deterministic. Theoretically, if a decision-maker chooses an alternative, she will choose the alternative that she perceives possesses the deterministic characteristics and the highest levels of the deterministic characteristics. The decision-maker also makes a social value judgment of how good it is for the alternatives to be so positioned on each characteristic (Louviere 1988). It is the combining of the various levels of these deterministic characteristics and the studying of the relative importance of these deterministic characteristics which conjoint analysis addresses.

COLLECTING CONJOINT MEASUREMENT DATA

Before discussing data collection methods, a quick explanation of terminology is needed. The deterministic characteristics of a decision alternative are called factors. The different amounts of these factors are called levels. A person's utility for a specific level is the value he places on that level. For example, consider the decision to purchase a car. Some of the factors involved in this decision may be the price, color, and engine size. The levels of these factors may be $10,000 and $15,000 for price; red and blue for color; and 2.0 liters and 3.0 liters for engine size.

In a conjoint task, respondents are asked to indicate their preferences for various combinations of levels of deterministic factors. There are many methods to obtain these preference data. In a full factorial design using pair-by-pair comparisons of the factors, the respondent is presented with every possible pair-by-pair comparison of all the levels of all the factors and asked which combination he most prefers, which combination he prefers second most and so on (see Figure A.1). In a full profile design, the respondent is presented with profiles including different levels of all

		COLOR	
		Red	Blue
ENGINE SIZE	2.0 L	Red, 2.0 L Rank: 3	Blue, 2.0 L Rank: 2
	3.0 L	Red, 3.0 L Rank: 1	Blue, 3.0 L Rank: 4

		PRICE	
		$10,000	$15,000
ENGINE SIZE	2.0 L	10 K, 2.0 L Rank: 4	15 K, 2.0 L Rank: 2
	3.0 L	10 K, 3.0 L Rank: 3	15 K, 3.0 L Rank: 1

		COLOR	
		Red	Blue
PRICE	$10,000	Red, 10 K Rank: 3	Blue, 10 K Rank: 1
	$15,000	Red, 15 K Rank: 2	Blue, 15 K Rank: 4

FIGURE A.1. Pair-by-Pair Comparison of Three Factors

factors and asked to express his preferences (see Figure A.2). In both these designs, if there are very many factors or levels within factors, the respondent will be asked to make quite a few comparisons.

When there is a large number of possible comparisons or profiles, a fractionated design is commonly used. The fractionated design is a sample of all possible comparisons or profiles. In the most basic fractionated designs, enough comparisons or profiles are selected to estimate just main effects and not interactions. In these basic designs, a respondent's preference for an alternative is a linearly additive expression of the factors involved and there is very little or no interaction between the factors. For example, a person's preference for a car can be expressed by adding the individual

	Engine	Color	Price	Preference Ranking
Profile 1	2.0	Red	$10,000	4
Profile 2	2.0	Blue	$10,000	7
Profile 3	2.0	Red	$15,000	2
Profile 4	2.0	Blue	$15,000	5
Profile 5	3.0	Red	$10,000	8
Profile 6	3.0	Blue	$10,000	3
Profile 7	3.0	Red	$15,000	1
Profile 8	3.0	Blue	$15,000	6

FIGURE A.2. Full Profile Comparison of Three Factors

utility values representing his preference for a specific engine size, color, and price. Also, the preference for a specific engine size is not dependent on a preference for color or price.

In full factorial or fractionated designs, respondents are asked to indicate their preferences by rating or ranking the comparisons or profiles. The original conjoint studies used ranking tasks (e.g., I prefer this alternative compared to that alternative) to derive interval level preference data. Rating scales (e.g., I rate this alternative an 8 on a scale where 1 represents no preference and 10 represents most preferred) are also used in conjoint studies and do not require as much effort from the respondent. A relatively recent development in conjoint designs is the discrete-choice response design (Louviere and Gaeth 1988). In this type of design the respondent is presented with several different sets of full profiles and asked to choose the preferred alternative from each set. For example, the respondent could be presented with Profile 1, Profile 4, and Profile 7 from Figure A.2 and asked to choose the profile representing the car he most preferred. The respondent would then be presented with a different set of three profiles and asked to choose the preferred profile. This process would

continue until all combinations of the profiles in sets of three had been presented.

Conjoint measurement has its theoretical roots in ranking tasks. The early conjoint practitioners were able to demonstrate the derivation of quasi-interval scales from ranked data. However, ranking tasks can be burdensome to the respondent, especially if a large number of comparisons is involved. In many situations, rating scales are just as reliable as ranking tasks and are less taxing on the respondent.

However, respondents tend to use rating scales in a relative way. Many respondents tend to avoid using the extremes of the scales and concentrate their answers near the middle, or vice versa. "The original reason to use rank-order inputs over quasi-metric ones stemmed from a legitimate uncertainty about what respondents meant in responding to, for instance, a ten-point strength of preference scale" (Huber 1987). The reliability of preference scales can be somewhat improved by anchoring the ends of the scale with extreme examples of alternatives.

By having the respondent choose a preferred alternative from a set of alternatives, the discrete-choice response designs may have greater external validity in purchase decisions than the ranking or rating tasks. Actual decisions are seldom made by rating or ranking a set of alternatives and then choosing one. Ranking and rating tasks do not directly study the process of primary interest, which is choice behavior.

ASSESSING THE RELIABILITY AND VALIDITY OF CONJOINT STUDIES

In discussing the different conjoint analysis techniques two important concepts must be considered. These are the concepts of reliability and validity.

Reliability is the extent to which any measuring procedure yields the same results on repeated trials. "The amount of chance error may be large or small, but it is universally present to some extent. Two sets of measurements of the same features of the same individuals will never exactly duplicate each other" (Stanely 1971, p. 356). Even though measures of social phenomena will never exactly duplicate each other, they do tend to be consistent. An

individual who has the highest measured preference for a red car will, on subsequent measures, also tend to have the highest preference level for red cars. The tendency towards this consistency for measures is what is meant by reliability (Carmines and Zeller 1979).

Measurement error comes from many different sources. These sources include the method of data collection, the definition of preference, the measurement scale for preference (ratings or rankings), the number of factors, and the estimation procedure for utility values, to mention a few. Two common measures of the group reliability of conjoint data involve the use of what are called "hold-out cards." In a fractionated, full profile conjoint design the respondents are asked to indicate their level of preference for more profiles than are actually needed to estimate their utility functions. A utility function for the sample is estimated from the responses to the necessary profiles. This group utility function is the addition of the averages across all the respondents of the utility values for each factor. This group utility function is used to predict how the individual respondents would rank (rate) the extra profiles. The correlation between the predicted ranks and the actual ranks of the extra profiles is a measure of the reliability of the conjoint design for the sample. The absolute difference between the respondents' ranks for the hold-out cards using the group utility function and their actual ranks is also a useful measure of reliability. By using the individual's utility functions, instead of the group utility function, to predict the rankings of the hold-out cards, a more accurate assessment of the consistency of an individual's responses is obtained.

Using the group utility function to predict the rank of the hold-out cards provides an estimate of the reliability of the results for the sample. Using individual utility functions to predict the rank of the hold-out cards tests the reliability of the data collection technique for the individuals.

Validity is the extent to which a measuring device measures what it intends to measure. "Validity concerns the crucial relationship between concept and indicator" (Carmines and Zeller 1979, p.12). A technique of measurement may be considered highly reliable by providing almost the same results on repeated measures, but if the technique is not measuring the

concept it is supposed to be measuring, then the technique is not a valid one to measure the particular concept.

The validity of conjoint results can be appraised by examining the methodology used to collect the data (content validity) and by assessing the predictive power of conjoint results. For an example of content validity, consider a math exam. Such a test would not have much content validity if it only covered addition, thus neglecting subtraction, multiplication, and division (Carmines and Zeller 1979). The present study would not be considered to have content validity if it did not take into account the many different factors affecting the decision to buy a home or if it did not reflect the possibility of choosing between different homes with different characteristics.

The predictive power of conjoint results can be assessed by concurrent validity, the correlation between a measure and the criterion at the same point in time, or by predictive validity, correlation of a future criterion and a relevant measure (Carmines and Zeller 1979). The concurrent validity of a conjoint analysis is more readily assessed than its predictive validity. For example, it is quicker to examine the correlation between the utility for red cars and the number of red cars the dealer has sold, than it is to examine the correlation between the utility for a new product and its market share three months from now.

Even though conjoint analysis has been used since the earlier 1970s, there needs to be more work done to provide adequate formal evidence to support the validity of conjoint analysis and reliability of its different techniques. However, "its heavy use for commercial applications suggests there is a great deal of confidence in the method" (Wittink and Walsh 1988).

ANALYZING CONJOINT DATA

The methods used to calculate utility values from conjoint data are numerous and depend on how the data were collected. In the first applications of conjoint analysis, data were analyzed by a number of non-metric techniques, such as MONANOVA (Kruskal 1965) or LINMAP (Srinivasan 1973), which permitted easy analysis of input data about which only ordinal properties could be

assumed. Non-metric techniques are used when the data reflect that one alternative is preferred over a second alternative, but just how much more the first alternative is preferred is not measured. The example presented earlier of comparing a person's preference for potatoes over rutabagas to their preference for artichokes over eggplant is an illustration.

Metric methods of analyzing conjoint data are preferred over non-metric routines because Ordinary Least Squares (OLS) methods can be used. Metric routines assume interval level data from which stronger interpretations of the data can be made. Quasi-metric data, such as conjoint data, have some interval properties that non-metric routines treat as noise, but metric routines are able to use. "Non-metric routines may be losing popularity simply because they do not appear to help predictions" (Huber 1987). The switch to metric routines is pragmatic since there are few theoretical reasons why metric routines should work better.

A strength of conjoint analysis is the ability to use the utility values to simulate choice behavior between hypothetical alternatives. Two theoretical models are commonly used. The more frequently used first choice model states that the alternative with the highest total utility will be chosen. For each respondent, the utility for each alternative in the simulation is calculated. The alternative with the highest utility is marked the "winner". The results are aggregated across the respondents to determine the results for the entire sample (Bretton-Clarke 1987).

The Bradley, Terry, and Luce (BTL) model is based on the concept that the greater a person's utility is for an alternative, the greater the probability is the person will choose that alternative. "According to this theory, the probability of choosing any given alternative is equal to the utility of that product divided by the sum of the utilities for each product in the simulated market" (Bretton-Clarke 1987). This model works well for special cases of conjoint analysis, but performs poorly in many other cases. For example, if a respondent prefers electrically heated homes, adding homes that were heated with other fuels would not affect the respondent's selection. However, according to this model, adding additional profiles from which to choose will continue to lower the probability of the respondent's choosing an electrically heated home. The probability of a respondent choosing a particular profile

can be lowered just by adding more profiles to the simulation. Market simulations using the BTL model that contain a large number of profiles will usually provide extremely conservative results.

ANSWERING THE QUESTIONS FOR THIS STUDY

For this study, respondents were asked to rank a set of 18 full profiles of new homes according to the likelihood of their purchasing the home if they were in the market for a new home. The basic design consisted of 16 profiles. Two profiles were added as hold-out cards to assess the reliability of the design. The data were collected through mail surveys.

Validity and practical issues were considered in the selection of this design. Recent buyers of new homes were chosen for the sample because it was felt that the purchase decision would still be relatively fresh in their minds. They would be able to remember what factors actually influenced their decisions. Comparing full profiles, instead of pairs of home characteristics, increased the external validity of the design. When purchasing a home, a person does not consider one or two characteristics in isolation of all other characteristics. Having the respondents rank full profiles more closely represented the actual decision process in purchasing a home. A discrete-choice response design was not used even though it may have improved the realism of the study. This method is a recent development in conjoint designs. Few comparisons have been made of discrete choices with the more widely accepted ranking and rating conjoint tasks. Also, according to Louviere (1988), discrete choice response designs have some major disadvantages:

1. It is very difficult to develop individual-level choice models because discrete choice responses do not contain as much statistical information as rating and/or ranking responses.

2. The statistical properties of discrete multi-variate statistical models are only asymptotic; thus, even if one can estimate the utility parameters of interest, one cannot test them with any statistical confidence.

3. Choice tasks are more difficult to design than full-profile conjoint tasks because one must design both the profiles and the choice sets into which to place them.

Ranking the profiles was chosen over a rating task because ranked tasks provide data that have more interval level properties than rating data. Theoretically speaking, ranked conjoint analysis data are superior to rated data. Also, the number of profiles the respondents were asked to rank was small, so the ranking task did not add much additional burden to the respondent's task. For these reasons, it was thought that the ranking of full profiles was more practical and would produce better results than other alternatives.

The selection of the factors and their levels is a crucial part of any conjoint analysis. Correct selection of these factors and their levels improves the content validity of the design. Making the levels of the factors location specific also aids in improving the content validity. The objective of the present study is to investigate the role of the fuel choice in buying new homes. Because of Bonneville's MCS programs, the role of energy efficiency in homes and the effect of incentives on new home purchases are important factors to consider. Also, to be able to estimate just main effects of these factors, the factors chosen should be independent of each other. For example, the comparison of profiles should not restrict a person's choice of a highly energy-efficient home to only electrically heated homes.

The focus groups were used to gather information on the factors that influence the buying of a new home and their relative importance. From the focus groups, a list of several factors was compiled (Table A.1). These factors were examined for dependence on each other and the final factors were selected. The levels of the selected factors were decided using information from the focus groups, input from realtors in the study areas, and information on Bonneville's present MCS programs.

A complete listing of all the factors influencing the home purchase decision was impossible. The focus groups indicated that the location, financing, price, amenities, and floor plan features were probably the most important factors. Extremely important factors such as location, availability of financing, type of financing, and the price range of the home were designed

TABLE A.1. Factors That Influence the Purchase of a Home

Factors Considered	Factors Selected
Floor plan Factors	Type of Home
Number of bedrooms	Custom-built
Number of baths	Semi-custom
Number of living areas	Tract
Square footage	Size of Home
Number of floors	Under 1,300 ft^2
Lot size	1,300 - 1,699 ft^2
Basement	1,700 - 2,099 ft^2
Garage	Over 2,100 ft^2
Price of Home	Heating Fuel Type
Heating Fuel	Electricity
Heating System	Natural gas
Level of Amenities	Wood
Type of Home	Energy Efficiency
(custom, tract, etc.)	Meets state building code
Location	Exceeds state building code
Financing	Cash Rebate Incentive
Style of Home	High rebate ($1,250 or $1,900)
(Tudor, Modern, etc.)	Medium rebate ($800 or $1,250)
Energy Efficiency of the Home	Small rebate ($400 or $600)
Incentives for Purchasing the Home	None
	Discount on Utility Rates Incentive
	Yes ($15 or $20 a month)
	No
	Levels in Home
	Single-level
	Multi-level

to be extraneous to the profiles. The respondents were asked to "keep in mind the factors and constraints that influenced their decision (e.g. price, financing, location) to purchase their present home." Factors which were highly dependent on each other (level of amenities, type of home, price of home) were represented by the factor which best represented the group of factors (type of home). The number of factors and levels chosen allowed for a manageable number of profiles for the respondents to rank, taking into consideration the use of a mail survey.

Ordinary Least Squares regression was used to analyze the utility values of the factors in the study (Bretton-Clark 1987). Depending on the type of the factor, three models were used to analyze the data: the part-worth model, the vector model, and the ideal point (quadratic) model. Categorical factors

are analyzed using the part-worth model. The part-worth model uses effects coding to create two-level dummy coded variables from the levels of the categorical variables. The vector model is used for quantitative variables which exhibit a linear relationship. In this model, dummy coded variables are not required and the levels of the factor are entered directly into the regression. The result is a vector which is multiplied by the level of the factor to estimate the utility value of that level. The ideal-point model is used for those variables where there is a strong curvilinear relation between the levels of a factor and the respondent's utility values for those levels. In other words, too much or too little of the feature decreases the respondents utility value for that feature. The result of this model is a vector and an ideal-point coefficient. The utility value for a specific level is the sum of two products; the product of the vector coefficient and the value of the level and the product of the square of the value of the level and the quadratic coefficient.

To simplify the discussion, the procedures used to select an appropriate model are discussed using the data from Spokane County, but the same procedures were used for all the study areas. The type of factor and the relationship between the levels of a factor were examined to decide an appropriate model. Categorical factors (nominal data) must be analyzed with the part-worth model. For this study the factors of home type, level of energy efficiency, the presence of an utility rate discount, and floors are categorical factors and were analyzed with the part-worth model.

The quantitative factors of home size and the amount of cash rebate were examined for the appropriateness of using the vector model or the ideal point model. The correlations and plots between the part-worth utility values and their corresponding factor levels were examined to determine if a linear or curvilinear relationship existed. Table A.2 shows these correlations.

There appears to be a curvilinear relationship between the levels of home size and the part-worth utility values associated with these levels. Although there is a strong negative relationship between the part-worth utility values for the smallest and largest home size (-0.703), small positive relationships exist between levels one and two, as well as levels three and four, indicating a curvilinear relationship. The correlations between the part-worth values

TABLE A.2. Correlations Between the Part-Worth Utility Values for the Levels of Home Size and Amount of Cash Rebate, Spokane County

Factor: Size of Home	Level 1	Level 2	Level 3	Level 4
Level 1: Under 1,300 ft^2	1.000			
Level 2: 1,300 - 1,699 ft^2	0.247	1.000		
Level 3: 1,700 - 2,099 ft^2	-0.664	-0.287	1.000	
Level 4: Over 2,100 ft^2	-0.703	-0.729	0.229	1.000

Factor: Amount of Cash Rebate	Level 1	Level 2	Level 3	Level 4
Level 1: No Cash Rebate	1.000			
Level 2: $600 Cash Rebate	-0.383	1.000		
Level 3: $1,250 Cash Rebate	-0.299	-0.254	1.000	
Level 4: $1,900 Cash Rebate	-0.281	-0.281	-0.413	1.000

for the levels of the cash rebate factor do not change signs between the different levels. These correlations indicate a negative linear relationship. The ideal point model is used to estimate the utility values for the size of home and the vector model is used to estimate the utility values for the amount of a cash rebate.

The profiles used in this study presented the home size as a range. A small home was under 1,300 ft^2, the next size home ranged from 1,300 ft^2 to under 1,700 ft^2, the next size ranged from 1,700 ft^2 to under 2,100 ft^2, and the largest home was over 2,100 ft^2. For the purpose of calculating the utility values for the size of home, 1,100 ft^2 was used for the small home size, 1,500 ft^2 for the next size, 1,900 ft^2 for the next size, and 2,300 ft^2 for the large home size.

The reliability of the conjoint design was tested using hold-out cards. As already stated, the basic design involved 16 full profiles. Two profiles were added as hold-out cards. The ranks of the two hold-out cards were predicted for each respondent using the group utility function and the respondents' individual utility functions calculated from the 16 basic design profiles. A correlation of 1.0 between the predicted ranks and the actual ranks means the hold-out cards were predicted perfectly. A correlation of 0.0 means the hold-out cards were not predicted by the utility function. The

absolute difference between the predicted ranks and the actual ranks is also reported in the main text.

Using the group utility function to predict the ranks of the hold-out cards is a measure of the reliability of the results for the entire group. The results in the text indicate that the respondents' individual utility functions predicted their rankings of the hold-out cards with a good degree of reliability.

The validity of the conjoint results is assessed by comparing the utility values for the factors with sources reflecting the actual preferences for the levels of the factors. For example, a check of the internal validity of this study is done by comparing the utility values for the levels of the heating fuel factor with the respondent's present heating fuel. Assuming that the respondent has his preferred heating fuel, his utility values for the specific fuel should be the highest. This same logic is used for comparing the utility values for the type of home with the respondents' reported type of home. The discussion in the text indicates that the results of the conjoint analysis agreed quite well with the data on the respondents, thus suggesting validity of the results.

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