EVALUATION REPORT

for the

# *MOBILE HOME NEW CONSTRUCTION PROGRAM*

in

Kentucky Power Company

Program Period: January 2003 - December 2004

Resource Planning & Economic Forecasting
Corporate Planning & Budgeting Department
American Electric Power

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# I. EXECUTIVE SUMMARY

This report summarizes the results of the process evaluation, load impact evaluation, and cost/benefit evaluation for the years 2003-2004 of Kentucky Power Company's (KPCo or Company) Residential Mobile Home New Construction Program (MHNC). The MHNC Program, initiated by the Kentucky DSM Collaborative, has been successfully implemented in the American Electric Power (AEP) Kentucky service area since 1996. This report presents the evaluation results for 2003 – 2004 while supporting the continuation of the program beyond 2005, and at the same time, proposing to discontinue the promotion of the 12 SEER high efficiency central air conditioning systems.

In the Kentucky Power service territory, approximately one third of all new construction consists of manufactured homes (commonly referred to as mobile homes or HUD code homes). Typically, new mobile homes have heating, ventilation, and air conditioning (HVAC) systems consisting of an electric central furnace and a central air conditioning unit (see Appendix A). Kentucky Power's Mobile Home New Construction Program was designed to investigate the energy impacts of alternative heating/cooling systems and improved envelope efficiency design and construction. The program was designed to investigate the marketing of new mobile homes in the KPCo service area, primarily focusing on the potential impact of the installation of high efficiency heat pumps in place of resistance heat and standard efficiency central air conditioning (AC) systems and of improved insulation levels in the building structure.

During the evaluation period (2003-2004), the Company continued the promotion of the program through mobile home dealerships with incentives paid to both the dealer and the customer who purchased a new mobile home with a high efficiency heat pump / air-conditioner and a Zone 3 insulation package. The customer / dealer incentive for the installation of a high efficiency heat pump / air-conditioner were $500/$50 and $125/$25 respectively. The program was implemented

through twenty (20) mobile home dealerships with 110 customers purchasing a high efficiency heat pump and 1 customer purchasing a high efficiency central air-conditioner in 2003 and 138 customers purchasing a high efficiency heat pump and 1 high efficiency central air-conditioner in 2004.

A follow-up survey conducted by MQA Research (MQA) during June 2002 to a randomly selected sample of MHNC program participants showed high levels of satisfaction among the participants with their new heat pumps, with the heat pump installer, and with the program rebate level. Approximately nine-out-of-ten of the program participants surveyed said they were "very satisfied" with all aspects of the program. The survey also indicated approximately twenty percent (17%) of freeriders participating in the program.

In the evaluation of the load impacts of the program, the load research data collected from the HVAC systems monitored during the first phase of the program, together with the participants' billing data, and installation information gathered from the 250 new mobile homes sold during 2003-2004 were used to estimate the program's total energy and demand impacts. The estimated load impacts, and the actual and anticipated program and participants' incremental costs are used to perform the cost/benefit evaluation for the program.

The results of 2003–2004 program evaluation showed the MHNC Program has significantly reduced participants' electric consumption and it was cost-effective based on the Total Resource Cost (TRC), Utility Cost (UC) and Participant (P) economic tests. The program's total annual energy savings was estimated at 1,903 MWh based on the 250 actual participants for 2003 and 2004 and 150 estimated participants for 2005 in the program. The MHNC program total net annual energy saving was estimated to be 1,580 MWh (including 10% Transmission and Distribution Loss Savings and estimated 17% of program freeriders.). The total net demand reduction was estimated to be 976 kW in Winter and 46.5 kW in Summer (including 11% Transmission and Distribution Loss Savings and 17% of freeriders.).

# II. TECHNOLOGY DESCRIPTION

Kentucky Power's Mobile Home New Construction Program was designed to investigate the energy impacts of alternative heating/cooling systems and improved envelope design and construction. The program was designed to investigate the marketing of new mobile homes in the KPCo service area, primarily focusing on the potential impact of the installation of high efficiency heat pumps in place of resistance heat and standard efficiency central air conditioning systems and of improved insulation levels in the building structure. Approximately one third of all the Company's residential electric space heating customers live in mobile homes. Furthermore, many of these mobile homes are heated and cooled by relatively inefficient HVAC systems. Significant efficiency gains in the HVAC systems can be obtained by installing high efficiency heat pumps or high efficiency central AC in new mobile homes when they are manufactured, along with upgrading the insulation levels which improve the home's envelope efficiency. These high efficiency measures provide optimum levels of cost-effective energy efficiency design and construction features for new mobile homes, which improve the energy performance, comfort, livability and affordability of new manufactured homes. Installing these measures after the mobile home has been constructed increases the costs significantly and results in a loss opportunity of marketing high efficiency in the mobile home industry.

Heat Pumps:

Heat pumps are the most energy efficient home heating and cooling technology available in today's market. The basic concept of a heat pump can be described as a mechanical device that pumps heat from a cooler to a warmer location. Even in cold temperatures, the outside air contains some level of heat that can be utilized. During the winter, heat is extracted from the outside air and is pumped into the dwelling. In the summer, the system is reversed and the heat is removed from the indoor air and delivered to the outside. Heat pumps include a supplemental resistance heater that

automatically provides additional heat when outdoor temperatures are too low for the heat pump to supply the total heating load.

Most of the significant energy savings from the heat pump are obtained during the heating season since it utilizes the heat that already exists in the air. The heat pump efficiency is determined by the seasonal energy efficiency ratio (SEER) for the summer and the heating seasonal performance factor (HSPF) for the winter. These are defined as follows:

$$\text{SEER} = \frac{\text{Total cooling provided during cooling season (BTU's)}}{\text{Total energy consumed by the system (Watt-hours)}}$$

$$\text{HSPF} = \frac{\text{Total heating provided during heating season (BTU's)}}{\text{Total energy consumed by the system (Watt-hours)}}$$

High Efficiency Central Air Conditioning:

The energy savings from high efficiency central AC are obtained during cooling season by upgrading central air conditioning from 10 SEER to 12 SEER.

Insulation Levels:

The transfer of heat flow between a home's structure and its outside environment can be retarded by increasing the insulation in the home's walls, ceiling and floor and other building components. The rate of heat transmitted through the home by air is measured by the term, coefficient of heat transmission, U, defined as follows:

U = air-to-air overall coefficient of heat transmission through the surface of building components such as walls, ceiling, floor, etc. (Btu/h x sq.ft. x F)

The U-value is directly related to the amount of heat loss and heat gain through the building and is used by manufacturers to rate the building's envelope efficiency. The smaller the U-value, the more efficient the building because it reflects a decrease in the rate of heat flow through the building components.

By increasing the insulation level in building components, the rate of heat transfer between the home's structure and outside environment decreases, thus increasing the building's envelope efficiency. This reflects a decrease in the rate of heat gain through the building in the summer and heat loss through the building in the winter. As a result, the building's HVAC system will not use as much electrical energy to maintain the comfort level of the home.

Mobile home manufacturers must meet U-value level requirements pertaining to various HUD Zone areas under the New Manufactured Housing Construction and Safety Standards. The HUD Zones, which pertain to geographical areas across the United States, specify a U-value zone maximum coefficient of heat transmission. The manufacturer must be able to design and construct the mobile home to meet zone requirements. There are three zones, with Zone 3 pertaining the highest envelope efficiency.

# III. PROGRAM DESCRIPTION

Program Overview:

The Mobile Home New Construction Program (MHNC) was designed to study the market for new mobile homes within the Kentucky Power service territory and to determine the energy implications of current design and installation practices. The MHNC Program, initiated by the Kentucky DSM Collaborative, has been successfully implemented in the KPCo service area since 1996. During the first phase of the program, (April 1996 through March 1997), HVAC system loads were monitored with load research meters on three new mobile homes of different HUD codes situated at the KPCo Coal Run service facility in Pikeville, Kentucky. These HUD code test site mobile homes differed from the other, either by the type of HVAC system or the building insulation levels or both. The normalized energy savings between two similar mobile homes equaled 310 kWh in the summer months, 4,376 kWh in the winter months, and 4,686 kWh annually. The savings reflect the result of the more efficient heat pump compared to the electric central furnace and the central air conditioner.

In the second phase of the program, during 1997 and 1998, Kentucky Power's Demand Side Management Collaborative promoted the program directly to mobile home dealerships operating within the KPCo service territory. A $50 promotional incentive was provided to participating dealerships for each mobile home sold with a high efficiency heat pump and an upgraded insulation package. In order to qualify for the incentive, aside from the Zone 3 insulation package, the efficiency rating of a split system heat pump had to be at a minimum of 11.0 SEER or 7.2 HSPF and for a package system heat pump, 10.0 SEER and 6.8 HSPF. A $500 incentive was provided to the buyer of the mobile home to offset the incremental costs of upgrading the home's insulation package and HVAC system. Mobile homes with Zone 3 insulation packages had the highest envelope efficiency, which included a high efficiency heat pump system and upgraded insulation levels. A

detailed evaluation report on the findings from the first period of program implementation ("Mobile Home New Construction Program Final Evaluation Report 1996-1998") was issued August, 1999.

During the three-year extension of the program between 2003-2005, the DSM Collaborative continued to promote the program through mobile home dealerships with incentives paid to both the dealer ($50) and the customer ($500) who purchased a new mobile homes with a high efficiency heat pump and a Zone 3 insulation package. The program was implemented through twenty mobile home dealerships with 110 customers purchasing a high efficiency heat pump during 2003 and 138 customers purchasing a high efficiency heat pump during 2004.

In view of a potential of loss opportunity in improving cooling energy efficiency in the mobile home new construction market, the DSM Collaborative added an incentive for installing a high efficiency AC measure in the MHNC program. Beginning January 1, 2003, the program paid $25 to the dealer and $125 to the customers who purchased a new mobile home with a high efficiency central AC equal to or exceeding 12 SEER. Participation levels for the high efficiency air-conditioning measure were well below anticipated levels. Only 2 customers purchased a high efficiency air-conditioning system during 2003-2004 evaluation period. Participating manufactured housing dealerships are not promoting the 12.0 SEER air-conditioning systems due to the increased cost.

The KPCo DSM Collaborative is requesting Kentucky Public Service Commission (KPSC or Commission) approval to discontinue this measure at the end of the 2005 calendar year due to lower than expected participation levels and the revised federal energy efficiency standards that are scheduled to go into effect on January 23, 2006.

On April 14, 2005, the Department of Energy's Office of Hearing and Appeals (OHA) granted Nordyne's application for exception relief from the 2006 13.0 SEER requirement for split system air-conditioners of the 3 to 5 ton capaciity. The OHA granted Nordyne's application, which

in effect would permit a 12 SEER air-conditioning system to be installed in HUD-Code homes until January 1, 2010. Only Nordyne 12.0 SEER air-conditioning systems will be allowed to be installed in HUD-Code homes. Since 70% of the manufactured housing dealers use Nordyne equipment, this exception eliminates any possibility of upgrading air-conditioning systems next year. Therefore, the DSM Collaborative is recommending the measure for high efficiency air-conditioning be discontinued effective January 1, 2006.

Rationale for Program:

A substantial percentage of new residential construction in the KPCo service territory consists of manufactured homes, also known as HUD code or mobile homes. The goal of the program is to determine the load impacts of various design and construction features of newly constructed mobile homes and alternative heating/cooling systems and the marketability of the new mobile home design.

Program Promotion:

The program participants were secured through direct-customer contact by participating mobile home dealerships during the 2003-2004 program evaluation. The Company was successful in achieving 250 participants by the end of second year of the three-year extension. Table 1 summarized the annual participation of the program.

**Table 1: Annual Participation**

| Year | Heat Pump | A/C | Total |
|---|---|---|---|
| 2003 | 110 | 1 | 111 |
| 2004 | 138 | 1 | 139 |
| | **248** | **2** | **250** |

Program Implementation:

The program was implemented through 20 participating mobile home dealerships (Exhibit 1). The dealers provided each potential buyer a brochure describing the program (Exhibit 2). The

dealers provided the Company with customer installation reports on a periodic basis (shown in Appendix B). The incentive payment for the dealer and the buyer was compiled from these reports.

# IV. DATA COLLECTION

The survey responses from the AEP 2000 Residential Customer Survey conducted in the summer of 2000 in the Kentucky Power service area were utilized to analyze the mobile home new construction market. The results of the AEP 2000 Residential Customer Survey served as a basis to define the potential market segments, and the future penetration and/or expansion of the program. The results from AEP 2000 Residential Customer Survey are presented in Appendix A. A follow-up survey of 50 randomly selected participants in the KPCo service area was conducted by MQA Research in June 2002. The follow-up survey was used to determine why customers chose to participate in the program and to provide information used to estimate freeriders among participants. The follow-up survey was also used to determine customer satisfaction with the performance of new heat pump operation, the service performed by the heat pump installer, and overall satisfaction with the rebate level of the program. The results from the follow-up survey are presented in Appendix B.

For all participants in the evaluation period (2003-2004), a data collection form was used to record information for each mobile home sold having a Zone 3 insulation package. The form was completed by the dealership which included information on the dealership, the home buyer, the home size and characteristics and description of the HVAC equipment contained in the mobile home. A copy of the form is included in Appendix C, along with the tabulation of some of the data collected. The dealership and customer information was used to track where the mobile homes were sold, the location where they were installed, the purchase and delivery date, and verification of the Zone 3 insulation package sold to qualify for the incentives. Detailed information on the home size and HVAC system in each mobile home sold was used to estimate the energy savings projected as a result of selling the high efficiency Zone 3 unit compared to a standard Zone 2 unit that is less efficient. This information was incorporated with the results of load data monitoring from the three test site mobile homes in the first phase of the program to develop the projected engineering

estimated energy savings and demand reduction for the 2003-2004 program participants. No new load research metering data on test sites were collected during the evaluation period of 2003-2004 However, energy consumption of participants after the date of heat pump installation was retrieved from the Company's billing history database. The post installation billing information, along with engineering estimated energy savings and weather data on heating and cooling degree days obtained from the National Oceanic and Atmospheric Administration, were used to develop the final estimates of the load impacts of the MHNC Program. Information collected in the follow-up survey served as a basis to estimate freeriders.

# V. PROCESS AND MARKET EVALUATION

Process:

The program's implementation during the first two years of the three-year extention period (2003-2004) consisted of securing program participants through direct-customer contact by twenty (20) participating mobile home dealerships (Exhibit 1). Potential buyers were provided a brochure (Exhibit 2) describing the program, which explained the incentives offered for purchasing a new mobile home with a high efficiency heat pump and upgraded insulation package which is a Zone 3 unit. The dealers provided the Company with customer installation reports (Appendix C) from which incentive payments were made to the dealers and customers. 250 customers participated in the program between the years of 2003-2004, and an estimate of 150 participants is expected for 2005.

Process Analysis

The process analysis of the MHNC Program utilized the installation data, recruitment tracking data, results from follow-up survey to evaluate the delivery mechanism, promotional effectiveness, and customer satisfaction.

Delivery Mechanism: Kentucky Power Company utilized the new mobile home dealers/salesman and the Company DSM program cooordinator to administer the program.

Promotional Effectiveness: Based on the follow-up survey, mobile (manufactured) home salesmen were the main source (56%) for the program awareness to the participants. Additionally, 26% of the participants indicated that they first became aware of the program through friends or relatives. Therefore, "word-of-mouth" was still an effective source of information on the MHNC Program.

Customer Satisfaction: As participants indicated in the follow-up survey, overall satisfaction with the MHNC Program was very high, with 70% of the respondents indicating that they are very satisfied with the rebate level provided by the program. Almost nine out of ten (86%) of the

respondents indicated that they were "very satisfied" with the performance of the high efficiency heat pump. When asked about the service provided by the heat pump installer, 74% of the participants indicated they were "very satisfied".

Market Analysis

In the analysis of the marketing of the MHNC Program, the product awareness, effectiveness of incentives, freeridership, market penetration and market potential were examined. Results from, the follow-up survey and AEP 2000 Residential Customer Survey were utilized to perform the market analysis.

Product Awareness: Customer's awareness of the product of a heat pump is very high. Based on the follow up survey, 84% of the participants had planned on purchasing and installing a high efficiency heat pump prior to participating in the program. However, the awareness of upgrading insulation is lower, only 52% of the participants planned on purchasing insulation for their new homes.

Effectiveness of Incentives: Customers participating in the program resulted from Kentucky Power Company's rebate of $500 offered toward the cost of a new heat pump and Zone 3 insulation. However, when participants were asked how likely would they have been to install a heat pump if there was not a rebate, about two-thirds (66%) said they are likely to install a heat pump without a rebate. Close to one-half (44%) said they are likely to purchase the upgraded insulation package without a rebate. In addition, almost all participants (90%) are either very satisfied (70%) or somewhat satisfied (20%) with the rebate level, indicating the incentive level is not a concern for program participation.

Freeridership: To identify the freeriders, which were customers who had planned to install a heat pump in the absence of this program, some cross tabulations of survey questions were necessary. It was assumed that a customer who had planned on purchasing and installing a high-

efficiency heat pump prior to participating in the MHNC Program and who was somewhat likely or very likely to install a heat pump without a rebate, and who had planned on purchasing insulation for the new home prior to participating the MHNC Program and who was somewhat likely or very likely to purchase the upgraded insulation package without a rebate, was a freerider in the program. Based on this assumption, 17% of participants were identified as freeriders in this program.

Market Potential: From the follow up survey, a majority of participants cited "to save money" or "to save energy" (32% and 24%, respectively) as the main reasons for participating in the MHNC Program and they also indicated high awareness of the heat pump and upgraded home insulation and a high satisfaction with the heat pump performance. Therefore, it was concluded that there is still a significant market potential for this program.

# VI. IMPACT EVALUATION

Findings:

Based on the first two-years of the three-year extension (2003-2004) of the MHNC Program with 250 participants, the net total annual energy savings was estimated to be 1,580 MWh (which includes 10% Transmission and Distribution loss savings and 17% of program freeriders). On average, each participant was estimated to experience an annual energy savings of approximately 4,758 kWh at the meter. The net total demand reduction was 976 kW in winter and 46.5 kW in summer (including 11% Transmission and Distribution loss savings and 17% of program freeriders). These impacts resulted from demand reductions per participant of 2.94 kW and 0.14 kW at the meter in winter and summer, respectively. Table 2 summaries the entire MHNC program load impacts.

**Table 2: Average Load Impacts for MHNC Program**

| | 2003 - 2004 MHNC Participants |
|---|---|
| **Annual Energy Savings/Participant** | 4,758 kWh |
| **Winter Demand Reduction/Participant** | 2.94 kW |
| **Summer Demand Reduction/Participant** | 0.14 kW |
| **Net Total Annual Energy Savings**(1) | 1,579,660 kWh |
| **Net Winter Demand Reduction**(2) | 976 kW |
| **Net Summer Demand Reduction**(2) | 46.5 kW |
| (1) Includes 10% Transmission and Distribution Loss Savings<br>(2) Includes 11% Transmission and Distribution Loss Savings | |

Energy Impact Analysis:

The energy savings estimate was calculated from an Statistical Adjusted Engineering (SAE) Model utilizing results of the load research data collected at the KPCo Coal Run service facility during the first phase of the program. The load research data was used to estimate the unknown heat losses and heat gains of the mobile homes tested at the KPCo Coal Run service facility and were applied to ASHRAE's (American Society of Heating, Refrigeration and Air-Conditioning Engineers) Heating and Cooling Degree Day Models to estimate the heating and cooling energy savings for the

participants in the 2003-2004 program evaluation period. The heat losses and heat gains are input variables for the Heating and Cooling Degree Day Models that reflect the thermal characterisitics of the mobile home. Additionally, the mobile home size, indoor and outdoor temperature differences, heating and cooling degree days and heating/cooling system efficiency are also inputs into the models. The ratio of mobile home size for program participants versus the mobile home size at the test facility was used to adjust the heat losses and heat gains accordingly to reflect the adjusted energy savings for the program participants between 2003 to 2004. Appendix D gives the details of the Energy Impact Analysis based on engineering estimates. The result of the analysis was input into a data base to calculate the average percentages of energy savings for each participant. The engineering estimates of energy savings for an average 2003-2004 participant from the heat loss/heat gain analysis are shown in Tables 3.

**Table 3: Average Energy Saving kWh/Participant Based on Engineering Estimate**

| | Electric Furnace / Central AC To High Efficiency Heat Pump 2003 - 2004 |
|---|---|
| Heating | 5,826 |
| Cooling | 167 |
| **Total** | **5,993** |

The engineering estimated energy savings were further refined by the actual participant's post-installed billing energy consumption. The post-installation monthly energy consumption of participants was retrieved from a billing history tape. The average annual post-installation heating and cooling seasonal billed usages were estimated and then weather-normalized to represent average normal weather conditions in the Kentucky region. Table 4 shows the normalized post-installation consumption for the cooling and heating seasons for an average participant.

The percentage of energy savings from the engineering analysis of the electric central furnace and standard efficiency air conditioning system versus the new heat pump system was

applied to the normalized consumption to arrive at an adjusted engineering estimate savings for each participant in the MHNC Program (see Table 4). The average total energy savings was 4,758 kWh of which 4,659 kWh was heating savings and 99 kWh was cooling savings.

**Table 4: Average Energy Consumption-Based on Post-Installation Billing Data**

| | High Efficiency Heat Pump / Zone 3 Insulation |
|---|---|
| **Average Billed Usage** | |
| Winter Month Total | 9,803 kWh |
| Summer Month Total | 5,300 kWh |
| **Annual Total** | 15,103 kWh |
| **Annual Percentage of Usage for Heating & Cooling** | |
| Heating | 39.4% |
| Cooling | 10.8% |
| **Seasonal Billed Usage** | |
| Heating | 5,957 kWh |
| Cooling | 1,623 kWh |
| **Weather Normalized Seasonal Billed Usage** | |
| Heating | 7,266 kWh |
| Cooling | 1,524 kWh |
| **% of Seasonal Energy Savings** | |
| Heating | 36.6% |
| Cooling | 7.7% |
| **Estimate of Seasonal Energy Savings** | |
| Heating | 4,659 kWh |
| Cooling | 99 kWh |
| **Total** | **4,758** kWh |

Demand Impact Analysis:

The demand reduction was estimated based on results of AEP internal studies that made a comparison of load characteristics between a high efficiency heat pump system and an electric central furnace and air conditioning system. These studies had incorporated information gathered from AEP system-wide heat pump end-use metering data, which also included data on KPCo customers. The seasonal demand reductions are estimated based on seasonal load factors derived from from the end-use load data, along with seasonal hours of use. This information was incorporated with the seasonal energy savings for the Mobile Home New Construction Program to determine the heating and cooling demand reductions. The results are summarized in Appendix E.

# VII. COST/BENEFIT EVALUATION

Results:

Cost/benefit analyses of DSM programs may be performed using either an historical basis or a prospective basis. From an historical basis, actual costs and load impacts for DSM programs participants during an historical period (such as the first year of a program) are utilized to assess the net benefits. The net benefits may be calculated over a 20-year period for the first year's participants. These are after-the-fact analyses which could be utilized to determine the cost-effectiveness of previous activity, but may not by representative of the future and therefore, should not be the basis for DSM program decision-making.

Cost/benefit analyses from a prospective basis anticipate future DSM program participation, costs and impacts. These analyses expand upon actual field experience (cost, impact, etc.) to estimate the net benefit from projected implementation in the future. The foundation of DSM program knowledge serves as a basis to estimate projected costs, impacts, etc. This is the real value of field experience: applying what has been learned to guide decisions on future DSM program implementation. Cost/benefit analyses were performed on the MHNC program with the existing measures of high efficiency heat pump, high efficiency air conditioning, and Zone 3 insulation.

The benefit/cost (B/C) ratios for the 2003 - 2004 Mobile Home New Construction Program are significantly higher than the benefit/cost ratios seen in previous program evaluations. The primary drivers for the increased B/C ratios were increased fuel costs and increased emission rates. A decrease in On Peak and Off Peak system sales utilization negatively affected the B/C ratios for the program.

The 2002 and 2005 input data files were examined and later compared to determine which files had significant impacts (greater than 0.1 impact) on the B/C ratios for the program. The files that consistently drove this magnitude of change were the marginal cost, emissions, and the system

sales files. For High Efficiency Heat Pump and Zone 3 Insulation, based on 2002 input files, the Total Resource Cost test results for marginal costs and emission costs improved 0.97 and 2.27 respectively. The Total Resource Cost test results for system sales utilization decreased 0.29. For High Efficiency Air Conditioning, based on 2002 input files, the Total Resource Cost test results for marginal costs and emission costs improved 0.33 and 3.44 respectively. The Total Resource Cost test results for system sales utilization decreased 0.13.

MHNC Program with High Efficiency Heat Pump and Zone 3 Insulation:

On a prospective basis, the Mobile Home New Construction Program was found to be cost effective based on the TRC, UC and Participant tests. However, the RIM test results which are highly significant in today's environment, are negative.

| B/C Ratio | Economic Test |
|---|---|
| | |
| 4.14 | Total Resource Test |
| 0.78 | Rate Impact Measure |
| 6.60 | Utility Cost |
| 2.37 | Participant |

Assumptions:

I. Program Costs (2003 $)

The cost/benefit analysis was performed using projected program costs based on the actual program costs realized in the second phase of the program but adjusted to exclude any one-time costs such as load research meters and contracted electrician costs. Based on the first two years of the three year extension (2003 –2004) with a total of 250 participants, the total Mobile Home New Construction Program costs were $140,124. This includes promotional/administrative, customer and dealer incentives, evaluation, and other miscellaneous costs. A breakdown of actual program costs for 2003-2004 are outlined in Table 5.

The costs for 2003 – 2004 are as follows:

**Table 5: Actual Program Costs**

| | 2003 - 2004 |
|---|---|
| Evaluation | $ 1,514 |
| Equipment/Vendor | $ 12,400 |
| Customer Incentives | $ 124,250 |
| Other | $ 1,960 |
| **Total Program Cost** | **$ 140,124** |

The anticipated program costs on per participant basis are shown in Table 6.

**Table 6: Anticipated Costs**

| Costs Used in Cost/Benefit Analysis | Per Participant |
|---|---|
| Promotional Costs (Dealer Incentive) | $ 50 |
| Customer Incentive | $ 500 |
| Evaluation Cost | $ 20 |
| **Total** | **$ 570** |

Additional measure/program characteristics based on the three-years of the program and assumed for the cost/benefit analysis are:

A. Life of a high efficiency heat pump assumed at 15-years, with no replacement

B. 17% Freeriders

C. Incentive Payments : $500 to the participant and $50 to the dealer

D. Average Incremental cost to the participant $ 1,012

E. Evaluation costs set at $20 per participant

F. Includes T&D loss savings of 10% for energy and 11% for demand

The assumed load impacts are described in Appendix E.

High Efficiency Air Conditioning Measure:

On a prospective basis, adding an incentive for high efficiency central AC in the Mobile Home New Construction Program was found to be cost effective based on the TRC, RIM, UC and Participant tests.

| B/C Ratio | Economic Test |
|---|---|
| | |
| 5.15 | Total Resource Test |
| 1.60 | Rate Impact Measure |
| 5.35 | Utility Cost |
| 1.69 | Participant |

Assumptions:

I. Program Costs (2003 $)

The total incremental cost to the participant of a high efficiency central AC (12 SEER) in place of standard efficiency central AC (10 SEER) is estimated to be $175 based on a survey of HVAC dealers. During the program duration between 2003-2004, there were a total of 2 participants for this measure. The anticipated program costs on per participant basis are shown in Table 7.

**Table 7: Anticipated Costs**

| Costs Used in Cost/Benefit Analysis | Per Participant |
|---|---|
| Promotional Costs (Dealer Incentive) | $ 25 |
| Customer Incentive | $ 125 |
| Evaluation Cost | $ 20 |
| **Total** | **$ 170** |

Additional measure/program characteristics based on the three-years of the program and assumed for the cost/benefit analysis are:

A. Life of a Central AC assumed at 15-years, with no replacement

B. 25% Freeriders

C. Incentive Payments : $125 to the participant and $25 to the dealer

D. Average Incremental cost to the participant $175

E. Evaluation costs set at $20 per participant

F. Includes T&D loss savings of 10% for energy and 11% for demand

The assumed load impacts are described in Appendix D.

## *Exhibit 1: Participating Mobile Home Dealerships*

*Exhibit 1*

Participating Mobile Home Dealerships

Mobile Home New Construction Program – Manufactured Housing Dealers

Grayson Mobile Homes
P.O. Box 8
Grayson, KY 41144

The Home Show
RR7 Box 23580
Lousia, KY 41230

Lakeside Homes
42 Jerrs Dr.
Jackson, KY 41339

White Hall Mobile Homes, Inc.
P.O. Box 274
Banner, KY 41603

The Home Show
P.O. Box 897
Belfry, KY 41514

Glenn's Finer Homes
615 Kentucky Ave.
Norton, VA 24273

Watt's Mobile Homes
917 Morton Blvd.
Hazard, KY 41702

Jerry Adkins Mobile Homes
2741 US 23 South
Pikeville, KY 41501

Clayton Homes
State Route 1947
Grayson, KY 41143

White Hall Mobile Homes
171 Citizens Lane
Hazard, KY 41701

The Home Show
13135 St. Rt. 180
Ashland, KY 41102

Dream Homes
580 C. W. Stevens Blvd.
Grayson, KY 41144

Oakwood Homes
530 HWY 1947
Grayson, KY 41144

Fleetwood Homes
P.O. Box 1327
Louisa, KY 41230

Rainbow Homes
HWY 321
Paintsville, KY 41240

LUV Homes
8499 US 23
Ivel, KY 41642

Hylton Homes
P.O. Box 170
Ivel, KY 41642

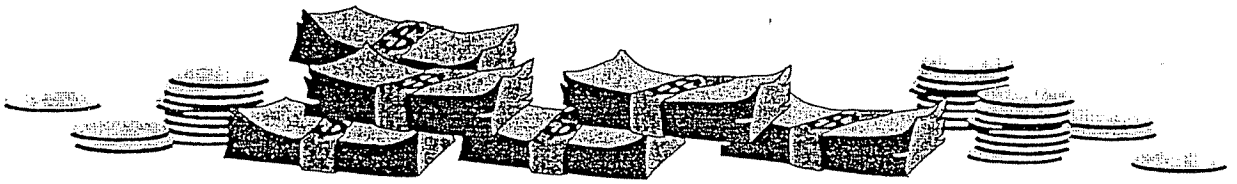
Edgewood Mobile Homes
P.O. Box 360
Hazard, KY 41701

Best Buy Homes
2939 North Mayo Trail
Pikeville, KY 41502

Glenn's Finer Homes
P.O. Box 307
Pound, VA 24279

***Exhibit 2: Program Brochure***

# Purchase a New Mobile Home . . . . equipped with an Electric Heat Pump Receive $500* . . . from American Electric Power



You can receive a $500 Rebate from AEP when you order a New Mobile Home with an High Efficiency Heat Pump and an upgraded Insulation Package

OR

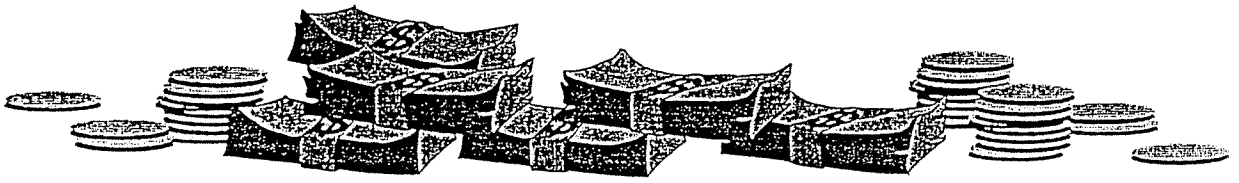
Purchase a mobile home with an upgrade Insulation Package and have the dealer install a High Efficiency Heat Pump

The Electric Heat Pump provided Heating & Cooling in one system, while saving up to 46% over an electric furnace **

To Qualify Efficiency Rating Must be:
Split System 11.0 SEER or 7.2 HSPF
Package System 10.0 SEER and 6.8 HSPF

* For Residential Services Only

** Savings based on Study conducted over 1 year, comparing various heating systems and insulation packages. Study conducted by AEP is on file with the Public Serice Commission and copies of study are available upon request.



## For more information call
## Don Music
## 1-800-572-1113

# Appendix A: AEP 2000 Residential Customer Survey Results

## Kentucky Mobile Home New Construction Market Characteristics

*Appendix A*

Kentucky Power Company

Kentucky Mobile Home New Construction Market Characteristics

Based on AEP 2000 Residential Customer Survey

Market Size & Penetration of Electric Heat Pump

Market Size

| Percent of Mobile Home | |
|---|---|
| <= 2-Years Old | 7.5% (2,980 Customers) |

Penetration of Heat Pump in Mobile Home New Construction Market

| | |
|---|---|
| Electric Heat Pump | 28.7% |
| Electric Central Furnace & Central AC | 47.3 % |
| Electric Central Furnace & Window AC | 0 % |
| Electric Central Furnace & No AC | 0 % |
| Non-Electric Central Furnace & Central AC | 10.5 % |
| Other | 13.5 % |

*Appendix A*

Kentucky Power Company
Kentucky Mobile Home New Construction Market Characteristics
Based on AEP 2000 Residential Customer Survey

Market Characteristics:

| Location of Home | |
|---|---|
| City or Urban | 4.7% |
| Suburban | 17.2% |
| Town or Village | 4.6% |
| Rural Non-Farm | 66.8% |
| Farm | 6.6% |

| Size of Home | |
|---|---|
| Under 1200 sq. ft. | 30.8% |
| 1201 - 2000 sq. ft. | 37.4% |
| 2001 - 3000 sq. ft. | 20.8% |
| Over 3000 sq. ft. | 0.0% |
| Do Not Know | 11.0% |

| Education Level | |
|---|---|
| <= Grade School | 27.4% |
| Some High School | 17.2% |
| Completed High School | 22.1% |
| Some College or Technical College | 20.0% |
| Completed College | 13.4% |

*Appendix A*

Kentucky Power Company
Kentucky Mobile Home New Construction Market Characteristics
Based on AEP 2000 Residential Customer Survey

Market Characteristics

Income Level

| | | |
|---|---|---|
| Under $20,000 | 41.8% | |
| $20,001 - $30,000 | | 6.4% |
| $30,001 - $40,000 | | 16.4% |
| $40,001 - $50,000 | | 0% |
| $50,001 - $60,000 | | 19.0% |
| $60,001 - $70,000 | | 16.4% |
| $70,001 - $80,000 | | 0 % |
| Over $80,000 | | 0% |

Natural Gas Available

| | | |
|---|---|---|
| Yes | | 29.2% |
| No | | 45.7% |
| Do Not Know | 25.1% | |

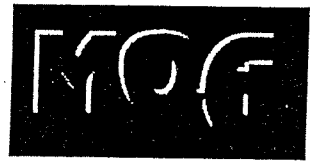
# Appendix B: Customer Follow-Up Survey Questionnaire And Results

Kentucky Power

# Mobile Home New Construction Customer Survey

June 2002

Conducted by:

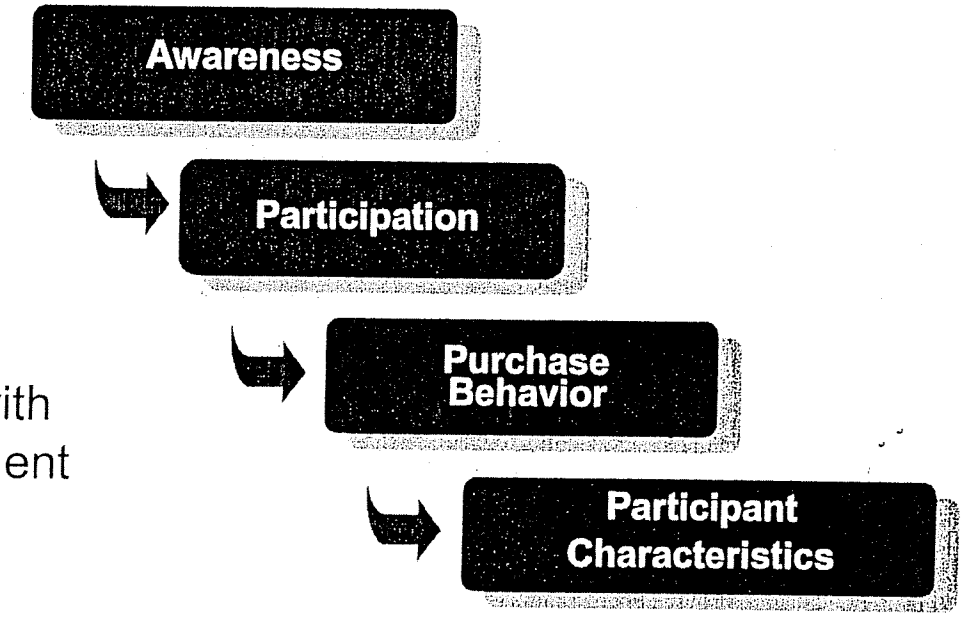


# Contents

# Introduction

## *Research Objectives*

- To gauge program awareness.
- To understand reasons for participation in the mobile home new construction program.
- To measure customer satisfaction with equipment performance, the equipment installer, and the rebate level.
- To measure Freerider effects.



# Introduction

*Methodology*

- Telephone interviews were conducted with 50 participants in the Mobile Home New Construction Program.
- Respondents were randomly recruited for participation in the study.
- The questionnaire was pre-tested for accuracy on May 22, 2002.
- Interviews were conducted May 28 through June 3, 2002.
- Interviews were conducted by MQA Research, Inc.

# Introduction

## *Representative Nature of Results*

- Respondents were randomly recruited for participation of the study. Interviews were attempted on various days and at a variety of times in order to reach respondents at convenient times and maximize use of the sample.

- Based on information provided by Kentucky Power, survey respondents are representative of the overall population. A comparison of respondent characteristics to the population is outlined below:

| AREA | Population | Sample |
|---|---|---|
| 11 | 56% | 58% |
| 12 | 19% | 10% |
| 13 | 5% | 8% |
| 14 | 1% | 4% |
| 15 | 8% | 12% |
| 16 | 10% | 6% |

| TAR | Population | Sample |
|---|---|---|
| 15 | 31% | 24% |
| 22 | 69% | 74% |

N.B. Percentages in tables do not sum to 100% as some participants were not identified by AREA or TAR.

# Awareness and Participation

# Key Findings

Awareness

- Nearly three of every five participants (56%) in the new construction program indicated that they first became aware of the program through a mobile home salesman.

- Approximately one in four participants (26%) learned about the new construction program through a friend or word of mouth.

- The remaining participants learned about the new construction program through ads (4%) and one participant (2%) reported being aware because of owning a heat pump in a previous home.

- One in ten participants (12%) had no recollection of when they first became aware of the program.

# Key Findings



Participation

- Multiple answers were accepted by participants as to the reason for participating in the new construction program. Among the reasons frequently mentioned were items relating to cost. This includes one in three participants (34%) who chose the new construction program to save money, and nearly two of every ten participants (16%) who chose the program to receive a rebate. Additionally, just over one in ten participants (14%) reported that they participated in the program because it was a good deal.

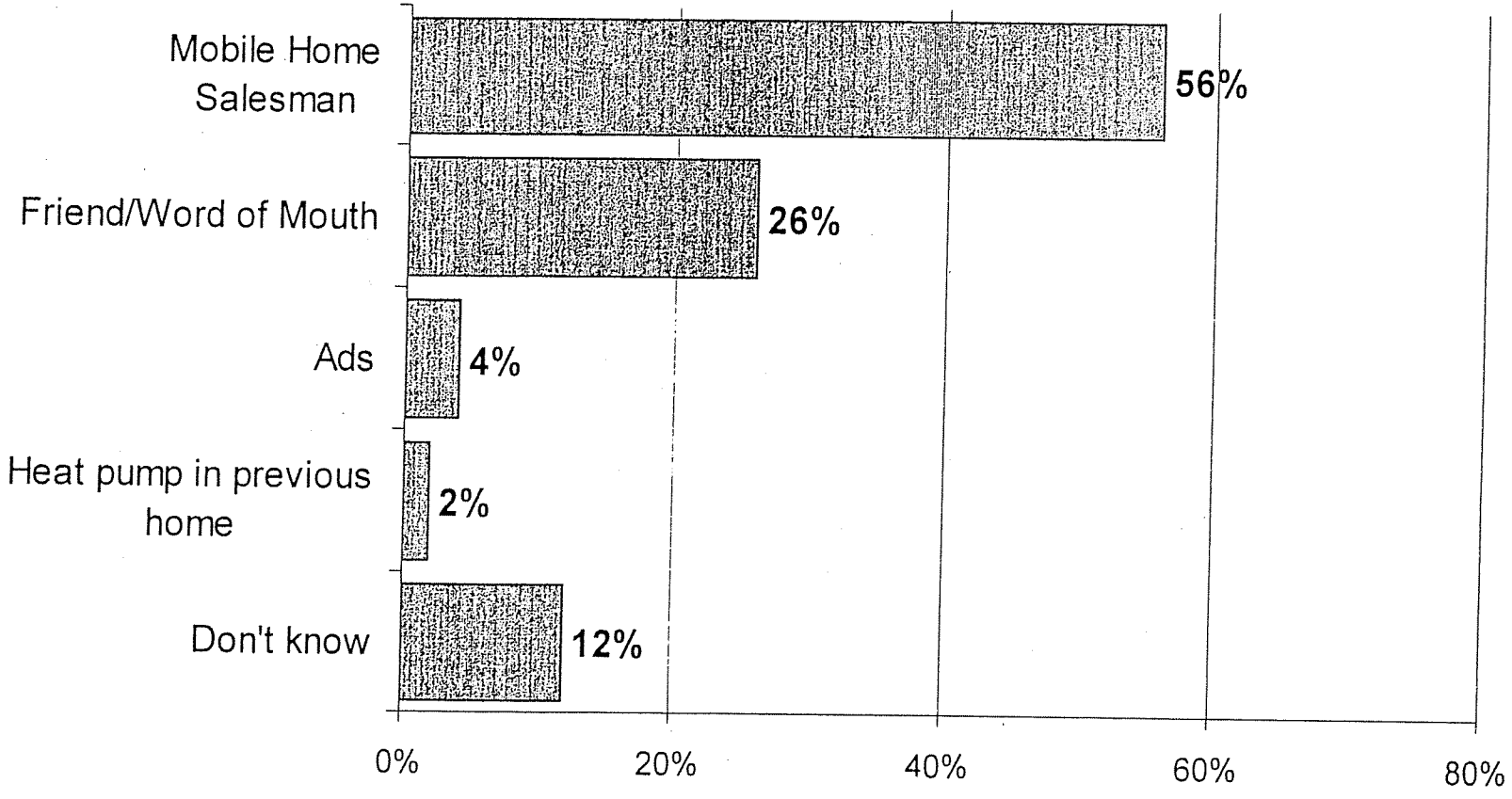
- Approximately one out of four participants (24%) believe in saving energy and reported participating in the program for this reason.

- Nearly one of every five participants (18%) indicated they participated because the rebate program came with their construction package.

- One participant (2%) participated in the new construction program simply for the comfort of owning a heat pump, based upon prior experience.

# How Became Aware Of New Construction Program

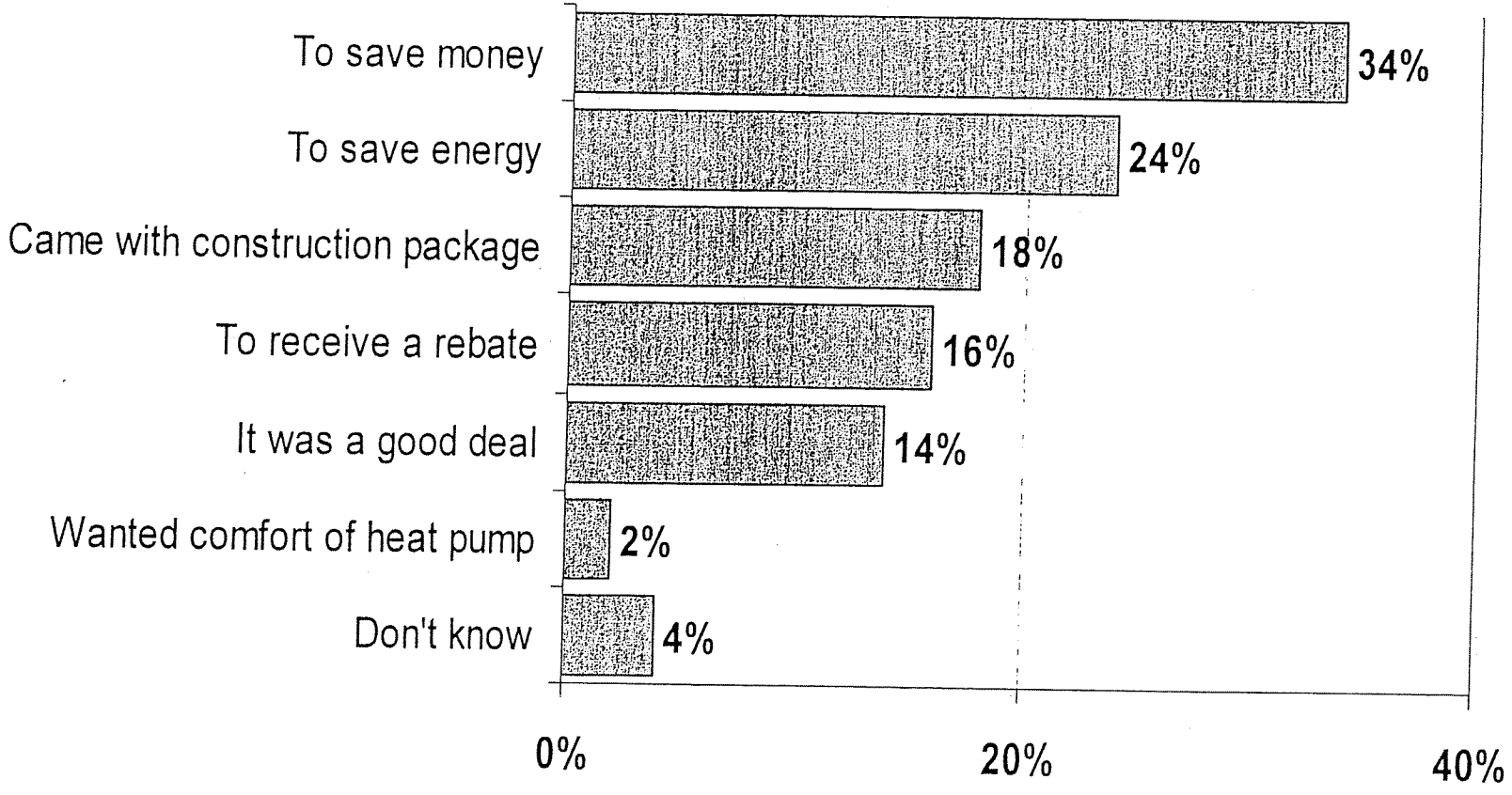
(Q1. How did you first become aware of the mobile home new construction program?)




(n = 50)

# Main Reason For Participation In New Construction Program

(Q2. What was the main reason why you participated in the mobile home new construction program?)




(Note: Multiple responses allowed)

(n = 50)

# Purchase Information

# Key Findings



Dealer Comparison

- Two of every ten participants (22%) reported that the sales representative who sold them their mobile home offered a comparison between the high efficiency heat pump and a standard efficiency heat pump or other unit. Nearly seven of ten participants (66%), however, reported that no comparison was made – the sales representative only discussed the high efficiency heat pump.

Personal Comparison

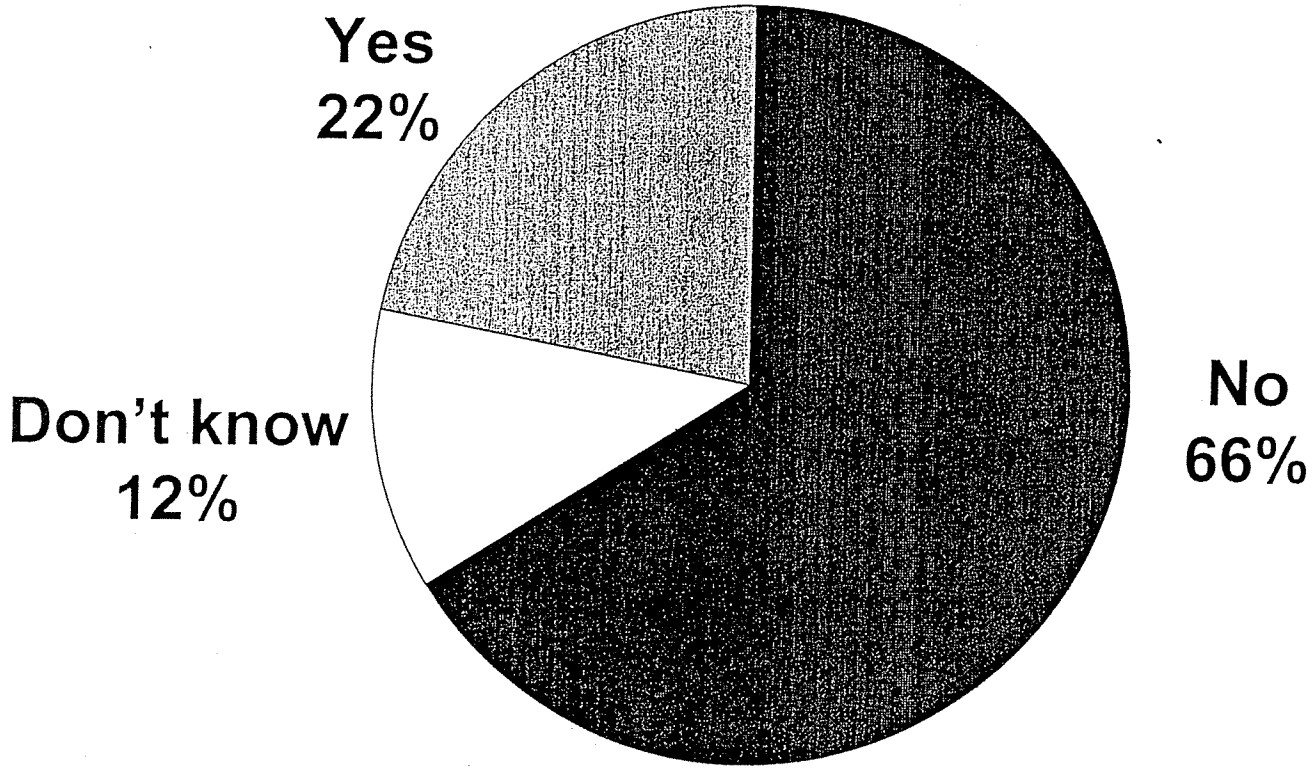
- Nearly seven of every ten participants who reported that the sales representative did not offer any comparison suggested that they collected information on their own that allowed for a comparison between the high efficiency heat pump and another unit.

Dealer Influence

- All of the participants (10 in total) who reported that the sales representative did not offer a comparison and they did not seek a comparison on their own also reported that they purchased a high efficiency heat pump solely because it was included in the mobile home package that they purchased.

# Dealer Comparison – Heat Pump

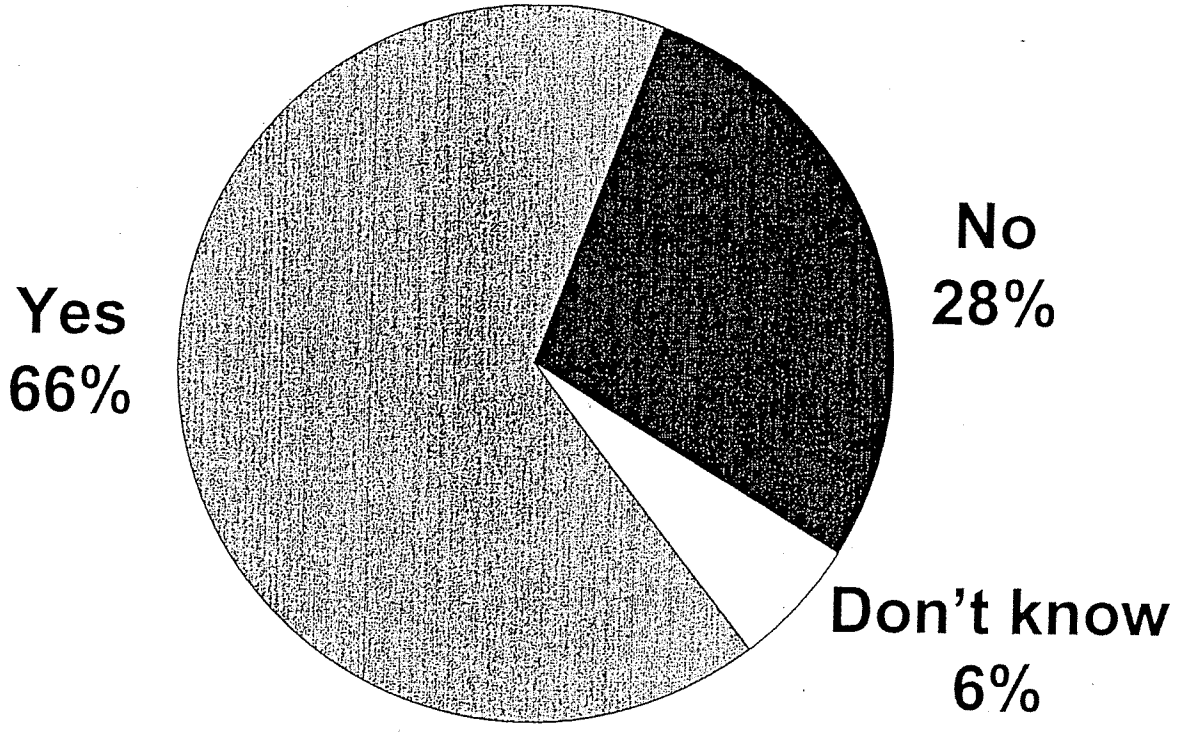
(Q4. Did the sales representative who sold you your heat pump explain to you the difference between purchasing a high efficiency heat pump versus purchasing a standard efficiency heat pump or another heating and cooling unit?)




(n = 41)

# Personal Comparison – Heat Pump

(Q5. Did you already know about the heat pump or did you find information about the cost and operational differences between a high efficiency heat pump and a standard efficiency heat pump or other unit?)




(Question asked of participants who did not receive a comparison from the sales rep) (n = 32)

# Key Findings

Dealer Comparison

- Three of every ten participants (32%) reported that the sales representative who sold them their mobile home explained the need to upgrade to Zone 3 insulation because they were installing a high efficiency heat pump. Nearly six of ten participants (56%), however, reported that the sales representative did not discuss Zone 3 insulation.

Personal Comparison

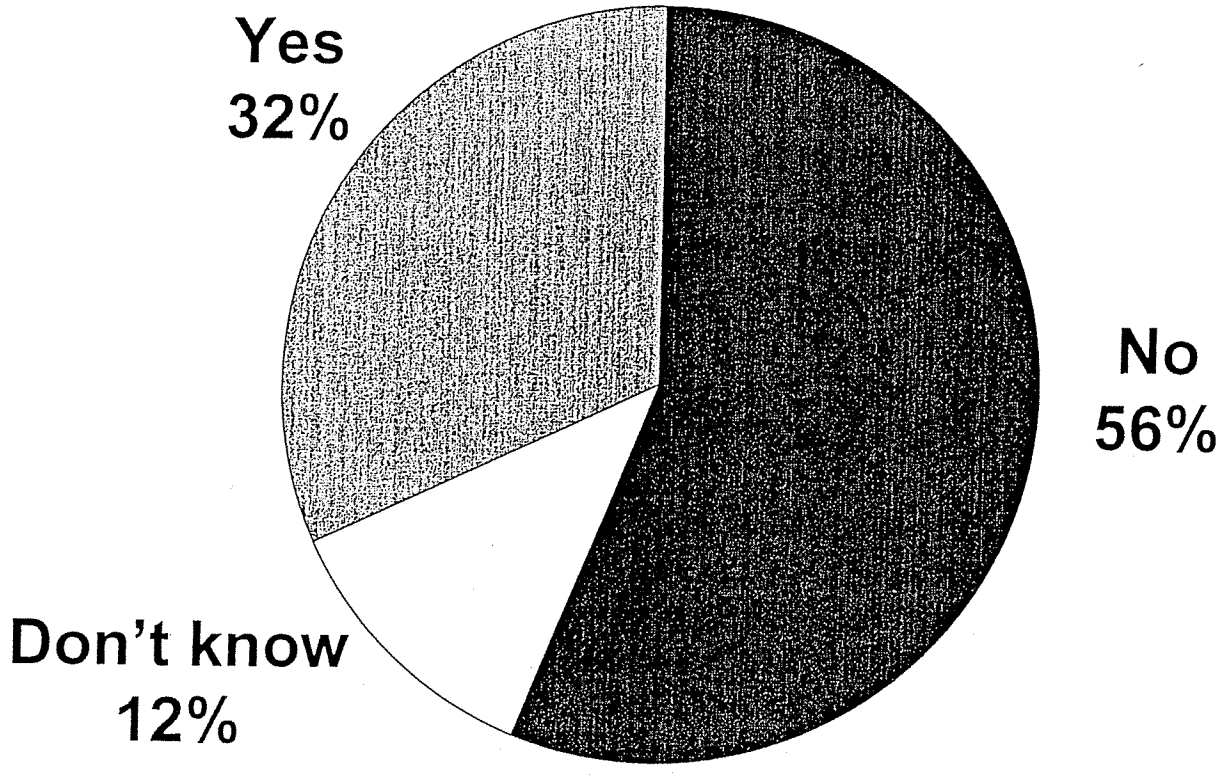
- Approximately two of every ten participants (18%) who reported that the sales representative did not discuss Zone 3 insulation suggested that they were already aware of the need to upgrade to Zone 3 insulation. Approximately eight in ten (78%), however, knew nothing about Zone 3 insulation.

Dealer Influence

- All of the participants (23 in total) who reported that the sales representative did not discuss Zone 3 insulation and they had no knowledge of the need to upgrade also reported that they upgraded their insulation solely because it was included in the mobile home package that they purchased.

# Dealer Comparison – Insulation

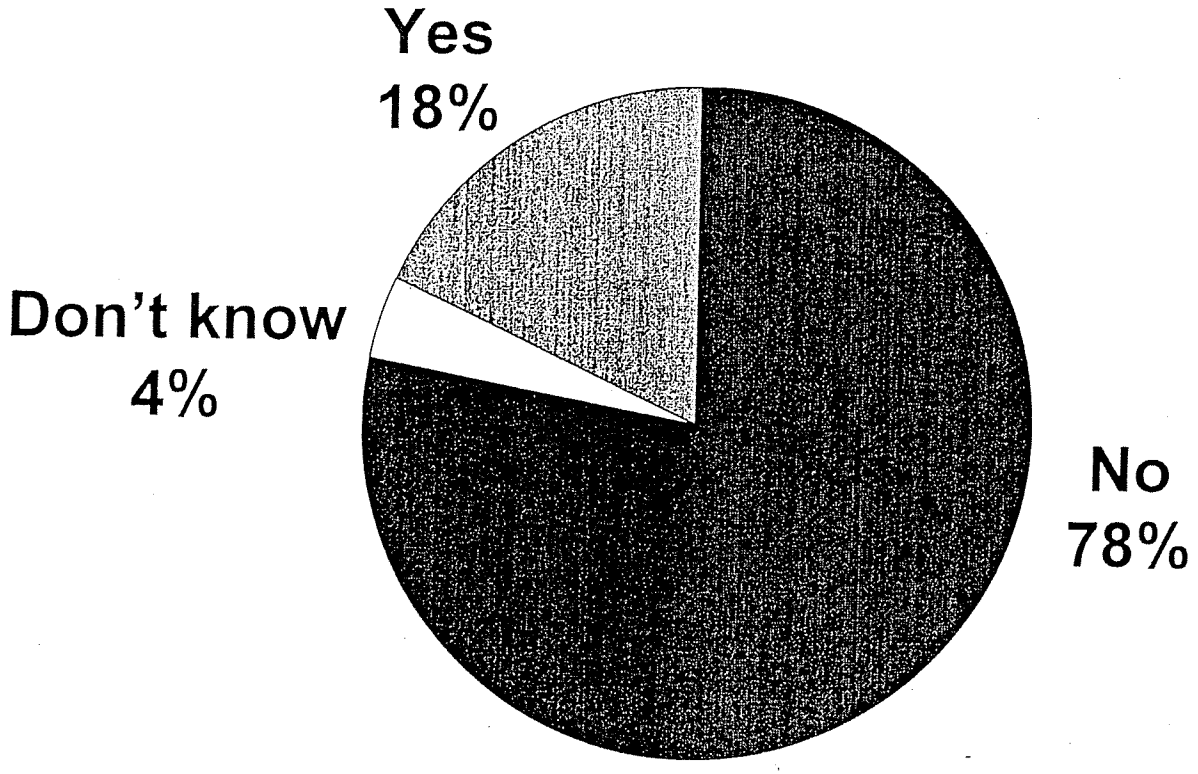
(Q8. Did the sales rep who sold you your heat pump explain to you the need to upgrade your insulation because you were installing a high efficiency heat pump, or did the sales rep not say anything about the need to upgrade your insulation?)




(n = 41)

# Personal Comparison – Insulation

(Q9. Did you already know about the need to upgrade your insulation, or were you not aware that you would need to upgrade the insulation in your new home?)




(Question asked of participants who did not receive a comparison from the sales rep) (n = 28)

# Purchase Behavior

# Key Findings



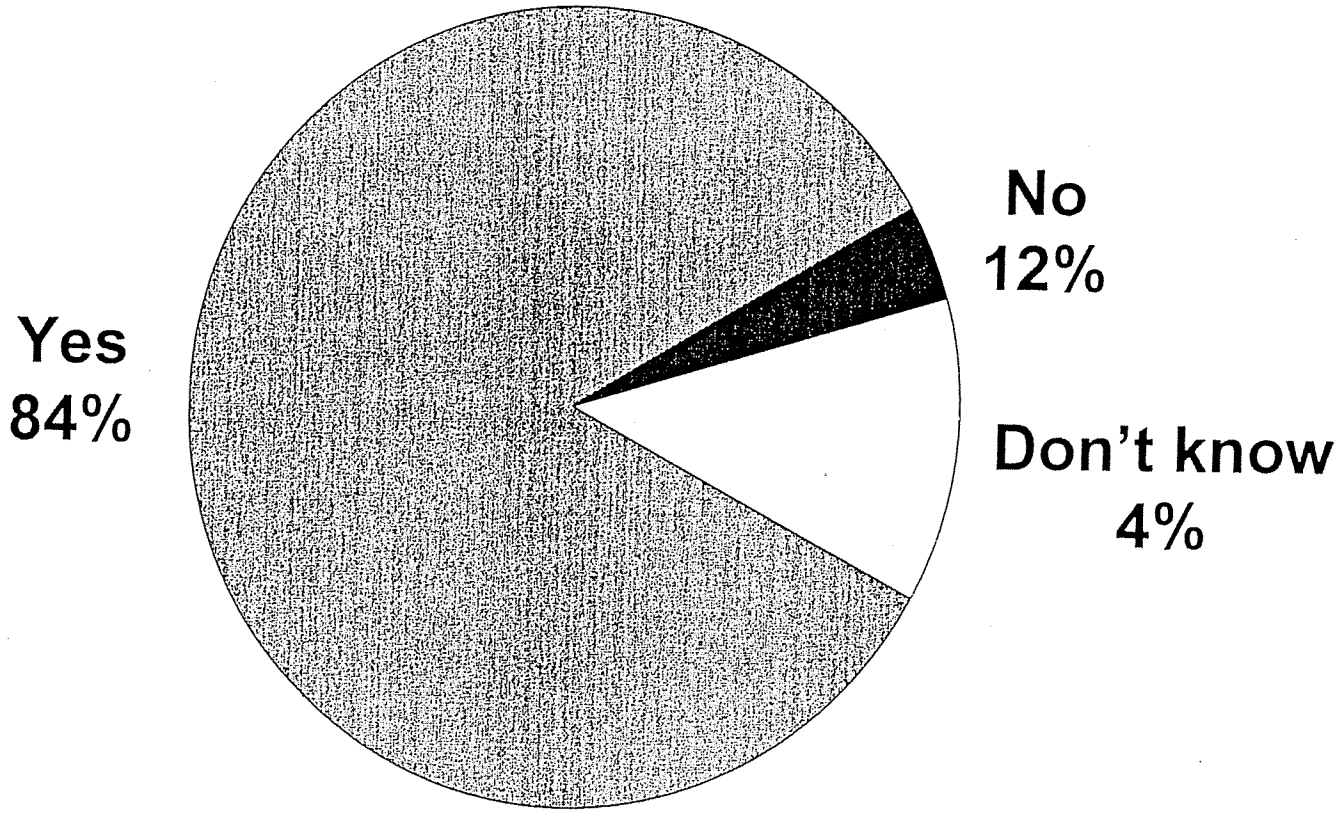
Purchase Plans

- Just over eight in ten participants (84%) in the mobile home new construction program suggested that they planned on purchasing a heat pump even prior to participating in the program. Approximately one participant in every ten (12%) had not planned on a heat pump prior to participating in the program.

- One-half of participants (52%) reported that they planned on purchasing Zone 3 insulation for their new home prior to participating in the new construction program. Nearly two out of every five (38%) had not planned on purchasing insulation prior to participating in the program.

# Planned On Purchasing High Efficiency Heat Pump In New Home

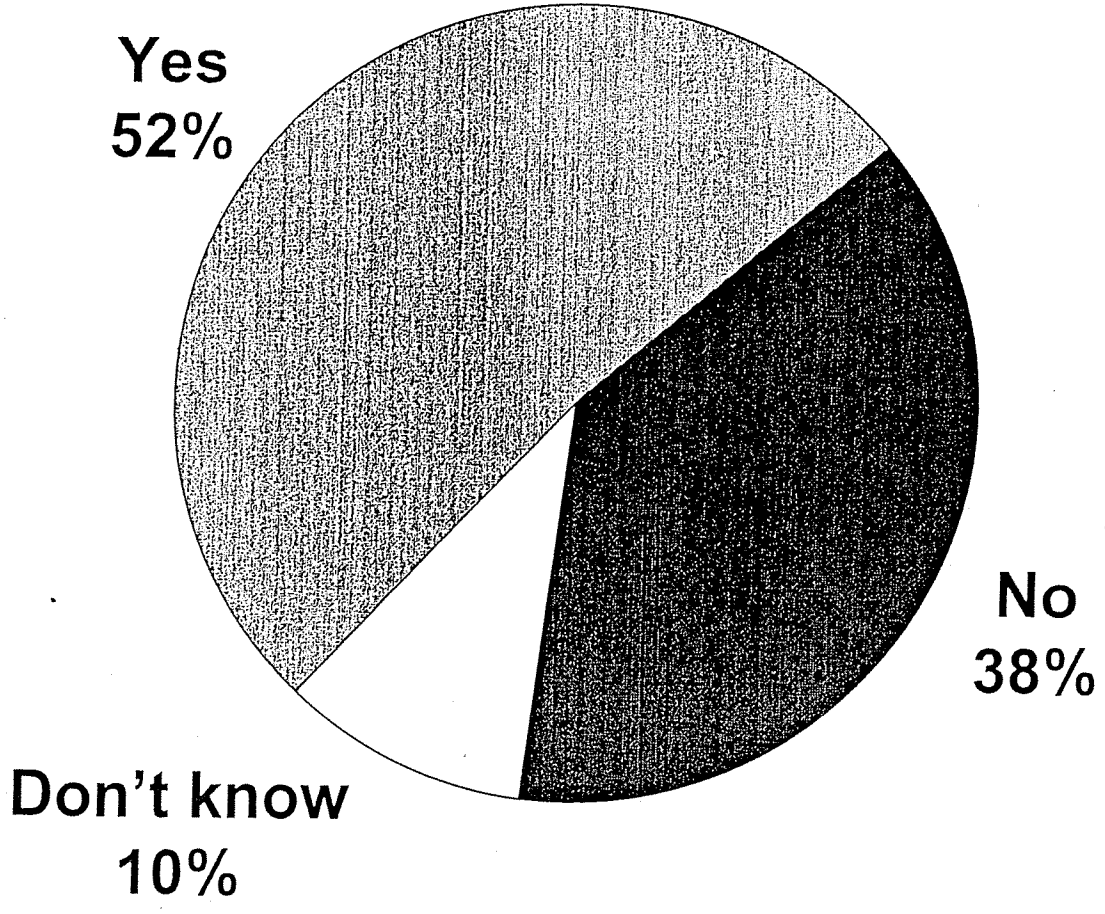
(Q3. Prior to participating in the mobile home new construction program, had you planned on purchasing a high efficiency heat pump in your new home?)




(n = 50)

# Planned On Purchasing Insulation For New Home

(Q7. Prior to participating in the mobile home new construction program, had you planned on purchasing upgraded insulation for your new home?)




(n = 50)

# Key Findings

Purchase Intent – Heat Pump

- Nearly seven out of ten participants (66%) in the mobile home new construction program reported that they were likely to purchase a high efficiency heat pump even if there was no rebate, including just over one in three (37%) who reported being very likely.

- One in ten participants (10%) reported that they were not likely to purchase the high efficiency heat pump without the rebate. Moreover, one in four (24%) were not likely in that they reported being neither likely nor not likely since the high efficiency heat pump was included with the overall package that they purchased for a mobile home new construction.

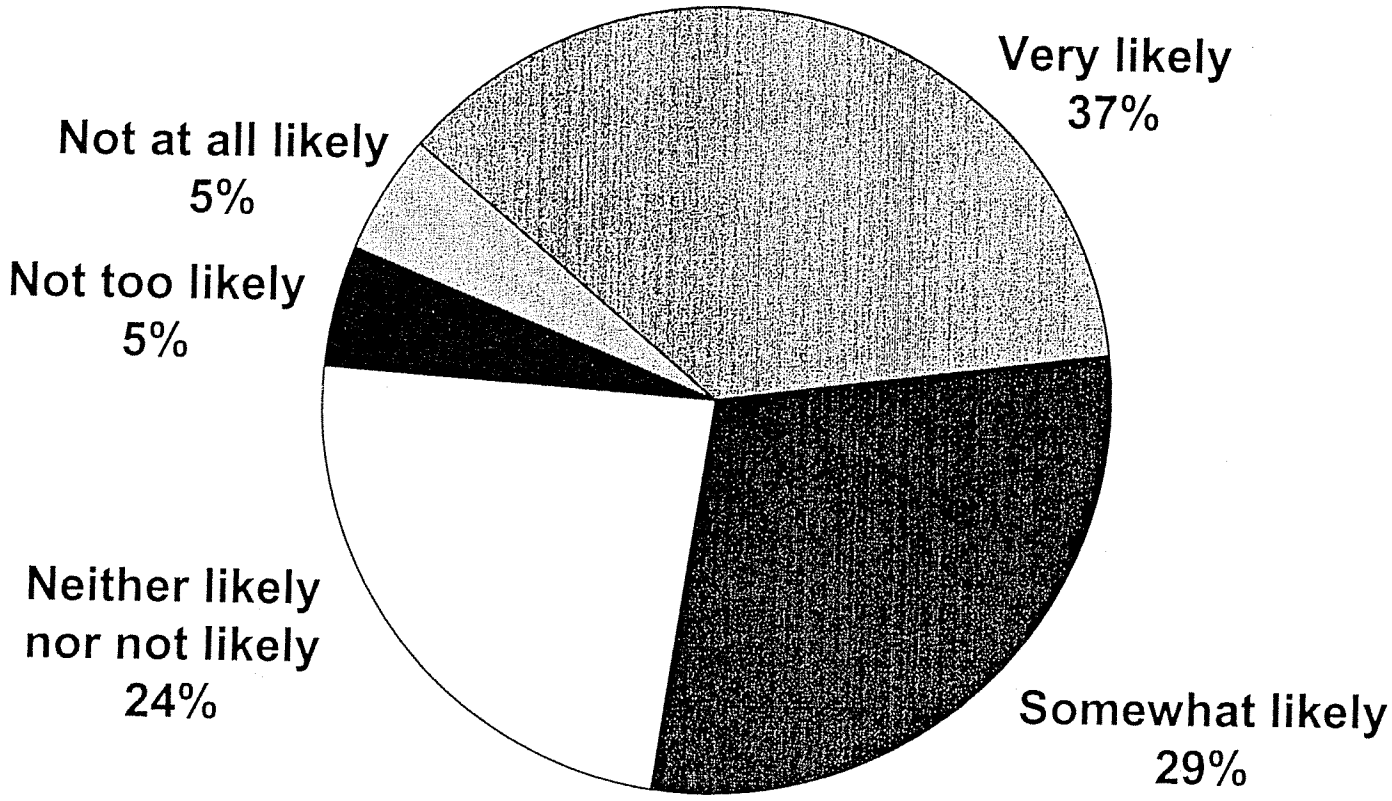
Purchase Intent – Zone 3 Insulation

- Just over four of ten participants (44%) reported that they were likely to upgrade their insulation even if there was no rebate.

- Few participants (4%) reported that they were not likely to upgrade their insulation without the rebate. Moreover, one-half (52%) of participants were neither likely nor not likely to upgrade their insulation. This is because one-half of participants either did not know that they needed upgraded insulation or they simply accepted the insulation that was included in the mobile home package which they selected.

# Likelihood Of Installing High Efficiency Heat Pump If There Wasn't A Rebate

(Q17. How likely were you to install a high efficiency heat pump if there was not a rebate?)



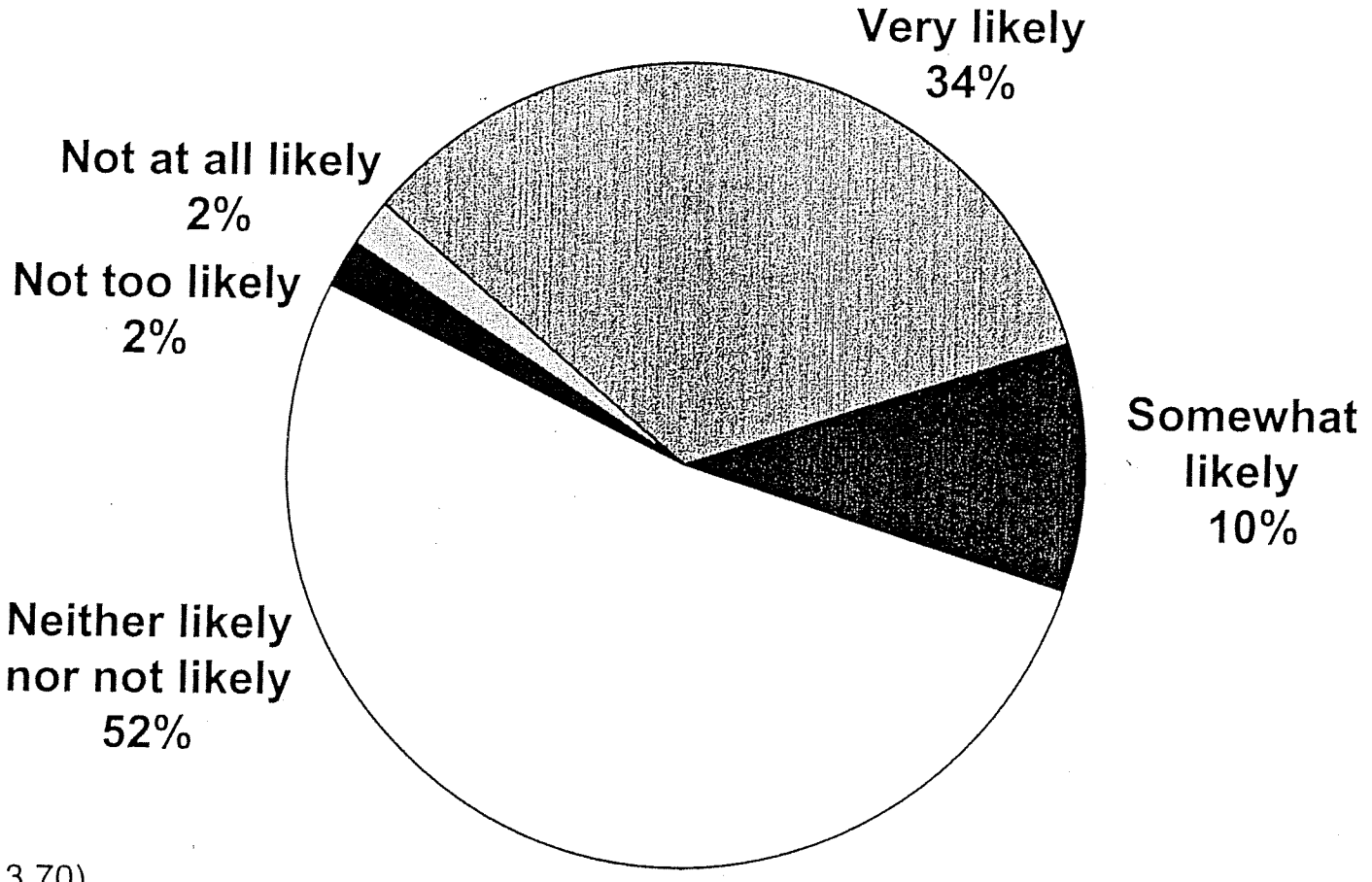

(Mean = 3.88)

(Mean based on a 5 point scale where 5 = Very likely and 1 = Not at all likely)

(n = 41)

# Likelihood Of Purchasing Upgraded Insulation Package If There Wasn't A Rebate

(Q18. How likely were you to purchase the upgraded insulation if there was not a rebate?)




(Mean = 3.70)

(Mean based on a 5 point scale where 5 = Very likely and 1 = Not at all likely)

(n = 41)

# Satisfaction

# Key Findings

Installation

- Nine out of ten participants (90%) in the mobile home new construction program expressed satisfaction with the service that they were provided by their installer, including approximately three of every four participants (74%) who reported being very satisfied with the service.

- Nearly two in ten participants (16%) reported being somewhat satisfied, while only a small number (4%) reported being neither satisfied nor dissatisfied.

- The one participant who expressed dissatisfaction with the service provided by the installer indicated that the reason for dissatisfaction is that the installer was from out of town and acted in a peculiar manner.

Performance

- Nearly all participants reported being satisfied with the performance of their heat pump. Overall, approximately six of every seven participants (86%) in the heat pump program reported being very satisfied with the performance of their new heat pump and approximately one in ten participants (12%) reported being somewhat satisfied. Only one respondent reported being neither satisfied nor dissatisfied.

# Key Findings

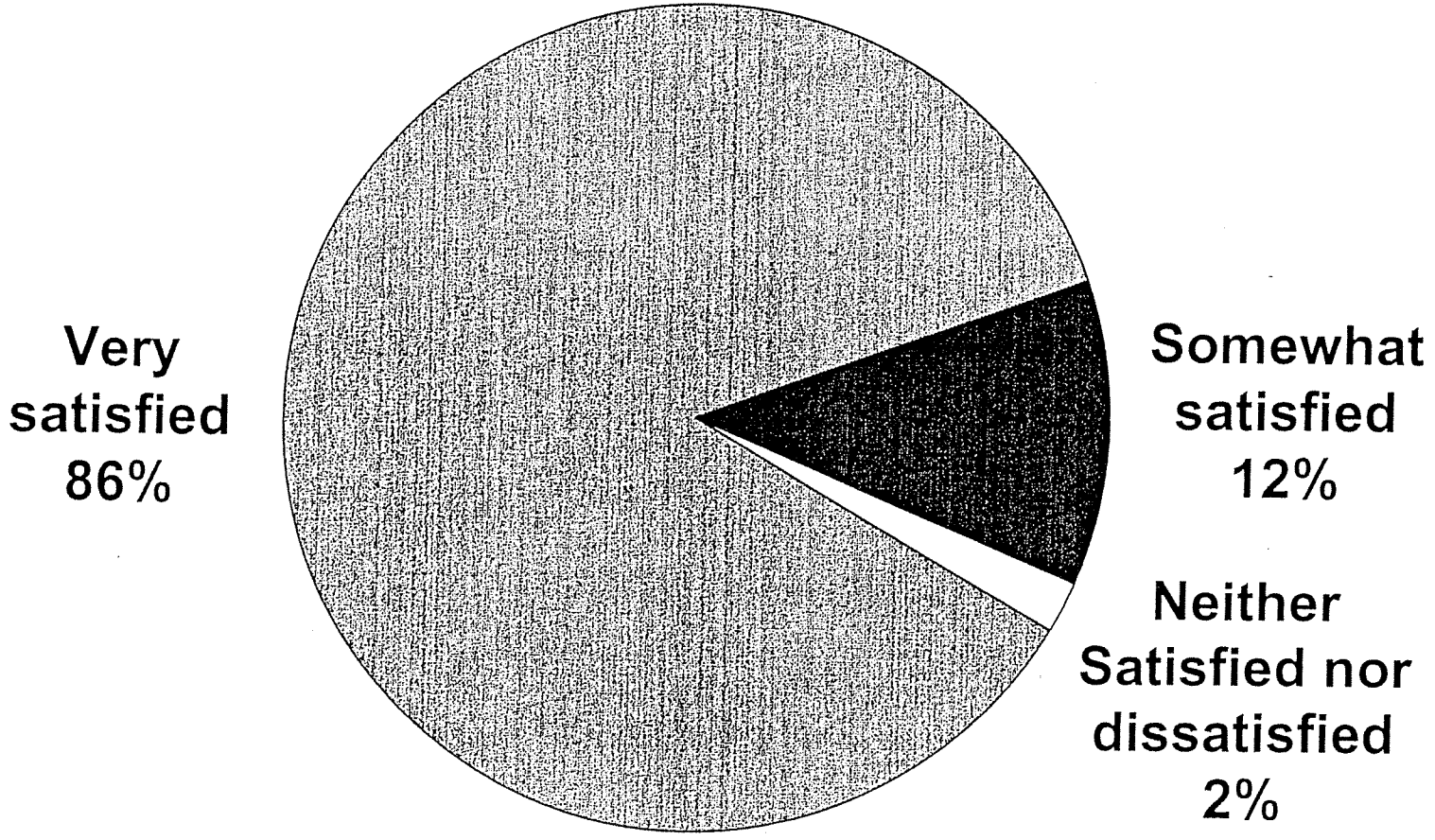
Rebate Satisfaction

- Nine out of ten of the mobile home new construction participants reported that they are satisfied with the level of rebate which they were afforded, including seven in ten participants (70%) who reported being very satisfied with their rebate.

- While no participant reported dissatisfaction, one participant (2%) reported no satisfaction or dissatisfaction regarding the amount.

# Satisfaction With Heat Pump Performance

(Q11. How satisfied are you with the performance of the high efficiency heat pump?)

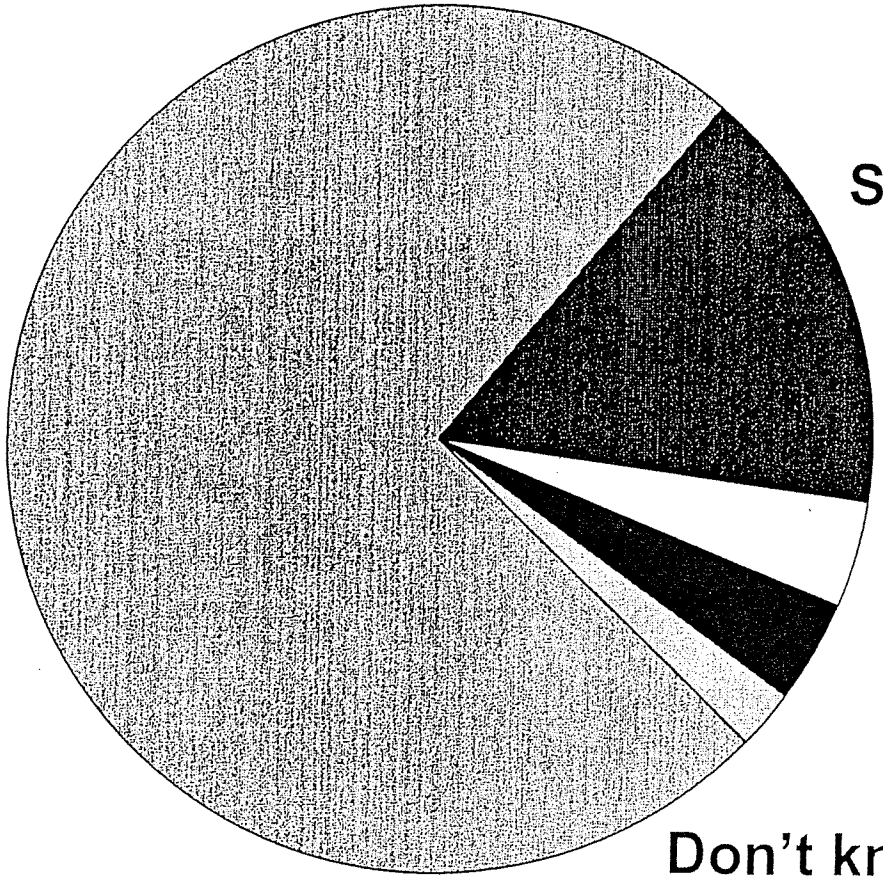



(Mean = 4.84)

(Mean based on a 5 point scale where 5 = Very satisfied and 1 = Not at all satisfied) (n = 50)

# Satisfaction With Service Provided By Installer

(Q13. How satisfied are you with the service provided by the installer?)



Very satisfied 74%

Somewhat satisfied 16%

Neither satisfied nor dissatisfied 4%

Not too satisfied 4%

Don't know 2%

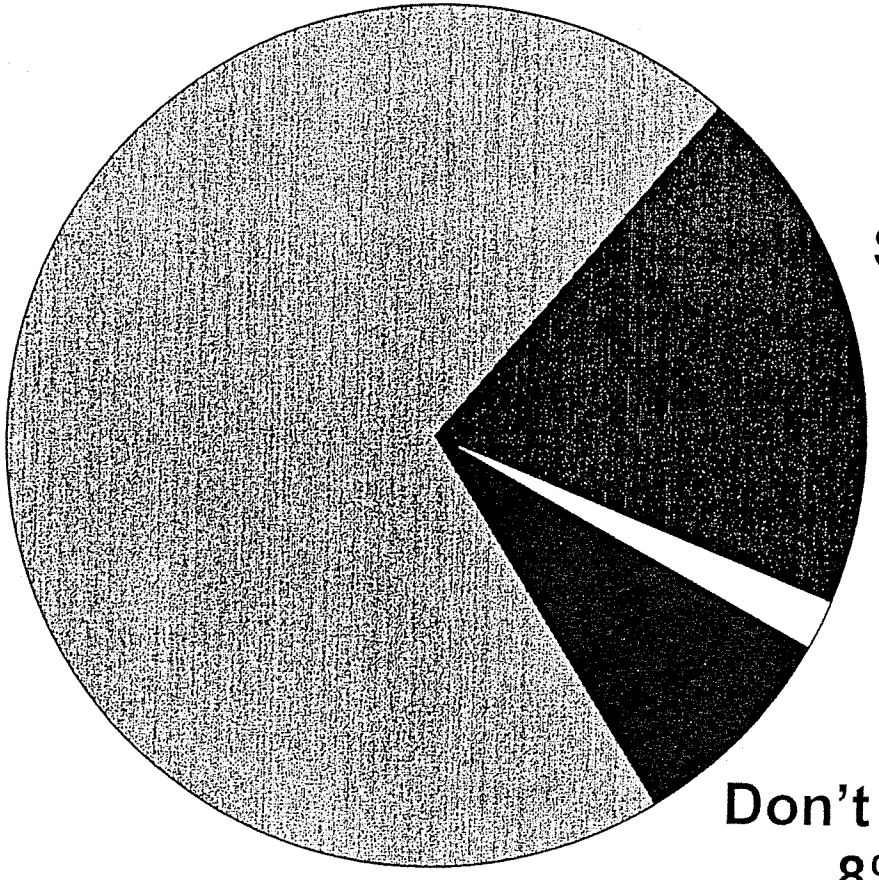
(Mean = 4.63)

(Mean based on a 5 point scale where 5 = Very satisfied and 1 = Not at all satisfied)

(n = 50)

# Satisfaction With Rebate Level

(Q19. How satisfied are you with the rebate level that you were provided?)




(Mean = 4.74)

(Mean based on a 5 point scale where 5 = Very satisfied and 1 = Not at all satisfied)

(n = 50)

# Heating and Cooling Settings

# Key Findings

Heat Pump Heat Setting

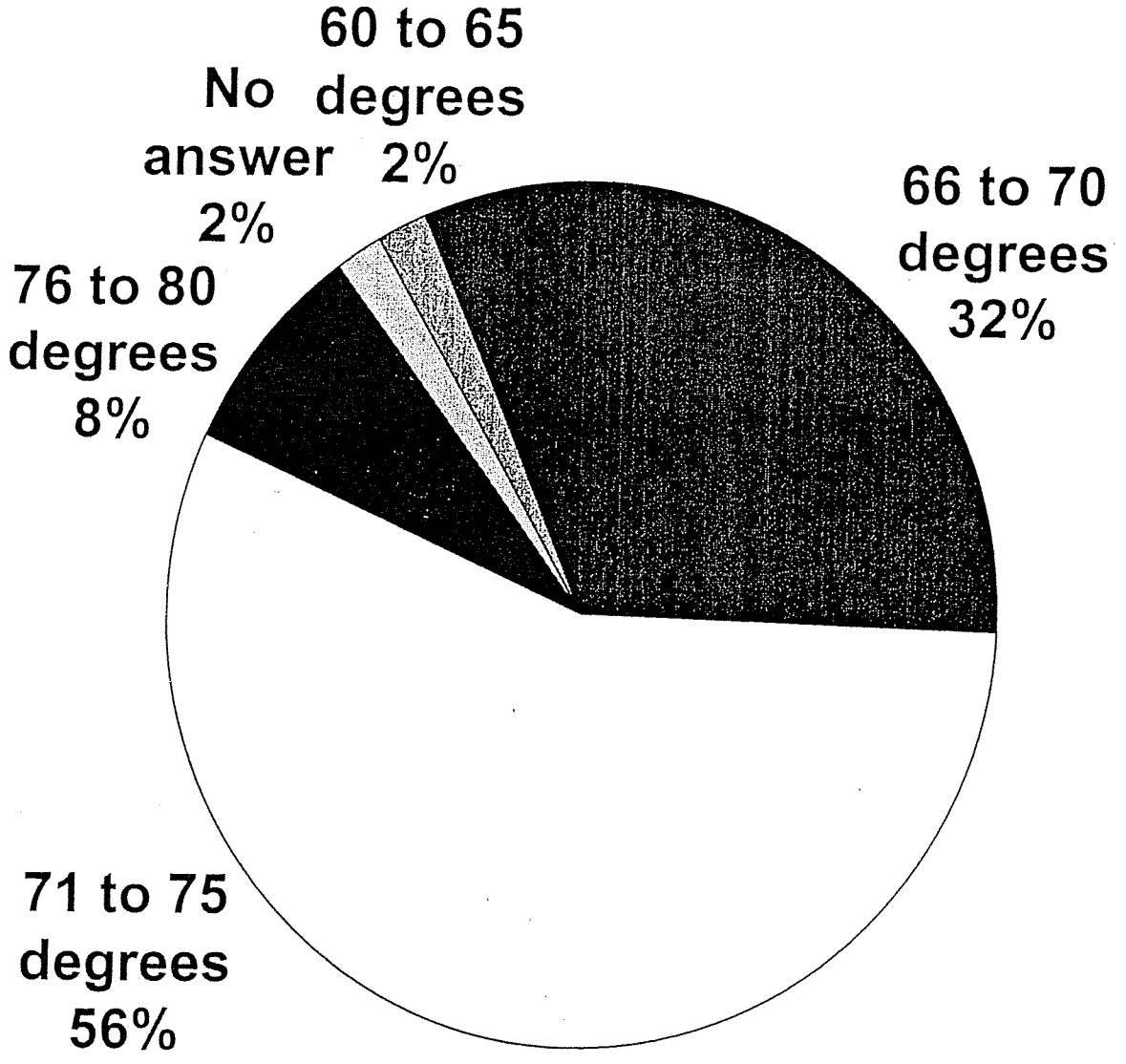
- Just over one-half of program participants (56%) reported that the heating temperature setting for their heat pump is between 71 degrees and 75 degrees. Nearly one in three (34%) reported that they keep their heat pump set at a heating temperature of 70 degrees or lower, nearly one in ten (8%) have their heat pump set at more than 75 degrees.

Heat Pump Cooling Setting

- One-half of program participants (50%) reported that the cooling temperature setting for their heat pump is between 71 degrees and 75 degrees. Two in five (40%) keep their heat pump set at a cooling temperature that is between 66 degrees and 70 degrees, while only a small number (6%) have their heat pump set to cool at 76 degrees or higher.

# Heating Temperature – New Heat Pump

(Q15. What is the heating temperature setting for your new heat pump?)

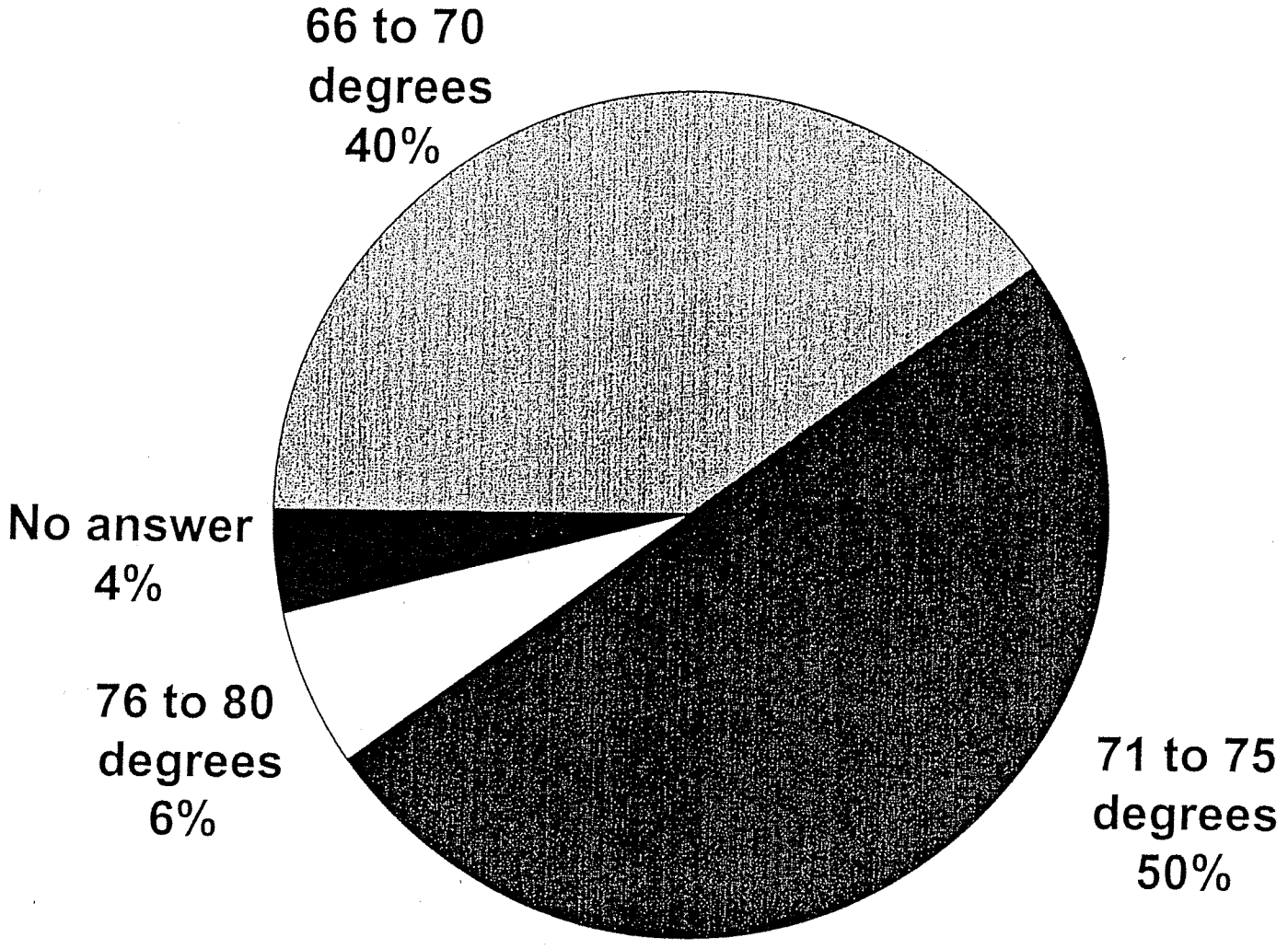



(Average temperature setting = 71.6 degrees)

(n = 50)

# Cooling Temperature – New Heat Pump

(Q16. What is the cooling temperature setting for your new heat pump?)




(Average temperature setting = 71.2 degrees)

(n = 50)

# Issues of Note

# Issues of Note



Observations

- Sales representatives and word of mouth are the key ways in which knowledge about the Mobile Home New Construction Program is spread. Sales representatives play the major role in promoting the program, but participants who discuss their experiences are strong links to communicating the program.

- There are no obvious issues or concerns with the contractors, quality of installation, or performance of heat pump.

- The rebate level is not a concern to program participants.

- Anecdotal information provided by participants suggest that knowledge about costs of installation are lacking. Many participants reported that they simply selected a mobile home model and were told a net cost; costs for key features of the home were not itemized.

# Issues of Note



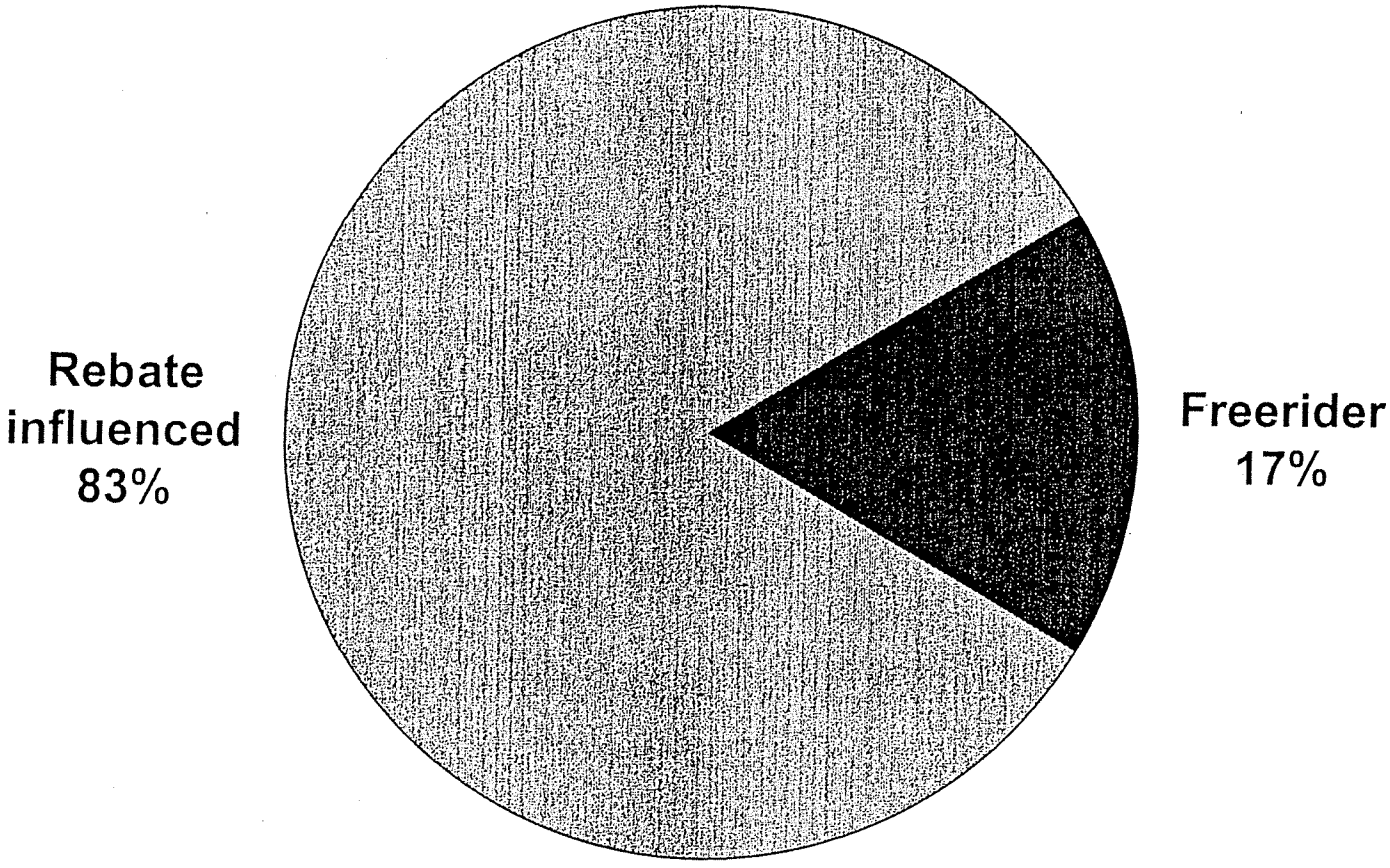
Freeriders

- Relatively few participants in the new construction heat pump program are classified as freeriders. While just over eight in ten participants reported that they planned on purchasing a heat pump for their new home, and nearly seven in ten participants reported that they would have installed a heat pump even without a rebate, fewer participants appeared likely to upgrade their insulation without a rebate.

- For new construction, much of the purchase motivation may be explained in mobile home purchase behavior: participants select a model based on overall appeal, comfort, and affordability; the heat pump and related rebate are included in the package. Indeed, eight of ten participants reported that, in the end, they installed what came with the package they selected or simply what the mobile home sales representative suggested would be the best unit.

- While most participants did not directly report that they purchased a heat pump due to a rebate program, one in four suggested that they participated in the program to get the rebate or because the program made purchasing a heat pump a good deal.

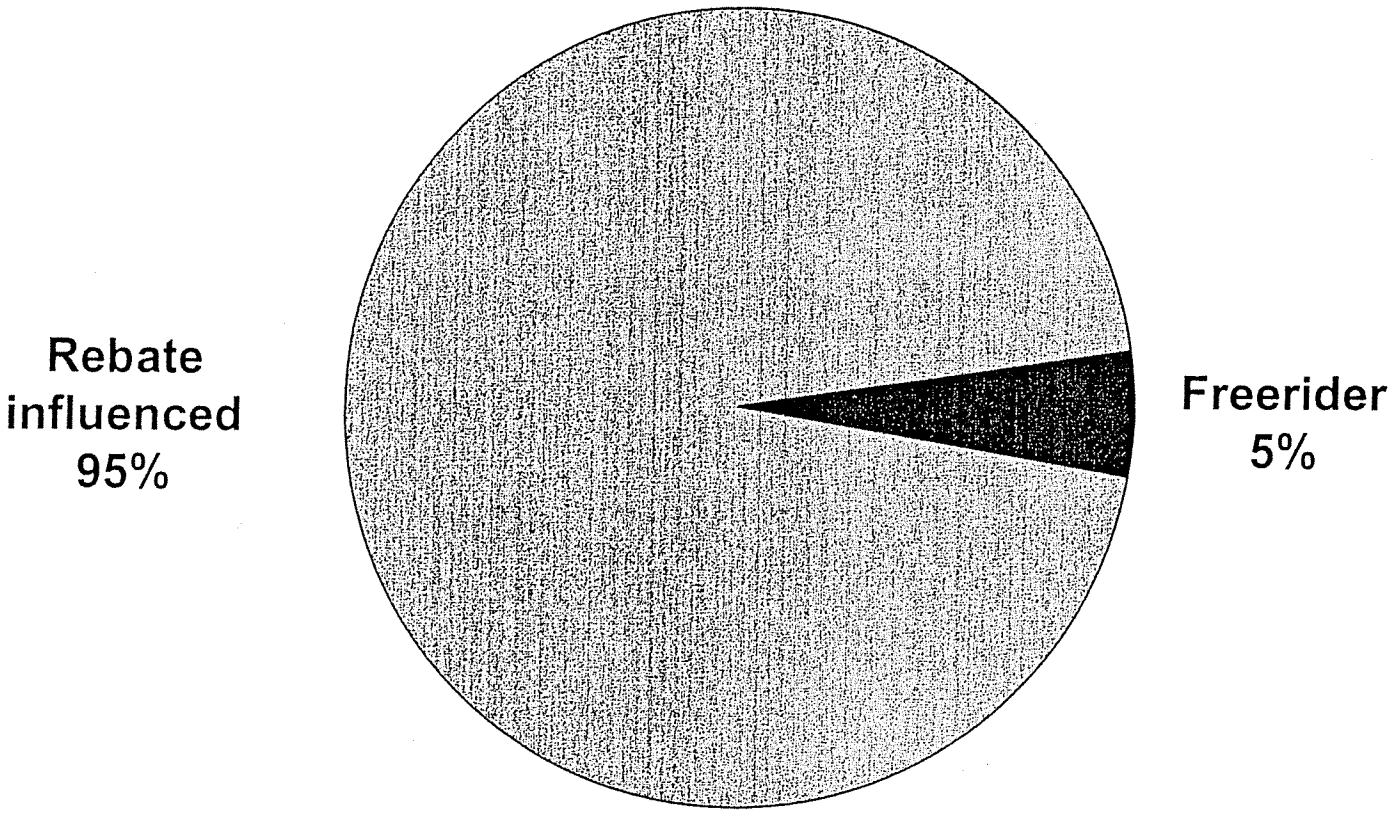
# Freeriders




(Freerider = planned on heat pump; planned on Zone 3 insulation; likely to buy even without rebate on high efficiency unit and on Zone 3 insulation)

(n = 41)

# Clearly Freerider




(Clearly Freerider = planned on heat pump; planned on Zone 3 insulation; very likely to buy even without rebate on high efficiency heat pump and on Zone 3 insulation)

(n = 44)

# Appendix C: Data Collection Form & Customer Installation Report

# MOBILE HOME NEW CONSTRUCTION

A Demand Side Management Program

Date _____ AEP Confirmation No. _____

Dealer Name _____

Address _____

Telephone No. _____

City _____ State _____ Zip _____

Salesperson _____

Tax Exempt No. _____ Social Security No. _____

Purchase Date _____ Home Size _____X_____

One Site Date _____

Zone Three Insulation _____ yes Fireplace _____ yes _____ no Sky lights _____ yes _____ no
(must have to qualify for incentive)

## Description of HVAC Equipment

Manufacturer _____ System Size _____
In Tons

Outdoor Unit Model # _____ Serial # _____
Indoor Unit Model # _____ SEER _____ HSPF _____

To Qualify Efficiency Ratings Must Be:
Split System 11.0 SEER or 7.2 HSPF
Package System 10.0 SEER and 6.8 HSPF

Heat Pump
Design: _____ Split System II _____ Package System
Installed in: _____ New Construction (Must be to Qualify)

Heat Pump Installed in
AEP/Kentucky Region _____ yes
(Must be to Qualify)

Social Security No _____
Electric Meter No. _____
Account No. _____

Customer Name _____

Street Address _____

City _____ State _____ Zip _____

Telephone No.
(H) _____
(W) _____
(O) _____

Mailing Address, if different: _____
_____

---

I verify that the existing equipment is currently being used to space condition the customer's residence at the above address

HVAC/Mobile Home Dealer Signature _____ Date _____

I verify that the above information is correct and I understand that the rebate I will receive is considered taxable income by the IRS.

Customer Signature _____ Date _____

# 2003
# MOBILE HOME NEW CONSTRUCTION PROGRAM

| Agreement # | Customer Name | Customer Address | City | Customer Acct Number | M/H Dealer | Customer Date | M/H Dealer Date | Received Date | Accts. Payable Date | Check Mailed Date | Heat Pump SEER | Heat Pump HSPF | A/C SEER | Mobile Home Dimension | Skylight Y/N | Fireplace Y/N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 03-01 | Spears, Jerry | 9130 Robinson Crk Rd | Pikeville | 0325893990 | Glenn's | 10/10/2002 | 12/14/2002 | 01/02/2003 | 01/02/2003 | 01/15/2003 | 12 | 7.6 | | 16X76 | y | n |
| 03-02 | Swindall, Virgie | 520 Marshalls Branch | Jenkins | 0346961590 | Glenns | 10/22/2002 | 12/14/2002 | 01/02/2003 | 01/02/2003 | 01/15/2003 | 12 | 7.6 | | 32X76 | n | y |
| 03-03 | Kendrick, Christene | 167 Shop Branch Rd | Stanville | 0307288740 | LUV | 01/06/2003 | 01/06/2003 | 01/06/2003 | 01/06/2003 | 01/15/2003 | 10 | 7.2 | | 32X56 | n | y |
| 03-04 | Ritchie, Abbey | 14 Tribbey Camp Rd | Bulan | 0384175610 | White's | 01/03/2003 | 01/03/2003 | 01/06/2003 | 01/06/2003 | 01/15/2003 | 10 | 7.5 | | 28X68 | n | y |
| 03-05 | Bowling, Roderick | Brickyard Hill | Jenkins | 0396705890 | Glenn's | 01/06/2003 | 01/02/2003 | 01/10/2003 | 01/10/2003 | 01/21/2003 | 12 | 7.2 | | 28X60 | y | y |
| 03-06 | Collins, Wanda | 629 Brush Crk | Argillite | 0338523740 | Fleetwood | 01/17/2003 | 01/17/2003 | 01/22/2003 | 01/22/2003 | 02/06/2003 | 10 | 7.2 | | 28X60 | n | y |
| 03-07 | Dolson, James | Pond Fork Rd | Phelps | 330599880 | LUV | 01/04/2003 | 02/13/2003 | 02/12/2003 | 02/13/2003 | 03/04/2003 | 10 | 7.2 | | 28x68 | y | y |
| 03-08 | Sexton, Timothy | 11814 Hwy 160 | Whitesburg | 0342734090 | Glenns | 11/25/2002 | 02/13/2003 | 02/24/2003 | 02/24/2003 | 03/05/2003 | 12 | 7.6 | | 28X60 | n | y |
| 03-09 | Flynn, Ron | 191 Riffe Hollow | Rush | 0375673630 | Dream | 02/25/2003 | 02/25/2003 | 02/24/2003 | 02/27/2003 | 03/11/2003 | 10 | 7.2 | | 28X70 | n | y |
| 03-10 | Taylor, Darlene | 84 Williams Branch | McVeigh | 0348977050 | Hylton | 11/07/2002 | 11/07/2002 | 02/24/2003 | 02/27/2003 | 03/11/2003 | 11 | 7.2 | | 28X62 | n | y |
| 03-11 | Justice, James | 211 Peach Orchard Br. | Pikeville | 0302522120 | Keene's | 02/26/2003 | 02/26/2003 | 02/27/2003 | 02/27/2003 | 03/11/2003 | 10 | 7.2 | | 24X60 | n | n |
| 03-12 | Kimbler, Roy | 1152 Kimbler Ln | Hager Hill | 0303545120 | LUV | 02/06/2003 | 02/06/2003 | 02/06/2003 | 02/28/2003 | 03/11/2003 | 10 | 7.2 | | 32X56 | n | y |
| 03-13 | Webb, Nellie | 153 Number three Hill | Jenkins | 0394084890 | Whitehall | 02/25/2003 | 02/26/2003 | 02/28/2003 | 02/28/2003 | 03/14/2003 | 10 | 7.2 | | 14X56 | n | n |
| 03-14 | Crawford, Nyoka | 99 Corkwood Lane | Mayking | 0309447970 | Adkins | 03/06/2003 | 03/06/2003 | 03/14/2003 | 03/14/2003 | 03/26/2003 | 12 | 7.6 | | 28X72 | n | y |
| 03-15 | Childers, Junior | 67 Rose Hollow | Elkhorn City | 0371061520 | Glenn's | 11/22/2002 | 03/08/2003 | 03/21/2003 | 03/21/2003 | 04/03/2003 | 12 | 7.6 | | 28X44 | n | n |
| 03-16 | Thacker, Terry | 2884 Shelby Dry Fork | Shelbiana | 0312300044 | LUV | 03/25/2003 | 03/24/2003 | 03/25/2003 | 03/26/2003 | 04/07/2003 | 10 | 7.2 | | 28X68 | y | y |
| 03-17 | Knight, Robert | 8059 Hwy 119 N | Jenkins | 0311050400 | LUV | 03/26/2003 | 03/26/2003 | 03/27/2003 | 03/27/2003 | 04/07/2003 | 11 | 7.2 | | 28X44 | n | n |
| 03-18 | Griffith, Roger | 74 Straight Fork | Cornettsville | 0380400854 | Watts | 03/18/2003 | 03/18/2003 | 03/28/2003 | 03/28/2003 | 04/08/2003 | 10.5 | 6.9 | | 16X76 | y | n |
| 03-19 | Blanton, Nick | Combs Road | Combs | 0308591631 | Watts | 03/07/2003 | 03/07/2003 | 03/28/2003 | 03/28/2003 | 04/08/2003 | 12 | 7.9 | | 16X80 | n | n |
| 02-20 | Horn, Anthony | 550 Weddington Branch Rd | Pikeville | 0377725860 | LUV | 04/11/2003 | 04/11/2003 | 04/14/2003 | 04/14/2003 | 04/24/2003 | 11 | 7.2 | | 16X76 | n | n |

*Appendix C*

Tabulation of Data from Installation Information Form

I. Summariztion of Data Regarding New Mobile Home
   a) Size of Mobile Home (Average Size 1,650 ft.$^2$)

| | |
|---|---|
| Under 700 ft.$^2$ | 0.3% |
| 700 - 800 ft.$^2$ | 1.9% |
| 800 - 1,000 ft.$^2$ | 5.6% |
| 1,000 - 1,200 ft.$^2$ | 7.6% |
| 1,200 - 1,400 ft.$^2$ | 20.3% |
| 1,400 - 1,600 ft.$^2$ | 12.2% |
| 1,601 - 1,900 ft.$^2$ | 16.4% |
| >=1,900 ft.$^2$ | 35.7% |

II. Information Regarding New Heat Pump Installation
   a) SEER (Average SEER = 10.65)

| | |
|---|---|
| 10 | 60.7% |
| 10.1 - 10.9 | 2.8% |
| 11 | 6.1% |
| 11.1 - 11.9 | 6.9% |
| 12 | 22.7% |
| >12 | 0.8% |

   b) HSPF (Average HSPF = 7.35)

| | |
|---|---|
| <=6.8 | 0.8% |
| 6.9 - 7.5 | 73.7% |
| 7.6 - 8.0 | 24.7% |
| > 8.0 | 0.8% |

# Appendix D: Energy Impact Reduction

*Appendix D*

Energy Impact Reduction

## I. ASHRAE Heating and Cooling Degree Day Models

### A. Heating Degree Model:

Heat Pump System: $E_h = 24*[H_L/(T_i - T_o)]*[HDD/1000*HSPF]$

Electric Resistance: $E_h = 24*[H_L/(T_i - T_o)]*[HDD/3413]*C_D$

where;

$E_h$ = Annual Energy Savings (kWh)
$H_L$ = Design Heat Loss (Btu/h)
$T_i$ = Indoor Thermostat Setting ($^0$F)
$T_o$ = Outdoor Design Temperature ($^0$F) @ $97^1/_2$% db
HDD = Annual Heating Degree Days ($^0$F-days)
HSPF = Heating System Performance Factor (Btu/Wh)
$C_D$ = Adjustment factor for solar and internal heat gains, dimensionless

and,

24 is a conversion factor for hrs/day
1000 is a conversion factor for Wh/kWh
3413 is a conversion factor for Btu/kWh

### B. Cooling Degree-Day Model:

Central Air Conditioner/Heat Pump:

$E_c = 24*[H_G/(T_o - T_i)]*[CDD/1000*SEER]$

where;

$E_c$ = Annual Energy Savings (kWh)
$H_G$ = Design Heat Gain (Btu/h)
$T_o$ = Outdoor Design Temperature ($^0$F) @ $2^1/_2$% db
$T_i$ = Indoor Thermostat Setting ($^0$F)
CDD = Annual Cooling Degree Days ($^0$F-days)
SEER = Seasonal Enrgy Efficiency Ratio (Btu/Wh)

with, 24 and 1000 being conversion factors as defined above.

*Appendix D*

Energy Impact Reduction

**II. Estimation of Heat Losses and Heat Gains**

**A. Mobile Homes @ AEP/KPCo Coal Run service facility (Phase I/Period I):**

Given Conditions: $E_h$ = 4,332 kWh* and $E_c$ = 1,173 kWh*(Home 3/Zone 2 Heat Pump)
$E_h$ = 8,708 kWh* and $E_c$ = 1,483 kWh*(Home 2/Zone 2 Elec.Furn.&CAC)
$T_i$ = 72 $^0$F Heating and Cooling Thermostat Settings
$T_o$ = 9 $^0$F** Outdoor Design Temperature for Heating and,
92 $^0$F** Outdoor Design Temperature for Cooling
HDD = 4,393 $^0$F-days** (Normalized)
CDD = 1,033 $^0$F-days** (Normalized)
HSPF = 8.0 Btu/Wh
SEER = 12.0 Btu/Wh
$C_D$ = 0.75
* Load Research Data Results
** Jackson, Ky. National Weather Station

Unknown: $H_L$ = Design Heat Loss (Btu/h)
$H_G$ = Design Heat Gain (Btu/h)

**B. Design Heat Loss & Heat Gain Estimates:**

Home 3/ Zone 2 Heat Pump:

$H_L = [E_h*(T_i-T_o)*1000*HSPF]/[24*HDD]$
$H_L$ = [4,332 kWh*(72$^0$F-9$^0$F)*1000*8.0 Btu/h]/[24*4,393 $^0$F-days] = 20,708 Btu/h

$H_G = [E_c*(T_o-T_i)*1000*SEER]/[24*CDD]$
$H_G$ = [1,173 kWh*(92$^0$F-72$^0$F)*1000*12.0 Btu/h]/[24*1,033 $^0$F-days] = 11,355 Btu/h

Home 2/ Zone 2 Electric Furnace with CAC:

$H_L = [E_h*(T_i-T_o)*3413]/[24*HDD*C_D]$
$H_L$ = [8,708 kWh*(72$^0$F-9$^0$F)*3413]/[24*4,393 $^0$F-days*0.75] = 23,679 Btu/h

$H_G = [E_c*(T_o-T_i)*1000*SEER]/[24*CDD]$
$H_G$ = [1,424 kWh*(92$^0$F-72$^0$F)*1000*12.0 Btu/h]/[24*1,033 $^0$F-days] = 13,785 Btu/h

Assume Maximum $H_L$ and $H_G$ (rounded off): $H_L$ = 23,700 Btu/h
$H_G$ = 13,800 Btu/h

*Appendix D*

Energy Impact Reduction

## III. Estimation of Energy Impact Savings

### A. Characteristics Mobile Homes Sold To 250 Program Participants (2003 - 2004):

Given Conditions:

$H_L$ = 23,700 Btu/h*
$H_G$ = 13,800 Btu/h*
$T_i$ = 72 °F (Heating) & 71 °F (Cooling) for Thermostat Settings
$T_o$ = 9 °F** Outdoor Design Temperature for Heating and,
92 °F** Outdoor Design Temperature for Cooling
HDD = 4,393 °F-days** (Normalized)
CDD = 1,033 °F-days** (Normalized)
HSPF = 7.35 Btu/Wh*** (2003 - 2004 Participant Average)
SEER = 10.65 Btu/Wh*** (2003 - 2004 Participant Average)
SEER = 10.00 Btu/h (Minimum Standard Efficiency)
$C_D$ = .75
$A_2/A_1$ = Area of Participant Mobile Home vs.Mobile Home at Test Site
= 1,650 sq.ft.***/980 sq.ft.= 1.6837 (Adjustment for $H_L$ and $H_G$)

* Estimated From Load Research Data Results
** Jackson, Ky. National Weather Station
*** Data Collection Form - Customer Installation Reports

### B. Engineering Estimated Annual Energy Savings for MHNC Program:

Heat Pump System:

$E_h = 24*[H_L*A_2/A_1/(T_i - T_o)]*[HDD/1000*HSPF]$
$E_h = 24*[23{,}700\ Btu/h*1.6837/(72^0F - 9^0F)]*[4{,}393^0F\text{-}days/1000*7.35\ Btu/Wh] = 9{,}086\ kWh$

$E_c = 24*[H_G*A_2/A_1/(T_o - T_i)]*[CDD/1000*SEER]$
$E_c = 24*[13{,}800\ Btu/h*1.6837/(92^0F - 71^0F)]*[1{,}033^0F\text{-}days/1000*10.65\ Btu/Wh] = 2{,}576\ kWh$

Electric Furnace w/CAC:

$E_h = 24*[H_L*A_2/A_1/(T_i - T_o)]*[HDD/3413]*C_D$
$E_h = 24*[23{,}700\ Btu/h*1.6837/(72^0F - 9^0F)]*[4{,}393^0F\text{-}days/3413]*0.75 = 14{,}911\ kWh$

$E_c = 24*[H_G*A_2/A_1/(T_o - T_i)]*[CDD/1000*SEER]$
$E_c = 24*[13{,}800\ Btu/h*1.6837/(92^0F - 71^0F)]*[1{,}033^0F\text{-}days/1000*10.0\ Btu/Wh] = 2{,}743\ kWh$

Energy Savings:

$E_h$ (Electric Furnace) - $E_h$ (Heat Pump) = 14,911 kWh - 9,086 kWh = 5,286 kWh
$E_c$ (Central Air) - $E_c$ (Heat Pump) = 2,743 kWh – 2,576 kWh = 167 kWh

*Appendix D*

Energy Impact Reduction

**C. Engineering Estimated Annual Energy Savings From High Efficiency Central AC:**

Assumptions:

$H_G$ = 21,350 Btu/h*
$T_i$ = 71 $^0$F (Cooling) for Thermostat Settings
$T_o$ = 92 $^0$F** Outdoor Design Temperature for Cooling
CDD = 1,033 $^0$F-days** (Normalized)
SEER = 12.00 Btu/Wh
SEER = 10.00 Btu/h (Minimum Standard Efficiency)
* Estimated Based on Typical Home
** Jackson, Ky. National Weather Station

High Efficiency Central AC System:

$E_c = 24*[H_G/(T_o - T_i)]*[CDD/1000*SEER]$
$E_c = 24*[21,350 \text{ Btu/h}/(92^0\text{F} - 71^0\text{F})]*[1,033^0\text{F-days}/1000*12 \text{ Btu/Wh}] = 2,100$ kWh

Standard Efficiency Central AC System:

$E_c = 24*[H_G/(T_o - T_i)]*[CDD/1000*SEER]$
$E_c = 24*[21,350 \text{ Btu/h}/(92^0\text{F} - 71^0\text{F})]*[1,033^0\text{F-days}/1000*10.0 \text{ Btu/Wh}] = 2,520$ kWh

Energy Savings:

$E_c$ (High Efficiency CAC) - $E_c$ (Standar Efficiency CAC) = 2,520 kWh – 2,100 kWh = 420 kWh

# Appendix E: Demand Impact Reduction

*Appendix E*

Demand Impact Reduction

AEP Previous Studies

Winter Load Factor = 0.283
Summer Load Factor = 0.254

Winter Demand Reduction = $\frac{\text{Winter Energy Saving (kWh)}}{\text{Winter Load Factor x Hours in Winter Seasons}^{(1)}}$

Summer Demand Reduction = $\frac{\text{Summer Energy Savings (kWh)}}{\text{Summer Load Factor x Hours in Summer Seasons}^{(2)}}$

Mobile Home New Construction Program – High efficiency Heat Pump

Average Winter Demand Reduction = $\frac{4{,}228 \text{ kWh}}{0.283 \times 5{,}088 \text{ hrs}}$ = 2.94 kW

Average Summer Demand Reduction = $\frac{131 \text{ kWh}}{0.254 \times 3{,}672 \text{ hrs}}$ = 0.14 kW

Mobile Home New Construction Program – Central AC

Summer Load Factor = 0.159

Average Summer Demand Reduction = $\frac{420 \text{ kWh}}{0.159 \times 3{,}672 \text{ hrs}}$ = 0.72 kW

(1) Winter Season is October through April
(2) Summer Season is May through September

EVALUATION REPORT

for the

# *MODIFIED ENERGY FITNESS PROGRAM*

in

Kentucky Power Company

Program Period: January 2003 - December 2004

Resource Planning & Economic Forecasting
Corporate Planning & Budgeting Department
American Electric Power

August, 2005

## TABLE OF CONTENTS

# I. EXECUTIVE SUMMARY

This report summarizes the results of the process evaluation, impact evaluations, and cost/benefit evaluation that were performed for Kentucky Power Company's (KPCo or Company) Modified Energy Fitness (MEF) Program during its first two years (January 2003 through December 2004). The MEF Program was approved by the Kentucky Public Service Commission (KPSC or Commission) as a three year program. As approved, the Company's goal was to serve 500 customers during each year of the program. However, the Company underestimated the number of annual participants in the initial application due to the customers' overwhelming endorsement of the program. The Collaborative agreed that the program should run consecutively until the 1,500 participants are achieved. On September 24, 2004, the Commission approved the Collaborative's request to audit an additional 500 customers' homes in 2005 for a total number of homes in this program of 2,000 versus the original approved number of 1,500 homes. The implementation contractor, Honeywell DMC Services, Inc. (DMC), completed 542 audits in 2003, 725 audits in 2004, and expects to complete an additional 730 audits in 2005.

The Company's MEF Program was developed to further promote conservation and efficient use of electricity by improving the energy fitness of electric heated residential homes. The major goals of the program were to: (1) reduce customer usage of electric energy for space heating; (2) reduce customer usage of electric energy for water heating; (3) encourage the use of energy efficient measures in the home of residential customers; (4) increase customer services and customer satisfaction; (5) to educate customers as to the proper application of high efficiency measures such as compact fluorescent bulb (CFB) for lighting, cleaning refrigerator coil, caulking, weather stripping and etc.; and (6) reduce the Company's long-range peak demand.

To achieve the MEF Program goals, the program was offered to residential customers in the KPCo region, who currently utilize an electric heating system and an electric water heater and use a minimum average of 1,000 kWh per month. Customers have overwhelmingly endorsed this program since its inception in March 2003.

The potential program participants were informed of the MEF Program through direct mail, which described the program explaining that all the services were free of charge, and that the implementation contractor, Honeywell DMC Services, Inc., would contact the customer directly, offer the program, and arrange for a time to implement the program at the customer's home.

The MEF Program net total cumulative annual energy savings is estimated to be 2,899 MWh (which includes 10% Transmission and Distribution loss savings). This corresponds with a 2,525 ton reduction in carbon dioxide ($CO_2$) emissions, a 20 ton reduction in sulfur dioxide ($SO_2$) emissions, and a 6 ton reduction in nitrogen oxide ($NO_x$) emissions based on two years of actual and one year of estimated participation. Each participant experienced an average savings of 1,453 kWh at the meter. The net total demand reduction was 1,086 kW in winter and 352 kW in summer (including 11% Transmission and Distribution loss savings). These impacts translate into 0.544 kW and 0.176 kW net reductions per participant at the meter, in winter and summer, respectively.

The MEF Program was found to be cost effective based upon the Total Resource Cost (TRC) and Utility Cost (UC) economic tests, but not cost effective based upon Rate Impact Measure (RIM) test. The participant test was not applicable since the services were free of charge to the participants.

# II. TECHNOLOGY DESCRIPTION

A. Background

A primary contributor to a home's inefficiency in space heating and cooling is air infiltration through the home's envelope and excess air leakage in the heating and cooling ductwork. Heating and cooling equipment inefficiencies are also a contributor, but the effects from upgrading a home's heating and cooling system can be nullified if the home's air infiltration is not at acceptable minimum levels and the ductwork is not properly sealed to prevent air leakage.

B. Benefits

The MEF Program provided the qualifying customer free service to install various weatherization measures to reduce the home's air infiltration and energy conservation measures to improve the home's water heating efficiency and lighting efficiency. Customer education was provided to greatly enhance the customer's understanding of the importance of improving their home's energy efficiency and incorporating energy conservation activities in their daily lifestyles. The benefits for the services provided in the program are described in detail below.

1. Air Leakage Correction:

Air leakage through the structure of the home due to the infiltration of outside air and the exfiltration of conditioned indoor air is a major contributing factor toward the home's heating and cooling demand and energy use. In homes that are not properly sealed to prevent excessive air infiltration and exfiltration, the home's total heat losses and heat gains can be significantly affected by the convection of heat through the home structure by air flow. Potential areas of air infiltration and exfiltration in the home, aside from windows and exterior doors, are around pipe and electrical chase ways, chimneys, attics, wall cavities, basements and crawl spaces.

Ducted heating and cooling systems can hinder heating, ventilation, and air conditioning (HVAC) system efficiency when air leakage through duct seams and other ductwork components exists. Correcting this deficiency can result in significant electric heating and cooling energy savings. This savings, in some cases, can be more significant than the savings achieved from sealing air leakage in the structure of the home.

Home heat loss and heat gain due to the infiltration of outside air into a home is retarded by applying weatherization measures such as weather-stripping, caulking, switch and outlet gaskets, foam sealant and pliable backer rod in leakage areas in the outside walls, and around doors and windows. The rate of air leaking into a home is based on the difference between the outdoor and indoor air pressure acting on the walls of the home. The pressure differences are directly related to the wind velocity and its direction on the walls. The wind velocity builds up pressure on the windward side of the home and a slight vacuum on the leeward side. The build-up of outdoor pressure on the windward side causes air to infiltrate through crevices in the wall construction and cracks around the windows and doors, and exfiltrate through the same type of wall components on the leeward side, thus attributing to greater heat loss and heat gain in the home.

Various sealing measures used for air leakage correction are weather-stripping, caulking, door sweeps, foam sealant and plug/outlet gaskets. Duct sealing or mastic tape is used for sealing duct leaks. The use of blower door tests can measure the amount of air leakage and indicate the location of air leaks with the use of a pressure testing instrument. Customer education can be a benefit by informing participants of low cost measures that they can install to reduce air leakage and increase their comfort level.

2. Water Heating Efficiency:

Hot water energy usage is normally the home's second largest electrical energy usage next to electric space heating. There are a variety of energy conservation services and measures that can be provided to improve the domestic hot water system's overall efficiency, and thus reduce the hot water electrical energy consumption and demand. A walk-through inspection can identify appropriate energy conservation services and measures to implement.

A hot water system's energy consumption is the input energy needed to raise a quantity of water from the average input temperature of the cold water supply to the desired outlet hot water temperature. This energy consumption is made up of energy associated with system standby losses and useful energy. System standby losses relate to heat losses from the heated water in the hot water tank and pipe distribution system, while useful energy relates to the amount of heated water used. The installation of a water heater wrap around the water heater tank and pipe insulation to the piping distribution system, along with the setting back of the water heater thermostat, will reduce the system standby losses and improve the overall water heater system efficiency. The installation of an energy saving showerhead and also faucet aerators will reduce the useful energy consumption. Customer education provides information that is used to determine the appropriate domestic hot water measures and services to be offered to the customer.

3. Lighting Efficiency:

A compact fluorescent bulb utilizes an electronic or magnetic ballast to supply electricity to the bulb in the same manner as a fluorescent lamp. Compact fluorescent bulbs are made in the shape of incandescent light bulbs. For appropriate levels of hourly use, the replacement of an incandescent light bulb with a compact fluorescent bulb of equivalent lumen output can result in

an energy savings of 75%, with a life expectancy 13 times greater, thereby greatly improving the lighting efficiency of the lamp. Today's generation of compact fluorescent bulbs are more adaptable for residential lighting uses. Their smaller physical size, along with their instantaneous start, dimness capability and stamina for outdoor use allows for more applications in a residential home. Also, customer education can be helpful in instructing participants on the efficient use of lighting in their home.

4. Refrigerators/Freezer Coil Cleaning:

Refrigerators and freezers are normally the largest energy consuming electrical appliances next to electric space heating/cooling systems and electric water heating systems. As the refrigerator/freezer coil collects dirt and dust, the unit operational efficiency decreases. Therefore, the cleaning of condenser coils can increase the efficiency of the refrigerator/freezer and thereby reduce the energy consumption by up to 18%.

5. Waterbed Cover:

Waterbeds are commonly found in many residential low-income households because they are lower in cost compared to most conventional beds. However, since they are heated by an electric heating element, their energy consumption can be significant and in some cases nearly equal to or greater than that of a refrigerator or freezer. By installing an insulating cover, which is a foam pad, directly on the waterbed mattress underneath the sheets, the heating energy used to heat the waterbed can be reduced by as much as 60% or more because the insulating cover reduces the heat losses escaping from the mattress. During the winter season, the waterbed temperature is normally set to near normal body temperature, which is significantly higher than room temperature. Therefore, a significant heat loss can occur through the waterbed mattress.

6. Programmable Thermostat

In the winter, significant savings can be obtained by manually or automatically reducing the thermostat's temperature setting for as little as four hours per day. These savings can be attributed to a building's heat loss in the winter, which depends greatly on the difference between the inside and outside temperatures. By turning the thermostat back 10°F to 15°F for 8 hours, a savings of 5% to 15% a year on a heating bill can be realized[1].

[1] http://www.eere.energy.gov/consumerinfo/factsheets/thermo.html

# III. PROGRAM DESCRIPTION

The Modified Energy Fitness (MEF) program was targeted to residential customers within the KPCo Region who use electricity as their heating and water heating source and use a minimum of 1,000 kWh per month. The program provides an energy audit and consultation to pinpoint energy conservation measures that can be implemented by a customer and educate the customer on the benefits of energy efficiency. Participants were provided with the direct installation of appropriate energy conservation measures which can decrease energy consumption, lower their electric bills, and increase the comfort level of their home.

**Contractor Selection**

Upon Commission approval (September 24, 2002), the Company issued a Request for Proposal (RFP) on November 5, 2002 to four qualified energy service contractors. Two energy services contractors responded to KPCo's RFP. The selected contractor had to demonstrate the ability to implement this program on a turnkey basis including program promotion, participant recruitment, screening and scheduling, procurement and installation of energy conservation measures, tracking of program process, collection of required customer demographic information and other pertinent data in an economically acceptable manner.

Honeywell DMC Services, Inc. provided the most impressive proposal and was awarded the contract. DMC immediately began the recruiting and training of local staff, provided promotional plans, installation guidelines, and developed appropriate channels of communication.

Kentucky Power's DSM Collaborative renewed the contract with DMC on an annual basis in 2004 and 2005 due to a backlog of applicants. Customer demand for the program exceeded original projections of 500 participants per year. The Collaborative selected DMC as

the program implementation contractor because the channels of communication between Kentucky Power and DMC had been established, the clerical and management staff were familiar with the promotional and installation guidelines, and the installers of the energy conservation measures were trained. Startup costs would have been duplicated if another vendor had been selected to continue the program.

During the evaluation period, the contract prices for the installation of energy conservation measures remained the same as originally stated in DMC's bid. To improve the cost-effectiveness of the program, the DSM Collaborative reduced the number of installed CFB's from 2 to 1 and eliminated the refrigerator coil cleaning measure on May 6, 2004.

**Program Promotion**

DMC, as agreed to in the terms of the original contract, was responsible for program promotion including participant recruitment, screening and scheduling. KPCo provided DMC with a database of residential customers who use a minimum of 1,000 kWh per month and assisted with the development of a direct mail recruitment letter. A copy of the direct mail promotional letter is shown in Appendix A.

Recruitment letters were sent to 1,383 customers in 2003 and 1,768 customers in 2004. The initial mailing of recruitment letters began in April, 2003 with additional mailings being sent in May, June, July, August and November of 2003. The mailing of recruitment letters for 2004 began in January with additional mailings being sent in February, April, May, September, and October of 2004. Additional participants were obtained by referrals from program participants. The Company was successful in securing 542 participants in 2003 and 725 in 2004.

**Program Implementation**

The Scope of Work clarified contractor and the Company responsibilities and set forth program goals and guidelines for the contractor to follow. The Company and the contractor worked closely during the implementation design phase of the Program. Regular communications between the Company and DMC helped resolve any questions or situations that developed. Periodic quality control inspections were conducted by the Company to ensure the quality of installed energy conservation measures. Participant data was requested from DMC on an annual basis to ensure data collection guidelines were being followed.

# IV. DATA COLLECTION

Data collection was extensive for the MEF Program so that an appropriate and comprehensive home energy analysis could be performed. The energy analysis included the load impact from the results of installing the multiple weatherization and other energy conservation measures in the home. The data collection also enabled the projection of load impacts for any recommended measure to be installed. This information was needed in order for the Company to perform appropriate process and impact evaluations of the program. The Company's evaluation objectives were: (1) determine the program's load impact, (2) assess the effectiveness of the program delivery mechanism and (3) assess the program's cost-effectiveness.

Data collection forms were used to obtain information on the customer's building structure, space heating/cooling system, hot water heating system and on the various weatherization and other energy conservation measures installed in the home. No demographic survey was conducted because DMC already collected demographic information (type of building, age of home, size of home). The Company and the Collaborative did not see a need for a survey to collect education level and income level of participants.

DMC completed the necessary data collection forms at the customer's home and then input the information into a computerized database at their office.

A. HomeSTAR Data Collection Form

DMC's HomeSTAR Data Collection Form was actually a set of individual forms used to record specific information on participants shown in Appendix B. The first form was designed to collect customer information such as home address, phone number, customer's account number, owner information, and demographic information. This form was also used to record specific information on each home's structural, thermal characteristics, heating and cooling system

characteristics, water heating system characteristics, compact fluorescent bulb installations and blower door test results. Additional information was also provided to the field technician to determine HVAC and water heating system efficiency, and building components' heat losses and heat transfer coefficients.

# V. PROCESS EVALUATION

The process evaluation of the MEF program utilized the installation data, recruitment tracking data, and customer demographic information collected by DMC throughout the evaluation period to evaluate the delivery mechanism, promotional effectiveness and performance of the measures installed. The process evaluation, along with the impact evaluation, serves as a means to gauge the effectiveness in promoting a home energy efficiency program of this nature.

Delivery Mechanism: Kentucky Power Company provided DMC with a database of residential customers who use a minimum of 1,000 kWh per month and assisted with the development of a direct mail recruitment letter. The recruitment letter was sent to a total of 3,151 customers during the evaluation period. The goal of the Modified Energy Fitness Program was to target 500 customers each year, but due to overwhelming endorsement of the KPCo customers, the program was successful and reached 542 participants in 2003 and 725 in 2004. A copy of the direct mail recruitment letter is shown in Appendix A.

Promotional/Advertising Effectiveness: The program was promoted primarily through telemarketing services by DMC to the qualified customers and secondarily by participant referrals.

# VI. IMPACT EVALUATIONS

Findings

The KPCo Modified Energy Fitness (MEF) Program's net total annual energy savings is estimated to be 2,899 MWh (which includes 10% Transmission and Distribution loss savings). This corresponds with a 2,525 ton reduction in carbon dioxide ($CO_2$) emissions, a 20 ton reduction in sulfur dioxide ($SO_2$) emissions, and a 6 ton reduction in nitrogen oxide ($NO_x$) emissions based on two years of actual and one year of estimated participation. Each participant experienced an average savings of 1,453 kWh at the meter. The net total demand reduction was 1,086 kW in winter and 352 kW in summer (including 11% Transmission and Distribution loss savings). These impacts translate into 0.544 kW and 0.176 kW net reductions per participant at the meter in winter and summer, respectively. For the above impact values, the freeridership, persistence and snapback effects were assumed from previous studies. Table 1 summarizes the load impact of the MEF Program.

**Table 1: Average Load Impacts**

| | 2003 | 2004 | 2005 Estimated | MEF Program |
|---|---|---|---|---|
| **Annual Energy Savings/Participant** | 1,430 kWh | 1,572 kWh | 1,361 kWh | 1,453 kWh |
| **Winter Demand Reduction/Participant** | 0.54 kW | 0.54 kW | 0.54 kW | 0.54 kW |
| **Summer Demand Reduction/Participant** | 0.18 kW | 0.18 kW | 0.18 kW | 0.18 kW |
| **Net Total Annual Energy Savings[1]** | 837,803 kWh | 1,067,581 kWh | 993,729 kWh | 2,899,112 kWh |
| **Net Winter Demand Reduction[2]** | 305 kW | 389 kW | 393 kW | 1,086 kW |
| **Net Summer Demand Reduction[2]** | 98 kW | 131 kW | 122 kW | 352 kW |
| (1) Includes 10% Transmission and Distribution Loss Savings | | | | |
| (2) Includes 11% Transmission and Distribution Loss Savings | | | | |

Participant Classification

The MEF Program is offered to customers with electric water heating and electric space heating. As of end of year 2003 there were 542 participants in the program, of which approximately 62.6% had an electric heat pump, 7.7% had an electric resistance baseboard

heating, and 29.7% had an electric furnace or boiler. Table 2 summarizes the participants' space heating characteristics.

**Table 2: Space Heating Characteristics**

| Type | Saturation | | |
|---|---|---|---|
| | 2003 | 2004 | MEF Program |
| Electric Heat Pump | 62.6% | 56.2% | 59.0% |
| Electric Resistance Heating | 7.7% | 4.9% | 6.1% |
| Electric Furnace or Boiler | 29.7% | 38.9% | 34.9% |

Energy Impact Analysis

The following energy impact analysis uses data/assumptions gathered from the Energy Fitness Program evaluation of January 1996 – December 1998 to determine the inputs to the cost/benefit analysis unless otherwise indicated by year in which the data was recorded.

Electric Water Heater Conservation Measures:

To estimate base energy consumption for a typical water heater in the program in Kentucky, AEP electric water heating end-use metering results were used as a starting point. A preliminary water heater average consumption was 4,020 kWh for a typical water heater of 10 years old and tank size of 46 gallons with thermostat setting of 129°F. However, this base energy consumption had to be adjusted for tank size and efficiency to represent a typical water heater for the MEF Program. A typical water heater in the MEF Program was assumed to be approximately 45 (2003) and 43 (2004) gallons in size. The typical water heater efficiency over the two years was approximately 85%. As a result of adjustment for tank size and efficiency, a preliminary base energy consumption of 3,952 kWh, and 3,938 kWh was derived for 2003 and 2004 participants, respectively. Appendix D summarizes the assumptions for the base load calculation.

The impact for the water heater energy conservation measures was calculated separately for each participant because not every participant received all the measures. As a starting point, the individual participant's water heater energy consumption was calculated based on the data gathered by the program contractor, DMC, regarding the vintage year, tank size, temperature setting and efficiency of the water heater.

The next step in the evaluation process was to determine the impact of thermostat setback on the water heater energy consumption. On average, the water heater temperature was set back about 13°F to18°F, which resulted in an overall two year average annual energy savings of 364 kWh. In addition, due to the interactions between the water heater measures, the individual participant's water heater energy savings was affected by what measures were installed in their home. For example, due to reduced standby losses as a result of installation of a water heater jacket, the impact for an energy-saving showerhead and faucet aerators would be reduced for a participant receiving those measures.

A typical water heater system in the program had 16% tank losses and 3% distribution losses for a total of 19% system losses. The water heater jacket used in the program covered the top and side of the tank, and was assumed to reduce tank standby losses by 41%. Tank standby losses for the average water heater were calculated to be 616 kWh for participants receiving a water heater jacket and therefore a water heater jacket reduced these losses by 252 kWh, which was an average.

The pipe wrap reduced water heating distribution losses by 33% (for a minimum of 6 feet of wrap). The losses in the distribution system were 3% of the base energy, or approximately 118 kWh. Therefore, the average energy savings due to the pipe wrap was estimated to be 37 kWh for a participant in the program.

The energy savings contributed to an energy-saving showerhead is the sum of the water heater's useful energy plus reduced system standby losses. The energy-saving showerhead reduced the water usage by reducing the flow rate of water at the showerhead. It was assumed that showering typically uses 40% of the hot water's useful energy for a home having two showers. Therefore, for participants receiving energy-saving showerheads, the typical useful energy used for showering in a two-shower home was estimated to be 1,291 kWh. The typical water flow rates before and after the energy-saving showerhead installation were assumed to be 3.65 gpm and 2.5 gpm, respectively. In other words, the energy-saving showerhead's flow rate was approximately 68% of the old showerhead, resulting in a 32% savings in the hot water useful energy. If only one showerhead was replaced, the savings was assumed to be 60% of the savings for a two-shower home or 19% (0.6x32%=19%). The average useful energy savings for all participants over the evaluation period receiving energy saving shower heads was about 323 kWh per participant.

The system standby losses due to the energy-saving showerhead was less if a water heater jacket and pipe installation were installed in the home, since the standby losses had already been reduced. As a result of these interactions, the total energy savings of useful energy and system standby losses per participant attributed to an installation of an energy-saving showerhead was estimated to be 381 kWh.

Faucet aerators also reduced hot water usage by reducing the flow rate of water at the faucet. The energy savings due to installation of aerators is the sum of the water heater's useful energy savings plus reduced system standby losses. Approximately 6% of the hot water usage in a home is attributed to faucet usage which was 187 kWh for participants receiving faucet aerators (assuming 4 faucets per home). It was estimated that faucet aerators reduce the amount of hot

water consumption by 66%. But, on average, 1.5 aerators were installed in each home. Therefore, the faucet useful energy required was reduced by 46 kWh. The total average savings per participant attributed to installation of an average of 1.5 faucet aerators per home (including the interaction for pipe wrap and water heater jacket in the system standby losses) was estimated to be 58 kWh.

Lighting Measure:

Characteristics of the bulbs replaced by the compact fluorescent bulbs were gathered by DMC at the time of installation. The information regarding the wattage, and the number of hours of use per day of the bulb which was replaced by the CFB was used in the analysis. The results from participant usage indicated that the typical daily use of a light bulb replaced with a CFB was approximately 4.9 hours a day and had an average wattage of 76 W. The hourly energy savings per CFB was calculated to be 53 Wh. The annual energy savings/bulb was calculated by multiplying average daily hours of operation (4.9 hour) times 351 day/year (assuming two week vacation) to arrive at 91 kWh/bulb.

Refrigerator/Freezer Coil Cleaning Measure:

Refrigerators and freezers are normally the largest energy consuming electrical appliances next to electric space heating/cooling system and electric water heating systems. As the refrigerator or freezer coils collect dirt and dust, the unit's operational efficiency decreases. Therefore, the cleaning of condenser coils can increase the efficiency of a refrigerator or freezer and thereby reduce the energy consumption by up to 10%. For MEF participants, it was estimated that cleaning refrigerator or freezer condenser coils resulted in an annual energy savings of 138 kWh/unit.

Waterbed Cover:

Energy savings due to the installation of a waterbed cover were based on information obtained from the end-use metering of waterbeds conducted in an AEP DSM Program in another jurisdiction. The results of the end-use metering showed an estimated annual energy savings of 912 kWh.

Weatherization Measure:

Blower door tests were used to quantify the air flow rate before and after the installation of the weatherization measures. The DMC representative gathered blower door test data on the air flow rate and recorded the cubic feet per minute (CFM), and air changes per hour (ACH) which depends on volume of the home. This information was used to calculate the weatherization impacts. It should be noted that the weatherization measure energy impacts varied according to electric space heating system type (electric resistance, electric furnace or electric heat pump) due to their different heating efficiencies and performance characteristics.

The equations in Appendix E were used to estimate the energy savings due to weatherization measures for different types of space heating during the winter season (October

through April) and for space cooling during the summer season (May through September). Based on blower door test results, a participant in the MEF Program saved an average of 322 kWh during the heating season for the evaluation period. In addition, a participant which had air conditioning saved an average of 119 kWh during the summer season. Taking into consideration that not all participants had air conditioning the total average savings per participant was 420 kWh for the evaluation period. The results from the blower door test analysis are summarized in Table 3.

Programmable Thermostat Measure:

Annual energy savings for 2003 and 2004 participants was calculated using energy savings formulas provided by DMC. The savings was calculated by taking the seasonal usage multiplied by a usage factor (0.83) multiplied by a savings factor (0.03) multiplied by the average of the day, evening, and night setbacks. Based on those who set back their thermostat, the programmable thermostat measure has an annual energy savings per participant of 1,365 kWh.

## Table 3: Weatherization Load Impact Evaluation

## KENTUCKY POWER COMPANY

## Modified Energy Fitness (MEF) Program

| | 2003 | 2004 |
|---|---|---|
| **Winter Season Heating Energy Savings by Space Heating Type (kWh)** | | |
| Electric Resistance | 665 | 468 |
| Electric Heat Pump | 245 | 298 |
| Electric Furnace | 360 | 369 |
| Weighted Average per Participant | 311 | 334 |
| **Summer Season Cooling Energy Savings (kWh)** | | |
| Average/Participant | 103 | 118 |
| **Total Weatherization Energy Savings (kWh)** | | |
| Average/Participant | 468 | 502 |
| Note: Only 99% (2003) and 99% (2004) of participants had air conditioning | | |

Demand Impact Analysis

The following demand impact analysis uses data gathered from the Energy Fitness Program evaluation of January 1996 – December 1998 to determine the inputs to the cost/benefit analysis unless otherwise indicated by year in which the data was recorded.

Electric Water Heater Energy Conservation Measures:

Demand impacts for water heater energy conservation measures were taken from the results of similar programs in other jurisdictions of the AEP System, and adjusted to reflect for the characteristics of water heaters of participants in the MEF Program. The average demand reduction due to the installation of a water heater jacket was estimated to be 0.022 kW and 0.025 kW at the time AEP System peak in winter and summer, respectively. In addition, the average AEP coincident peak demand reductions attributed to installation of an energy-saving showerhead were 0.133 kW in winter and 0.050 kW in summer. The demand reduction for participants with water heater setback was estimated to be 0.068 kW and 0.038 kW at the time of AEP winter and summer peak, respectively. The pipe wrap demand reductions were estimated to be 0.004 kW for both winter and summer peak. The demand savings for faucet aerators were estimated to be 0.021 kW in winter and 0.008 kW in summer.

Lighting Measures:

Peak demand savings for the CFB was estimated by multiplying the coincident factor for the CFB by the average hourly demand reduction to arrive at 0.009 kW/bulb for both summer and winter peak. The coincident factor is the proportion of time that the bulb is on at the time of the AEP system peak. This was estimated to be 20%, based upon the results of a similar CFB program in APCO's West Virginia jurisdiction. The average hourly demand reduction was derived from the wattage difference between the replaced bulb and the CFB.

Weatherization Measures:

The demand reductions for the weatherization measures for an average participant in the program was estimated based on the annual average energy savings and the application of a load factor estimated from other field studies to arrive at a demand reduction of 0.288 kW and 0.032 kW for winter and summer peak, respectively.

Refrigerator/Freezer Coil Cleaning Measure:

The refrigerator/freezer demand reductions, as a result of application of coil cleaning measures were estimated to be 0.015 kW and 0.019 kW for winter and summer peak demand, respectively.

Programmable Thermostat Measure

The demand reductions as the result of installing a programmable thermostat were estimated to be 0.317 kW and 0.205 kW for winter and summer peak demand, respectively.

Summary of Energy and Demand Impact Analysis

The energy and demand impact results for 2003 and 2004 participants and total participants of the MEF program are summarized in Tables 4-1 through 4-4 shown below.

# Kentucky Power Company
# Modified Energy Fitness (MEF) Program

## Table 4-1: 2003 Summarization of Load Impact For Participants Added in 2003

| | Energy Reduction (kWh) | | | | Demand Reduction (kW) | | | |
|---|---|---|---|---|---|---|---|---|
| | kWh Reduction per Part. | # of Part. | Freeriders | Net Total Program | Per Participant | | Net Total Program | |
| Measure | (1) | (2) | (3) | (4) | Winter | Summer | Winter | Summer |
| Water Heater | | | | | | | | |
| Thermostat Setback | 364 | 8 | 0% | 2,912 | 0.068 | 0.038 | 0.5 | 0.3 |
| Water Heater Jacket | 252 | 87 | 25% | 16,443 | 0.022 | 0.025 | 1.9 | 2.2 |
| Pipe Wrap | 37 | 256 | 25% | 7,104 | 0.004 | 0.004 | 1.0 | 1.0 |
| Faucet Aerator | 46 | 223 | 25% | 7,741 | 0.021 | 0.008 | 4.7 | 1.8 |
| Energy Saving Showerhead | 381 | 429 | 25% | 122,636 | 0.133 | 0.050 | 57.1 | 21.5 |
| Weatherization | | | | | | | | |
| Blower Door Test/Seal Up* | 485 | 586 | 0% | 284,210 | 0.288 | 0.032 | 168.9 | 18.7 |
| Miscellaneous | | | | | | | | |
| Compact Fluorescent Bulb | 91 | 586 | 5% | 101,319 | 0.009 | 0.009 | 5.3 | 5.3 |
| Coil Cleaning Refrigerator | 138 | 584 | 20% | 64,474 | 0.015 | 0.019 | 8.8 | 11.1 |
| Programmable Thermostat | 1,365 | 176 | 5% | 228,228 | 0.317 | 0.205 | 55.8 | 36.0 |
| Water Bed Cover | 912 | 4 | 25% | 2,736 | 0.130 | 0.068 | 0.5 | 0.3 |
| Total Net Load Impact (including losses)** | | | | 837,803 | | | 304.5 | 98.2 |

* Not all participants had air conditioning

** Including 10% and 11% transmission and distribution loss savings for energy and demand impacts

## Table 4-2: 2004 Summarization of Load Impact For Participants Added in 2004

| | Energy Reduction (kWh) | | | | Demand Reduction (kW) | | | |
|---|---|---|---|---|---|---|---|---|
| | kWh Reduction per Part. | # of Part. | Freeriders | Net Total Program | Per Participant | | Net Total Program | |
| Measure | (1) | (2) | (3) | (4) | Winter | Summer | Winter | Summer |
| Water Heater | | | | | | | | |
| Thermostat Setback | 364 | 110 | 0% | 40,040 | 0.068 | 0.038 | 7.5 | 4.2 |
| Water Heater Jacket | 252 | 50 | 25% | 9,450 | 0.022 | 0.025 | 1.1 | 1.3 |
| Pipe Wrap | 37 | 224 | 25% | 6,216 | 0.004 | 0.004 | 1.0 | 1.0 |
| Faucet Aerator | 46 | 267 | 25% | 9,268 | 0.021 | 0.008 | 5.6 | 2.1 |
| Energy Saving Showerhead | 381 | 504 | 25% | 144,076 | 0.133 | 0.050 | 67.0 | 25.2 |
| Weatherization | | | | | | | | |
| Blower Door Test/Seal Up* | 485 | 679 | 0% | 329,315 | 0.288 | 0.032 | 195.7 | 21.7 |
| Miscellaneous | | | | | | | | |
| Compact Fluorescent Bulb | 91 | 468 | 5% | 80,917 | 0.009 | 0.009 | 4.2 | 4.2 |
| Coil Cleaning Refrigerator | 138 | 255 | 20% | 28,152 | 0.015 | 0.019 | 3.8 | 4.8 |
| Programmable Thermostat | 1,365 | 324 | 5% | 420,147 | 0.317 | 0.205 | 102.8 | 66.3 |
| Water Bed Cover | 912 | 0 | 25% | 0 | 0.130 | 0.068 | 0.0 | 0.0 |
| Total Net Load Impact (including losses)** | | | | 1,067,581 | | | 388.7 | 130.8 |

* Not all participants had air conditioning

** Including 10% and 11% transmission and distribution loss savings for energy and demand impacts

## Table 4-3: 2005 Estimation of Load Impact For Participants Added in 2005

| | Energy Reduction (kWh) | | | | Demand Reduction (kW) | | | |
|---|---|---|---|---|---|---|---|---|
| | kWh Reduction per Part. | # of Part. | Freeriders | Net Total Program | Per Participant | | Net Total Program | |
| Measure | (1) | (2) | (3) | (4) | Winter | Summer | Winter | Summer |
| Water Heater | | | | | | | | |
| Thermostat Setback | 364 | 68 | 0% | 24,752 | 0.068 | 0.038 | 4.6 | 2.6 |
| Water Heater Jacket | 252 | 79 | 25% | 14,931 | 0.022 | 0.025 | 1.7 | 2.0 |
| Pipe Wrap | 37 | 277 | 25% | 7,687 | 0.004 | 0.004 | 1.0 | 1.0 |
| Faucet Aerator | 46 | 283 | 25% | 9,823 | 0.021 | 0.008 | 5.9 | 2.3 |
| Energy Saving Showerhead | 381 | 538 | 25% | 153,795 | 0.133 | 0.050 | 71.6 | 26.9 |
| Weatherization | | | | | | | | |
| Blower Door Test/Seal Up* | 485 | 730 | 0% | 354,050 | 0.288 | 0.032 | 210.4 | 23.3 |
| Miscellaneous | | | | | | | | |
| Compact Fluorescent Bulb | 91 | 608 | 5% | 52,562 | 0.009 | 0.009 | 5.5 | 5.5 |
| Coil Cleaning Refrigerator | 138 | 0 | 20% | 0 | 0.015 | 0.019 | 0.0 | 0.0 |
| Programmable Thermostat | 1,365 | 289 | 5% | 374,761 | 0.317 | 0.205 | 91.7 | 59.1 |
| Water Bed Cover | 912 | 2 | 25% | 1,368 | 0.130 | 0.068 | 0.3 | 0.1 |
| Total Net Load Impact (including losses)** | | | | 993,729 | | | 392.7 | 122.8 |
| * Not all participants had air conditioning | | | | | | | | |
| ** Including 10% and 11% transmission and distribution loss savings for energy and demand impacts | | | | | | | | |

## Table 4-4: 2003 - 2005 Summarization of Load Impacts For Participants Added in 2003 - 2005

| | Energy Reduction (kWh) | | | | Demand Reduction (kW) | | | |
|---|---|---|---|---|---|---|---|---|
| | kWh Reduction per Part. | # of Part. | Freeriders | Net Total Program | Per Participant | | Net Total Program | |
| Measure | (1) | (2) | (3) | (4) | Winter | Summer | Winter | Summer |
| Water Heater | | | | | | | | |
| Thermostat Setback | 364 | 186 | 0% | 67,704 | 0.068 | 0.038 | 12.6 | 7.1 |
| Water Heater Jacket | 252 | 216 | 25% | 40,824 | 0.022 | 0.025 | 4.8 | 5.4 |
| Pipe Wrap | 37 | 757 | 25% | 21,007 | 0.004 | 0.004 | 3.0 | 3.0 |
| Faucet Aerator | 46 | 773 | 25% | 26,832 | 0.021 | 0.008 | 16.2 | 6.2 |
| Energy Saving Showerhead | 381 | 1,471 | 25% | 420,506 | 0.133 | 0.050 | 195.6 | 73.6 |
| Weatherization | | | | | | | | |
| Blower Door Test/Seal Up* | 485 | 1,995 | 0% | 967,575 | 0.288 | 0.032 | 574.9 | 63.7 |
| Miscellaneous | | | | | | | | |
| Compact Fluorescent Bulb | 91 | 1,662 | 5% | 234,798 | 0.009 | 0.009 | 15.0 | 15.0 |
| Coil Cleaning Refrigerator | 138 | 839 | 20% | 92,626 | 0.015 | 0.019 | 12.6 | 15.9 |
| Programmable Thermostat | 1,365 | 789 | 5% | 1,023,136 | 0.317 | 0.205 | 250.4 | 161.4 |
| Water Bed Cover | 912 | 6 | 25% | 4,104 | 0.130 | 0.068 | 0.8 | 0.4 |
| Total Net Load Impact (including losses)** | | | | 2,899,112 | | | 1,085.9 | 351.7 |
| * Not all participants had air conditioning | | | | | | | | |
| ** Including 10% and 11% transmission and distribution loss savings for energy and demand impacts | | | | | | | | |

# VII. COST/BENEFIT EVALUATION

Results

Cost/benefit analyses of DSM programs may be performed using either a historical basis or a prospective basis. From a historical basis, actual costs and load impacts for DSM programs participants during a historical period (such as the first year of a program) are utilized to assess the net benefits. The net benefits may be calculated over a 20-year period for the first year's participants. These are after-the-fact analyses which could be utilized to determine the cost-effectiveness of previous activity, but may not by representative of the future and therefore, should not be the basis for DSM program decision-making.

Cost/benefit analyses from a prospective basis anticipate future DSM program participation, costs and impacts. These analyses expand upon actual field experience (cost, impact, etc.) to estimate the net benefit from projected implementation in the future. The foundation of DSM program knowledge serves as a basis to estimate projected costs, impacts, etc. This is the real value of field experience: applying what has been learned to guide decisions on future DSM program implementation.

On a prospective basis, the MEF Program is found to be cost effective using the TRC and UC tests. Prospective basis means that the cost benefit analysis was run for 20 years with the base year being 2003. The actual number of participants was used for the first two years, and the expected number of participants was used for the last year. The Participant Test was not applicable since there were no participant costs in the program. However, the RIM results which are more significant in today's environment are strongly negative.

| B/C Ratio | Economic Test |
|---|---|
| | |
| 2.92 | Total Resource Test |
| 0.80 | Rate Impact Measure |
| 3.40 | Utility Cost |
| N/A | Participant |

Assumptions

I. Program Costs (2003 $)

The cost/benefit analysis was performed using projected program costs based on the actual program costs realized in 2003 but adjusted to exclude any one-time costs such as meters and contractor's startup costs. The program evaluation period covers years 2003 – 2004 with a total of 1,267 participants. The total MEF Program costs were $479,964 (as of December 31, 2004), including promotional/administrative, customer incentives, evaluation and other miscellaneous costs. The average per participant cost was approximately $378.

A breakdown of actual program costs for year 2003 and 2004 are outlined in Table 5.

**Table 5: Actual Program Costs**

| | 2003 | 2004 | Program |
|---|---|---|---|
| Promotional and Administrative (excluding Company labor) | $ 0 | $ 0 | $ 0 |
| Evaluation | $ 2,807 | $ 196 | $ 3,003 |
| Contractor | $ 201,870 | $ 275,091 | $ 476,961 |
| **Total Program Cost** | **$ 204,677** | **$ 275,287** | **$ 479,964** |

The anticipated program costs used in the cost/benefit on per participant basis are shown in Table 2. The anticipated promotional and administration costs, along with contractor costs are expected to increase in the future, therefore, the average cost per participants increases by $10.

**Table 6: Anticipated Costs**

| Costs Used in Cost/Benefit Analysis | Per Participant |
|---|---|
| Promotional and Adminstrative | $ 10 |
| Evaluation Cost (including AEP Labor) | $ 22 |
| Contractor | $ 330 |
| **Total** | **$ 362** |

II. Load Impacts (Average-Per-Participant)

A. Compact Fluorescent Bulb

| | |
|---|---|
| Annual Energy Savings | 91 kWh |
| Winter Demand Reduction (at time of AEP peak) | 0.009 kW |
| Summer Demand Reduction (at time of AEP peak) | 0.009 kW |
| Life | 6 years |
| Freeriders | 5 % |
| Program Participation Level | 83.3 % |

B. Low Cost Water Heating (WH) Measures

| **Low Cost Water Heating (WH) Measures** | **Pipe Wraps & Faucet Aerators** | **WH Thermostat Setback** |
|---|---|---|
| Annual Energy Savings | 85 kWh | 364 kWh |
| Winter Demand Reduction (at time of AEP peak) | 0.021 kW | 0.068 kW |
| Summer Demand Reduction (at time of AEP peak) | 0.008 kW | 0.038 kW |
| Life | 10 years | 6 years |
| Freeriders | 25 % | 0 % |
| Program Participation Level | 38.3 % | 9.3 % |

C. Water Heater Jacket and Energy Saving Showerhead

| **Water Heater Jacket and Energy Saving Showerhead** | **Water Heater Jacket** | **Energy Saving Showerheads 1-2** |
|---|---|---|
| Annual Energy Savings | 252 kWh | 381 kWh |
| Winter Demand Reduction (at time of AEP peak) | 0.022 kW | 0.133 kW |
| Summer Demand Reduction (at time of AEP peak) | 0.025 kW | 0.050 kW |
| Life | 6 years | 20 years |
| Freeriders | 25 % | 25 % |
| Program Participation Level | 10.8 % | 73.7 % |

D. Weatherization Measures

| | |
|---|---|
| Annual Energy Savings | 485 kWh |
| Winter Demand Reduction (at time of AEP peak) | 0.288 kW |
| Summer Demand Reduction (at time of AEP peak) | 0.032 kW |
| Life | 15 years |
| Freeriders | 0 % |
| Program Participation Level | 100 % |

E. Waterbed Covers Measure

| | |
|---|---|
| Annual Energy Savings | 912 kWh |
| Winter Demand Reduction (at time of AEP peak) | 0.130 kW |
| Summer Demand Reduction (at time of AEP peak) | 0.068 kW |
| Life | 3 years |
| Freeriders | 25 % |
| Program Participation Level | 0.3 % |

F. Refrigerator Coil Cleaning Measure

| | |
|---|---|
| Annual Energy Savings | 138 kWh |
| Winter Demand Reduction (at time of AEP peak) | 0.015 kW |
| Summer Demand Reduction (at time of AEP peak) | 0.019 kW |
| Life | 2 years |
| Freeriders | 20 % |
| Program Participation Level | 42.1 % |

G. Programmable Thermostat Measure

| | |
|---|---|
| Annual Energy Savings | 1,365 kWh |
| Winter Demand Reduction (at time of AEP peak) | 0.317 kW |
| Summer Demand Reduction (at time of AEP peak) | 0.205 kW |
| Life | 15 years |
| Freeriders | 5 % |
| Program Participation Level | 39.5 % |

H. Average MEF Load Impact per Participant

| | |
|---|---|
| Annual Energy Savings | 1,453 kWh |
| Winter Demand Reduction (at time of AEP peak) | 0.544 kW |
| Summer Demand Reduction (at time of AEP peak) | 0.176 kW |

# Appendix A: Sample of Direct Mail Letter

AEP AMERICAN ELECTRIC POWER

Kentucky Power Company
Modified Energy Fitness Program
11233 Kevin Avenue
Ashland, KY 41102

# KENTUCKY POWER COMPANY

## The **Modified Energy Fitness Program is a Free weatherization program** for **Kentucky Power's** All Electric Customers.

**Kentucky Power** is committed to their customers and the environment. We have been serving your energy needs for more than 80 years. We have created a program to help with both. The **Modified Energy Fitness Program** is designed to help you save energy while maintaining your level of comfort. The program identifies key areas within your home where you are losing valuable energy. Honeywell DMC Services, a nationally recognized energy management firm, has been contracted by **Kentucky Power** to provide this residential energy efficiency service to our qualified customers.

To qualify for the program you must: **have a billed usage of over 1000 kWh monthly, own a single family home, heat with electricity**, and **have an electric hot water heater. (Program is not available to gas customers)**

**By participating in The Modified Energy Fitness Program you will receive:**

- **Free** Air Infiltration Diagnostic Test
- **Free** Customized Report
- **Free** Energy Savings Booklet
- **Free** Energy Conservation Measures *(Installation of measures is solely based on determined need by the auditor)*:
  - * Hot Water Tank Insulating Blanket
  - * Pulsating Low Flow Showerhead
  - * Low Flow Faucet Aerators
  - * Weatherstripping / Caulking / Doorsweep
  - * Duct Sealing
  - * Compact Fluorescent Light Bulbs
  - * Water Bed Insulation Cover
  - * Programmable Thermostat
  - * **All Free!!!!!!!!!!!!!!!!!!!!!!!!**

**A representative of Honeywell DMC Services will contact you to schedule an energy audit of your home within a few days of receiving this letter.** Remember that there is nothing to buy, and no follow-up sales call will result from your participation in the program. If you have any questions or wish to **enroll immediately, call 1-866-225-0686.**

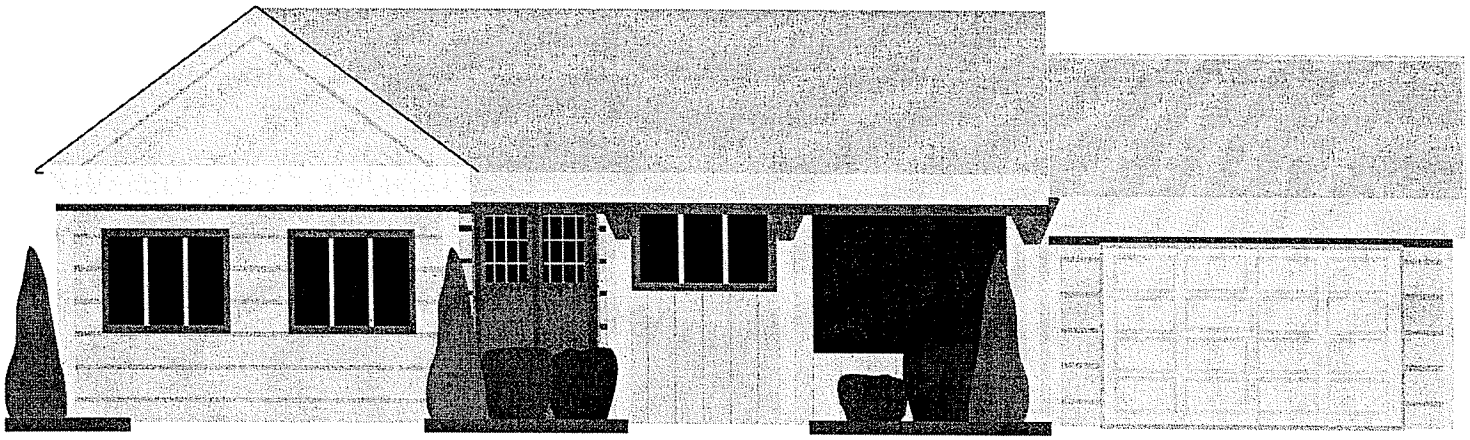
Sincerely

**Don Music**
Customer Services Coordinator
Kentucky Power 1-800-572-1113

Dan Sturdevant
Program Manager
Honeywell DMC Services

# Appendix B: Home STAR Data Collection Form

# HomeSTAR Data Collection Form



## Customer Information

Auditor Last Name

Audit Date ___/___/___

Customer First Name

Customer Last Name

Address

City/Town

State KY

Zip Code

Home Phone Number ___-___-___

Account Number ___-___-___-___-___

## Demographics

**Residence Type:**

- Single ☑
- Multifamily ☐

**Home Type:**

- Detached Garage ☐
- Attached End Garage ☐
- Attached Middle ☐
- Attached Vertical ☐
- Mobile Home ☐

**Conditioned Area:** ☐☐,☐☐☐

**Number of Stories Above Grade:** ☐

**Age of Home:** ☐☐

**Ownership Type:**

- Owner ☑
- Renter ☐

**Portion of Year In Home:**

- All Year ☐
- Winter Only ☐
- Summer Only ☐

**Number of Occupants:**

- Adults ☐
- Teens ☐
- Children ☐
- Seniors ☐

**Air Leakage/Condition Rating:**

- Tight **(Good - 01)** ☐
- Average **(Fair - 02)** ☐
- Drafty **(Poor - 03)** ☐

## Domestic Hot Water

**Fuel Type:**

- Electric ☑
- Gas ☐

**DHW Type:**

- Standard ☐
- Tankless Coil ☐
- Instantaneous ☐
- Solar ☐
- Other ☐

**Percent (%):** ☐☐☐

**Age:** ☐☐☐

**Size (gallons:** ☐☐

**Tank Wrap:**

- Not Needed **(AIP - 1)** ☐
- **Warning Label - 2** ☐
- **Poor Cond. - 3** ☐
- **No Access - 4** ☐
- **CDNW - 5** ☐
- Insulated ☐
- Needs Insulation ☐

**Conditioned Space:** Y ☐ N ☐

**Temp Before:** ☐☐☐

**Temp After:** ☐☐☐

**Pipe Insulation Type:**

- Not Needed ☐
- Insulated ☐
- Needs Insulation ☐

**Pipe Insul. Rec.(ft)** ☐☐

## Basement

**Type:**

- Full
- Crawl - Open
- Crawl - Enclosed
- Slab
- Garage, Under

**Rec. Insulation:**

- Insulated
- Needs Insulation

**Ceiling Sq. Ft.**

**Rim Joist Rec.**

- Not Needed
- Insulated
- Needs Insulation

**Perimeter:**

**Conditioned Space:** Y / N

**Ceiling Type:**

- Plaster - 1
- Wood - 2
- Stucco - 3
- Open - 4

**Insulation Present:**

- None - 0
- Cellulose - 1
- Fiber. Batts - 2
- Loose Fiber - 3
- Rock Wool - 4
- Urea Formldhyd - 5
- Other - 6

## Basement Cont.

**Add inches:**

**Recommend Wall Insulation:** Y / N

**Wall square Footage:**

**Basement Face:** N / S / E / W

**% of Basement above Grade:** %

## Heating System

**Fuel Type:** 1 (Electric ☑, Gas) 2 (Electric ☑, Gas)

**System Type:**

- Hot Water Boiler
- Air
- Resistance
- Heat Pump

**Size (Mbtus):** k

**Efficiency:**

**Heated Space (%):**

**Recommendation:**

- No Action
- System Maintenance
- Replacement

**Age:**

## Distribution

Type: 1 2

- Duct Round
- Duct Rect
- Elbows

Insulation Existing:

- Yes
- No

Insulation Rec. Y N Y N

Length

Location: 1 2 1 2

- Base Unisul - 1
- Base Insul. - 2
- Crawl - 3
- Attic Unisul. - 4
- Attic Insul. - 5
- Garage Uninsul. - 6
- Garage Insul. - 7

## Window AC

Total Window/Wall units:

Average Age of Units:

EER:

Units used:

- Never
- Rarely
- Sometimes
- Always

Daytime Setting:

Night Setback:

## Thermostat

Current Setting:

T-stat Type:

Setback Rec.(# of Deg.):

T-Stat set points:

- Day Temp
- Day Setback
- Night Temp
- Night Setback

## Cooling

Type: 1 2

- Central
- Heat Pump
- % of House
- Age:
- SEER:
- Tons: . .
- Temperature Setting:

Use:

- Never
- Rarely
- Sometimes
- Always

Recommendation:

- No Action
- System Maintenance
- Replacement

# Windows

**Type:**

- Double Hung
- Casement
- Fixed

**Size:**

- Small
- Medium
- Large
- Extra Large

**# of Glazings:**

**Quantity:**

**Condition:**

- Good
- Fair (W/S Caulk)
- Fair (Add Storm)
- Poor (Replace)

---

**Orientation:**

N
S
E
W

**Shading:**

- **None - 1**
- **Blnds/Drpe-2**
- **Shades - 3**

## Doors

**Type:**

- Solid
- Slider
- Atrium
- Steel

**Quantity:**

**Condition:**

- Good
- Fair (W/S Caulk)
- Fair (Add Storm)
- Poor (Replace)

**Shading:**

- **None - 1**
- **Blnds/Drpe-2**
- **Shades - 3**

**Orientation:**

N S E W

N S E W

N S E W

## Walls

**Type:** 1 2 3 4

- Other
- Wood
- Aluminum
- Brick
- Stucco
- Vinyl

## Walls Cont.

**Insulation Present:** 1 2 3 4

Y N

Y N

Y N

Y N

**Insulation Type:**

- None
- Cellulose
- Fiber. Batts
- Loose Fiber.
- Mineral/Rockwool
- UREA Formldhyd
- Other

**Length:** 1 2 3 4

**Height:** 1 2 3 4

**Orientation:**

N S E W

N S E W

N S E W

N S E W

**Partition Type:**

- **Open**
- **Closed**

**Wall Type:**

- **Exterior**
- **Partition**

**Siding Color:**

- **Light**
- **Dark**

## Attic

**Types:**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Floored | | | | |
| Unfloored | | | | |
| Knee wall | | | | |
| KW Flat Floored | | | | |
| KW Flat Unfloored | | | | |
| Flat Roof | | | | |

**Square Feet:**

1 ,  2 ,

3 ,  4 ,

**Insulation Type:**

| | | | | |
|---|---|---|---|---|
| None | | | | |
| Cellulose | | | | |
| Fiber. Batts | | | | |
| Loose Fiber. | | | | |
| Mineral/Rockwool | | | | |
| UREA Formldhyd | | | | |
| Other | | | | |

**Depth:** 1  2

3  4

**Rec. Insul. Type:**

| | | | | |
|---|---|---|---|---|
| None | | | | |
| Cellulose | | | | |
| Fiber. Batts | | | | |
| Loose Fiber. | | | | |
| Mineral/Rockwool | | | | |
| UREA Formldhyd | | | | |
| Other | | | | |

## Attic Cont.

**Recommended Inches:**

1  2  3  4

**Is Vent Required:**

| | | | |
|---|---|---|---|
| Y | Y | Y | |
| N | N | N | |

**Access Type:**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| No access avail. | | | | |
| Ceiling access | | | | |
| Knee wall | | | | |
| Pull down stairs | | | | |
| Temporary | | | | |
| Walk up stairway | | | | |
| Exterior access | | | | |

**Access Insul. Type:**

| | | | | |
|---|---|---|---|---|
| None | | | | |
| Cellulose | | | | |
| Fiber. Batts | | | | |
| Loose Fiber. | | | | |
| Mineral/Rockwool | | | | |
| UREA Formldhyd | | | | |
| Other | | | | |

**Access Insul. Rec.:**

| | | | | |
|---|---|---|---|---|
| Not Needed | | | | |
| Insulated | | | | |
| Needs Insul. | | | | |

## Lighting

**Location:** 1 2 3 4

- b-Bedroom
- d-Dining
- e-Exterior
- f-Family/Sitting
- h-Hallway
- k-Kitchen
- l-Living
- o-Office/Study
- p-Porch/utility
- w-Work/Shop

**Existing Quantity:**

1 2 3 4

**Watts:**

1 2 3 4

**Hours per Week:**

1 2 3 4

**Replace Watts:**

1 2 3 4

**Product Installed:**

23 Watt CFL

**Quantity Installed:**

1 2 3 4

**Quantity Rec.:**

1 2 3 4

## Refrigerator

**Size:**

1 2 3 4

**Defrost Type:** 1 2 3 4

- Manual
- Automatic

**Style:**

- Side by Side
- Freezer Top
- Freezer Bottom

**Age:**

1 2 3 4

**Make:** _____

**Model:** _____

**Measure/Table Usage:**

1 2 3 4

**Recommendation:**

- Leave alone
- Replace
- Remove

## Freezer

**Size:** 1 2 3 4

**Auto Defrost:** Y / N

**Age:** 1 2 3 4

**Style:**

- Upright
- Chest

**Recommendation:**

- Leave alone
- Replace
- Remove

## Appliances

| | | | | |
|---|---|---|---|---|
| **Kitchen Aerator:** | | Y | | N |
| **Low-Flow Showerhead:** | | Y | | N |
| **Bathroom Aerator:** | | Y | | N |
| **Bathroom Ventilated:** | | Y | | N |
| **Ventilation Needed:** | | Y | | N |

## Pool/Hot Tub

**Pool Heater Fuel:**

- Gas
- Electric

**Pool Temp. Setting:**

**Pool Cover:**

- No Cover
- Solar Cover
- Other

**Covered % of Time:**

**Hot Tub Size (gallons):**

**Hot Tub Location:**

- Outside
- Inside

**Hot Tub Temp. Setting:**

## Appliance List

| Appliance: | Quantity | Hrs. Use |
|---|---|---|
| Electric Range/Stove | | |
| Gas Range/Stove | | |
| Clothes Washer | | |
| Gas Dryer | | |
| Electric Dryer | | |
| Attic Fan | | |
| Ceiling Fan | | |
| Dehumidifier | | |
| Sump Pump | | |
| Pool Pump | | |
| Humidifier | | |
| Electric Blanket | | |
| Waterbed | | |
| Stereo | | |
| Color TV | | |
| B&W TV | | |
| Aquarium | | |
| Computer | | |
| Laser Printer | | |
| Fax Machine | | |
| Well Pump | | |
| Microwave | | |
| Dishwasher | | |
| Other | | |

## PRE-TEST

Number of Floors

Number of Occupants

Outside Temp.

Inside Temp.

Volume

Surface Area

Minimum Vent.

Windshield Factor

Shielded

Average

Exposed

| | House | Fan Pressure | Fan Configuration | CFM Airflow |
|---|---|---|---|---|
| 1 | | | O A B C | |
| 2 | | | O A B C | |
| 3 | | | O A B C | |
| 4 | | | O A B C | |
| 5 | | | O A B C | |

CFM @ 50

AC/H

Correlation Coefficient r= 0.99

Flow Coefficient c= . 

Exponent n= .

## POST-TEST

Number of Floors

Number of Occupants

Outside Temp.

Inside Temp.

Volume

Surface Area

Minimum Vent.

Windshield Factor

Shielded

Average

Exposed

| | House | Fan Pressure | Fan Configuration | CFM Airflow |
|---|---|---|---|---|
| 1 | | | O A B C | |
| 2 | | | O A B C | |
| 3 | | | O A B C | |
| 4 | | | O A B C | |
| 5 | | | O A B C | |

CFM @ 50

AC/H

Correlation Coefficient r= 0.99

Flow Coefficient c= . 

Exponent n= .

## PRESSURE PAN TEST

**CAPTURE ALL PRESSURE PAN READINGS**

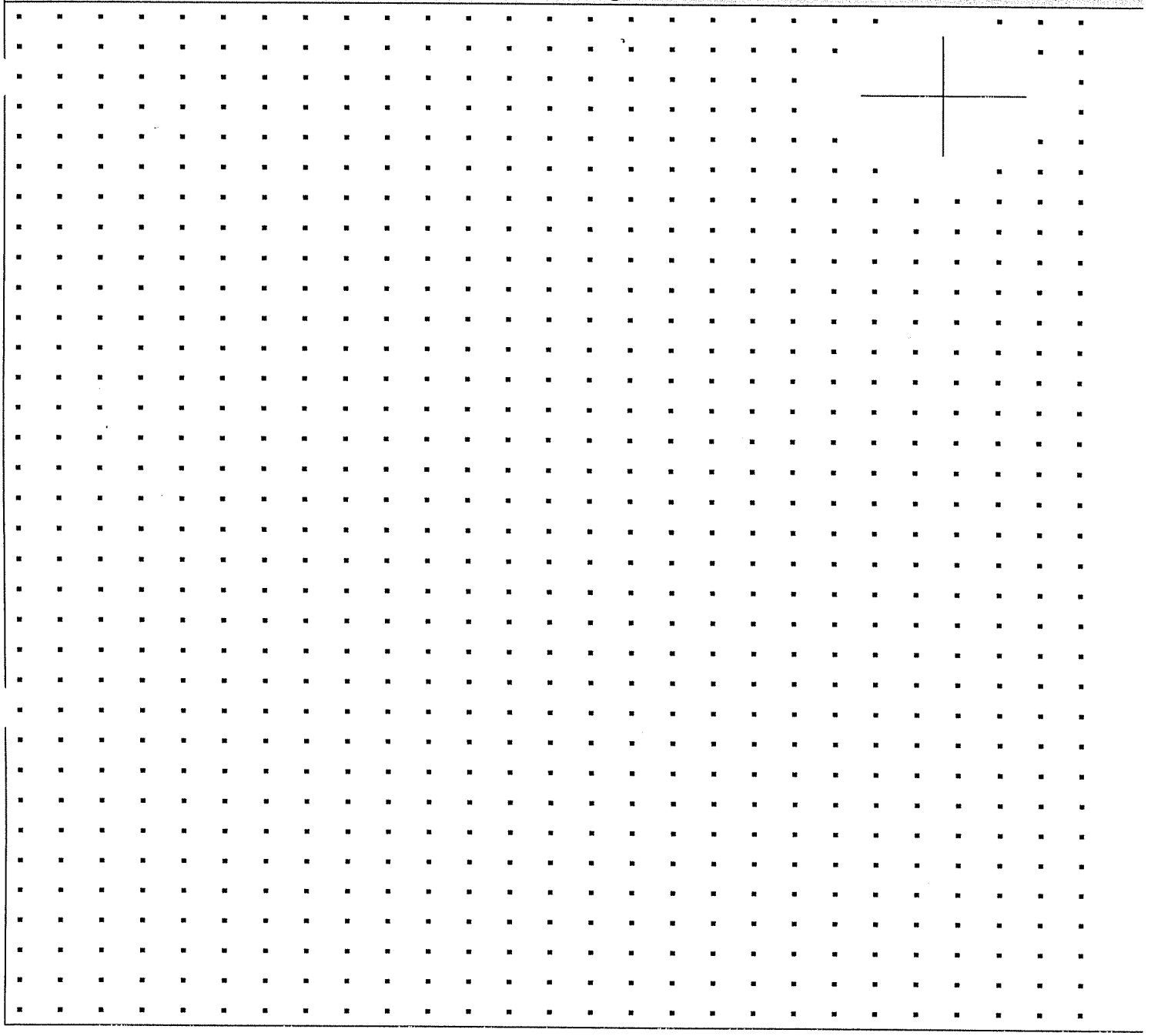
**LOG ONLY THE HIGHEST PRE-TEST AND POST-TEST READINGS INTO THE COMPUTER**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| Pre | Post | Pre | Post | Pre | Post | Pre | Post |
| | | | | | | | |

## Installations

| | Recommend | Installed |
|---|---|---|
| Audit Services: | 1 | 1 |
| Blower Door Test | 1 | 1 |
| Programmable Thermostat (Heat Pump) | | |
| Programmable Thermostat (Electric Furnace) | | |
| Compact Fluorescent Bulb (2 installed) | | |
| Low Flow Showerhead (Installed) | | |
| Water Heater Wrap (Installed) | | |
| Setback Water Heater Thermostat | | |
| Switch and Outlet Gaskets (Installed) | | |
| Hot Water Pipe Insulation - 1/2" | | |
| Hot Water Pipe Insulation - 3/4" | | |
| Kitchen Aerators (Installed) | | |
| Faucet Aerators (Installed) | | |
| Refrigerator Coil Cleaning Kit | 1 | 1 |
| Waterbed Covers (Installed) | | |
| Caulk (per lineal foot) | | |
| Weatherstrip (per lineal foot) | | |
| Door Sweep (each) | | |
| Duct Sealing - Aluminum Tape (per foot) | | |
| Duct Sealing - Aluminum Grip Tape (per foot) | | |
| Education Booklet (each) | 1 | 1 |

## House Diagram



## Notes/Comments

# Appendix C: Home STAR Customer Survey Questionnaire and Form Results

*Appendix C*

Modified Energy Fitness Participants Demographic Survey Results
Kentucky Power Company

## Dwelling Data:

### Type of Building

| | 2003 | 2004 |
|---|---|---|
| Single Family | 99.5% | 99.7% |
| Multi Family | 0.5% | 0.2% |
| Blank | 0.0% | 0.1% |

### Age of Home

| | 2003 | 2004 |
|---|---|---|
| 2 years or under | 0.0% | 1.0% |
| 3 to 5 years | 4.9% | 5.4% |
| 6 to 10 years | 16.7% | 16.7% |
| 11 to 15 years | 14.7% | 17.0% |
| 16 to 20 years | 10.7% | 12.6% |
| 21 to 30 years | 27.5% | 24.0% |
| 31 to 40 years | 14.0% | 13.1% |
| Over 40 years | 11.5% | 9.9% |
| Do Not Know | 0.0% | 0.3% |

### Configuration

| | 2003 | 2004 |
|---|---|---|
| Detached | 43.8% | 39.9% |
| Attached End | 17.3% | 16.3% |
| Attached Middle Horizontal | 0.6% | 0.0% |
| Attached Middle Vertical | 1.1% | 0.7% |
| Mobile Home | 36.5% | 43.0% |
| Do Not Know | 0.7% | 0.1% |

### Size of Home

| | 2003 | 2004 |
|---|---|---|
| Under 1200 $ft.^2$ | 36.9% | 38.4% |
| 1201 - 2000 $ft.^2$ | 41.1% | 42.5% |
| 2001 - 3000 $ft.^2$ | 15.8% | 14.5% |
| Over 3000 $ft.^2$ | 6.2% | 4.6% |
| Do Not Know | 0.0% | 0.0% |

*Appendix C*

Modified Energy Fitness Participants Demographic Survey Results
Kentucky Power Company

## Participant Energy Use Characteristics:

### AC Use

| | 2003 | 2004 |
|---|---|---|
| Never | 44.4% | 45.1% |
| Sometimes | 0.9% | 0.1% |
| Always | 54.2% | 54.4% |
| Do Not Know | 0.5% | 0.4% |

### Room AC Use

| | 2003 | 2004 |
|---|---|---|
| Never | 84.2% | 84.9% |
| Sometimes | 1.6% | 0.0% |
| Always | 14.2% | 15.1% |
| Do Not Know | 0.0% | 0.0% |

### Central AC Use

| | 2003 | 2004 |
|---|---|---|
| Never | 0.2% | 0.3% |
| Sometimes | 0.0% | 0.2% |
| Always | 98.6% | 98.6% |
| Do Not Know | 1.2% | 0.9% |

# Appendix D: Water Heating Assumptions

*Appendix D*

Water Heating Assumptions
Modified Energy Fitness (MEF) Program

I. Water Heater Base Load
   a. APCo-Virginia WHASH End-Use Metering

| | | |
|---|---|---|
| Control Group (Sept. '93 – Aug. '94) | 4,020 | kWh |
| Tank Age | 10 | Years |
| Vintage Assumed | 1984 | |
| Tank Efficiency (Default) | 0.836 | |
| Thermostat Setting | 129 | °F |
| Tank Size | 46 | Gallons |
| Winter Peak Demand | 0.84 | kW |
| Summer Peak Demand | 0.31 | kW |

$$4{,}020 \text{ kWh} = X / 0.836 \rightarrow X = 3{,}361 \text{ kWh}$$

II. 2003 MEF Base Load Per Water Heater Characteristics

| | | | |
|---|---|---|---|
| Tank Age | | 8 | Years |
| Tank Efficiency (Actual) | | 0.848 | |
| Thermostat Setting | | 127 | °F |
| Tank Size | | 46 | Gallons |
| Adjustment for Tank Efficiency | 3,356 kWh / 0.85 = 3,954 | | kWh |
| Adjustment for Size | $EF_A = (0.93 - (0.87 - 0.85)) - (.00132 * 45.07) = 0.851$ | | |
| (Tank Efficiency = 0.87 for 46 Gallons) | | | |
| No Adjustment for Thermostat Setting (127°F vs. 129°F) | | | |
| Annual Energy Usage | | 3,952 | kWh |
| Winter Peak Demand | | 0.83 | kW |
| Summer Peak Demand | | 0.30 | kW |

*Appendix D*

Water Heating Assumptions
Modified Energy Fitness (MEF) Program

III. 2004 MEF Base Load Per Water Heater Characteristics

| | | | |
|---|---|---|---|
| Tank Age | | 8 | Years |
| Tank Efficiency (Actual) | | 0.847 | |
| Thermostat Setting | | 124 | °F |
| Tank Size | | 46 | Gallons |
| Adjustment for Tank Efficiency | 3,356 kWh / 0.85 = | 3,954 | kWh |
| Adjustment for Size<br>(Tank Efficiency = 0.87 for 46 Gallons) | $EF_A = (0.93 - (0.87 - 0.85)) - (.00132 * 42.86) =$ | 0.851 | |
| No Adjustment for Thermostat Setting (124°F vs. 129°F) | | | |
| Annual Energy Usage | | 3,952 | kWh |
| Winter Peak Demand | | 0.83 | kW |
| Summer Peak Demand | | 0.30 | kW |

# Appendix E: Blower Door Evaluation Assumptions

*Appendix E*

# Blower Door Evaluation Assumptions
# Kentucky Power Company
# Modified Energy Fitness (MEF) Program
# Blower Door Evaluation

Evaluation of Blower Door Test Results

I. Engineering Model to Calculate Heating Energy Savings

| | | | |
|---|---|---|---|
| $Q_H$ | = | Vol. * ($AC/Hr_b$- $AC/Hr_a$) * HC * HDD * 24 Hr/Day * Cd | Where $Q_H$ in Btuh (Heat Loss) |
| E | = | $Q_H$/3413 | For Electric Furnace, Resistance, or Boiler |
| E | = | $Q_H$/(1000*HSPF) | For Electric Heat Pump |
| E | = | $Q_H$/(1000*HSPF)*A | For Electric Add-On Heat Pump |
| | | | Where E is kWh |

a. Given in DMC Database

| | | |
|---|---|---|
| i. | Vol. | Conditioned Volume ($ft.^3$) |
| ii. | $AC/hr_b$ | Air Changes/Hr Before (Pre-Test) |
| iii. | $AC/hr_a$ | Air Changes/Hr After (Post-Test) |
| iv. | Heating System Type | Electric Resistance |
| | | Electric Heat Pump |
| | | Electric Furnace |
| | | Electric Boiler |
| | | Other |
| v. | Add-On Heat Pump | Yes, No |
| vi. | Geothermal Heat Pump | Yes, No |
| vii. | Heating Seasonal Performance Factor (HSPF) | |
| viii. | Condition of House (Thermal Integrity) | Good |
| | | Fair |
| | | Poor |

b. Weather and Home Characteristic Data

| | | | | |
|---|---|---|---|---|
| HC | = | Heating Coefficient of Air | = 0.018 | For 70°F Standard Air (Btu/$ft.^3$ - °F) |
| HDD | = | Heating Degree Days (Kentucky Region) | = 4,676 | (°F - Day) |
| Cd | = | Adjustment Factor for | | Value Based on Condition of House |
| | | Solar and Internal Gains | = 0.30 | Good |
| | | | = 0.65 | Fair |
| | | | = 0.90 | Poor |
| A | = | Add-On Heat Pump Adjustment | = 0.759 | |

*Appendix E*

# Blower Door Evaluation Assumptions
# Kentucky Power Company
# Modified Energy Fitness (MEF) Program
# Blower Door Evaluation

II. Engineering Model to Calculate Cooling Energy Savings

$Q_C$ = HG Sensible + HG Latent

Where

| | |
|---|---|
| ΔCFM | = ΔAC/HR * Vol. * 0.0167 |
| $HG_s$ (Sensible) | = 1.1 * ΔCFM * $(t_o - t_i)$ |
| $HG_s$ | = 14.3 * ΔCFM; $t_o$ = 91°F, $t_i$ = 78°F) |
| $HG_L$ (Latent) | = 0.68 * CFM * ΔGrains Moisture |
| $HG_L$ | = 11.56 * CFM; ΔGrains = 17 @ 55% RH |

$Q_C$ = (14.3 + 11.56) * ΔCFM

$Q_C$ = 25.86 * ΔCFM  Where $Q_C$ in Btuh (Heat Gain)

E = ($Q_C$ * 24 Hr/Day * CDD) / (Δt * 1000 * SEER)

Where E is kWh

| | | | | |
|---|---|---|---|---|
| HC | = | Heating Coefficient of Air | = 0.018 | For 70°F Standard Air (Btu/ft.$^3$ - °F) |
| Δt | = | 95 F - 75 F | = 20 F | |
| CFM | = | Air Flow Rate | | ft.$^3$ / Min. |
| Δ CFM | = | Change in Air Flow Rate Before and After Weatherization | | |
| CDD | = | Where CDD is Cooling Degree Days (Kentucky Region) | = 1,121 | (°F - Day) |
| SEER | = | Seasonal Energy Efficiency Ratio | | |
| RH | = | Relative Humidity | | |