The Department of Energy's Home Energy Score: Can a home energy report influence consumers' willingness to pay for more energy efficient homes?

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ABSTRACT

The residential sector accounts for a substantial percentage of total energy use in the United States. Newer homes built under the ENERGY STAR label have increased awareness for home energy efficiency, but there is no standard metric for evaluating the energy use of older housing stock. To fill this gap the U.S. Department of Energy (DOE) created the Home Energy Score (HEScore) that scores existing homes on a 10-point scale based on energy performance. The score, along with a detailed home report, provides homeowners with a list of recommended improvements that – if implemented – will increase a home's efficiency and HEScore. Through this program the DOE hopes to improve the overall efficiency of U.S. homes.

This master's project investigates behavioral and economic factors that influence homeowners' willingness to pay (WTP) for energy-efficient home improvements, specifically as they relate to the DOE's HEScore. An experiment using a contingent valuation study was designed to measure how situational factors and the decision environment influence a homeowner's WTP for specific energy-efficient improvements. The experiment was delivered via an online survey to more than 1,600 current homeowners, home buyers and home sellers throughout the U.S. A response rate of 56 percent was achieved.

Results of the study indicate that no single agent influences a homeowner's choice in their WTP for energy-efficient improvements; rather it is a complex mix of socioeconomic, situational and political factors that play a role in the decision process. Choices are fraught with emotion and decisions are often processed through filters of long-held beliefs and biases that may ignore factual information. The HEScore may assist in simplifying the decision environment, but it is not a panacea for improving home energy efficiency. As the DOE moves forward with the program they should consider policy options that include tax incentives and educational initiatives to augment the HEScore.

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INTRODUCTION

According to the Energy Information Administration (EIA) the U.S. consumption of energy has tripled over the last fifty years. Of the four major sectors that account for overall energy use – i.e., commercial, industrial, transportation and residential – the residential sector accounted for 23 percent of total U.S. energy consumed in 2010. While this is lower than industrial and transportation totals (at 31 percent and 28 percent respectively), the residential sector still accounts for a substantial percentage of total energy (Energy Information Administration [EIA], 2011).

With the recent attention on rising fuel prices and fuel economy standards for vehicles, we tend to discount the contribution of other sectors on our nation's fossil fuel dependence. Few legislators understand that average residential use of energy is actually much higher than it is for a single vehicle. In fact, in 2008, the average household use of energy in the form of electricity was equivalent to the energy used by two passenger vehicles (EIA, 2012). And when considering electricity generation, one must also account for the production of greenhouse gas (GHG) emissions.

Most homes in the U.S. rely on electricity generated by fossil fuels – mainly natural gas and coal. The result of burning fossil fuels is direct GHG emissions into the atmosphere— primarily carbon dioxide, nitrous oxide and methane — which enhance the Earth's natural greenhouse effect and contribute to an increase in global average temperature (U.S. Environmental Protection Agency [EPA], 2012).

When looking at total electricity consumption, the U.S. totaled nearly 3,884 billion kilowatt hours (kWh) in 2010, with the residential sector consuming nearly 39 percent of this total (EIA, 2012). In terms of GHG emissions, the residential sector accounts for 1,158.9 million metric tons of carbon dioxide equivalent from distributed electricity, or approximately 19 percent of total GHG emissions among the four major sectors (EPA, 2011).

Addressing our nation's energy consumption requires a thorough understanding of how we use and distribute energy; the data prove the impacts of the residential energy sector are too large, and too significant, to ignore.

Residential Energy Use – New Homes vs. Older Homes

Voluntary energy efficiency standards for appliances began in 1992 with the introduction of the U.S. Environmental Protection Agency's (EPA) ENERGY STAR program. The first labeled products were computers and monitors and, through a partnership with the U.S. Department of Energy (DOE), the program expanded to include residential heating and cooling equipment, major appliances, lighting and a host of other consumer products. Beginning in 1995 the ENERGY STAR label, a recognized symbol of energy efficiency, expanded to new home construction (ENERGY STAR, 2012).

The latest ENERGY STAR data from 2011 reported the market share for ENERGY STAR-Certified new home construction reached 25 percent, or approximately 6.7 million homes in the U.S. (ENERGY STAR, 2011). While this number is impressive, it is only a small fraction of the number of homes in the U.S. According to the U.S. Census Bureau's latest American Housing Survey (2011), of the more than 130 million homes in the U.S., over 105 million were built before the ENERGY STAR Home certification was available. The median home was built in 1974 – nearly 40 years ago (U.S. Census Bureau, 2011). These homes are generally less efficient, have older technology and have larger utility bills. While the ENERGY STAR program has made great strides in new home construction, it fails to address the energy efficiency of existing homes within the U.S.

Home Energy Score

In May of 2009, Vice President Joe Biden tasked the White House Council on Environmental Quality (CEQ) with addressing and improving the nation's home energy efficiency. Through facilitated interagency discussions the CEQ issued a report identifying three main barriers within the home energy upgrade market – the first of which was homeowners' lack of access to clear and reliable information (Council on Environmental Quality, 2009). In the fall of that year, CEQ called upon the DOE to develop an affordable program that would assist homeowners in

assessing and understanding their home's energy efficiency, and compare their energy usage to other homes in their same geographic area and across the country (U.S. Department of Energy, 2012).

As a result of this request, the DOE created the Home Energy Score (HEScore). The HEScore is based on a ten-point scale that measures a home's efficiency. For a home to receive an HEScore, a qualified HEScore assessor conducts a home walk-thru using a scoring tool developed by the DOE. Assessors calculate the score based on the home's attributes, including square footage, heating and cooling systems, insulation, roof, wall, floor and window construction. The home is then scored on a scale of one to ten, with a score of one indicating poor energy performance and ten being excellent. In addition to the score, the homeowner is presented with a report providing the home's facts (air tightness rating, home characteristics and systems information) and recommended improvements specific to the home. The list of recommended improvements is prioritized by estimated cost savings that – if implemented – would increase the home's efficiency and raise the home's current HEScore.

The HEScore launched in 2012, but is only available on a limited distribution basis. The DOE continues to work on improvements but hopes to make the HEScore a standard feature for all existing homes. It would become a standard element in multiple listing service (MLS) listings to allow home buyers to see a listed home's energy consumption or as a tool for existing homeowners to evaluate their efficiency upgrade options. Through the HEScore program the DOE hopes to improve the energy efficiency of the nation's existing homes, thus reducing overall energy consumption and mitigating climate impacts.

Consumers' Willingness to Pay for Energy Conservation

One possible barrier to implementing a nationwide HEScore is the target audience for the program – the homeowner. Most people generally understand the relationship between efficiency improvements and lower utility bills and, in some cases, even make the connection to environmental benefits. Yet, despite this knowledge, many homeowners are unmotivated to make improvements to their home. While a small percentage of homeowners may voluntarily make energy-efficient upgrades, many will delay or forego these measures because they

believe the benefits fall short of the costs (Metcalf & Hassett, 1999, p. 516). In order to launch a sustainable and effective program, more understanding is needed to identify potential cost barriers – specifically how homeowners process the cost and benefits of energy efficient improvements. This study attempts to address this gap in knowledge.

Research Questions and Objectives

The primary research question I addressed for my project is: Does the DOE's HEScore report affect a homeowner's willingness to pay (WTP) for energy-efficient home improvements? Within this larger question I wanted to understand the role of specific factors in the decision-making process that might influence WTP. Specifically, how is WTP affected by a homeowner's:

1. Decision environment (the level of detail presented in the HEScore report);
2. Housing situation (whether they are currently buying, selling or staying in their home);
3. Do-it-yourself home repair preferences ;
4. Political affiliation;
5. Preference for tax incentives; and
6. Preference for public availability of the HEScore report.

Understanding how a homeowner (or potential homeowner) interprets the HEScore is critical to the development of the DOE's program. Conducting experiments on various report framing designs provides a basis for implementing a nationwide rollout and serves as one piece of a larger picture to improve home energy efficiency. Not only will these results help shape the design and implementation of the HEScore, but in a larger context they will add to the understanding of environmental labeling programs and federal policies to increase home energy efficiency.

In the U.S., as well as abroad, green labeling is used for everything from groceries to automobiles. There are still questions about the effectiveness of these labels and whether consumers are motivated to purchase products based simply on an eco-friendly label, or if price and economic factors are more influential. The findings from this research add to this larger body of knowledge and may help shape future environmental labeling programs thus providing

insight into the best methods and policies to motivate consumers to reduce energy consumption and make environmentally responsible choices.

METHODS

The HEScore provides a comprehensive list of recommended energy-efficient improvements to increase a home's score, ranging from the simple and inexpensive (like replacing standard lighting with compact fluorescent lighting) to the more complex and costly (like replacing duct sealing and insulation). When a homeowner reads through the HEScore they must weigh whether the cost of these improvements is worth the benefit of increasing the home's score and efficiency. The choice to make or forego these purchases is generally guided by two important elements – situational factors and the decision environment.

For the purposes of this study, the situational factor is whether or not a person is in the market to buy, sell or stay in their home and the decision environment is the DOE's HEScore report. The metric is based on the dollar amount an individual is willing to pay for energy-efficient improvements.

To understand the relationship between situational factors and the decision environment, I conducted an experiment using a contingent valuation study. The behavioral experiment was designed by Dan Ariely to determine how information detailed in the HEScore and report influences a person's willingness to pay (WTP) for energy-efficient improvements, and reveals if a person's current housing situation impacts their likelihood to act.

Sampling Group

To test situational factors (in this case a homeowner's current housing situation) that influence an individual's willingness to pay for energy-efficient home improvements, subjects in the experiment consisted of a stratified sampling frame of home buyers, sellers and homeowners staying put in their home. Since the DOE's HEScore program is intended for homes throughout the United States, the experiment targeted homeowners from across the nation to provide the most complete and representative sample for the study.

Given the large universe of potential subjects, and their wide geographic distribution, a panel partner was contracted to recruit study participants. Funding from DOE was utilized to work with the Qualtrics Panel Department to recruit a representative census group of homeowners throughout the U.S. The desired sample size for each treatment group was 250 to provide statistical significance and effect size, resulting in the distribution of over 1,600 surveys.

Qualtrics' panel partner, Clear Voice Research, pulled in quota groups from their panel of over one million members. They then used simple randomization to provide a representative sample of U.S. homeowners. Clear Voice Research provided subjects with a small incentive for participation in the experiment.

In conjunction with my research Kat Donnelly, a PhD candidate at the Massachusetts Institute of Technology (MIT) and also advised by Dan Ariely, looked at a defined sample of homeowners who participated in Connecticut's Neighbor to Neighbor (N2N) Energy Challenge. Together, we developed the variables and the experimental procedures.

Decision Environment

To test the decision environment (in this case, the DOE's Home Energy Score report) three different report designs with decreasing levels of information were developed:

- Detailed report including the HEScore and three pages of detailed recommendations (*Appendix A*);
- Basic report including the HEScore and one page of high level recommendations (*Appendix B*); and
- HEScore only (*Appendix C*).

The DOE's HEScore is currently comprised of five pages (*Appendix D*): a page containing a score based on a 10-point assessment of the home's heating, cooling and hot water systems; three pages of home facts that detail the home's structure and systems; and a final page of recommendations to improve the home's energy efficiency.

Prior to developing the experimental design, the DOE provided us with a draft write up of a pilot study conducted by EnergySavvy.com (2012). Through focus group analysis, EnergySavvy.com tested 12 different HEScore label variations and concluded the HEScore should be:

1. Simple with friendly language and intuitive imagery;
2. Personable – using language like, "your home;" and
3. Reflective of multi-year dollar savings rather than annual savings.

Taking this information into consideration, we chose to redesign the HEScore and report for the purposes of the experiment. Using current behavioral best practices (Schultz et al., 2007; Cialdini & Goldstein, 2004), and incorporating injunctive norms, the HEScore page was modified to include a gradated color scale for the score range, going from red to green to imply a sense of moving from bad to good (Elliot et al., 2007; Friedman & Forster, 2010). Any references to the DOE or the name "HEScore" were deleted to remove any potential study bias.

Throughout the report third-person references were changed to first-person and behavioral language was included per EnergySavvy.com's report recommendations. In addition to these modifications, simplified language was included to improve the readability of the HEScore report.

The current HEScore "Home Facts" section of the report presents the home's information using technical jargon without injunctive norm references or explanation. For the average homeowner, terms like 3,800 CFM50 (to indicate air tightness), or R-11 (to specify wall construction) would be either confusing or meaningless. Using examples from similar but successful home energy reports, plain-language terminology was incorporated into the report; for example, representing the amount of air escaping the home by indicating the size of an equivalent hole in the wall.

The "Home Facts" section was ultimately eliminated from the report and incorporated into a comprehensive "Recommendations" section. By presenting the current facts of the home, along with the suggested improvements, cost of the upgrades and utility cost savings,

homeowners can more easily make the connection between the problem, solution and benefits of making energy-efficient improvements. Adding a final page listing approved contractors provides a final "call to action" that gives homeowners the tools they need if they choose to make the suggested HEScore recommendations.

It should be noted that the modifications to the report design were built on the EnergySavvy.com recommendations and intended as a first iteration of suggested report improvements. For the purposes of this study, the implemented changes served to increase the likelihood that the sampled groups would understand the key elements contained in the HEScore report which, in turn, helped in the analysis of the relationship between information detail and WTP. This study does not test the report design itself.

Experimental Design

To understand the response to the level of report detail, as well as the situational factors that lead people to make home energy upgrades, an experiment was designed that manipulated these two factors. The experiment utilized a 3x4 factorial design (*Table 1*):

Table 1: Experimental design

Report Type		Situational Factor		
		Selling	Buying	Staying
Decision Environment	**Detailed Report (HEScore + Detailed recommendations)**			
	Basic Report (HEScore + High level recommendations)			
	HEScore only			
	Control (No report)			

The three conditions included homeowners:

- In the process of selling their home;
- Contemplating the purchase of a home; and
- Staying put in their home with no immediate plans to sell or buy a home.

These conditions were then tested against the decision environment using three different HEScore report designs with decreasing levels of information:

- Detailed report including the HEScore and three pages of detailed recommendations (*Appendix A*);
- Basic report including the HEScore and one page of high level recommendations (*Appendix B*); and
- HEScore only (*Appendix C*).

A control group received no HEScore or report.

Based on the various report versions and large sample size needed to provide statistical significance, a Web-based cross-sectional survey provided the most efficient and economical method of data collection. While Web-based surveys are a convenient option for large sample groups, there is a risk for hypothetical bias since a subject's willingness to pay may be exaggerated within the experiment compared to real-world application (List & Gallet, 2001; Murphy et al., 2005; Harrison, 2006).

Survey Procedure

Clear Voice Research invited survey subjects to participate in a research survey via email solicitation. Subjects were provided a small incentive (paid through Clear Voice Research) for completing the survey.

Four report types were generated and tailored to the three situational factors. An example house, representative of the average U.S. home, was used to insure responses were based on the same home facts.

At the beginning of the survey, participants answered a contingency question related to their current housing situation indicating whether they were:

1. In the market to buy a home
2. In the market to sell a home
3. In the market to buy AND sell a home

4. Planning to stay put in their home

Subjects that responded "yes" to question one (in the market to buy) or two (in the market to sell) were randomly and equally assigned to one of the four report type conditions asking them to "Imagine you are buying this home" and "Imagine you are selling this home," respectively.

Subjects that responded "yes" to question three (in the market to buy and sell) were randomly and equally assigned to one of the four report type conditions asking them to either "Imagine you are buying this home" or "Imagine you are selling this home."

Based on Kat Donnelly's Connecticut survey conducted in June 2012, we discovered that most subjects indicate staying put in their home. Therefore, to best capture all situational factors within the sample U.S. group, subjects that responded "yes" to question four were randomly and equally assigned to one of the three situational factors and one of the four report types.

Survey Design

In designing the survey I wanted to understand which decision environment (report type) and situational factor (selling, buying or staying) had the most influence on an individual's willingness to pay for home energy improvements. The survey was divided into five main sections: introduction, willingness to pay questions, attention filters and demographic questions. A final section consisted of open text questions.

In the introduction, subjects were provided a brief description of the home energy report and presented with a hypothetical home to imagine they were selling, buying or that they currently owned – depending on their assigned (or randomly assigned) situation. Subjects were then asked to thoroughly review the home energy report (randomly assigned) for their imagined home.

After reviewing the report, subjects were asked willingness-to-pay (WTP) questions for five separate energy-efficient improvements. The WTP questions were presented in three different formats: yes/no (*Figure 1*), matrix (*Figure 2*) and slider (*Figure 3*). The cost and benefit estimates for each improvement remained the same for each WTP question format. Offering the same information in different formats tests subjects' response consistency. In addition,

studies by Murphy et al. (2005) found that multiple question mechanisms may reduce the effects of hypothetical bias in contingent valuation experiments (p. 322).

Figure 1: Example yes/no question format

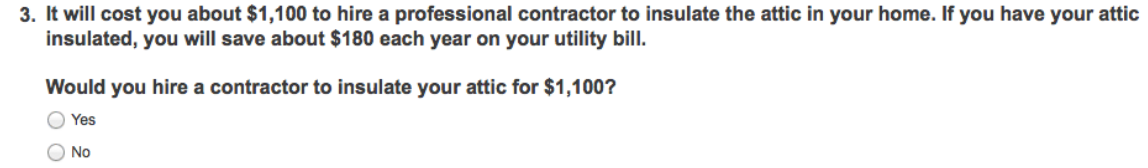


Figure 2: Example matrix question format

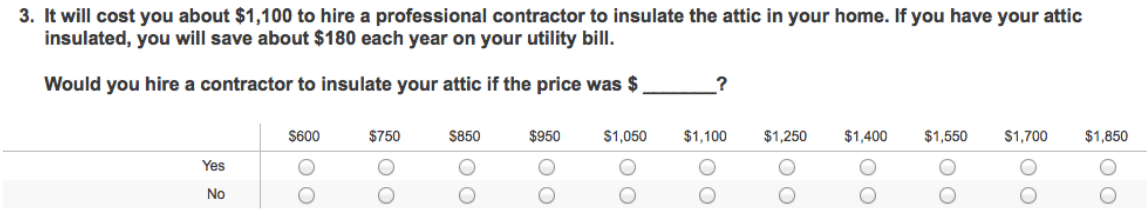
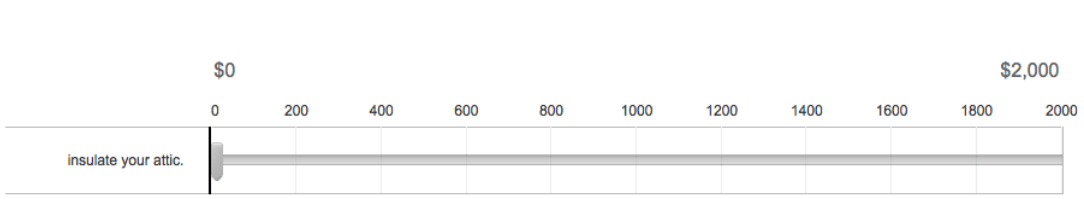


Figure 3: Example slider question format



Thumbnails of the report were embedded at the top of each survey page so subjects had the ability to refer back to the report they were shown.

After answering the last WTP slider question related to improvements, subjects were presented with several additional WTP slider questions, including a question related to tax incentives.

The third section tested subjects' confidence in their WTP responses, their comprehension of the report and their overall attention to the survey instructions.

In the demographic section, subjects were asked a series of 23 short questions based on their real-world housing situation (as opposed to their imagined housing situation presented in the survey). These questions related to the subject's age, political affiliation, income, race, household composition, etc.

Lastly, a series of open-ended questions were provided for respondents to write about their reaction to the report and their response to the survey.

The survey was pretested prior to final distribution and modified for Kat's Connecticut N2N subject group and my nationwide group.

Data Collection

Clear Voice Research distributed the survey during the week of September 9, 2012, with a total of 1,611 surveys disseminated to a representative population of U.S. homeowners. The raw survey data was reviewed and screened for invalid responses, incomplete surveys, subjects that read the report outside the customary timeframe (i.e., longer than 10 minutes) and patterned responses (e.g., zigzag response patterns). After reviewing the data, a total of 897 valid responses were recorded (*Table 2*).

Table 2: Distribution of survey responses

Condition	Report Type	HEScore	Basic	Detailed	Control	Total
Staying Put	Imagine Buy	66	76	51	63	256
	Imagine Home	62	61	55	67	245
	Imagine Sell	67	54	59	71	251
Buying & Selling	Imagine Buy	6	4	3	7	20
	Imagine Sell	11	16	11	14	52
Buying	Imagine Buy	7	18	13	16	54
Selling	Imagine Sell	4	9	2	4	19
	Total	223	238	194	242	897

Analytical Method

To capture the composition and representativeness of my sample group, I first wanted to understand the demographic profile of the survey respondents. To do this I ran distribution

analyses for the nominally scaled variables of education level, income, employment and political affiliation. In addition, I looked at housing composition, type and density as well as preferences for conservation and home repairs. Using ArcGIS software I then mapped the zip codes for each respondent to produce a map showing the location and geographic distribution of survey respondents.

Calculating WTP

Determining an individual's WTP for energy-efficient home improvements was central to my analysis. In this study, subjects were presented with the annual savings and purchase costs for five types of energy efficient improvements: compact fluorescent lights (CFLs); outlets and power strips; attic insulation; duct sealing and insulation; and air sealing (*Table 3*).

Table 3: Cost and savings for HEScore improvements

Improvement	Estimated Cost	Estimated Savings/Year
CFLs	$100	$160
Outlets and power strips	$40	$60
Attic insulation	$1,100	$180
Duct sealing and insulation	$950	$200
Air sealing	$1,400	$150

For each energy-efficient improvement, subjects were then asked to indicate their maximum WTP using three question types:

1. Yes or no for the average price of the improvement;
2. Yes or no for a matrix of 11 individual prices ranging from low to high, with the average price for the improvement shown in the middle of the range;
3. A movable slider ranging from zero to a maximum price slightly higher than the maximum of the matrix question.

To calculate the average maximum WTP for each improvement type, a final WTP was determined as follows: If the respondent selected "yes" to the first WTP question, then the average price expressed in the question was used as the maximum WTP amount and averaged with the maximum amounts the respondent selected for the matrix and slider questions. If an individual selected "no," then only the maximum amounts selected by the respondent for the matrix and slider questions were averaged. The final maximum WTP amounts for each home energy improvement were then used to run one-way analyses of variance (ANOVA), as well as independent *t* tests, to understand how a subject's WTP for certain energy-efficient home improvements is affected by:

1. The decision environment (HEScore report type)
2. Situational factors (actual and imagined housing situations)
3. A subject's political affiliation
4. A subject's home repair preference (handy vs. unhandy individuals)
5. Public availability of the HEScore report

The maximum average WTP amount for all home energy improvements was calculated by summing the maximum average WTP for each of the five improvements. The total maximum average WTP for all home energy improvements was then used to run independent *t* tests to understand how a subject's WTP is affected by tax incentives.

Categorization of Open Text Responses

There were a total of five open-ended text questions within the survey. The questions asked respondents to consider situations related to their current home and situation, including improvements they would make to increase their own home's energy score, attitudes toward making the score publically available, as well as general questions related to the home score and survey. Open-ended text responses were read in detail and categorized using combined content analysis.

Since the survey design did not require written answers for the open text questions, several respondents did not provide a response, provided nonsensical remarks or simply stated "I don't know." However, many of the answers revealed interesting insights and captured respondents'

perceptions. Given the inconsistency of the responses I opted to omit any formal results of the content analysis from the study, but did use select responses to inform my results and observations and to support the study's recommendations.

Analysis of Survey Validity

As previously stated, online surveys are ideal for reaching a large audience, but lend themselves to bias. Without direct observation of subjects, alternative methods are needed to gauge attention to the survey and details. Several questions were purposely built into the survey to measure comprehension and attention to detail. The first question asked subjects to rate the accuracy of their responses and WTP amounts using a confidence slider. The slider was anchored at zero percent with a maximum value of 100 percent.

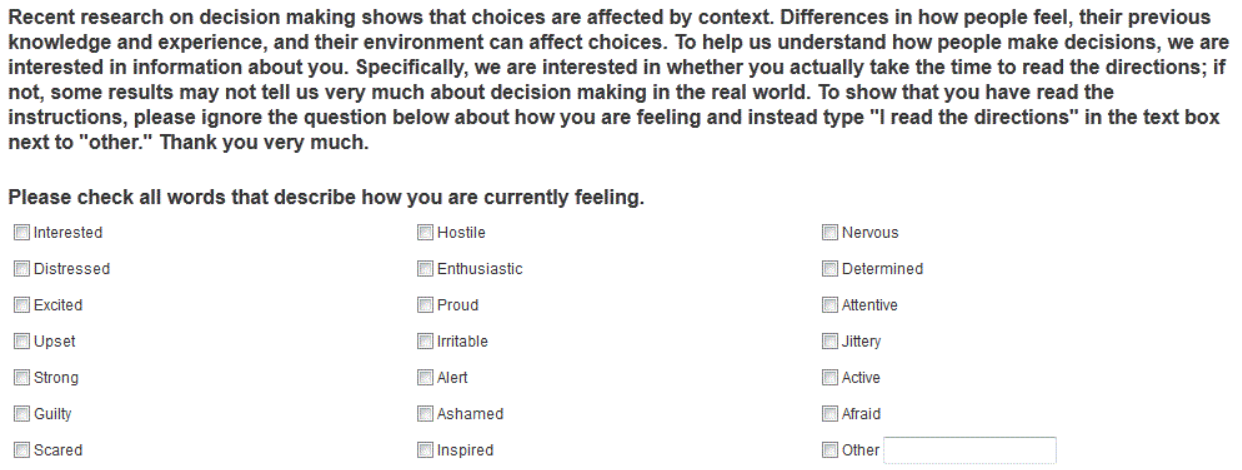
Three additional questions were based on comprehension and asked subjects about information contained in the HEScore report. These questions, with answers presented in multiple choice format, asked subjects to recall:

1. How much will your carbon footprint decrease if you make all of the home energy report's recommended improvements?
2. What color represents a home that uses the most energy?
3. What score do your neighbors with similar homes and completed improvements usually get?

The last question (*Figure 4*), designed by Dr. Ariely, was an attention filter to measure subjects' ability (or inability) to read through detailed, multipart instructions and provide a correct response.

The confidence slider, along with the comprehension questions and attention filter, were then analyzed to determine subjects' overall comprehension of the survey and attention to detail across all levels of situations and reports.

Figure 4: Attention filter question



Recent research on decision making shows that choices are affected by context. Differences in how people feel, their previous knowledge and experience, and their environment can affect choices. To help us understand how people make decisions, we are interested in information about you. Specifically, we are interested in whether you actually take the time to read the directions; if not, some results may not tell us very much about decision making in the real world. To show that you have read the instructions, please ignore the question below about how you are feeling and instead type "I read the directions" in the text box next to "other." Thank you very much.

Please check all words that describe how you are currently feeling.

Interested	Hostile	Nervous
Distressed	Enthusiastic	Determined
Excited	Proud	Attentive
Upset	Irritable	Jittery
Strong	Alert	Active
Guilty	Ashamed	Afraid
Scared	Inspired	Other

RESULTS & OBSERVATIONS

Survey Validity

Before analyzing the results of my main research questions, I first gauged survey validity by reviewing the results of subjects' confidence, comprehension and attention responses. The results of these analyses, explained below, suggest that most subjects were confident in their responses and understood the report, thus supporting the validity of the survey.

Confidence Slider Results

Using a slider within the survey I measured the respondents' assessment of confidence for accurately answering questions on a scale from zero percent to a maximum of 100 percent. Overall, most respondents expressed confidence in their ability to accurately answer the survey questions. Only 11 percent, or 95 out of 897 respondents, indicated a confidence level of less than 50 percent. After trimming the lower five percent from the distribution, the mean is 81 percent confident, with an upper quartile of 98 percent and a lower quartile of 71 percent.

Comprehension Questions Results

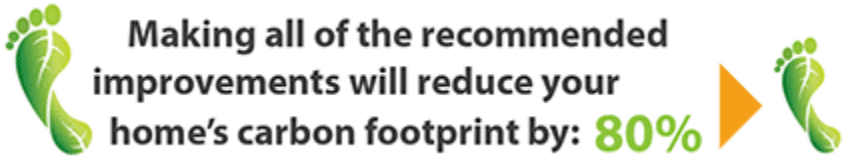
The next analysis of survey validity looked at respondents' comprehension of the report. Multiple choice responses to three questions, related to various aspects of the report, were designed to gauge understanding. Responses were recorded as correct or incorrect. Results of comprehension appear mixed with 40 percent of respondents, across all report types, missing

at least one of the three questions and only 32 percent answering all three questions correctly. Upon further analysis, the results of each question breaks down as follows:

- **Question 1:** How much will your carbon footprint decrease if you make all of the home energy report's recommended improvements? (49 percent correct/51 percent incorrect)
- **Question 2:** What color represents a home that uses the most energy? (78 percent correct/22 percent incorrect)
- **Question 3:** What score do your neighbors with similar homes and completed improvements usually get? (70 percent correct/30 percent incorrect)

A possible reason for the larger percentage of incorrect responses for question one is the location of the carbon footprint infographic within the HEScore report. The infographic (*Figure 5*) only appears on the detailed and basic report, and not on the HEScore-only report. Those receiving the control (or no report) were provided with instructional text that explained the carbon footprint reduction, but would be unfamiliar with the graphic. However, when looking at the incorrect responses by report type, there is little variance between groups. In fact, 52 percent of respondents receiving the detailed report answered question one incorrectly, compared to 51 percent who received no report at all.

Figure 5: HEScore Report carbon footprint infographic



Another probable explanation is the phrasing of the question and the choice of answers. There is a possibility that subjects were confused by the decrease in their carbon footprint. Although the correct answer is 80 percent, some may have chosen 20 percent thinking they needed to calculate a difference. Lastly, the term "carbon footprint" might be an unfamiliar or confusing concept, making the question difficult to answer.

Across all report types, questions two and three had higher levels of correct responses at 78 percent and 70 percent respectively. So, while question one seemed problematic, the greater percentage of correct responses to questions two and three seems to suggest that most respondents were able to comprehend the report.

Attention Filter Results

The last test of survey validity looked at subjects' ability to pay attention to lengthy instructions and multipart directions using an attention filter. Results from the attention filter analysis, across all report types and situational factors, show 72 percent of respondents read and answered the question correctly. For those who answered incorrectly, results seem to reflect individual feelings toward the survey itself. Subjects that selected words often chose multiple adjectives that expressed interest or inspiration, while others selected hostile words. In one case, a subject selected several feelings of irritation and even included a written response of, "I think this is full of [expletive deleted]."

Demographic Profile of Respondents

Geographic Distribution and Respondent Profile

Based on the zip code provided by each subject, I mapped the distribution of survey respondents. Each point on the map (*Appendix E*) indicates a respondent's geographic location. Survey results were received from each state with the exception of South Dakota. The majority of respondents come from states east of the Mississippi, with most respondents coming from Atlantic coast states.

Survey respondents are nearly evenly divided between men and women, with 52 percent male and 48 percent female (*Appendix F1*). The majority of subjects indicate their race as white/Caucasian (88 percent) with four percent indicating African American, and nearly three percent Hispanic and Asian (*Appendix F2*). The mean age of survey respondents is 49 years of age, with 25 percent younger than 39 and ten percent younger than 31. Approximately 25 percent are 59 or older and 10 percent are 64 or older. The majority of respondents, or 78 percent, classify their marital status as married or cohabitating, with 14 percent never married, six percent separated or divorced and only two percent widowed (*Appendix F3*).

The median number of household occupants is three, with one-quarter of homes having one or two occupants, and one-quarter having four or more. More than 70 percent of survey respondents indicate two adults live in their home, with 13 percent indicating one adult and 15 percent three or more adults (*Appendix F4*). Most homes (60 percent) have no children in the household, with 19 percent indicating one child and 15 percent two children (*Appendix F5*).

Education, Income and Employment

An income between $50K and $90K is reported by 44 percent of respondents, with 24 percent reporting incomes over $100K and 23 percent stating incomes between $25K and $50K. The smallest percentage of respondents, at nine percent, reports an income under $25K (*Appendix F6*).

Nearly 100 percent of respondents have a high school diploma or better, with nearly 50 percent of respondents indicating a bachelor's degree or higher (*Appendix F7*).

The data also show that more than half of respondents, at 51 percent, are employed full time with 14 percent retired, 13 percent employed part time, 11 percent homemakers, six percent temporarily unemployed, three percent as "other" and only one percent students (*Appendix F8*).

Housing Density and Type

Responses from the survey indicate 26 percent of respondents live in a rural area, 54 percent suburban and 20 percent urban (*Appendix F9*). Most respondents (93 percent) indicate they live in a detached single-family house, with only seven percent indicating they live in an attached single family house. The other housing types listed in the survey (multifamily building with 2 to 4 units, multifamily building with 5 or more units and mobile home) were not listed by respondents (*Appendix F10*).

Household Comfort and Energy Costs

The majority of respondents report being comfortable in their home, with 82 percent stating they are always able to stay comfortable in their home and 18 percent indicating some level of discomfort (*Table 4*). Among all respondents, more than half (55 percent) indicate reasonable

household energy costs, with 38 percent stating high energy costs and six percent indicating low energy costs.

Table 4: Household energy costs and comfort

Household Comfort	Household Energy Costs						
	Low		Reasonable		High		Total
Yes	55	6.13%	451	50.28%	233	25.98%	739
No	2	0.22%	48	5.35%	108	12.04%	158
Totals	**57**	**6.35%**	**499**	**55.63%**	**341**	**38.02%**	**897**

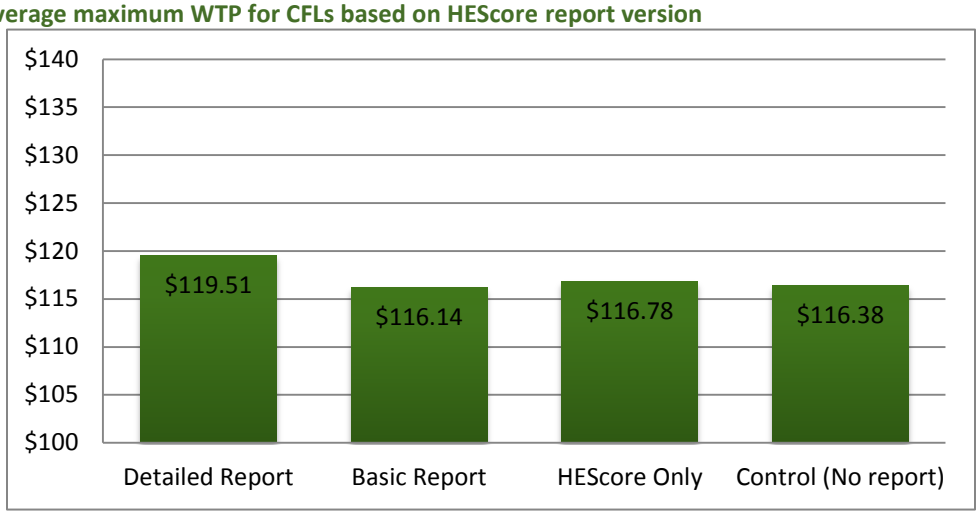
Willingness to Pay and the Decision Environment

To understand the factors that motivate an individual's WTP for energy-efficient home improvements, I first looked at the effects of the decision environment – in this case the HEScore report versions. For each of the five improvements: CFLs, outlets and power strips, attic insulation, duct sealing and air sealing, I wanted to determine if the report type might increase or decrease a subject's WTP. Using a one-way analysis of variance (ANOVA) I compared the average maximum WTP for each improvement and report type to reveal any significant differences between report types.

WTP for CFLs

Subjects were presented with an estimated cost of $100 for CFLs and an estimated utility savings of $220 per year. The survey results show an average maximum WTP for CFLs ranging from $116.14 to $119.51 with WTP evenly distributed across all report types as shown in Figure 6. Although the average WTP is higher than the estimated cost of $100, there is no statistical significance between report types and CFLs. These results would suggest that report type does not influence a subject's WTP for CFLs.

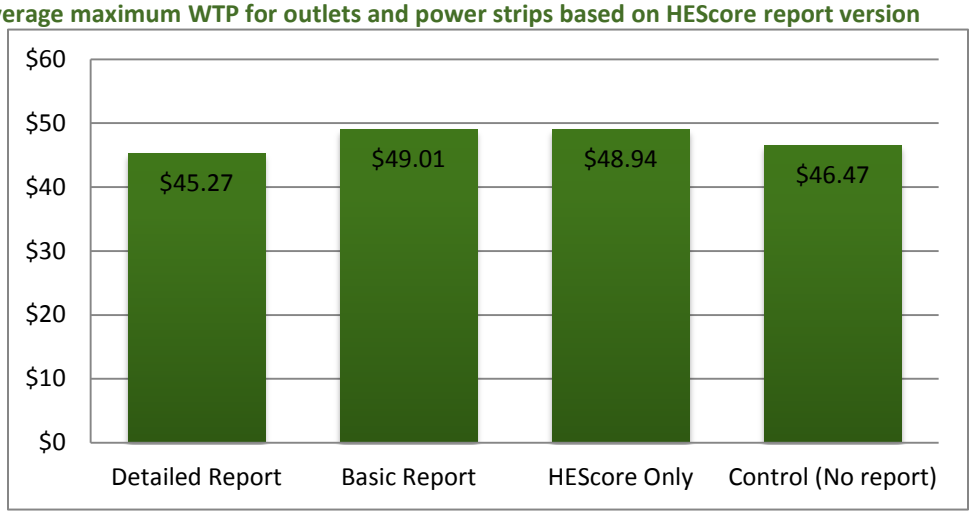
Figure 6: Average maximum WTP for CFLs based on HEScore report version



WTP for Outlets and Power Strips

For outlets and power strips subjects were presented with an estimated cost of $40 and an estimated utility savings of $80 per year. Survey results show the average maximum WTP for outlets and power strips ranges from $45.27 for subjects receiving the detailed report, to $49.01 for those receiving the basic report as shown in Figure 7. Again, the average WTP is slightly higher than the stated cost estimate of $40. Statistically significant differences are found between the detailed report and the basic report as well as the detailed report and HEScore-only. These differences suggest the detailed report slightly decreases a subject's maximum stated WTP for outlets and power strips.

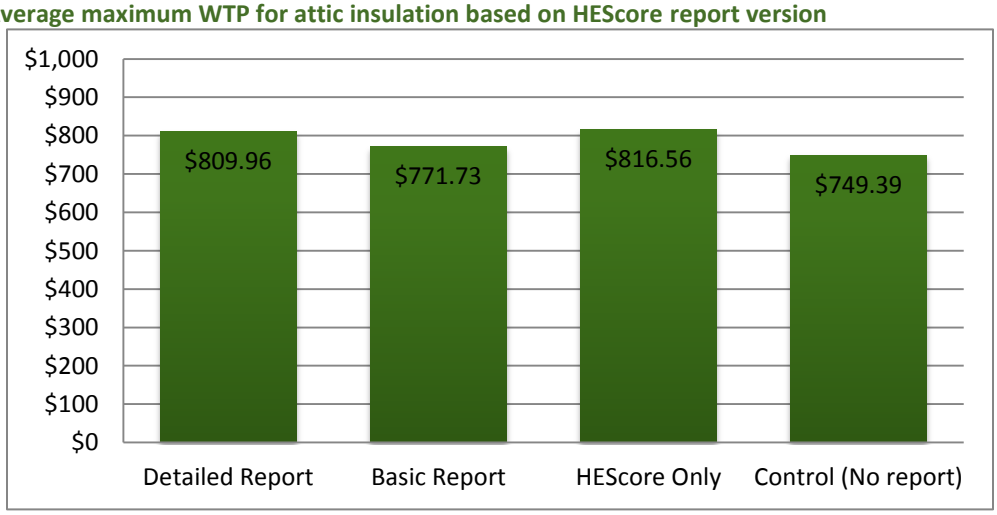
Figure 7: Average maximum WTP for outlets and power strips based on HEScore report version



WTP for Attic Insulation

Unlike CFLs and outlets, attic insulation is a more costly energy improvement with an estimated cost of $1,100 and annual utility savings of approximately $450. Survey results show a mean average maximum WTP nearly $310 lower than the estimated cost with the highest WTP of $816.56 for those receiving the HEScore only and the lowest WTP of $749.39 for the control group that received no report as shown in Figure 8. These results suggest that report type does not influence a subject's WTP for attic insulation.

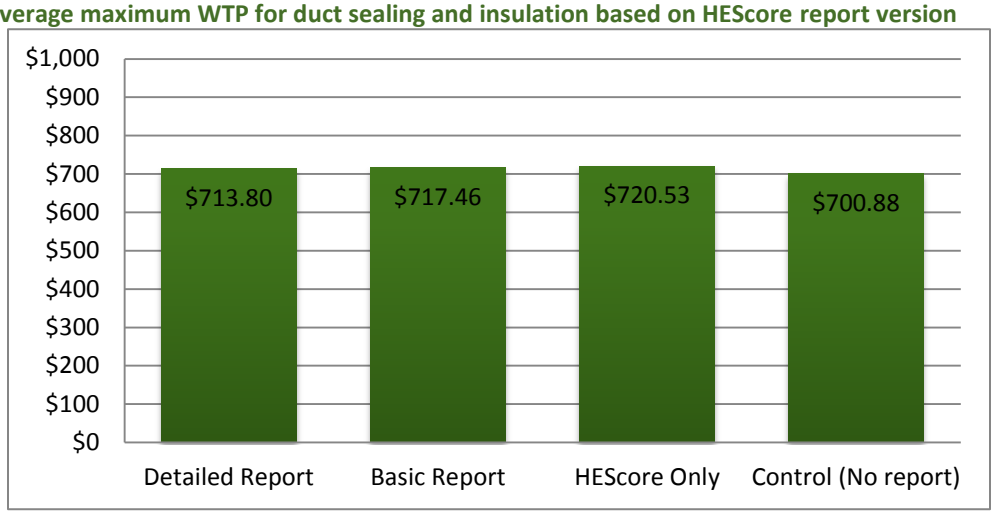
Figure 8: Average maximum WTP for attic insulation based on HEScore report version



WTP for Duct Sealing and Insulation

Another costly energy-efficient home improvement is duct sealing and insulation with an estimated cost of $950 and annual utility savings of $380. Like attic insulation, the cost and report type did not appear to have a significant effect on a subject's average maximum WTP. Across all report types, the mean average maximum WTP is $708.03 with the highest WTP of $720.53 for those receiving the HEScore only and the lowest WTP of $700.88 for the control group that received no report (*Figure 9*). There are no statistically significant differences between report types, suggesting report type has no effect on WTP for duct sealing and insulation.

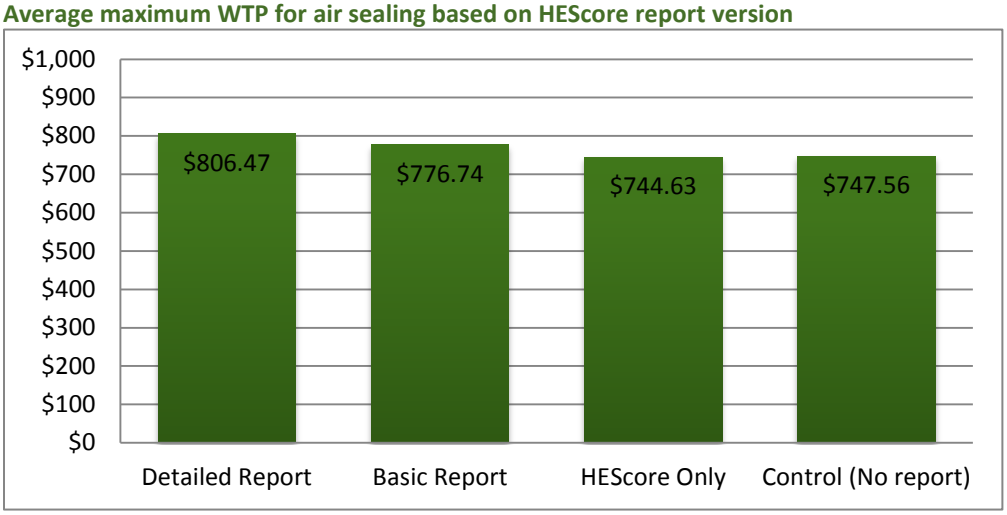
Figure 9: Average maximum WTP for duct sealing and insulation based on HEScore report version



WTP for Air Sealing

Air sealing is the final energy-efficient improvement analyzed. This is the most costly improvement listed in the report with an estimated cost of $1,400 and an annual estimated utility savings of $250. The results shown in *Figure 10* indicate an average maximum WTP range between $806.47 for subjects receiving the detailed report and $744.63 for those receiving the HEScore only. There are no statistically significant differences found between report types, suggesting report type has no effect on WTP for air sealing.

Figure 10: Average maximum WTP for air sealing based on HEScore report version



Summary of WTP Results Based on Report Type

Although statistically significant differences are noted in a subject's WTP for outlets and power strips based on the detailed report, there appears to be no other effects on a subject's WTP for other improvements. The results seem to indicate that the type of report – or the decision environment – has no significant effect on an individual's WTP for energy-efficient home improvements.

Willingness to Pay and Situational Factors

The next set of factors I wanted to analyze were the effects on WTP based on an individual's situation – in this case a homeowner's current housing situation. For each of the five improvements: CFLs, outlets and power strips, attic insulation, duct sealing and air sealing I wanted to determine if a subject's imagined or actual housing situation increases or decreases their average WTP.

In the pre-survey, subjects were asked to state their current housing situation. As outlined in Table 5 , subjects that indicated they were in the market to buy or sell a home were randomly assigned to a report type, but given surveys that asked them to imagine their current housing situation (i.e., buying or selling). Subjects that indicated they were staying put in their current home were also randomly assigned to a report type, and randomly assigned to an imagined

housing situation (either imagine this is your home, imagine this is a home you're buying or imagine this is a home you're selling).

Table 5: Subject assignment to experimental situations

Subject's Actual Situation	Subject's Imagined Survey Situation
Staying put	Imagine this is your home Imagine this is a home you're buying Imagine this is a home you're selling
Buying and selling a home	Imagine this is a home you're buying Imagine this is a home you're selling
Buying a home	Imagine this is a home you're buying
Selling a home	Imagine this is a home you're selling

For the analysis, groups were created based on subjects' current situations to test the difference between the actual and imagined mindset. Subjects that indicated they were staying put in their home were grouped into one of three imagined survey groups based on the survey they received: imagine home; imagine buy; imagine sell.

Subjects that indicated they were actually buying a home were grouped into the "actual buy" group and subjects indicating they were actually selling a home were grouped into the "actual sell" group. Subjects that indicated they were both buying AND selling a home were grouped into the "actual buy" or "actual sell" groups based on the imagined survey they received. In summary, five groups were analyzed:

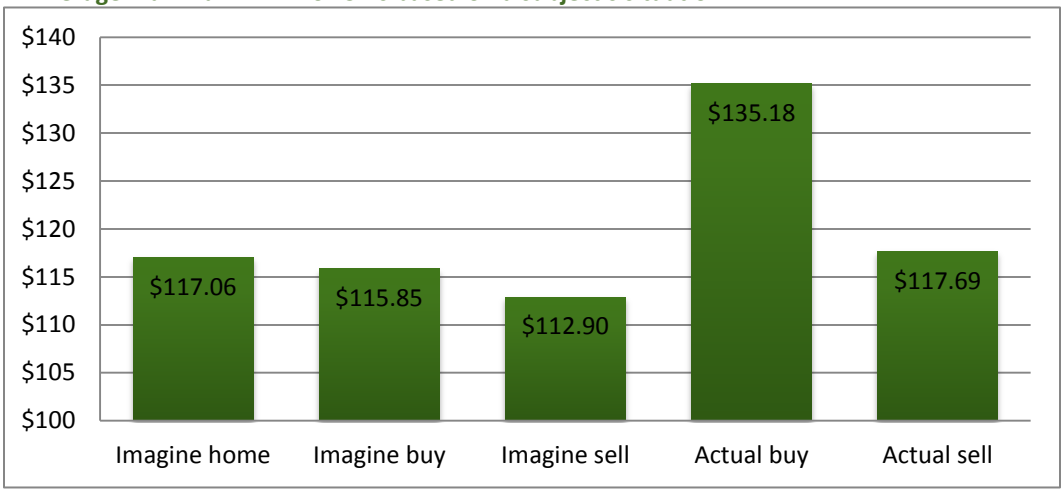
1. Imagine home
2. Imagine buy
3. Imagine sell
4. Actual buy
5. Actual sell

Using a one-way analysis of variance (ANOVA) I compared the average maximum WTP for each improvement by subjects' imagined and actual housing situations.

WTP for CFLs

Across all imagined and actual housing situations, the mean average maximum WTP for CFLs is $119.73 which is, again, higher than the estimated cost of $100 stated in the report and survey. When looking at each situational factor, the data show that subjects who are actually buying a home are willing to pay significantly more than all other situational factors combined (*Figure 11*). Statistically significant differences are found when comparing the average maximum WTP for actual home buyers compared to all other situations. The greatest difference is between actual home buyers and the imagine sell condition (p=0.0012). Differences also exist between actual home buyers and actual sellers (p=0.0427), actual home buyers and imagined buyers (p=0.0049) and actual home buyers and imagined homeowners (p=0.0086). These data would suggest that the actual buying situation has a positive and statistically significant effect on an individual's WTP for CFLs, but has no significant effect across the imagined housing situations and the actual selling situation.

Figure 11: Average maximum WTP for CFLs based on a subject's situation

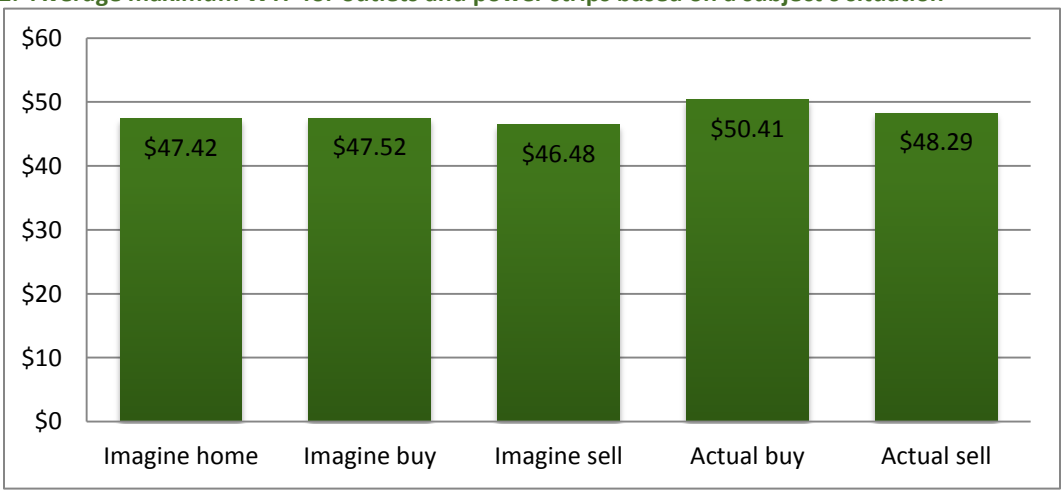


WTP for Outlets and Power Strips

Across all imagined and actual housing situations, the average maximum WTP for outlets and power strips is $48.02 which, like CFLs, is nearly 17 percent more than the estimated cost of

$40 stated in the report and survey (*Figure 12*). However, unlike CFLs, there is no statistically significant difference between actual and imagined housing situations and the average maximum WTP for this energy upgrade. The results of this analysis suggest that an individual's situation has little to no effect on WTP for outlets and power strips.

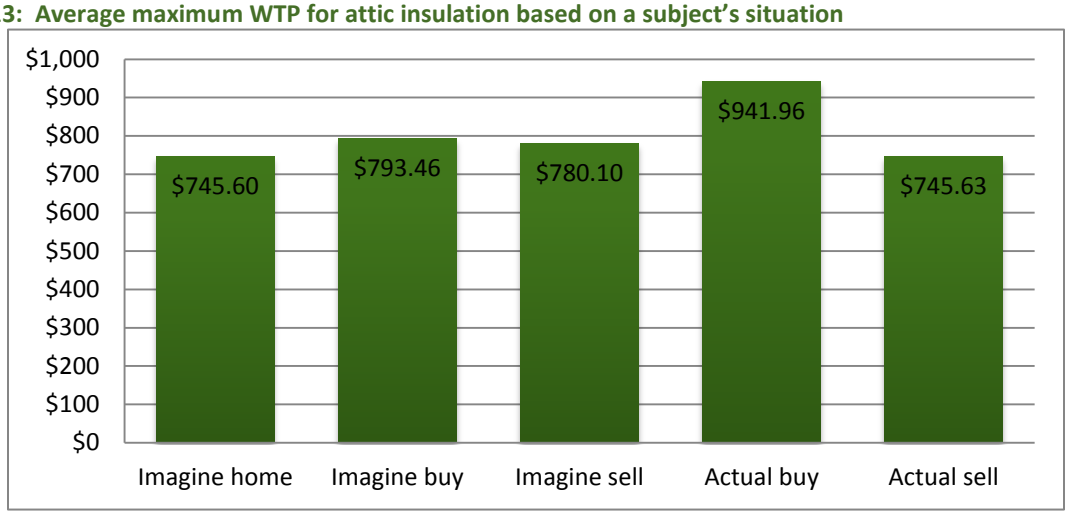
Figure 12: Average maximum WTP for outlets and power strips based on a subject's situation



WTP for Attic Insulation

Across all imagined and actual housing situations, the mean average maximum WTP for attic insulation is $801.35 which is more than 27 percent less than the estimated cost of $1,100 stated in the report and survey (*Figure 13*). When looking at each situational factor, statistically significant differences are found when comparing the average maximum WTP for actual home buyers compared to all other situations. The greatest difference is between actual home buyers and the imagined home situation ($p=0.0017$). Differences are also noted between actual home buyers and imagined sellers ($p=0.0093$), actual home buyers and actual sellers ($p=0.012$) and actual home buyers and imagined buyers ($p=0.0168$). These data would suggest that the actual buying situation has a positive and statistically significant effect on an individual's WTP for attic insulation.

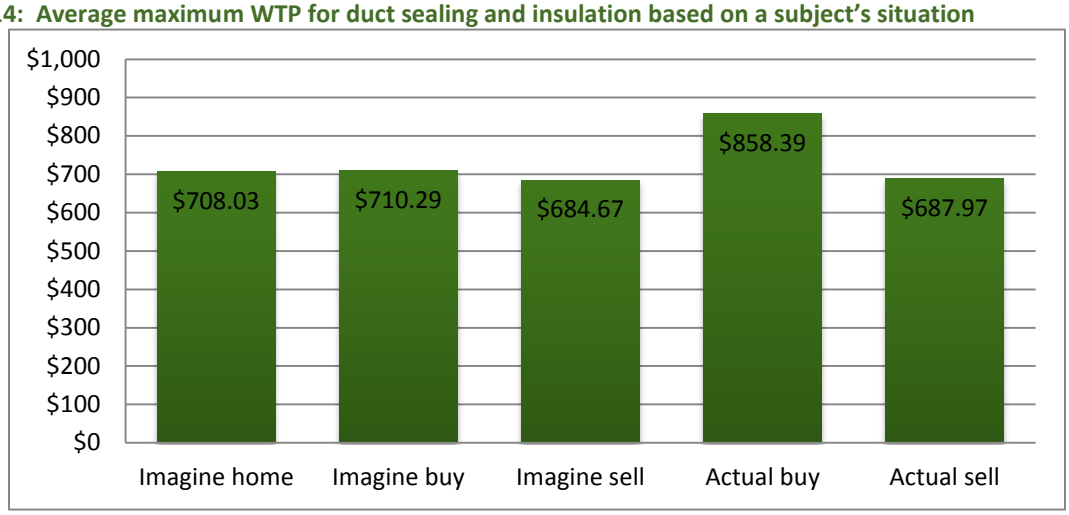
Figure 13: Average maximum WTP for attic insulation based on a subject's situation



WTP for Duct Sealing and Insulation

Similar to attic insulation, duct sealing and insulation are more costly home energy improvements. Across all imagined and actual housing situations, the mean average maximum WTP for duct sealing and insulation is $729.87 which is 23 percent less than the estimated cost of $950 stated in the report and survey (*Figure 14*). When looking at each situational factor, statistically significant differences are found when comparing the average maximum WTP for actual home buyers compared to all other situations. The greatest difference is between actual home buyers and the imagined selling situation ($p=0.0019$). Differences also exist between actual home buyers and imagined homeowners ($p=0.0072$), actual home buyers and imagined buyers ($p=0.0078$) and actual home buyers and actual sellers ($p=0.0149$). These data would suggest that the actual buying situation has a positive and statistically significant effect on an individual's WTP for duct sealing and insulation.

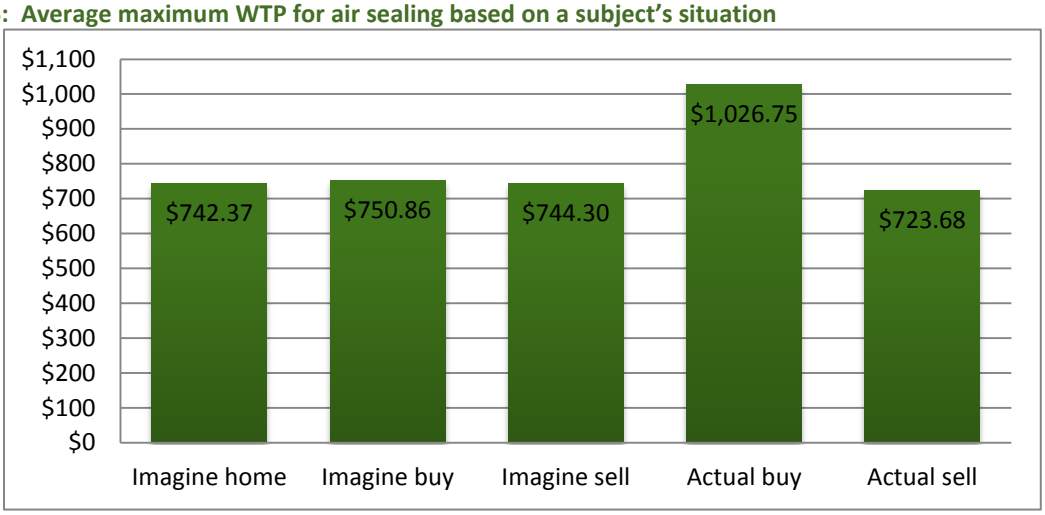
Figure 14: Average maximum WTP for duct sealing and insulation based on a subject's situation



WTP for Air Sealing

Air sealing was the final energy-efficient improvement analyzed. This is the most costly improvement listed in the report and survey at approximately $1,400. Across all imagined and actual housing situations, the mean average maximum WTP for air sealing is $797.59 which is 43 percent less than the estimated cost (*Figure 15*). When looking at each situational factor, the data again show statistically significant differences between subjects that are actually buying a home and all other situations. The greatest differences are between actual home buyers and the imagined home and imagined sell situations ($p \leq 0.0001$). Statistically significant differences are also found between actual home buyers and imagined buyers ($p=0.0002$) and actual home buyers and actual sellers ($p=0.0011$). These data would again suggest that the actual buying situation has a positive and statistically significant effect on an individual's WTP for air sealing.

Figure 15: Average maximum WTP for air sealing based on a subject's situation



Summary of WTP Results Based on Situational Factors

With the exception of outlets and power strips, the average maximum WTP for energy-efficient home improvements is higher for actual home buyers compared to all other situational factors (imagine home, imagine buy, imagine sell and actual sell). These data suggest that the actual buying situation has a positive and statistically significant impact on an individual's WTP.

Willingness to Pay and Do-it-Yourself Home Repair Preferences

An overwhelming 70 percent of households in the survey state that repairs involving ladders and tools are completed by a household member or relative. This compares to only 24 percent completed by a professional, four percent a combination of friend/professional, and only two percent stating "other" or they do not make repairs or renovations. These figures are supported by many of the open text responses submitted by respondents emphasizing their preference to make their own home improvements stating, for example, "I could do the work myself - more cost effective as well as quicker than hiring someone," and, "I would not pay a contractor to do [improvements]. I or my husband are capable of doing the job and that will save a lot of money."

Building on the hypothesis that do-it-yourselfers are willing to pay less for home energy improvements, I next looked at the link between a subject's stated home repair preferences and WTP. For each of the five improvements: CFLs, outlets and power strips, attic insulation,

duct sealing and insulation and air sealing I wanted to determine if a subject's stated handiness for home repairs increased or decreased their average WTP.

Within the survey, subjects were asked to answer the following question related to home repairs:

> In your household, who typically completes home repairs that involve ladders and tools?

Subjects then chose from four possible answers:

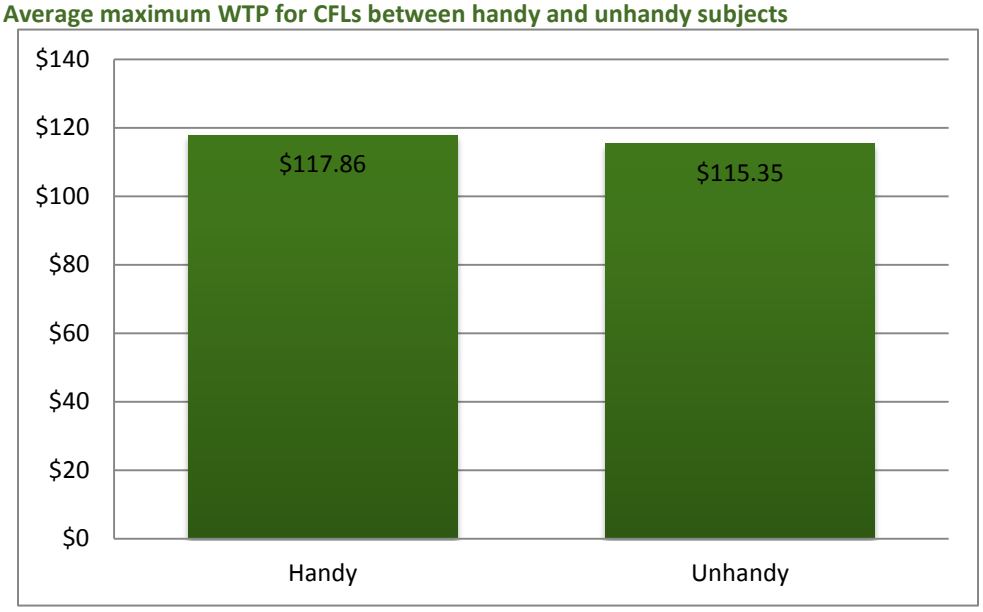
1. A household member
2. A handyman/contractor
3. We don't do repairs or renovations
4. Other (which subjects were then asked to specify with a text response)

To simplify the analysis I took the responses to this question and categorized subjects into two groups: handy and unhandy. Subjects that indicated a household member made repairs were categorized as handy, with all other responses categorized as unhandy. With this data I then performed independent *t* tests to compare WTP for energy efficient home improvements for handy and unhandy homeowners.

WTP for CFLs

I first looked at the average maximum WTP for CFLs (*Figure 16*). The average maximum WTP for handy subjects is $117.86 and $115.25 for unhandy subjects. This small difference in WTP of $2.61 also shows no statistical significance in WTP for CFLs between handy and unhandy respondents.

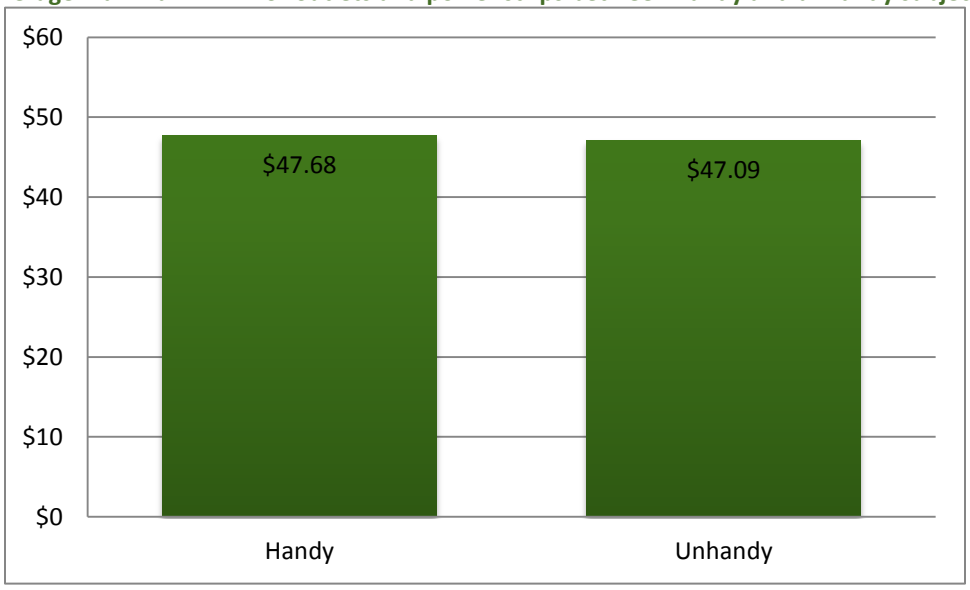
Figure 16: Average maximum WTP for CFLs between handy and unhandy subjects



WTP for Outlets and Power Strips

Similar to CFLs, outlets and power strips show no statistically significant difference between the average maximum WTP for handy and unhandy respondents. The highest WTP is $47.68 for handy subjects and $47.09 for unhandy subjects – a difference of only $0.59 (*Figure 17*).

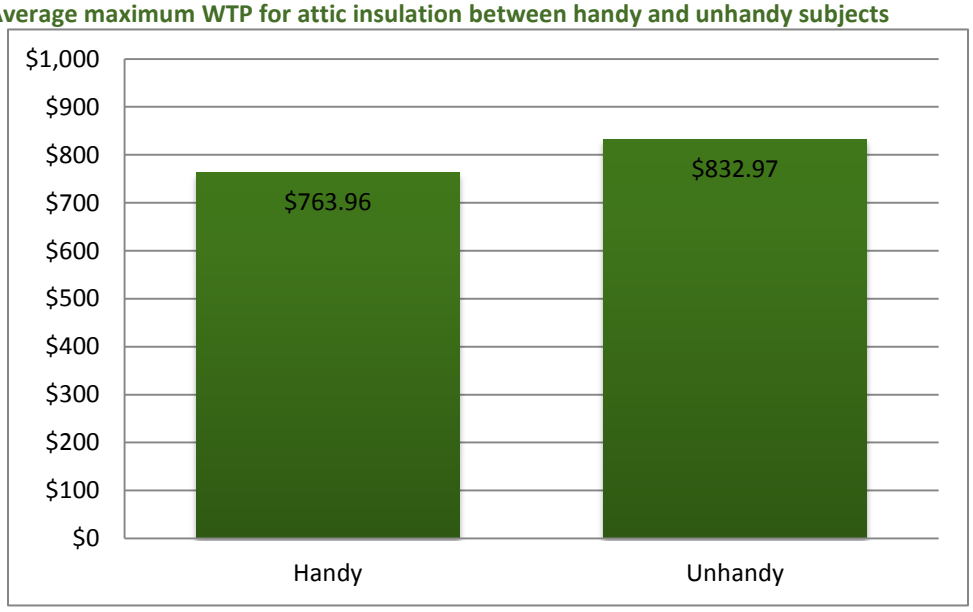
Figure 17: Average maximum WTP for outlets and power strips between handy and unhandy subjects



WTP for Attic Insulation

For attic insulation, unhandy respondents indicate a higher average WTP of $832.97 – more than eight percent higher than the handy respondents' WTP of $763.96 (*Figure 18*). A statistically significant difference (p=0.0419) is found between handy and unhandy individuals, suggesting that subjects with a do-it-yourself preference are willing to pay significantly less for attic insulation compared to subjects who hire a handyman or don't perform their own repairs.

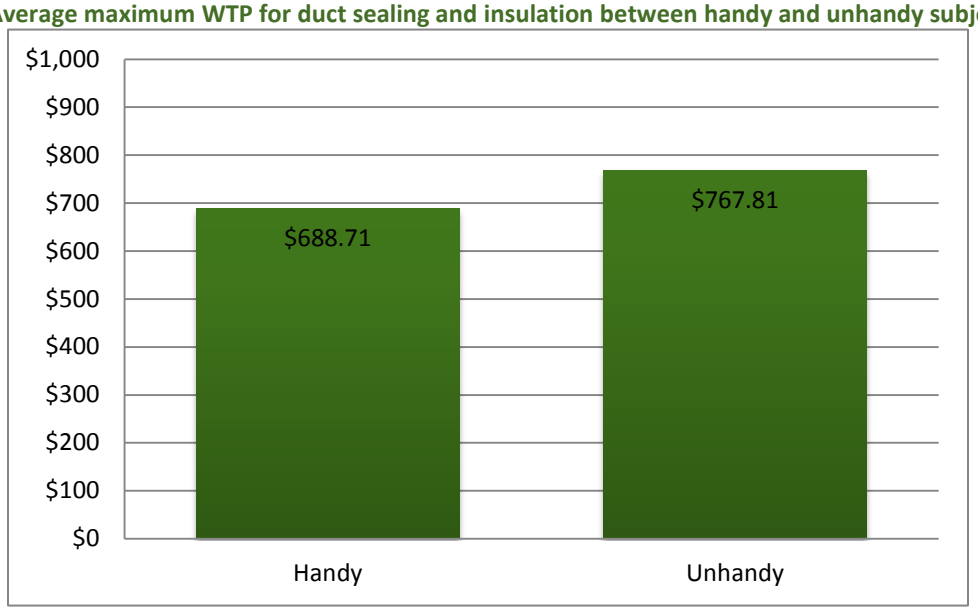
Figure 18: Average maximum WTP for attic insulation between handy and unhandy subjects



WTP for Duct Sealing and Insulation

For duct sealing and insulation, unhandy respondents indicate a 10 percent higher average WTP compared to handy respondents' WTP of $688.71 (*Figure 19*). A statistically significant difference (p=0.0077) is found between handy and unhandy individuals, suggesting that subjects with a do-it-yourself preference are willing to pay significantly less for duct sealing and insulation compared to subjects who hire a handyman or don't perform their own repairs.

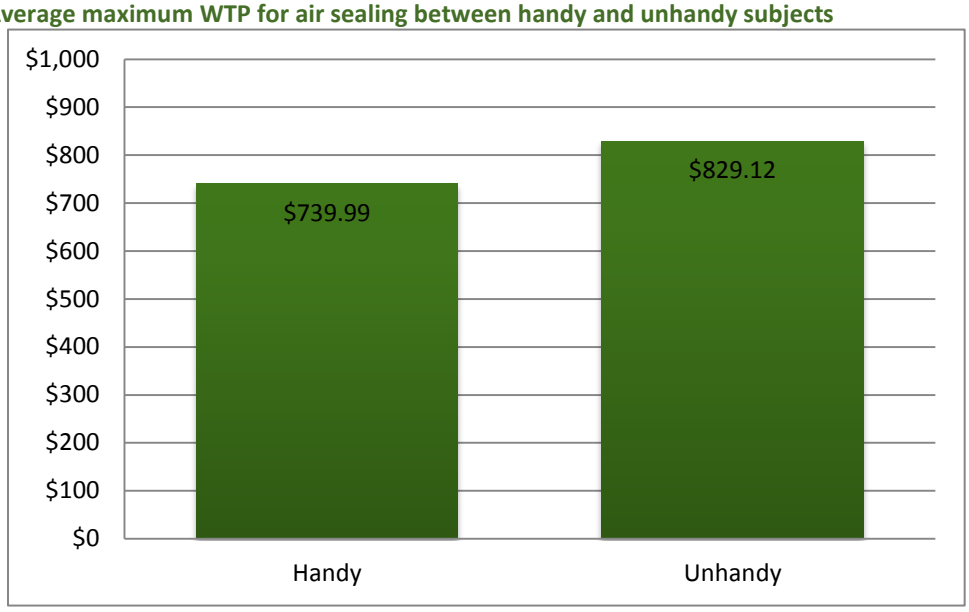
Figure 19: Average maximum WTP for duct sealing and insulation between handy and unhandy subjects



WTP for Air Sealing

The average maximum WTP for air sealing among unhandy subjects is $784.56 or seven percent higher than handy subjects stating $739.99 (*Figure 20*). This difference in average maximum WTP is statistically significant (p=0.0284) between handy and unhandy respondents suggesting that do-it-yourselfers are willing to pay less for air sealing than unhandy subjects.

Figure 20: Average maximum WTP for air sealing between handy and unhandy subjects



Summary of WTP Results for Do-It-Yourselfers

With the exception of CFLs and outlets and power strips, the average maximum WTP for energy-efficient home improvements is higher for unhandy subjects compared to do-it-yourselfers. These data suggest that a do-it-yourself preference significantly decreases a subject's WTP for energy-efficient improvements, but only for those improvements that involve installation by a professional or contractor.

Willingness to Pay and Political Affiliation

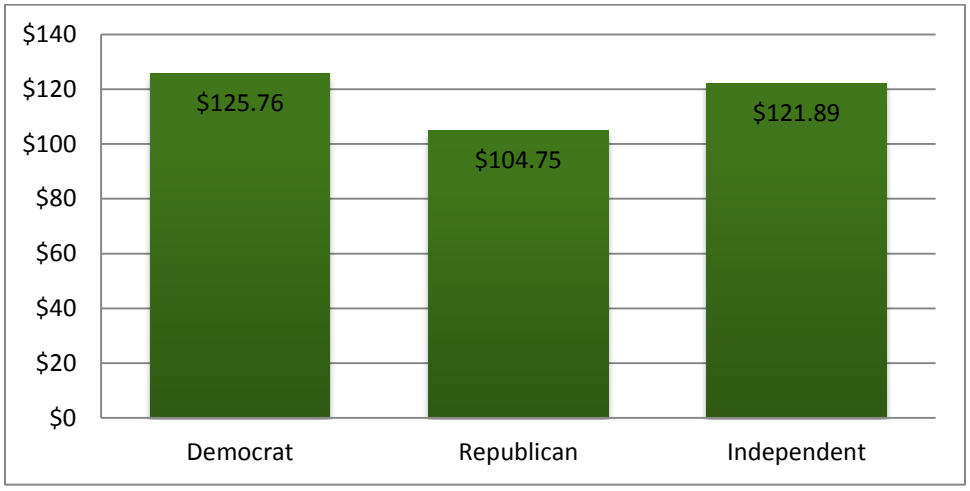
From a political standpoint, the survey sample is comprised of a fairly equal mix of Democrats, Republicans and Independents. Those with a Democratic political affiliation comprise 34 percent of respondents; Independents make up 31 percent and Republicans 30 percent. Those choosing "other" account for only 5 percent of respondents. Using a 2-way ANOVA, I compared WTP for each energy-efficient home improvement compared to a subject's stated political affiliation to determine if political affiliation affects WTP.

WTP for CFLs

For CFLs, Republicans' max average WTP is $104.75 compared to $125.76 for Democrats and $121.89 for Independents (*Figure 21*). These are the largest noted differences among the

individual improvements with statistically significant differences between Republicans and both Democrats and Independents (p≤0.0001). These results suggest that a Republican political affiliation has a negative and significant impact on WTP for CFLs.

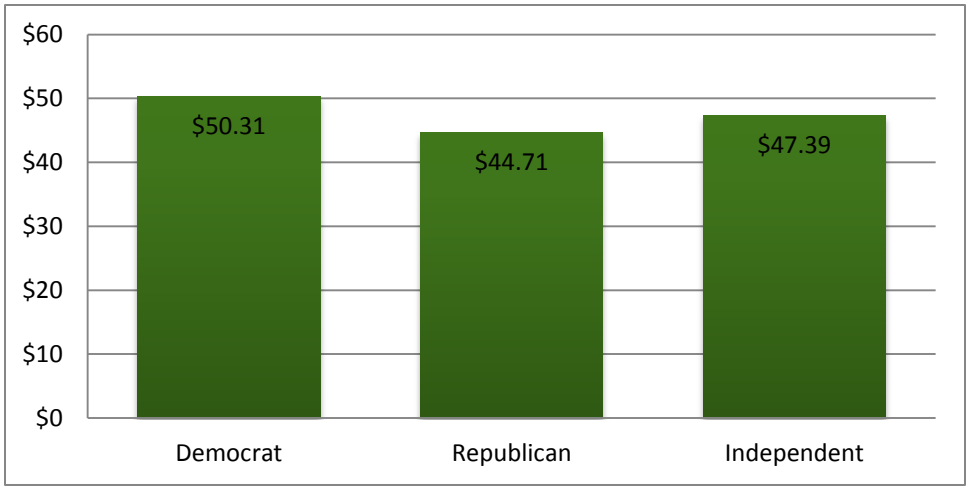
Figure 21: WTP for CFLs by political affiliation



WTP for Outlets and Power Strips

For outlets and power strips, Republicans' max average WTP is $44.71 compared to $50.31 for Democrats and $47.39 for Independents (*Figure 22*). Statistically significant differences are found between Republicans and Democrats (p≤0.0001) and Republicans and Independents (p=0.0816). These results again suggest that a Republican political affiliation has a negative and significant impact on WTP for outlets and power strips.

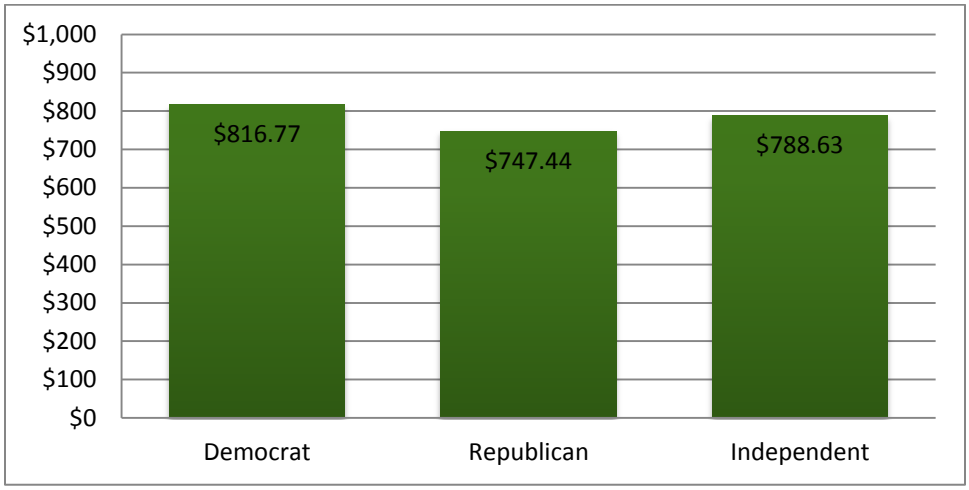
Figure 22: WTP for outlets and power strips by political affiliation



WTP for Attic Insulation

In looking at WTP for attic insulation, Republicans' max average WTP is $747.44 compared to $816.77 for Democrats and $788.63 for Independents (*Figure 23*). A statistically significant difference is found between Republicans and Democrats (p=0.07), but not between Republicans and Independents. These results suggest that a Republican political affiliation has a negative and significant impact on WTP for attic insulation compared to those with a Democratic political affiliation.

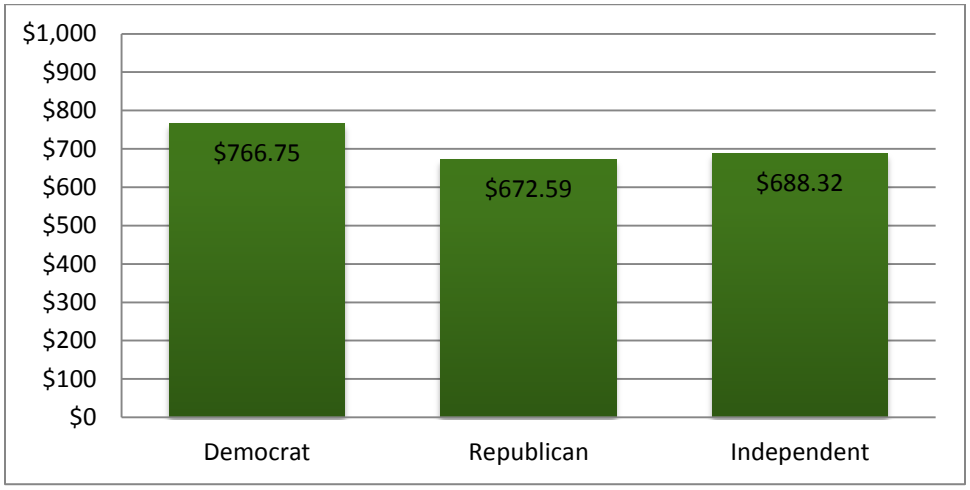
Figure 23: WTP for attic insulation by political affiliation



WTP for Duct Sealing and Insulation

For duct sealing and insulation, Republicans' max average WTP is $672.59 compared to $766.75 for Democrats and $688.32 for Independents (*Figure 24*). Statistically significant differences are found between Republicans and Democrats (p=0.0076) and Republicans and Independents (p=0.0244). These results suggest that a Republican political affiliation has a negative and significant impact on WTP for duct sealing and insulation compared to a Democratic or Independent political affiliation.

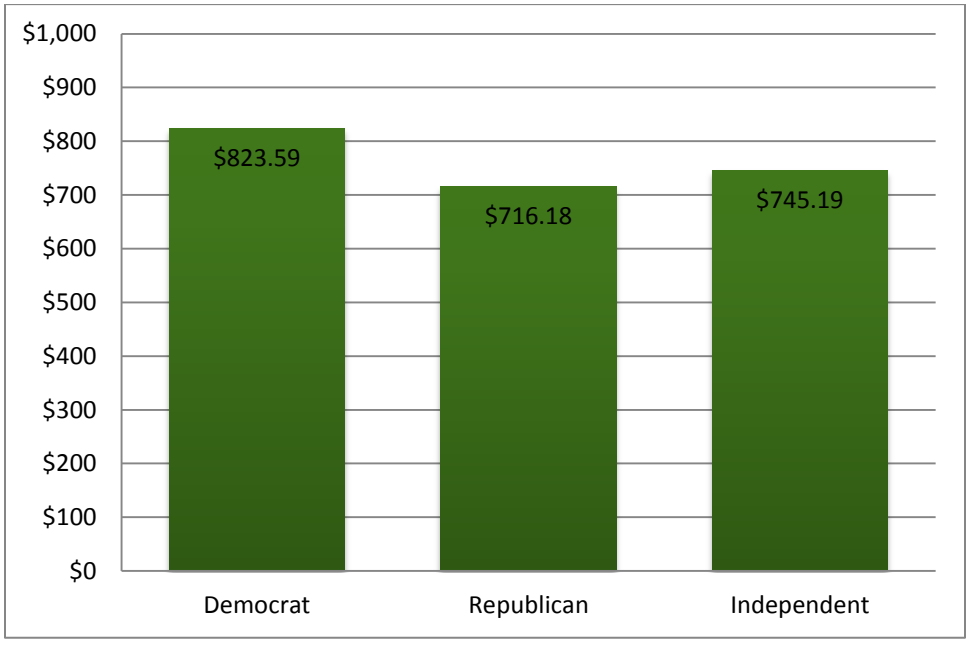
Figure 24: WTP for duct sealing and insulation by political affiliation



WTP for Air Sealing

Lastly, when looking at WTP for air sealing, Republicans' max average WTP is $716.18 compared to $823.59 for Democrats and $745.19 for Independents (*Figure 25*). Statistically significant differences are found between Republicans and Democrats (p=0.0222) and Republicans and Independents (p=0.908). These results suggest that a Republican political affiliation has a negative and significant impact on WTP for air compared to subjects with a Democratic or Independent political affiliation.

Figure 25: WTP for air sealing by political affiliation



Summary of WTP Results by Political Affiliation

When comparing WTP for all suggested improvements, the analysis shows Republicans WTP is significantly less than Democrats and Independents. While there are statistically significant differences in WTP for each energy-efficient improvement, some show greater disparity, including CFLs and air sealing – the least expensive and most expensive improvements suggested in the report.

Willingness to Pay and Tax Incentive Preferences

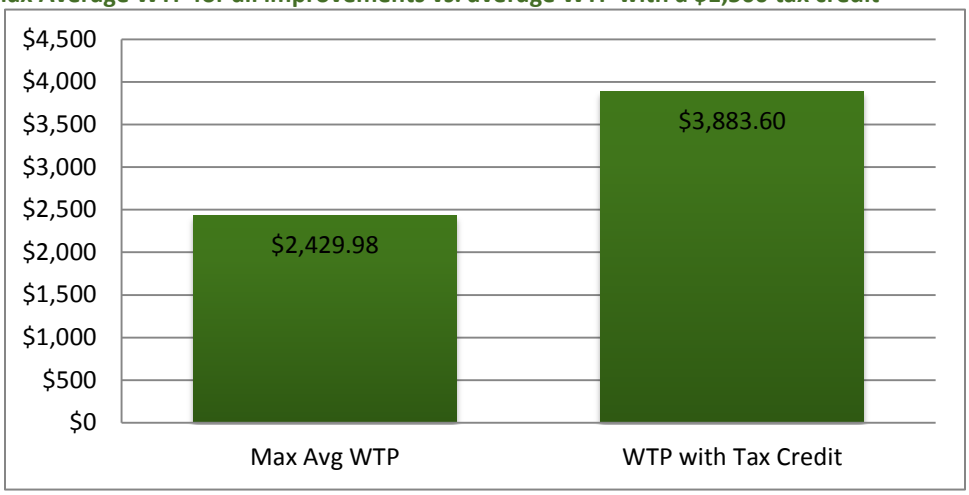
Financial incentives often play a role in WTP decisions and can be critical to developing effective public policy. Within the survey, subjects were asked about tax incentives, specifically:

> You can receive $1,500 in rebates and tax credits if you invest in the recommended home performance improvements.

Subjects were then asked to indicate the maximum they would spend if they received $1,500 in rebates and tax credits using a slider ranging from zero to a maximum of $20,000. Using an independent t-test I compared total average maximum WTP with and without rebates and tax credits.

Across all report types and situational factors, respondents indicate a maximum average WTP of $3,883.60 when offered $1,500 in rebates and tax credits (*Figure 26*). In comparison, the maximum average WTP for the sum of the individual improvements without an incentive is only $2,429.98. This statistically significant difference ($p \leq 0.0001$) suggests that incentives increase a subject's WTP by 60 percent.

Figure 26: Max Average WTP for all improvements vs. average WTP with a $1,500 tax credit



Willingness to Pay and Public Availability of the HEScore Report

Two questions at the end of the survey addressed subjects' feelings toward making the HEScore Report publically available. The questions were framed as yes/no with an open text field. Question one asked:

> If you were buying a home, would you be interested in seeing the home's energy score?

Question two asked:

> If you were selling a home, would you be interested in seeing the home's energy score?

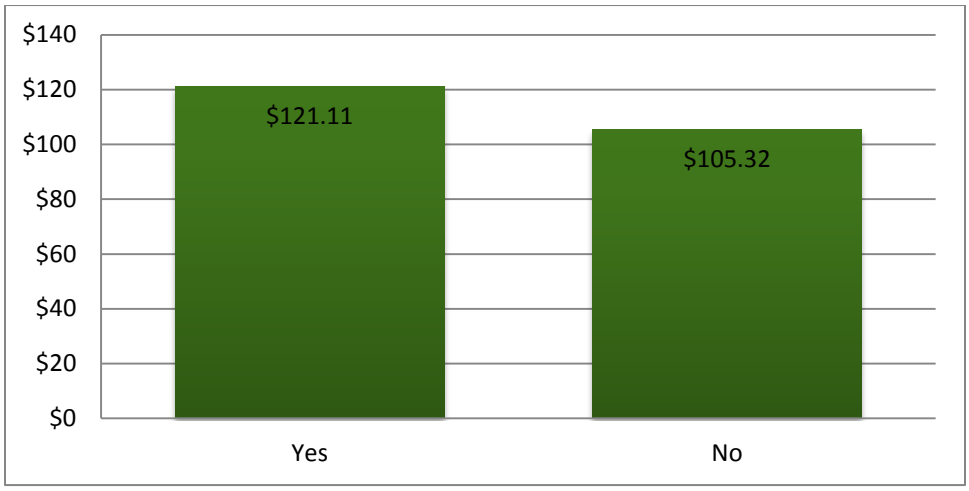
When buying a home, over 91 percent of respondents indicated "yes" they would be interested in seeing a home's energy score. For both the "buying a home" and "selling a home" questions I then ran independent *t* tests to compare subjects' yes and no responses to their average max WTP for energy efficient home improvements. (Note: the combined content analysis for the open text portion of these questions is not included in these results.)

WTP for CFLs

I first looked at the average maximum WTP for CFLs (*Figure 27*). The average maximum WTP for subjects indicating "yes" to see the score is $121.11 compared to $105.32 for subjects indicating "no." This difference in WTP is statistically significant ($p \leq 0.0001$) suggesting that

subjects interested in seeing a home's HEScore are willing to pay 15 percent more for energy-efficient improvements compared to those who are not interested in seeing the score.

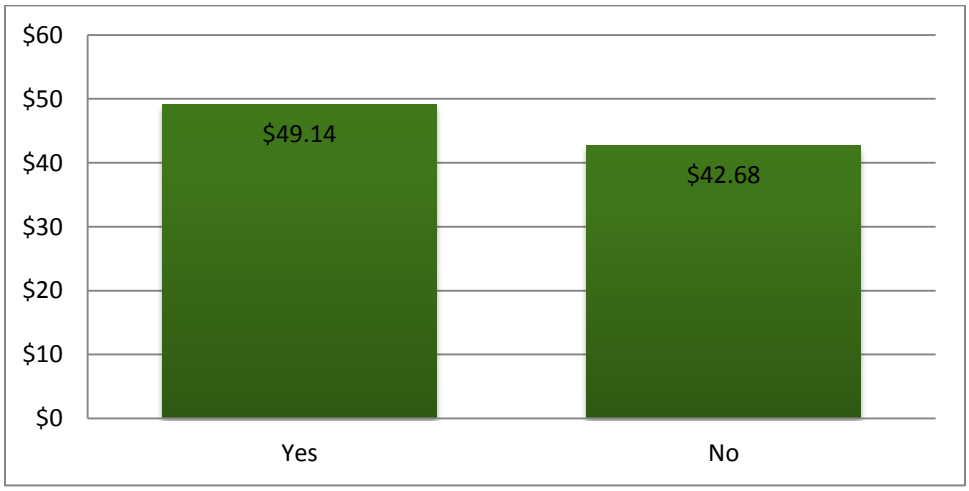
Figure 27: Average maximum WTP for CFLs based on willingness to see the HEScore



WTP for Outlets and Power Strips

For outlets and power strips, the average maximum WTP the average maximum WTP for subjects indicating "yes" to see the score is $49.14 compared to $42.68 for subjects indicating "no" (*Figure 28*). This difference in WTP is statistically significant ($p \leq 0.0001$) suggesting that WTP for outlets and power strips increases by 15 percent when subjects are interested in seeing a home's HEScore.

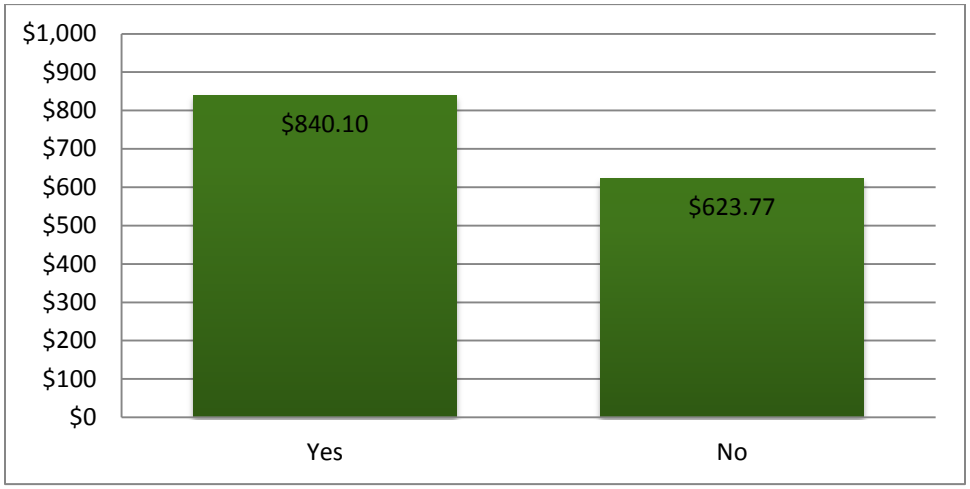
Figure 28: Average maximum WTP for outlets and power strips based on willingness to see the HEScore



WTP for Attic Insulation

Statistically significant differences are also found for attic insulation. The average maximum WTP for subjects indicating "yes" to see the score is $840.10 compared to $623.77 for subjects indicating "no" (*Figure 29*). This difference in WTP is statistically significant ($p \leq 0.0001$) suggesting that WTP for attic insulation increases by nearly 35 percent for subjects interested in seeing a home's HEScore.

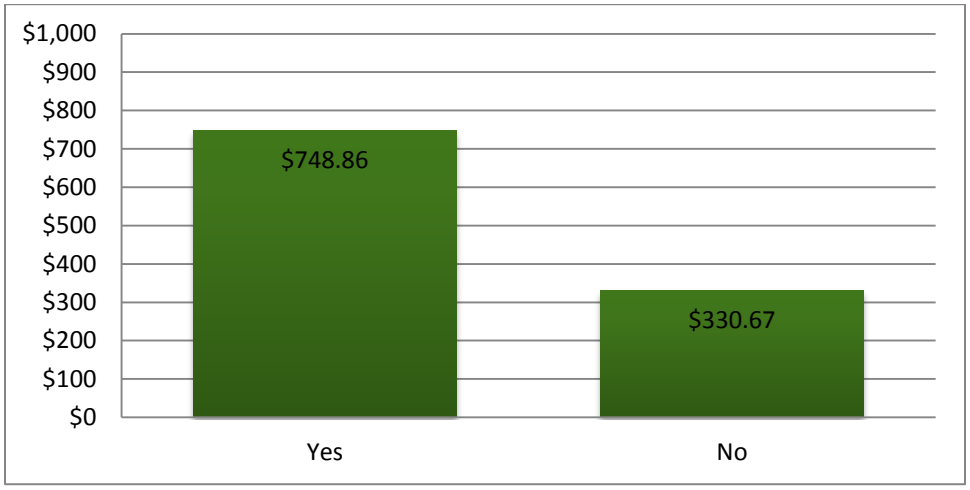
Figure 29: Maximum average WTP for attic insulation based on willingness to see the HEScore



WTP for Duct Sealing and Insulation

There are drastic differences in the results for duct sealing and insulation. The average maximum WTP for subjects indicating "yes" to see the score is $748.86 compared to only $330.67 for subjects indicating "no" (*Figure 30*). This difference in WTP is statistically significant ($p \leq 0.0001$) suggesting that WTP for duct sealing and insulation increases by more than 126 percent for subjects interested in seeing a home's HEScore.

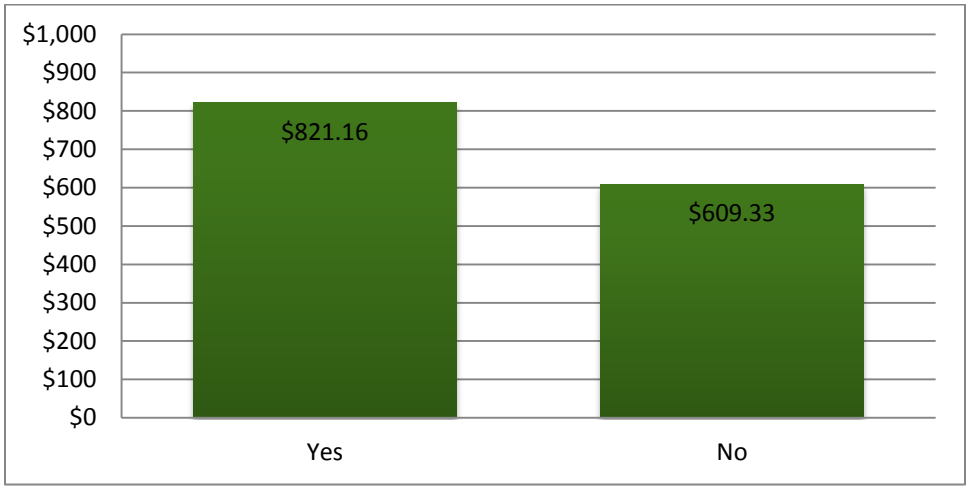
Figure 30: Maximum average WTP for duct sealing and insulation based on willingness to see the HEScore



WTP for Air Sealing

Lastly, Figure 31 shows another significant difference in results for air sealing. The average maximum WTP for subjects indicating "yes" to see the score is $821.16 compared to $609.33 for subjects indicating "no." This difference in WTP is, again, statistically significant ($p \leq 0.0001$) suggesting that WTP for air sealing increases by nearly 35 percent when subjects are interested in seeing a home's HEScore.

Figure 31: Maximum average WTP for air sealing based on willingness to see the HEScore



Summary of WTP Results Based on Willingness to See a Home's Energy Score

Regardless of the type of home energy improvement, the data clearly suggest that subjects interested in seeing a home's energy score before they buy it are willing to pay significantly

more for energy-efficient home improvements. Statistically significant differences ($p \leq 0.0001$) between the "yes" and "no" groups occur among all individual improvements, with the most notable difference seen for duct sealing and insulation.

DISCUSSION

The results of the experiment paint an interesting picture of the motivations and factors that seem to influence a homeowner's WTP for energy-efficient improvements. In reviewing the results there is no one single predictor that affects WTP, rather it is a complex mix of socioeconomic, situational and even political factors that play a role in the decision process.

As the DOE shapes the future of the program and plans a national rollout of the HEScore, results of this study should be considered. The following key findings will help inform decisions and assist in the development of a strategic implementation plan.

Report Type Has no Significant Effect on WTP

The results of the analysis find little to no correlation between the type of report a homeowner receives and their average WTP for improvements. As previously stated, this study did not aim to test the design of the report; rather it was meant to examine how the level of detail in the report might influence a homeowner's decision to improve a home's score. What the analysis found is that, in some instances, the detailed report showed lower average WTP than reports with less detail. In fact, the control group that received no report had nearly the same levels of WTP across all types of energy improvements as those that received a report. Several behavioral factors might explain these results.

Associative Memory – Energy efficiency and conversation are part of the national lexicon and a popular topic in political and media arenas. Most people are likely to have an understanding of energy efficiency gleaned from news stories or friends, as well as some familiarity with the terms of conservation. This information, gathered over time and experiences, becomes a part of an individual's associative memory. Research by behavioral scientists like Morewedge and Kahneman (2011) shows that information from associative memory is often weighted more heavily in the decision process than relevant knowledge (p.435). The small observed differences

in WTP between subjects that received a detailed report (or relevant knowledge) and those that received no report, suggests that subjects may have relied more heavily on their associative memory to respond to the survey questions. The role of heuristic judgments regarding energy efficiency, particularly how these judgments shape the understanding of the HEScore, are worthy of additional study and an important consideration in the overall design of the report.

Anchoring Effect – The framing of the WTP questions may have produced an anchoring effect among subjects. By stating the estimated costs and utility savings for each improvement, subjects may have used these estimates to fix their price. Behavioral economic research consistently demonstrates that choice decisions are often based on stated estimates of cost (Ariely et al., 2003; Simonson & Drolet, 2004). Again, applying associative memory, subjects may have accepted or rejected the validity of the estimates in the HEScore and stated their WTP as above or below the estimated values.

When looking at the average WTP for the less expensive improvements with the higher cost-benefit ratio (CFLs and outlets/power strips) respondents indicated a slightly higher WTP than the estimated cost. Conversely, for the more expensive improvements with lower cost-benefit ratios (attic insulation, duct sealing and air sealing) average WTP was consistently below the estimated cost – and remained below $1,000. These averages hold true regardless of report type. This seems to suggest that subjects may have adopted simplifying strategies by setting a maximum cutoff point of $1,000 – thus accepting the less expensive improvements while rejecting those with a higher cost estimate. Additional study into the effects of anchoring should look at the impacts of WTP estimates in the absence of cost estimates in the HEScore.

Actual Home Buyers Have the Highest Motivation

The results of situational factors showed a distinct correlation between actual home buyers and a higher WTP for energy-efficient home improvements. Compared to homeowners that are selling or staying put, home buyers were willing to pay significantly more to implement energy-efficient improvements. Several factors may explain this difference in WTP preferences.

Priming – One explanation for the disparity between actual home buyers and other groups is that buyers are currently in the mindset to contemplate real-world home improvements. Priming effects, according to Daniel Kahneman (2011), support a readiness to act – in this case making it easier for home buyers to contemplate the idea of buying energy-efficient home improvements. The HEScore is likely to be salient for this group compared to others, thus increasing overall WTP.

Among respondents, 72 percent indicated they bought their current home over five years ago. With so much time since their last home purchase, associative memory related to the home buying experience is likely less accessible to this group of subjects and could explain a lower average WTP.

Given the smaller sample size of home buyers, further study into this group is warranted to determine if these differences in WTP are maintained at scale.

General Evaluability – Another explanation for a higher WTP among home buyers is evaluability, which relates back to the priming effect and associative memory. In this study, energy efficient improvements were evaluated individually i.e., separate evaluation. When options are evaluated separately, values tend to be influenced by the ease of which each option can be evaluated – known as evaluability (Hsee & Zhang, 2010, p. 345). For home buyers, determining the value of improvements is likely easier given a higher level of temporal knowledge compared to those who are not in the buyer mindset.

This is an important consideration as the DOE proceeds with the HEScore program. Home buyers drive the market and can influence adoption of the HEScore. However, improving evaluability among groups that are not in the buyer mindset is critical to the development of the HEScore program. Increasing knowledge and understanding for the value of energy-efficient improvements among all homeowners – including buyers and sellers – may help foster acceptance of the HEScore.

Further study should build on evaluative criteria and the role of priming in WTP decisions across all situational factors.

Role of the Do-it-Yourselfer

Results of the study show a distinct preference for do-it-yourself home repairs. More than 70 percent or respondents indicate they or a friend perform repairs in the home. These results are interesting in light of data collected by the American Housing Survey (AHS). The AHS looks at total home improvement costs over two years for owner-occupied housing by breaking overall costs into "Professional" and "Do-it-Yourself" categories. For 2011 the total cost for all home improvement activity over a two-year period was $358.5 billion; of this amount 82 percent, or $295 billion, was completed by a professional with only 18 percent, or $63.5 billion, completed by a do-it-yourselfer (U.S. Census Bureau, 2011).

While these repairs include all types of home improvements – from kitchen remodeling to plumbing – it does capture one improvement i.e., insulation, that was included as part of the HEScore. According to the AHS data, $4.4 billion was spent nationally on insulation over a two-year period. Of those insulation renovations, $3.3 billion, or 74 percent, were completed by a professional with only $1.2 billion, or 26 percent, completed by a do-it-yourselfer (U.S. Census Bureau, 2011).

The results of my study show overall WTP for do-it-yourselfers is significantly lower than individuals without a do-it-yourself preference, yet real-world data suggests that professionals do most home repairs in U.S. households. While the role of the do-it-yourselfer should not be ignored, there are several reasons that may explain these differences.

Associative Priming – The design of the HEScore and the survey imply that suggested improvements should be made by a contractor or professional. This is standard language within most federally-managed programs, but the wording may have an unintended and negative connotation for some people. In the case of do-it-yourselfers, words like "professional" and "contractor" may evoke stereotypes and trigger a negative autonomic response (Morewedge & Kahneman, 2010; Simmons & Nelson, 2006; Perea & Rosa, 2002). This emotionally driven reaction may supersede logic and result in lower stated WTP – particularly for improvements that require professional installation.

Several respondents felt strongly enough to include comments at the end of the survey that reflect strong emotional reactions to contractors including, “I said no to all contractor questions because I would do the work myself, so report doesn't truly indicate what people would or wouldn't do.” Another flatly said, “Don’t trust contractors.”

At the risk of alienating a prominent segment of the homeowner population, further study is needed to understand the effects of specific wording choices within the HEScore. In addition, the DOE should consider more energy-efficient improvement options for do-it-yourselfers. How-to videos or classes for “weekend warriors” may help further the program among this group and increase the likelihood that homeowners will actually implement energy-efficient recommendations.

Mental Accounting – Another potential explanation for lower WTP among do-it-yourselfers may be attributable to mental accounting. When subjects mentally transact the cost of independent choices, they may selectively ignore certain elements when calculating their WTP (Chatterjee et al., 2009; Thaler, 1999; Kahneman & Knetsch, 1992). Although the questions asked subjects to state WTP based on factors in the HEScore, do-it-yourselfers may have calculated their WTP responses by subtracting labor costs and only accounting for the materials. If this is the case, it means that do-it-yourselfers are not less likely to make energy-efficient improvements, only that they would make the improvements on their own.

Aspects of evaluability may also affect the stated WTP amounts within the do-it-yourself segment. Do-it-yourselfers evaluating items separately may undervalue the true costs of improvements because they question the estimated values listed in the HEScore (Hsee et al., 1999; Kahneman & Knetsch 1992). Among this segment, improvements with higher stated WTP generally had a higher cost-benefit ratio. The do-it-yourselfers may have deemed certain improvements more worthy than others, especially since easier improvements generally had a higher WTP, with more complicated improvements (requiring a contractor) receiving lower WTP in relation to the estimated cost.

Again, this warrants further study and should be considered in the next phase of research – particularly given the sizable population that considers itself a do-it-yourselfer. In addition,

different framing options for the display of cost and savings estimates should be considered and tested for the HEScore and report.

Incentives are Important

Results indicate that regardless of situational factors or the decision environment, tax incentives and rebates increase overall WTP for energy-efficient home improvements. When considering the cost of the recommended improvements presented in the HEScore, most benefits are realized over the long term. In cases of choices that have delayed benefits or a slower feedback loop, incentives can increase the likelihood for adoption (Thaler &Sunstein, 2009, p. 98).

Behavioral theory also predicts that many people will underweight the opportunity costs of energy improvements, particularly when faced with upfront incentives (Thaler &Sunstein, 2009, p. 100). When considering choice architecture for the HEScore, bundling a tax incentive or rebate into the forefront of the program may increase adoption rates. As the DOE moves forward in planning a national launch of the HEScore, tax incentives should be considered as an integral part of the program. Although an incentive of $1,500 was used in the survey, more research should be conducted to determine the optimal level for eliciting desired changes in behavior.

Consider the Political Mindset

The results of the political analysis on WTP seem to support the results of other studies that indicate Democrats are generally green leaning and more engaged in energy issues and conservation (Carlsson et al., 2013; Konisky et al., 2008; Elliott et al., 1997). The lower average WTP of Republicans may be attributable to confirmation bias and a general weariness of conservation efforts, as well as skepticism over climate science. Associative memory and emotional response to the HEScore may have biased their responses within the survey. As a result, evaluability may have affected the stated WTP amounts of Republican respondents. In separately evaluating energy-efficient improvements, skepticism may have lead Republicans to undervalue the cost of improvements based on questions of validity for the HEScore and the value of improvements.

Similar to recommendations for do-it-yourselfers, further study is needed to understand the effects of specific wording choices within the HEScore as well as the display of cost and benefit estimates. In addition, targeting Democrats and Independents as early adopters, particularly in the initial phases of the HEScore program, may yield greater acceptance and improve traction for the program.

Make it Public

Perhaps the most notable finding within this study is the effect on WTP when the report is made public. An overwhelming 91 percent or respondents indicated they would want to see a home's HEScore when buying a home. Although only 75 percent said they would want the HEScore made public if they were selling a home, this still shows tremendous support for public availability of the HEScore. However, most telling is the difference in average WTP for energy improvements among these groups. Respondents advocating for public release of the HEScore (whether buying or selling a home) had significantly higher average WTP across all improvement types.

Reviews of the open text responses to the questions of making the HEScore publicly available reveal several main attitudes. For those wanting to see the HEScore when buying a home, the primary responses included:

- I want to know if the house is efficient
- It helps me calculate my costs of energy and ownership
- It helps me understand if the house needs improvement

For those wanting to share their HEScore when selling a home, the main responses included:

- It's a good selling point
- It shows honesty and transparency for potential buyers
- Increases the market value of the house

This information is valuable when considering effective strategies for implementing a national HEScore program. Homeowners crave information, especially when it comes to making choices. However, social influences also seem to play a prominent role.

Disclosure – When it comes to large infrequent purchases like a home, information and disclosure can help ease the angst associated with critical decisions (Thaler &Sunstein, 2009, p. 73). Many respondents indicated that public availability of the HEScore would "level the playing field" by creating an easy-to-understand standard. Instead of calculating utility bills for individual houses and determining average costs, a standardized HEScore provides home buyers with a consistent metric to measure a home's efficiency. It removes the complexity and allows for easier comparisons – thus simplifying one aspect of choosing a home (Yang et al., 2011, p. 395). Home buyers want assurance that they are making a good choice, and disclosure through the HEScore provides this certainty.

Peer Pressure – Many respondents that answered "yes" to making the HEScore publically available when selling a home, provided this standard caveat, "I would, but only if I had a good score." Most people want to look good to the outside world. In this way a home's score becomes more than just an energy rating – it becomes a reflection of the homeowner. The fear of disapproval is a powerful motivator. Peer pressure and the need to conform are often the strongest drivers for implementing change (Tayler & Bloomfield, 2011, p.758).

Social influences should not be overlooked as the HEScore program takes shape. The DOE should capitalize on the buyer and seller mindsets and consider the impacts of disclosure and peer pressure. Tapping into these human motivators could be powerful tools to elicit change in the home marketplace.

Limitations of the Study

While the results of this study seem to demonstrate strong relationships between mindsets, incentives and WTP, some caution should be taken when weighting these findings. Surveys are an excellent vehicle for reaching large populations and obtaining significant sample sizes, but they lend themselves to hypothetical bias. Since subjects were asked to imagine scenarios,

there is no assurance that a subject's stated WTP would be consistent with what they would pay in the real world.

Another limitation comes from the inherent flaws of contingent valuation studies. As Kahneman and Sugden (2005) note, responses generally reveal attitudes rather than actual preferences (p. 164). Some of the open text responses, particularly those related to feedback about the survey, seem to support this argument. A few people noted a general distrust for the HEScore, while others felt it was a "waste of time" given the state of the economy. On the flip side, many people expressed favorable feelings toward the HEScore and even bragged about their abilities to save energy. Although subjects reported high levels of confidence in providing accurate responses, there is no way of gauging the true impact of how these attitudes – both favorable and unfavorable – influenced the final results.

Further Research

This survey provides a good basis for understanding how situational factors and the decision environment might influence a homeowner's WTP for energy-efficient home improvements. The scope of my study is limited, and my analyses and results only scratch the surface of the amount of data collected; there is certainly more that can be discovered from the information gathered by the survey.

Qualitative research into the attitudes that guide feelings about home energy efficiency would certainly enhance the quantitative data collected in this study. This would also help in determining the extent of hypothetical bias in the results. Experiments utilizing real-world situations would help confirm or disprove whether imagined choices match actual choices.

This study did not test the design of the HEScore labeling, but further research should examine the use of injunctive norms and loaded syntax within the HEScore design. Building on the studies conducted by EnergySavvy.com should assist in this regard.

CONCLUSION

Before we can reduce the overall energy consumption of U.S. homes, we need to understand the factors that influence consumers to make energy-efficient choices. The results of this study clearly demonstrate that there is no single agent that determines these choice decisions; rather it is a complex mix of socioeconomic, situational and political factors that play a role in the decision process.

I used WTP as a metric to measure choice, but this only tells one a part of the story. Choices are fraught with emotion. Information is processed through a filter of preconceived ideas and biases that often ignore factual information. When designing public policies and programs we need to find ways to reduce the emotional chatter and provide easier choices so people can make informed and sound decisions.

My primary research question asked: Does the DOE's HEScore report affect a homeowner's willingness to pay (WTP) for energy-efficient home improvements? The results of this question are mixed.

While standard labeling programs are helpful, there needs to be a basis for understanding. An HEScore on its own will do little to change behavior and inspire energy-efficient choices. In designing an effective program the DOE needs to frame the conversation and educate the consumer. Education is critical to increase understanding, but shaping understanding requires knowledge of the audience. Considerations must be made for the role of the do-it-yourselfer, the home buyer, home seller and homeowner, as well as the political mindset of these groups. Policy that includes tax incentives and public availability options are additional nudging factors that will help further the program's acceptance.

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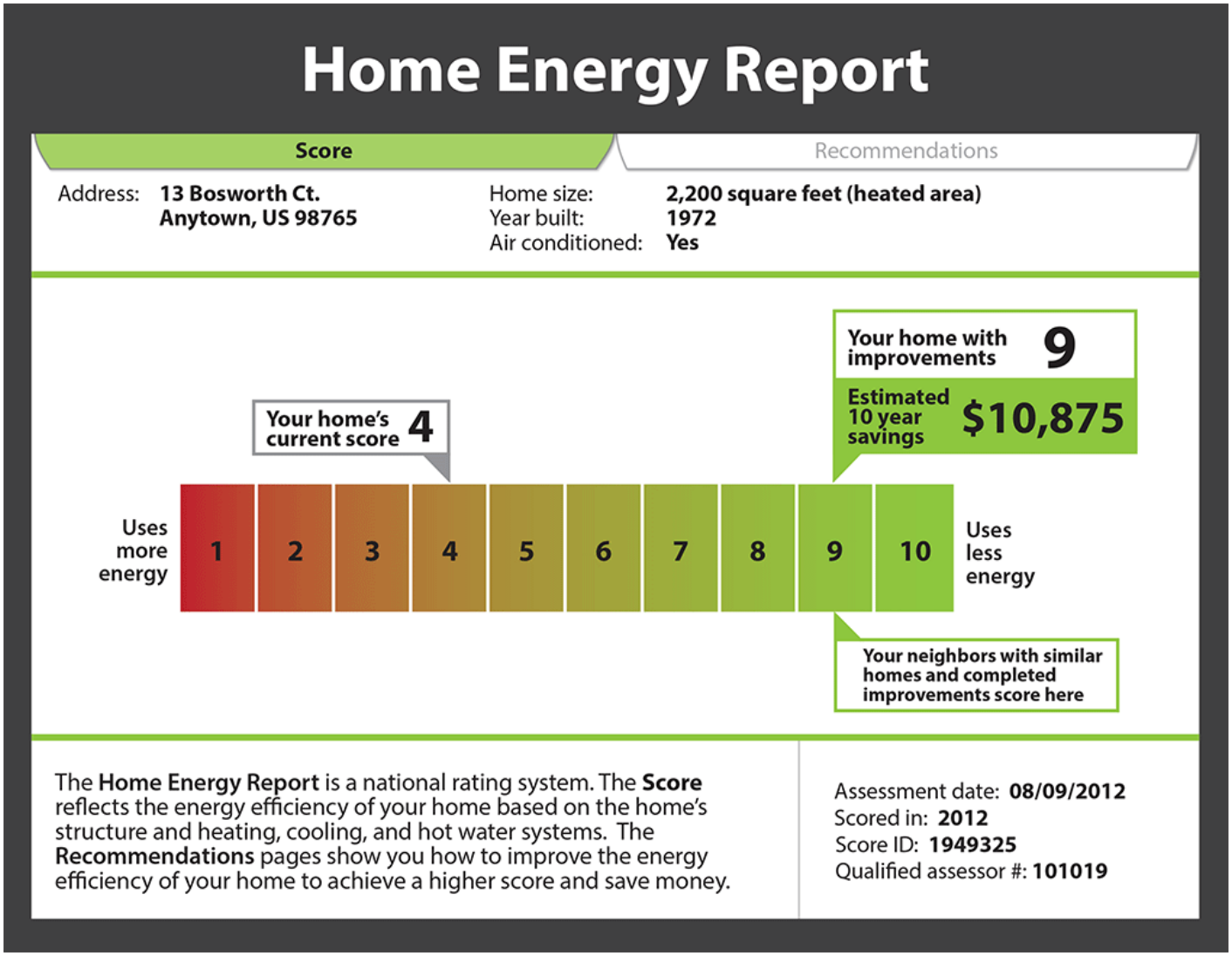
APPENDICES

Appendix A: Detailed Home Energy Report



Home Energy Report

Score | **Recommendations**

Your Top 2 Do-It-Yourself Tips: These low-cost, quick, and easy actions will help your family run your home for less money with very little effort

Estimated utility bill savings ($/year)

1. Reduce Your Lighting Waste with CFLs:

What: Purchase 25 compact fluorescent bulbs (CFLs) and replace your home's outdated standard light bulbs. Remember to flip out lights when you leave the room.
Why: CFLs can use 75% less energy and last an average of 10 times as long. Replacing outdated bulbs with CFLs is the most cost-effective action you can take in your home.

Average Cost: $100 for 25 CFLs

~$160/yr.

2. Eliminate Your Stand-By Power Waste with Power Strips and Outlet Timers:

What: Purchase at least 2 power strips, and then plug in clusters of electronics in the TV room, home office and bedrooms. Remember to turn off power strips when devices are not in use. Purchase and plug in at least 2 automatic outlet timers for electronics that operate only a few hours each day, such as coffee machines and lamps.
Why: Most electronics use stand-by electricity even when they are not being used. A display or small glowing LED light are tell-tale signs that your unused device is wasting your hard-earned money.

Average Cost: $40 for 2 power strips and 2 outlet timers (Avg. $10/each)

~$60/yr.

How: CFLs, power strips, and outlet timers are available at almost any retail store where you would normally purchase light bulbs and other household goods, as well as on-line from numerous retail store fronts, such as Amazon, EnergyFederation.org, Home Depot, Lowes, and more.

Address: **13 Bosworth Ct., Anytown, US 98765** Recommendations Page 1 of 3 Report ID: **1949325**

Appendix A: cont.

Home Energy Report

Score | **Recommendations**

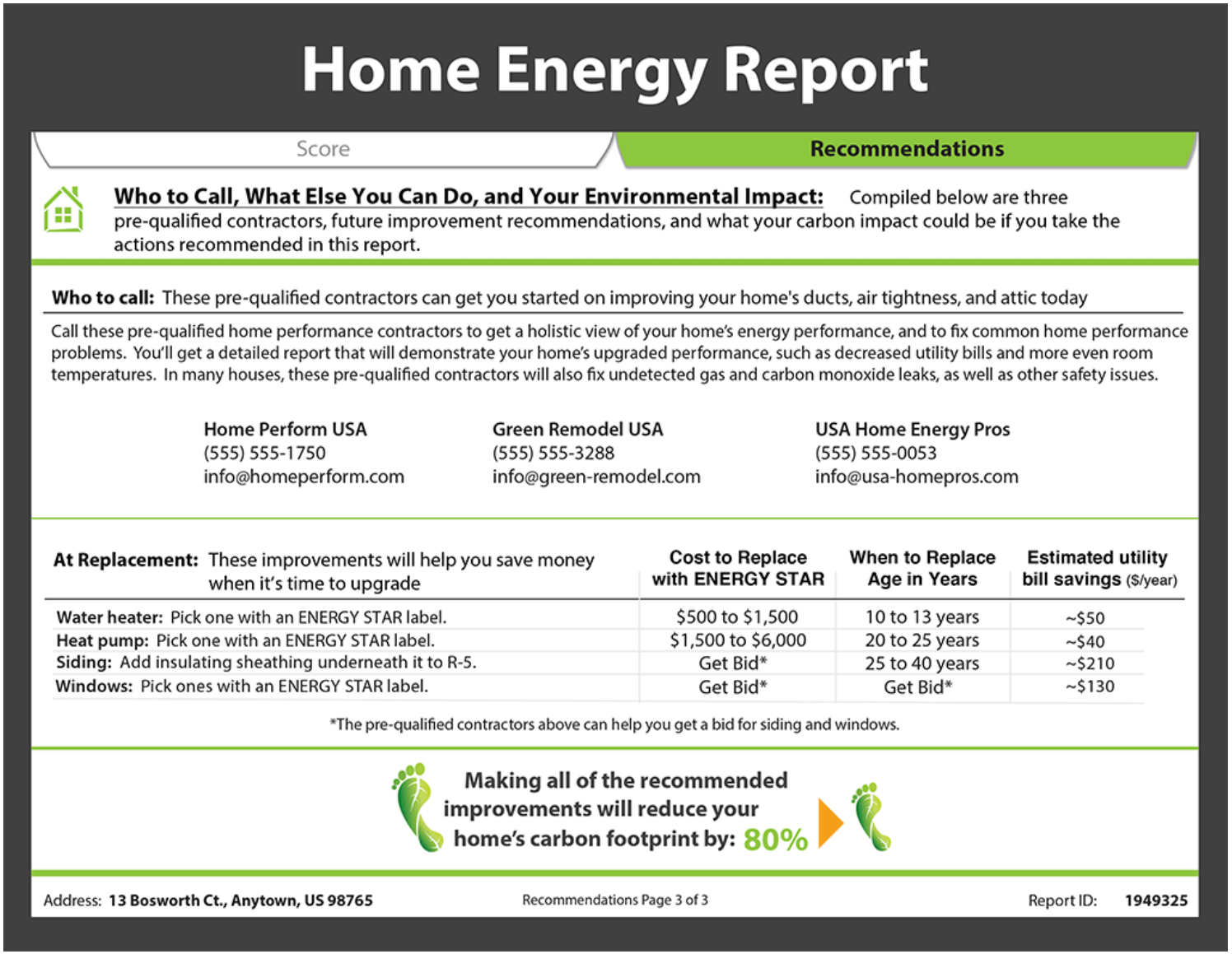
Your Top 3 Prioritized Home Performance Improvements: These home energy upgrades are normally installed by a contractor and are designed to shave money off your monthly utility bill, fix problems in your home before they cause excessive damage, and increase your family's overall comfort and safety.

	Average Cost	Performance ratings out of 10	Estimated utility bill savings ($/year)
1. Duct Sealing and Insulation: Have a professional seal and insulate ducts **Why:** Reducing heating and cooling system leaks by 5% will save about 15% on your cooling and heating bill, as well as achieve even room temperatures, increase comfort in the summer and the winter, and decrease dust and mold levels in your home.	~$950 	Comfort: 10 Health & Safety: 10 Fix Problems: 10 Quick Payback: 7	**~$200/yr.**
2. Attic Insulation: Increase attic floor insulation **Why:** Attic insulation is the most cost-effective home performance improvement you can make. It can significantly reduce your cooling and heating bills and substantially increase comfort levels. In addition, materials in older insulation may contain harmful chemicals such as formaldehyde which can increase exposure risks and impact your health.	~$1,100 	Comfort: 10 Quick Payback: 10 Fix Problems: 8 Health & Safety: 8	**~$180/yr.**
3. Air Sealing: Increase your home's air tightness **Why:** Air sealing plugs up leaks in your home from the outside air, which increases your home's comfort level. The current air leaking from your home is like having a 15" hole in the side of your house. Sealing your home will not only reduce your utility bills, but will also reduce drafts and pests entering your home and improve indoor air quality.	~$1,400 	Comfort: 10 Fix Problems: 10 Health & Safety: 9 Quick Payback: 5	**~$150/yr.**

How to implement the recommendations above: Get these home peformance improvements by contacting the pre-qualified contractors listed on the next page of this report. You will get an exact estimate before receiving professional upgrade services in your home.

Address: **13 Bosworth Ct., Anytown, US 98765** Recommendations Page 2 of 3 Report ID: **1949325**

Appendix A: cont.



Home Energy Report

Score | **Recommendations**

Who to Call, What Else You Can Do, and Your Environmental Impact: Compiled below are three pre-qualified contractors, future improvement recommendations, and what your carbon impact could be if you take the actions recommended in this report.

Who to call: These pre-qualified contractors can get you started on improving your home's ducts, air tightness, and attic today

Call these pre-qualified home performance contractors to get a holistic view of your home's energy performance, and to fix common home performance problems. You'll get a detailed report that will demonstrate your home's upgraded performance, such as decreased utility bills and more even room temperatures. In many houses, these pre-qualified contractors will also fix undetected gas and carbon monoxide leaks, as well as other safety issues.

Home Perform USA	Green Remodel USA	USA Home Energy Pros
(555) 555-1750	(555) 555-3288	(555) 555-0053
info@homeperform.com	info@green-remodel.com	info@usa-homepros.com

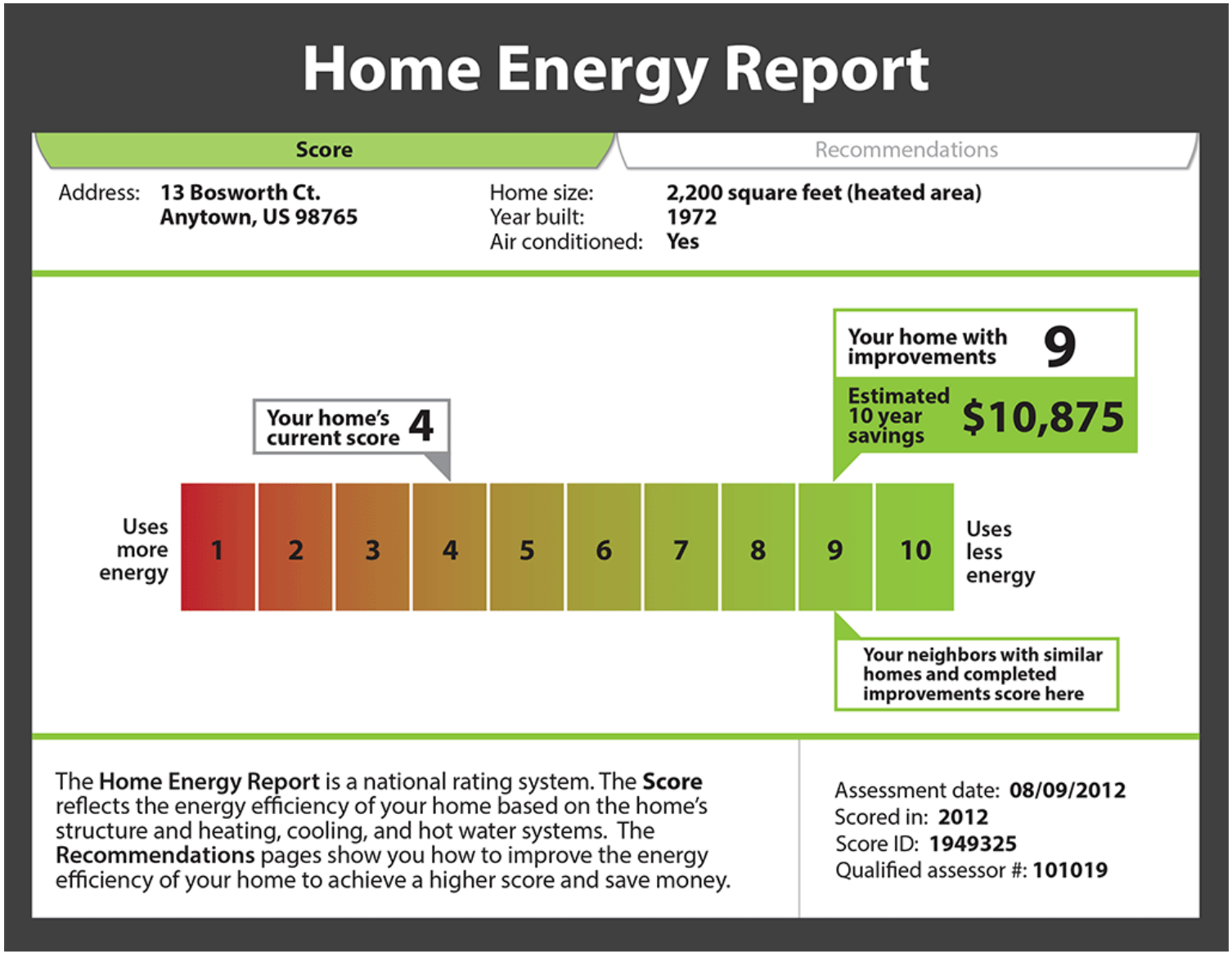
At Replacement: These improvements will help you save money when it's time to upgrade	Cost to Replace with ENERGY STAR	When to Replace Age in Years	Estimated utility bill savings ($/year)
Water heater: Pick one with an ENERGY STAR label.	$500 to $1,500	10 to 13 years	~$50
Heat pump: Pick one with an ENERGY STAR label.	$1,500 to $6,000	20 to 25 years	~$40
Siding: Add insulating sheathing underneath it to R-5.	Get Bid*	25 to 40 years	~$210
Windows: Pick ones with an ENERGY STAR label.	Get Bid*	Get Bid*	~$130

*The pre-qualified contractors above can help you get a bid for siding and windows.

Making all of the recommended improvements will reduce your home's carbon footprint by: 80%

Address: **13 Bosworth Ct., Anytown, US 98765** Recommendations Page 3 of 3 Report ID: **1949325**

Appendix B: Basic Home Energy Report



Appendix B: cont.

Home Energy Report

Score | **Recommendations**

Address: **13 Bosworth Ct.**
Anytown, US 98765

Repair now: These improvements will save your household money, eliminate energy waste, and improve your comfort now.	**Estimated utility bill savings** ($/year)
Lighting: Purchase 25 compact fluorescent bulbs (CFLs) and replace your home's standard light bulbs.	~$160
Stand-By Power: Purchase at least 2 power strips for household electronics (like TVs) and 2 automatic outlet timers for electronics that operate only a few hours a day (like lamps).	~$60
Attic Insulation: Increase attic floor insulation.	~$180
Air Sealing: Seal doors, outlets/switch gaskets, recessed lighting, windows, and the gaps and cracks that leak air into and out of your home.	~$150
Duct Sealing and Insulation: Seal and insulate ductwork throughout your home.	~$200

At Replacement: These improvements will help you save money when it's time to upgrade or replace equipment.	**Estimated utility bill savings** ($/year)
Water heater: Pick one with an ENERGY STAR label.	~$50
Heat Pump: Pick one with an ENERGY STAR label.	~$40
Siding: Add insulating sheathing underneath current siding.	~$210
Windows: Pick ones with an ENERGY STAR label.	~$130

Making all of the recommended improvements will reduce your home's carbon footprint by: 80%

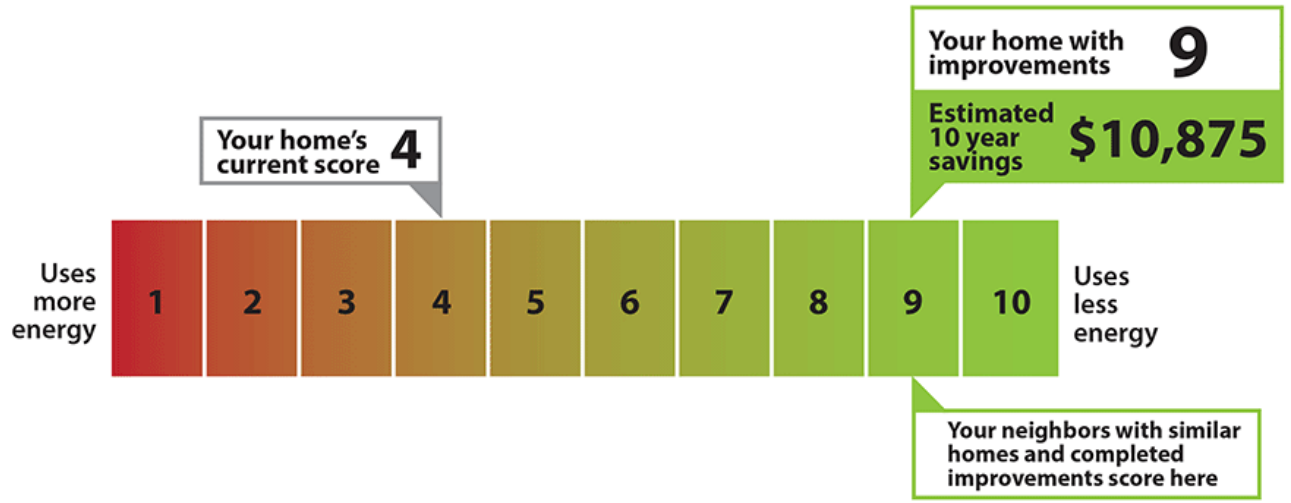
Score ID: **1949325**

Appendix C: HEScore Only Report

Home Energy Report

Address: **13 Bosworth Ct.**
Anytown, US 98765

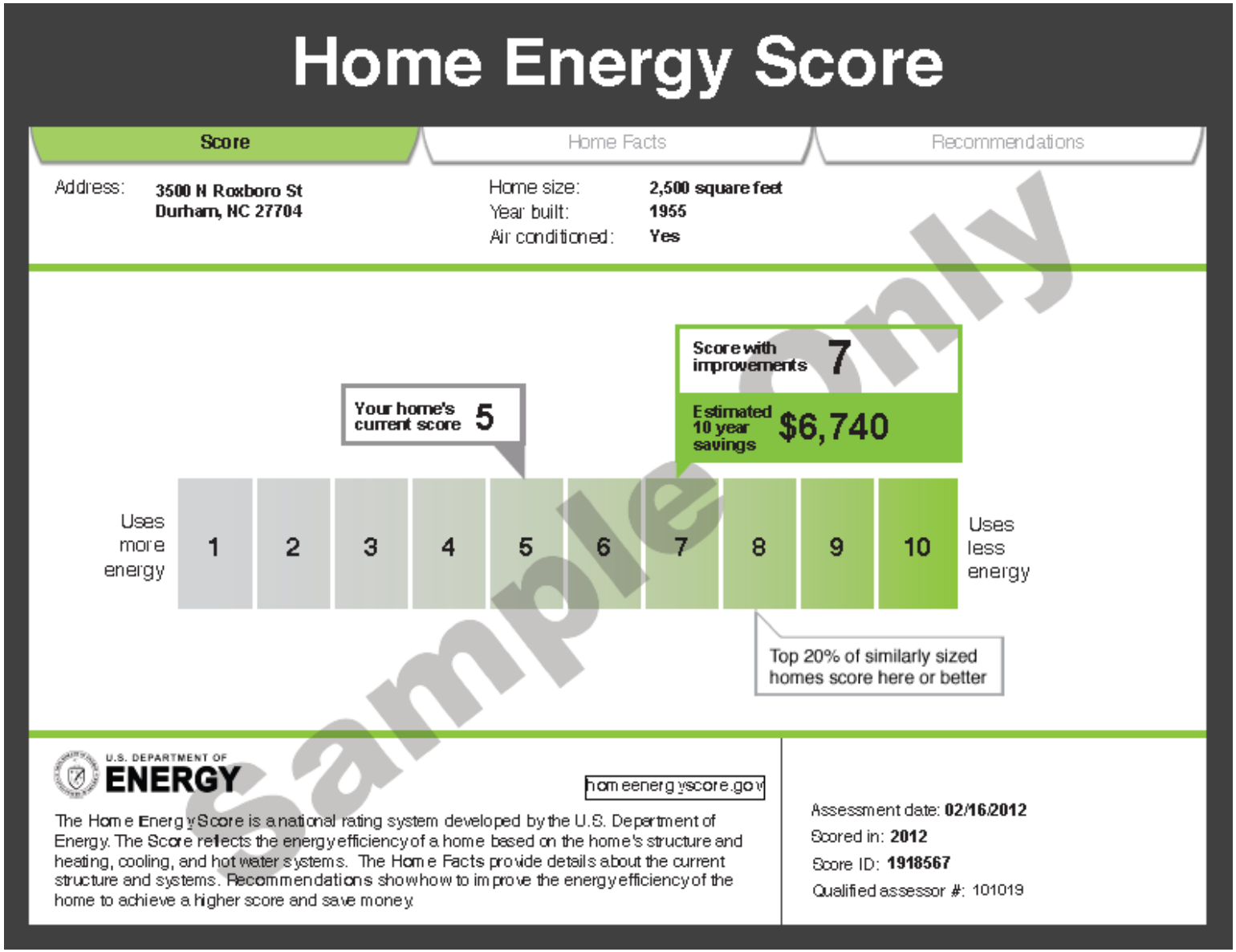
Home size: **2,200 square feet (heated area)**
Year built: **1972**
Air conditioned: **Yes**



The **Home Energy Report** is a national rating system. The **Score** reflects the energy efficiency of your home based on the home's structure and heating, cooling, and hot water systems.

Assessment date: **08/09/2012**
Scored in: **2012**
Score ID: **1949325**
Qualified assessor #: **101019**

Appendix D: Current HEScore and Report



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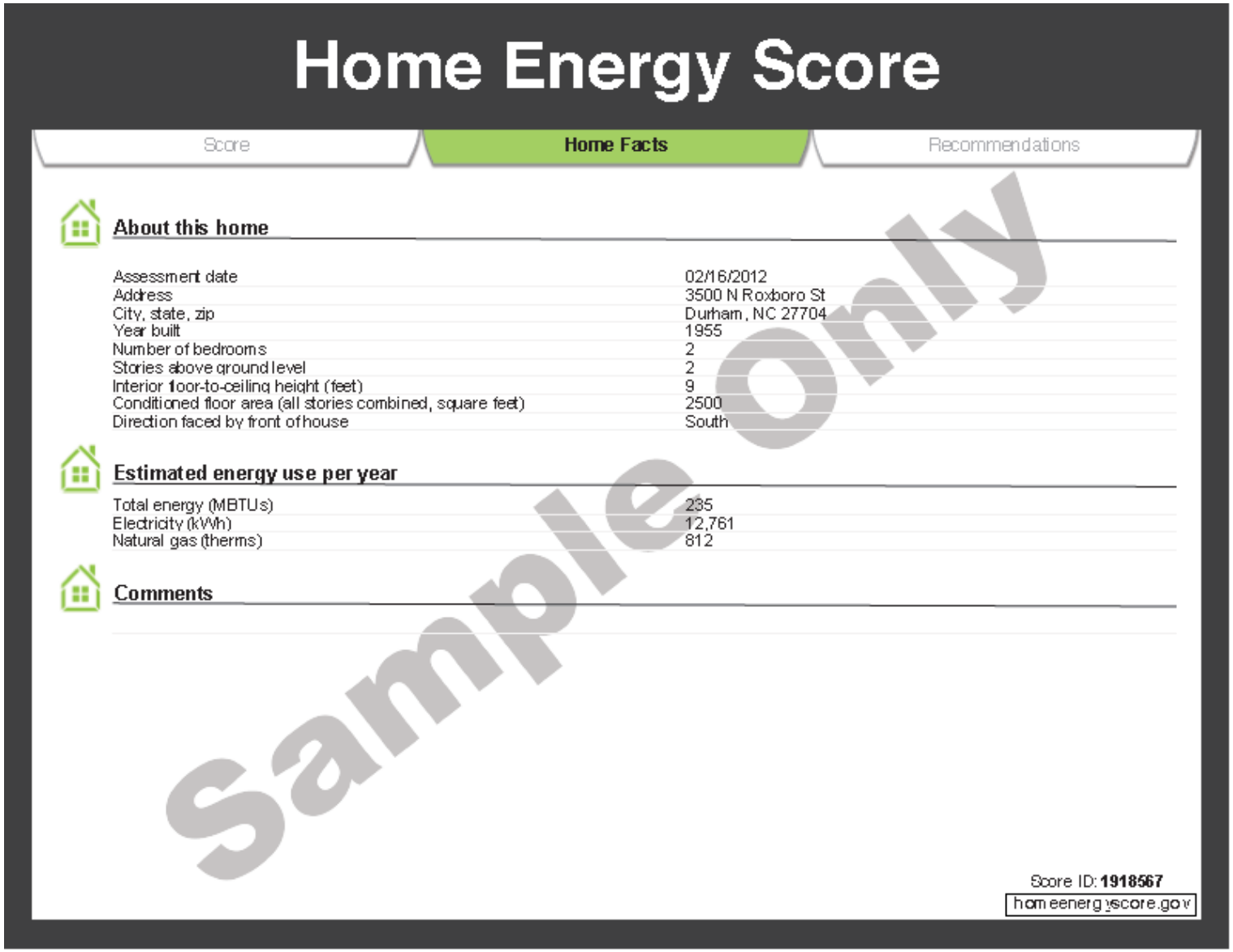


Home Energy Score

Score | **Home Facts** | Recommendations

About this home

Assessment date	02/16/2012
Address	3500 N Roxboro St
City, state, zip	Durham, NC 27704
Year built	1955
Number of bedrooms	2
Stories above ground level	2
Interior floor-to-ceiling height (feet)	9
Conditioned floor area (all stories combined, square feet)	2500
Direction faced by front of house	South

Estimated energy use per year

Total energy (MBTUs)	235
Electricity (kWh)	12,761
Natural gas (therms)	812

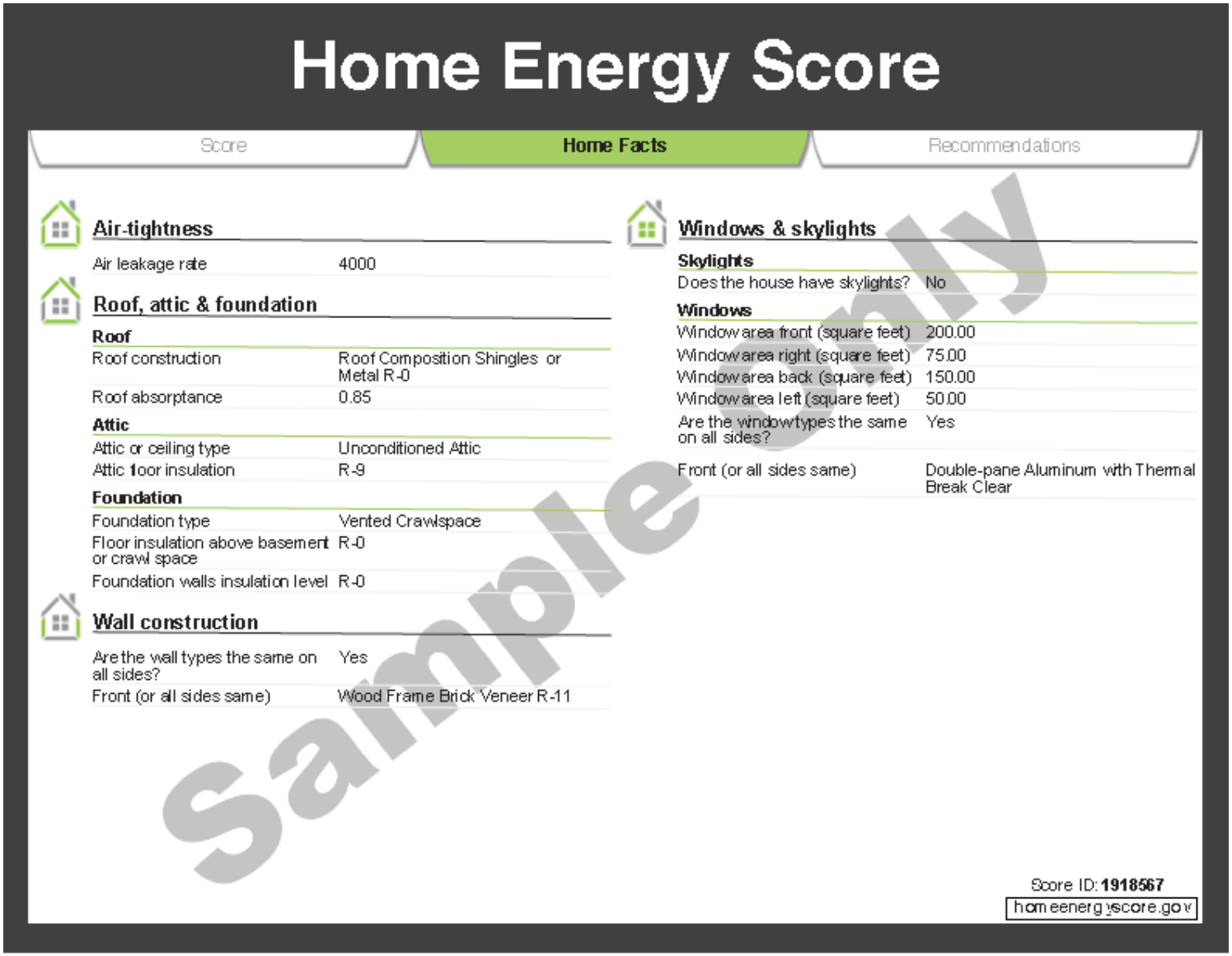
Comments

Sample Only

Score ID: **1918567**

homeenergyscore.gov

Appendix D: cont.



Home Energy Score

Score | **Home Facts** | Recommendations

Air-tightness

Air leakage rate	4000

Roof, attic & foundation

Roof

Roof construction	Roof Composition Shingles or Metal R-0
Roof absorptance	0.85

Attic

Attic or ceiling type	Unconditioned Attic
Attic floor insulation	R-9

Foundation

Foundation type	Vented Crawlspace
Floor insulation above basement or crawl space	R-0
Foundation walls insulation level	R-0

Wall construction

Are the wall types the same on all sides?	Yes
Front (or all sides same)	Wood Frame Brick Veneer R-11

Windows & skylights

Skylights

Does the house have skylights?	No

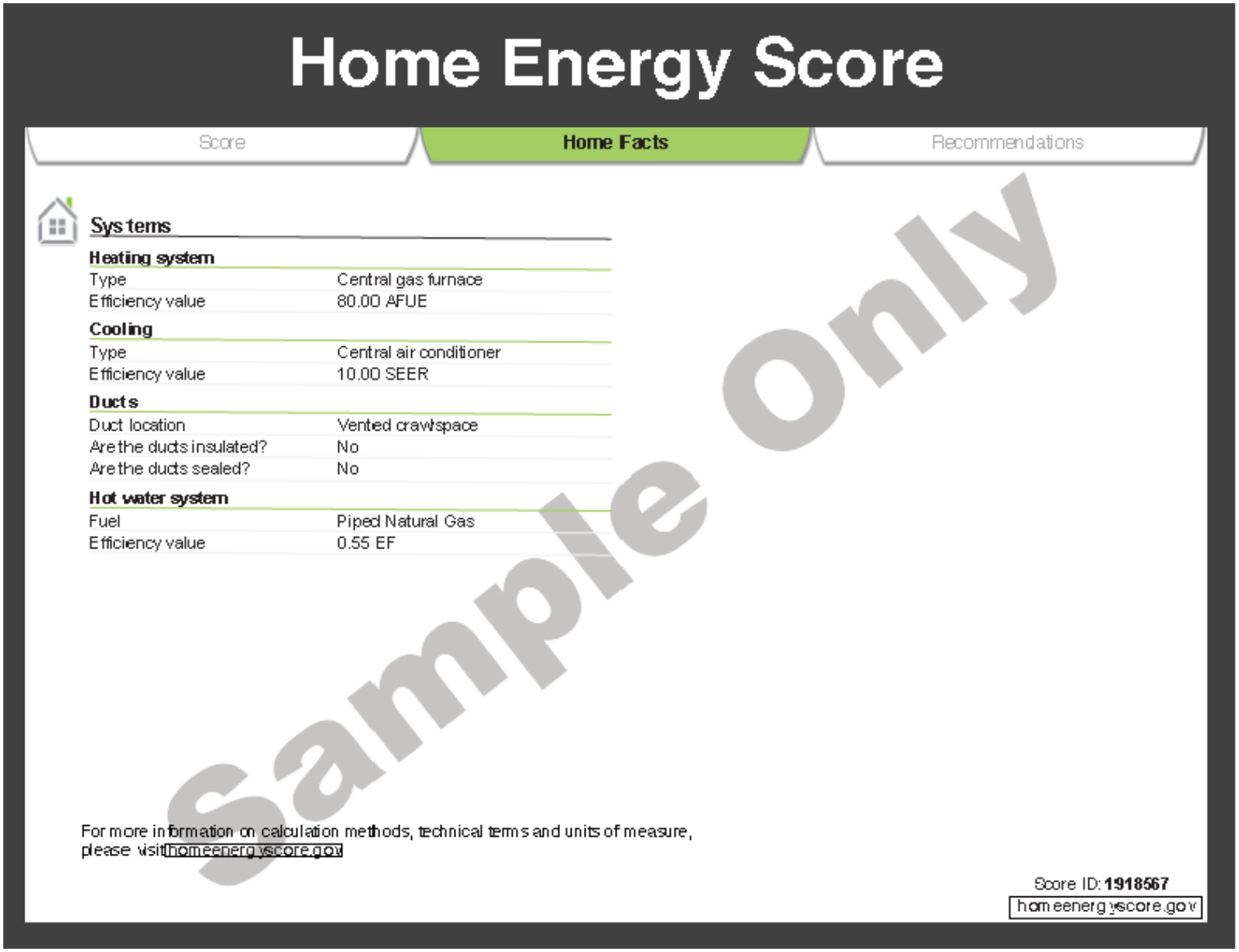
Windows

Window area front (square feet)	200.00
Window area right (square feet)	75.00
Window area back (square feet)	150.00
Window area left (square feet)	50.00
Are the window types the same on all sides?	Yes
Front (or all sides same)	Double-pane Aluminum with Thermal Break Clear

Score ID: **1918567**

homeenergyscore.gov

Appendix D: cont.



Home Energy Score

Score | **Home Facts** | Recommendations

Systems

Heating system	
Type	Central gas furnace
Efficiency value	80.00 AFUE
Cooling	
Type	Central air conditioner
Efficiency value	10.00 SEER
Ducts	
Duct location	Vented crawlspace
Are the ducts insulated?	No
Are the ducts sealed?	No
Hot water system	
Fuel	Piped Natural Gas
Efficiency value	0.55 EF

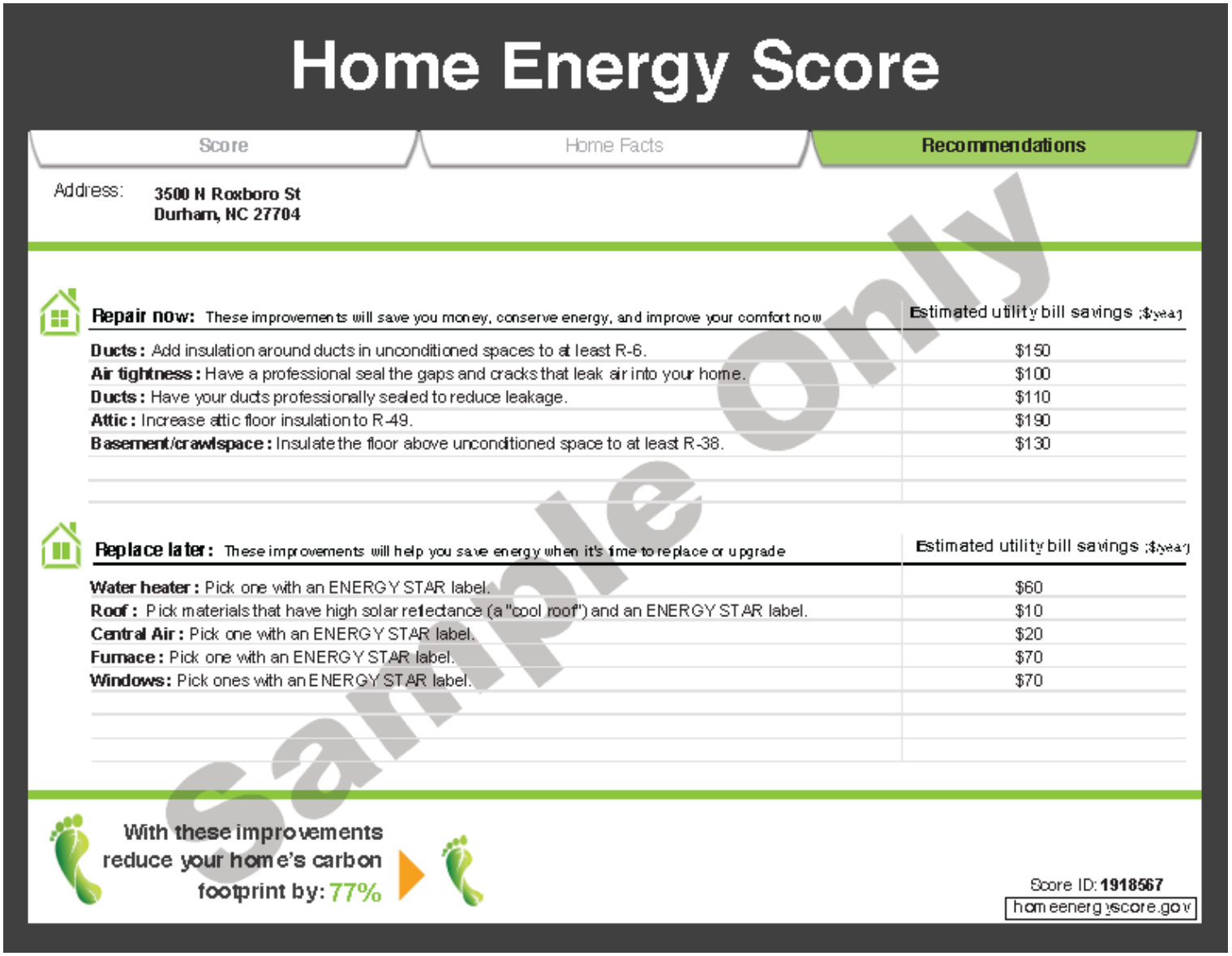
Sample Only

For more information on calculation methods, technical terms and units of measure, please visit homeenergyscore.gov

Score ID: **1918567**

homeenergyscore.gov

Appendix D: cont.



Home Energy Score

Score | Home Facts | **Recommendations**

Address: **3500 N Roxboro St**
Durham, NC 27704

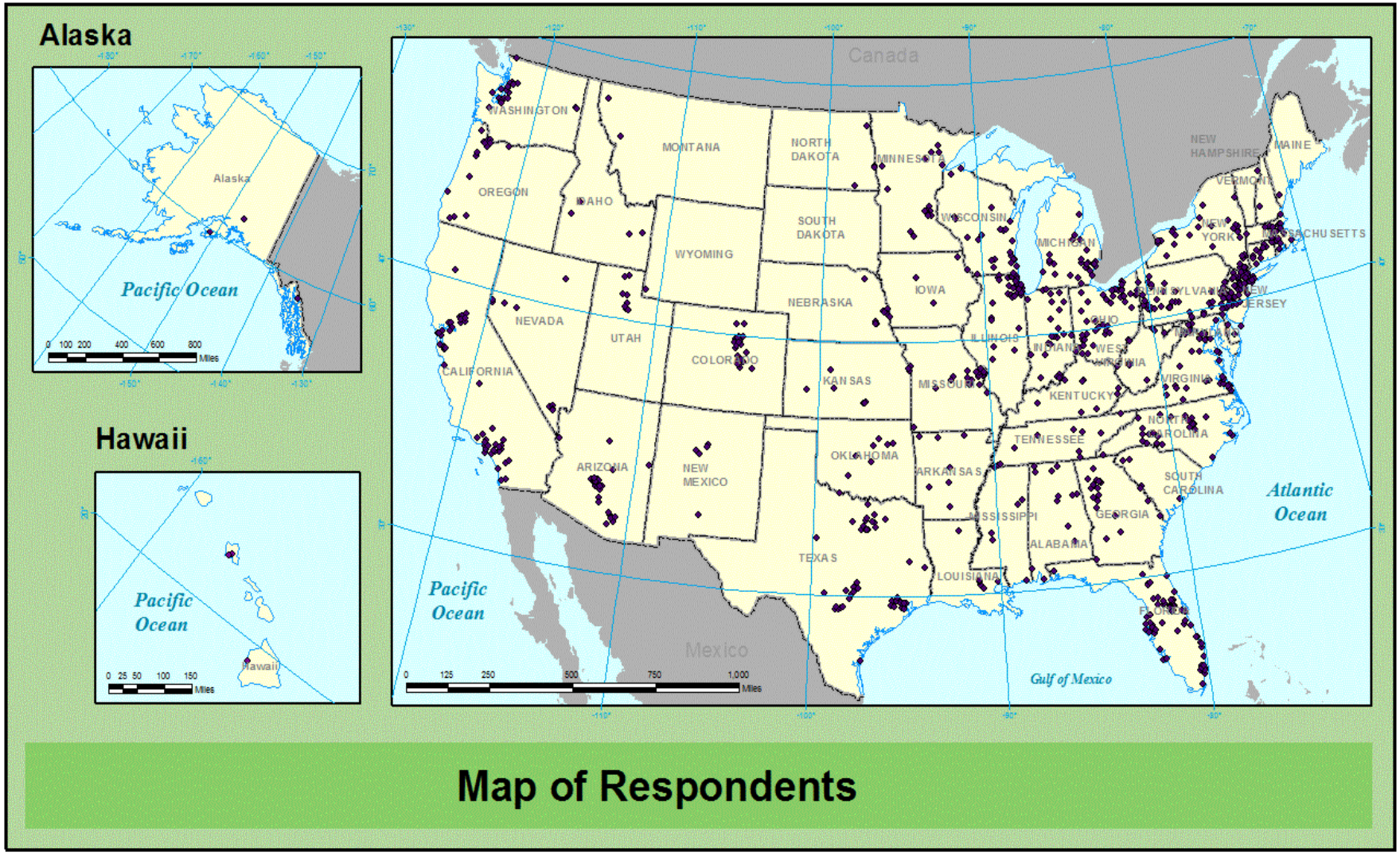
Repair now: These improvements will save you money, conserve energy, and improve your comfort now	Estimated utility bill savings ($/year)
Ducts: Add insulation around ducts in unconditioned spaces to at least R-6.	$150
Air tightness: Have a professional seal the gaps and cracks that leak air into your home.	$100
Ducts: Have your ducts professionally sealed to reduce leakage.	$110
Attic: Increase attic floor insulation to R-49.	$190
Basement/crawlspace: Insulate the floor above unconditioned space to at least R-38.	$130

Replace later: These improvements will help you save energy when it's time to replace or upgrade	Estimated utility bill savings ($/year)
Water heater: Pick one with an ENERGY STAR label.	$60
Roof: Pick materials that have high solar reflectance (a "cool roof") and an ENERGY STAR label.	$10
Central Air: Pick one with an ENERGY STAR label.	$20
Furnace: Pick one with an ENERGY STAR label.	$70
Windows: Pick ones with an ENERGY STAR label.	$70

With these improvements reduce your home's carbon footprint by: 77%

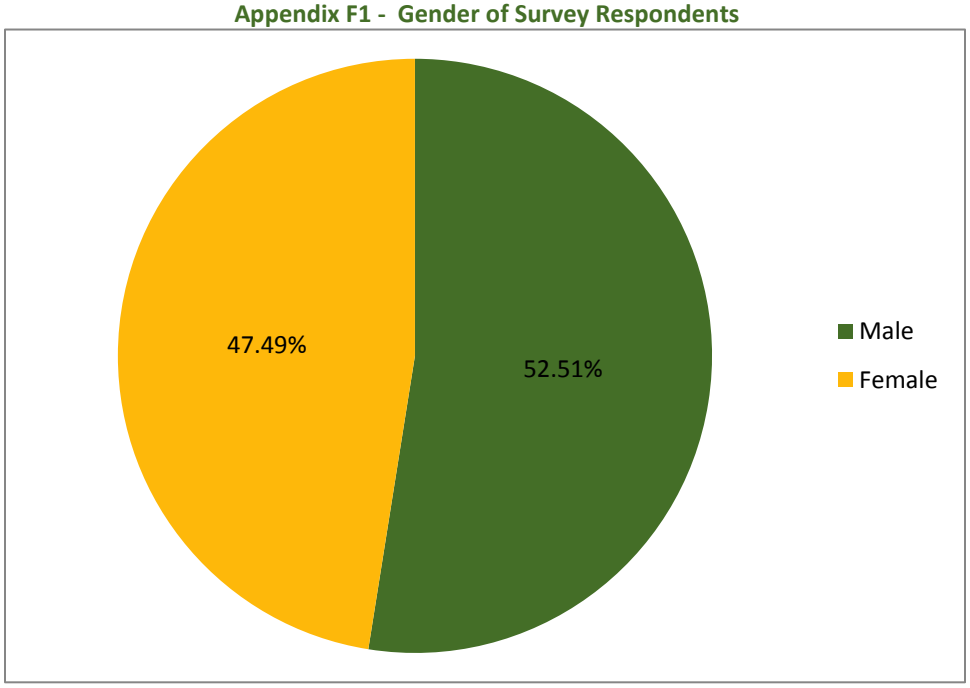
Score ID: **1918567**
homeenergyscore.gov

Appendix E: Map of Survey Respondents

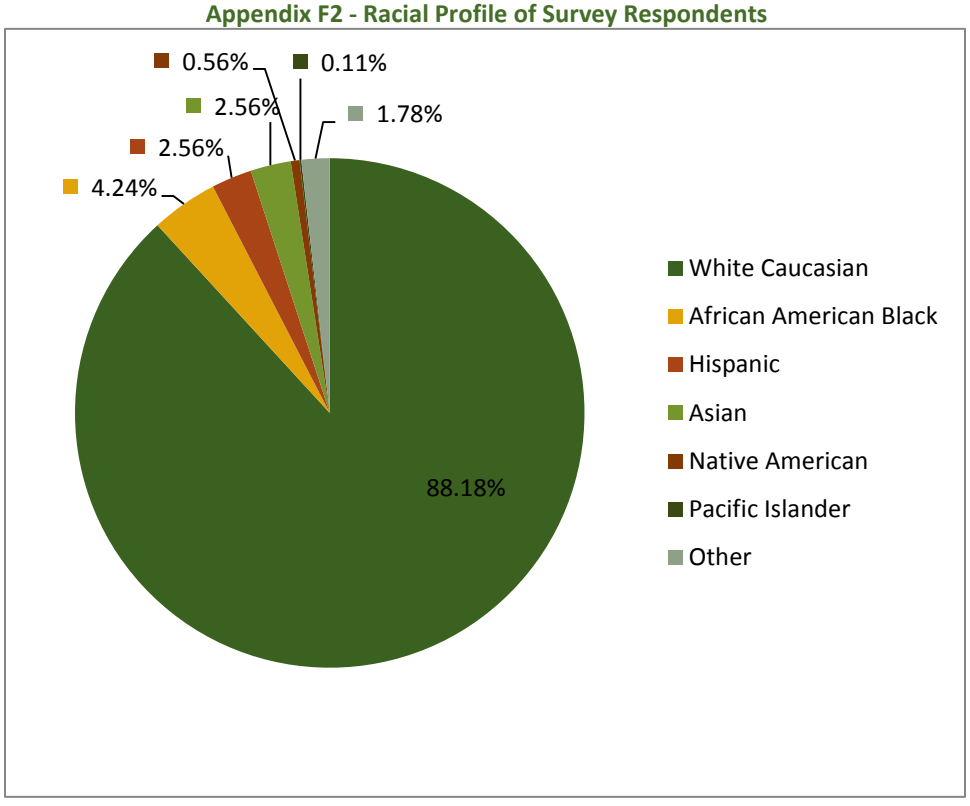


Appendix F: Demographic and Socioeconomic Profile Charts

Appendix F1 - Gender of Survey Respondents

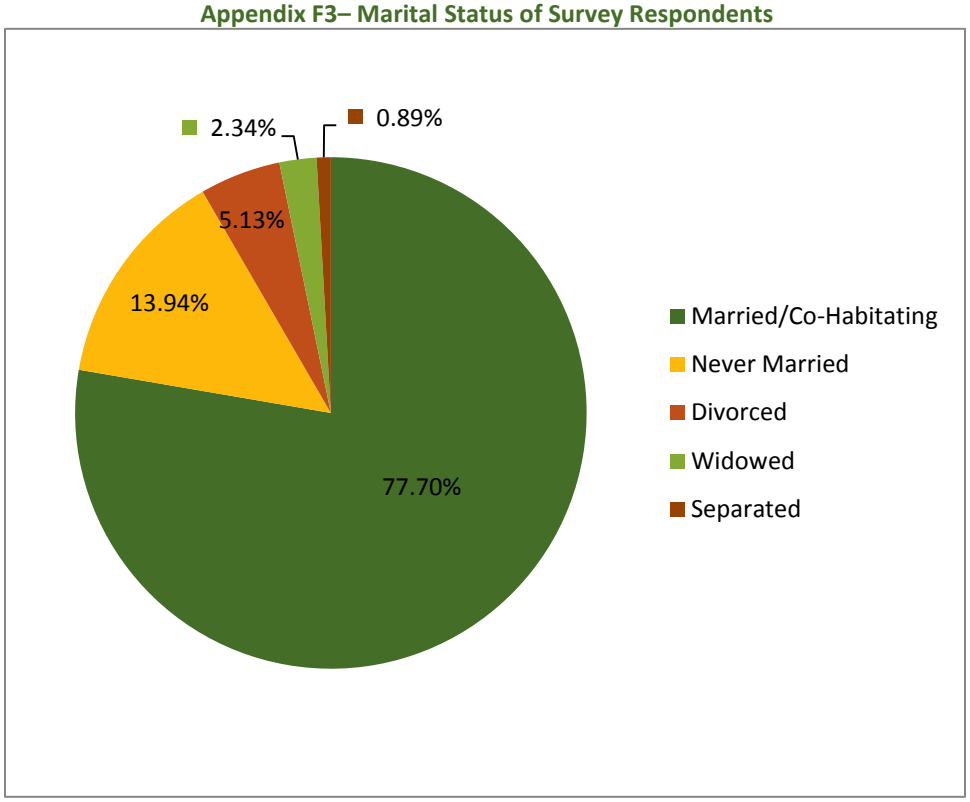


Appendix F2 - Racial Profile of Survey Respondents

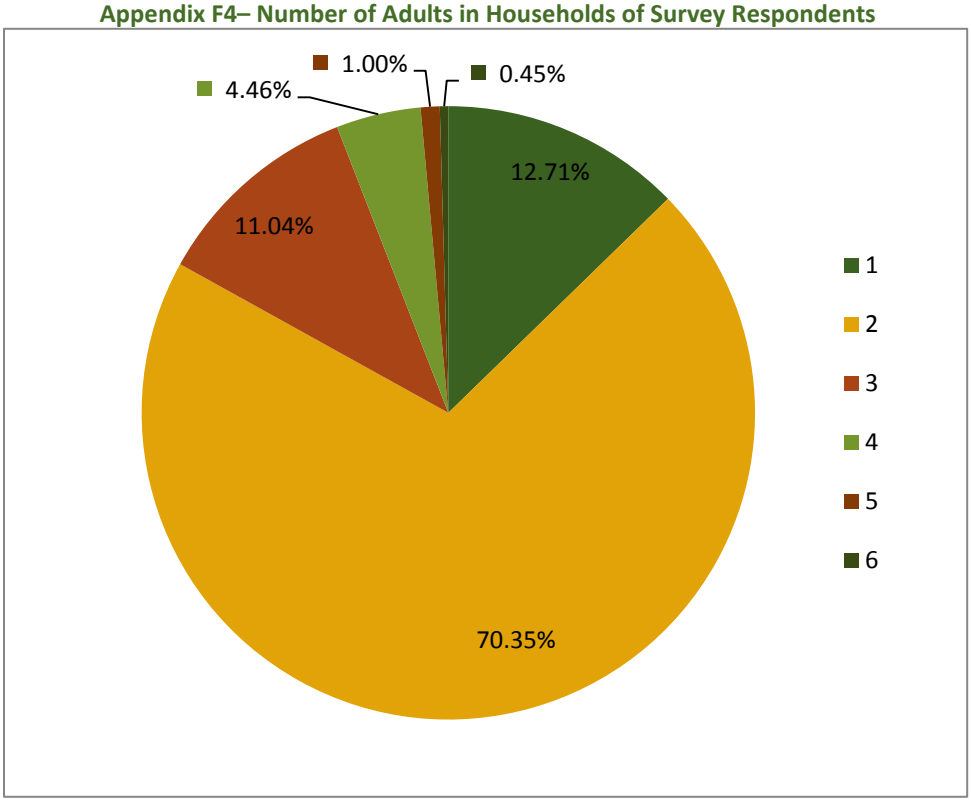


Appendix F: continued

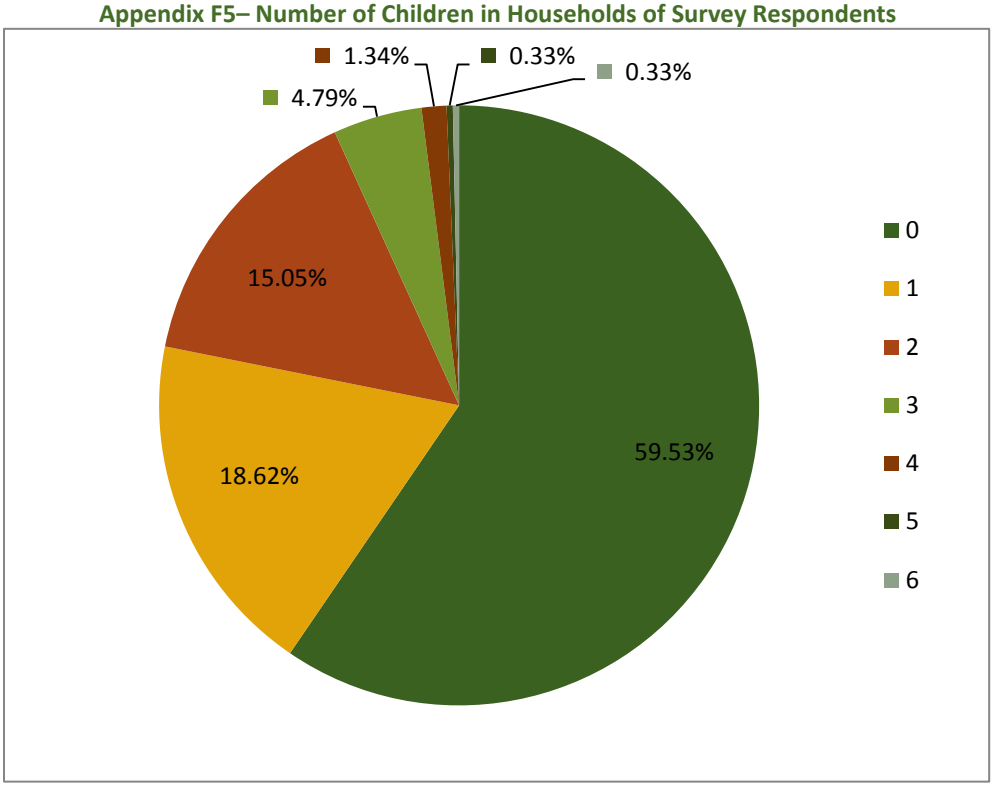
Appendix F3– Marital Status of Survey Respondents



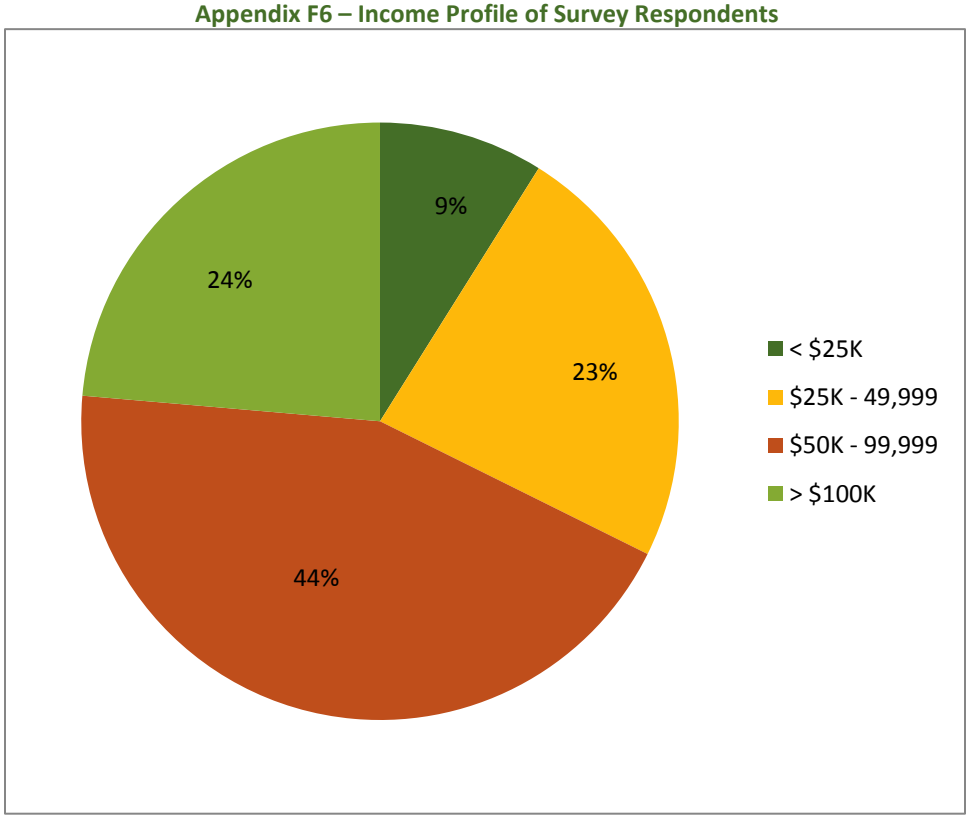
Appendix F4– Number of Adults in Households of Survey Respondents



Appendix F5– Number of Children in Households of Survey Respondents

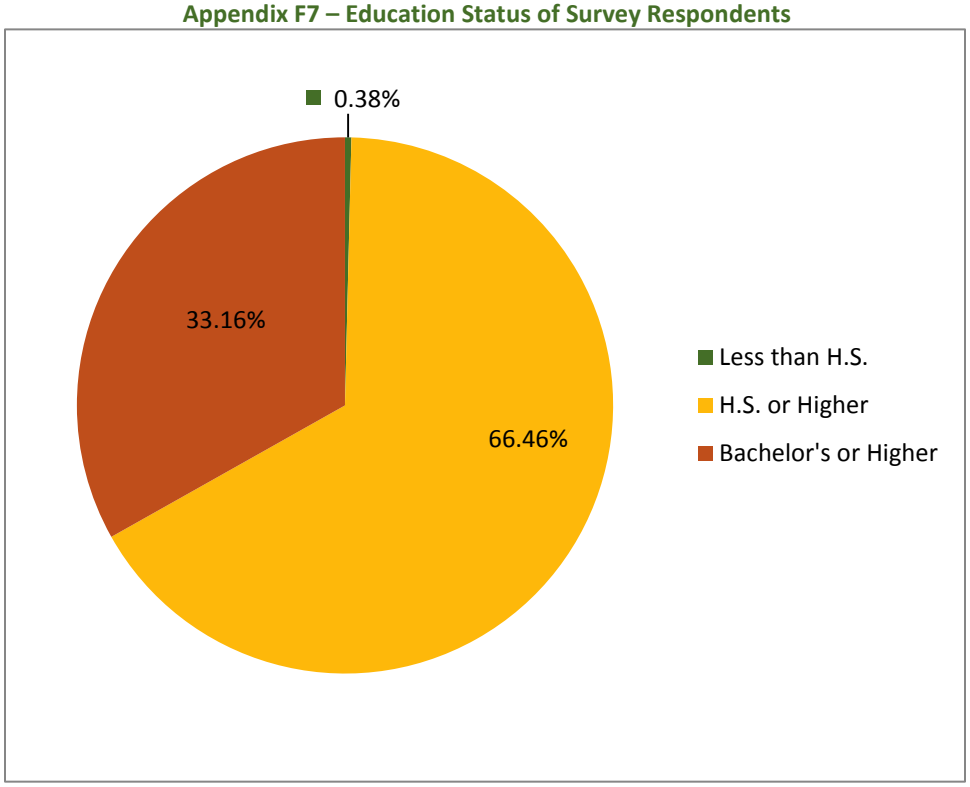


Appendix F6 – Income Profile of Survey Respondents

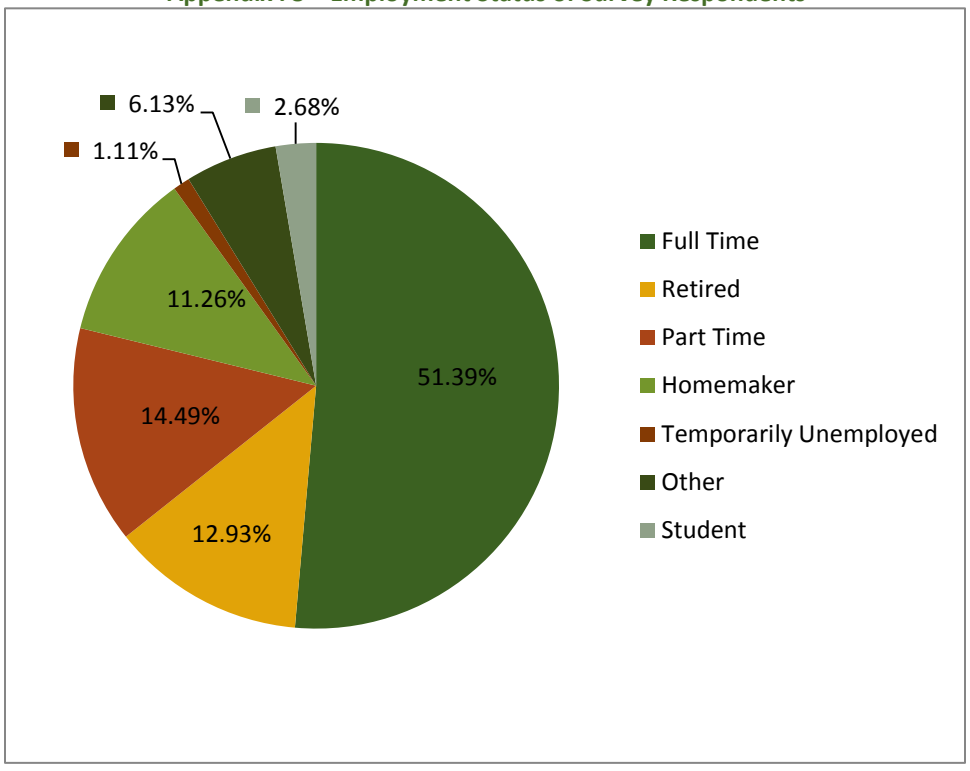


Appendix F: continued

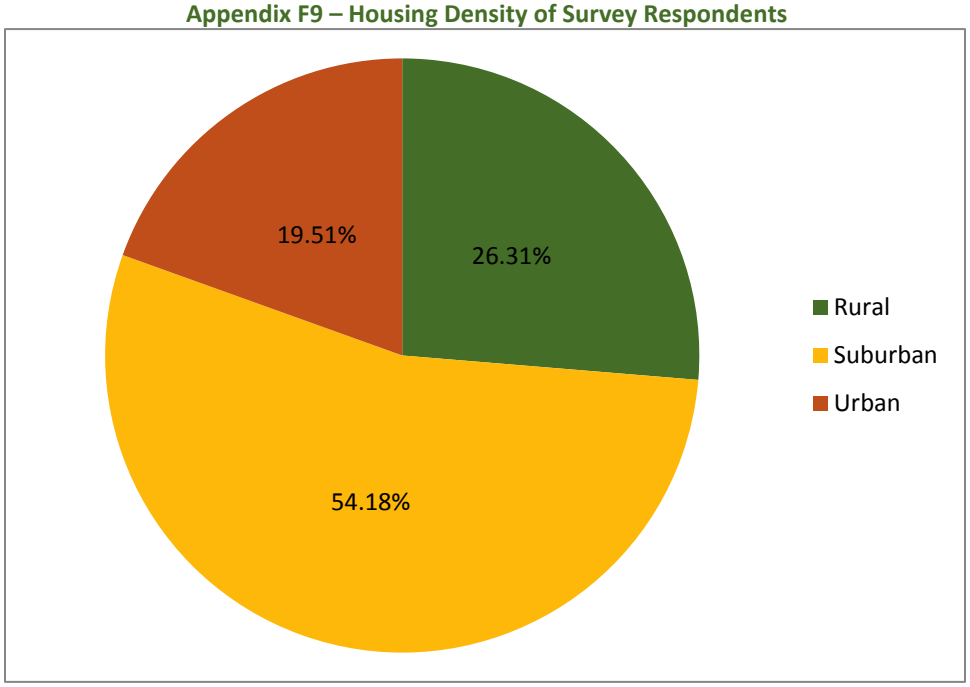
Appendix F7 – Education Status of Survey Respondents



Appendix F8 – Employment Status of Survey Respondents



Appendix F9 – Housing Density of Survey Respondents



Appendix F10 – Housing Type of Survey Respondents