

Residential Weatherization – Homeowner's Value of Weatherization Measures

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Building weatherization efforts have been common in society for a number of years. With changing standards of energy efficiency, particularly in the residential market, the understanding of energy weatherization retrofit efforts remains an area of concern for contractors. This study evaluates how homeowners understand and value the weatherization options when actual cost to benefit scenarios are introduced. A literature review of relevant studies in homeowner's weatherization willingness led to the development of cost-effective weatherization methods valid for the conditions in eastern North Carolina. With the models as a basis for evaluation, a survey was utilized to analyze age group specific homeowner's willingness to pay (WTP) for energy-saving measures, a determination of energy-savings measures valued by consumers indicated a variety of outcomes. Recommendations show the need for improved emphasis on consumer understanding of weatherization options.

Key Words: Residential Weatherization, Energy Costs, Homeowner Value, WTP

Introduction

Since the 1970's energy shortages, there has been a focus in design and construction to reduce energy loss. With the development of model energy codes, including the initial 1975 ASHRAE Energy Code (BCAP, 2009), and the Energy Policy and Conservation Act (EPCA) of 1975, there came the first step toward mandating fuel economy standards began. The 1978 amendment to the EPCA states those bodies receiving federal financial assistance were required to initiate mandatory energy conservation standards for new buildings. The acts assisted the movement for building related design and construction sciences toward energy efficiency and conservation.

With the arguments of climate changes and the uncertainty of stabilized energy costs, the discussion of energy efficiency has become a major point of discussion in the efficiency of residential construction. Of concern to builders is the owner understanding of construction weatherization options that are available for reduction of energy consumption. Weatherization is the practice of protecting a building and its interior from the elements, particularly from sunlight, precipitation, and wind, and of modifying a building to reduce energy consumption and optimize energy efficiency (EfficiencyFirst). It is important to discern how homeowners understand and value the weatherization options when actual cost to benefit scenarios are introduced. Too often, reputable cost to benefit information is not readily available to the average homeowner, thereby making it difficult for trained energy auditors and contractors to convince homeowners of the validity of guarantees of obtainable energy bill savings.

The basis of the research was to analyze homeowner's understanding of weatherization techniques, the benefits that can be derived from specific weatherization proposals, and the assumed vs. real cost of the weatherization. Basic weatherization in homes has been found to be cost effective; however, homeowners too often do not have the knowledge on the subject to determine the appropriate cost/benefit.

The researchers, with knowledge from the study, propose that basic weatherization and energy retrofit techniques are cost effective and homeowners too often do not have an understanding of true cost savings. The research employs a survey experiment approach to analyze the willingness to pay (WTP) for energy-saving measures in residential buildings by current homeowners, to determine if energy-savings measures are significantly valued by consumers.

Literature Review

The literature shows an active interest in energy savings using multiple paths of research subject areas. Parker (2008) addressed the development of low energy use buildings and their ability to use half or less energy than

standard house with marginal efficiency investment. Rodriques, Garratt, and Ebbs (2012) investigated the willingness of UK citizens to pay higher rent costs associated with energy efficient buildings and the impact of energy renewable technologies on the market. Kwak, Yoo, and Kwak (2009) evaluated and determined a consumer's willingness to pay for air conditioning and heating energy–savings measures in Korean residential buildings. Banfi, Farsi, Filippini, and Jakob (2006) evaluated Swiss consumer's willingness to pay for energy-savings measures and determined were significantly valued. Tuominen, Klobut, Tolman, Adjei, and Best-Waldhober (2012) discovered that European Union homeowners were not interested in improving energy efficiency of their homes if the cost did not proportionately increase the value of the property. Nair, Gustavsson, and Mahapatra (2010) investigated factors that influenced the adoption of investment measures to improve energy efficiencies of Swedish houses. No-cost measures over investment measures were the most widely used.

Based upon the previous research models, a survey instrument was developed using components from the noted articles, in addition to special conditions observed by the lead author's engagement as the director of the Pitt Community College Weatherization program. The survey instrument evaluated weatherization measures in eastern North Carolina, as regional considerations were critical to the local residential construction industry.

Methodology

To determine the most cost-effective weatherization methods valid for the conditions in eastern North Carolina, the researchers employed Department of Energy Weatherization Assistant NEAT weatherization software to develop a generic baseline residence, adjusted for the area. The National Audit Tool (NEAT) was developed by the Buildings Technology Center at Oak Ridge National Laboratory (ORNL) for the U.S. Department of Energy (DOE) Weatherization Assistance Program. The computer program is designed for use by State agencies and utilities to determine the most cost-effective retrofit measures for single-family and small multi-family site-built homes to increase the energy efficiency and comfort levels. NEAT examines over 45 envelop, equipment, and baseload measures ranked by SIR after accounting for their interactions (USDOE, 2012). The researcher's simulation models showed cost of individual weatherization alternates, annual savings, annual ROI, 5-year savings, 10-year savings, and 20-year savings. Analysis showed that the best use of funds should be that investment with the best ROI. The model evaluated the initial cost of replacement equipment and its estimated functional life. The results of the top ten items are shown in Table 1. Replacement windows and replacement doors were not included in the model as previous research has shown them to have insignificant ROI (Esswein, 2009). Improvements on any retrofit project must be evaluated on an individual basis, however when homeowners look at improvement from only an investment standpoint, all top ten improvements exceed the S&P 500 20 year average annual return of 6.1% (Cheng, 2010). The two best weatherization investments, the HW Thermal blanket and use of CFL light bulbs, and are the least expensive. Concerns for air leakage are a common item in advertisements for home improvement, yet only at high levels of leakage is this improvement cost effective. The generally accepted importance of adding R-19 insulation to a non-insulated space had significant return on investment. When R-19 insulation was initially in place, additional insulation had substantially diminished return on investments. Results reinforce common beliefs of attic insulation and mechanical ductwork system leakage as being important improvement areas and cost effective.

Table 1
Researcher's Energy Retrofit Rankings

Rank	Improvement description	Cost of Work	Annual Savings	Annual ROI	5 Year ROI	10 Year ROI	20 Year ROI
1	Install HW Heater Thermal Blanket	$40	$45	112.50%	563%	1125%	2250%
2	Lighting Retrofits to CFLs - 7 bulbs	$82	$61	74.39%	372%	744%	1488%
3	Add R-19 Crawlspace - Baseline R-0	$1,107	$388	35.05%	175%	350%	701%
4	Improve Envelope Leakage 25% - 250% Base	$636	$188	29.56%	148%	296%	591%
5	Add R-30 Crawlspace - Baseline R-0	$1,688	$438	25.95%	130%	259%	519%
6	Add Additional R-19 Attic - Baseline R-11	$926	$207	22.35%	112%	224%	447%
7	Add Additional R-25 Attic - Baseline R-11	$1,470	$289	19.66%	98%	197%	393%
8	Improve Envelope Leakage 25% - 225% Base	$636	$122	19.18%	96%	192%	384%

9	Reduce Duct Leakage 15 to 2% - Base 15%	$1,400	$247	17.64%	88%	176%	353%
10	Reduce Duct Leakage 15 to 6% - Base 15%	$1,102	$189	17.15%	86%	172%	343%

The survey questionnaire was developed to investigate the understanding and willingness to purchase weatherization measures. Because the research was concerned with the cost-effective weatherization methods valid for the conditions in eastern North Carolina, a population of potential homeowners in the region was selected for the study population. Since the lead researcher was on staff at Pitt Community College, the college faculty and staff became the population for the study. The official College method of email communication was the determined method of accessing the college population that led to a web-based link to a SurveyMonkey® survey instrument for interested respondents. The survey questionnaire consisted of 15 questions that requested the following information from respondents. The first four questions of the survey establish basic information of the respondent. Questions 5, 6, and 7 established understanding financing issues, utility costs, and weatherization methods. Questions 8 through 14 established what respondents would consider action thresholds when determining a willingness to make weatherization modifications. Question 15 asked for respondent comments not specifically addressed in the survey (See Appendix – Survey Questionnaire)

A total of 575 faculty and staff at Pitt Community College were contacted by email. Included in the email was an explanation of the research project, instructions on how to complete the survey, a deadline for completion of the survey and a link to the survey questionnaire. The authors, utilizing the capabilities of SurveyMonkey®, were able to monitor the results of the surveys completed on a daily basis. After the deadline passed, no further survey responses were received.

Results

Basic demographic data such as age and income level were gathered to determine if there was any meaningful differentiation between the groups along those breakdowns. The remainder of the survey sought to gain a greater understanding of what weatherization means to the public, what their action thresholds might be to motivate homeowners to request some weatherization work, and then gauge their comprehension of a simple savings to investment ratio, as it would apply to a cost benefit analysis of doing any weatherization work. This information is intended to be used to reinforce and/or contrast the cost data models and determine specific areas of weatherization opportunities for use by homeowners.

The survey had 165 respondents and 157 were homeowners. For the purpose of the research, only homeowners were used in data results. Of this group, seventeen respondents did not fill out all questions. The final population of 140 respondents used for analysis. It was also determined that the data would be further analyzed based on the age group of the respondents. The age group were 60+, 45 to 59, 30 to 44, and 18 to 29. The 45 to 59 year range was the predominate age group. Preliminary questions showed predominate household income of $80,000+, followed by the $55,001 - $80, 000 range. With the exception of the 18 to 29 age group, 78.3% of respondents expect to remain in their current residences for at least the next five years.

Homeowner Understanding of Issues – Questions 5-7

Questions 5, 6, and 7 were used to establish homeowner understanding of financing issues, utility costs, and weatherization methods. Question 5 asked if age groups felt their current energy bills were too high. (See. Fig. 1) All age groups felt their energy cost were too high with the 45 to 59 (37.3%) and 30 to 44 (22.5%) age groups having highest percentage. The researchers did not explore in this study why individuals felt their costs were too high. It will be addressed in a follow-up study.

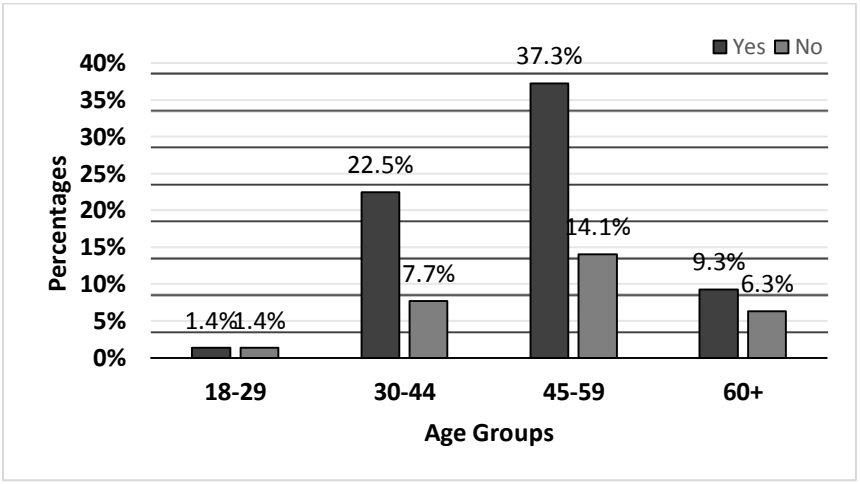

Figure 1: Are your current energy costs too high?

Question 6 asked if respondents were familiar with the term "Return on Investments. All age groups averaged 91.5% knowledgeable of the term. The reason for the question was to establish the general knowledge of the primary formula used in determining the cost effective for a weatherization project. Question 7 dealt with understanding the meaning of weatherization to a homeowner. Based on the data model outcomes for this region of the country, we provided four potential answers: 1) Sealing leaks in duct system, 2) Adding insulation, 3) Replacing windows, and 4) Improving comfort and reducing energy bills. Improving Comfort and reducing energy was the predominate selection averaging 67.4% across the three oldest age groups. Replacing windows was the second favorite with 11.4% across the four age groups (See Fig. 2). It was interesting that window replacement was believed by homeowners to be more important than either insulation or sealing leaks in the duct system, as those improvements generally have a far greater impact on the energy use and comfort for occupants in a home.

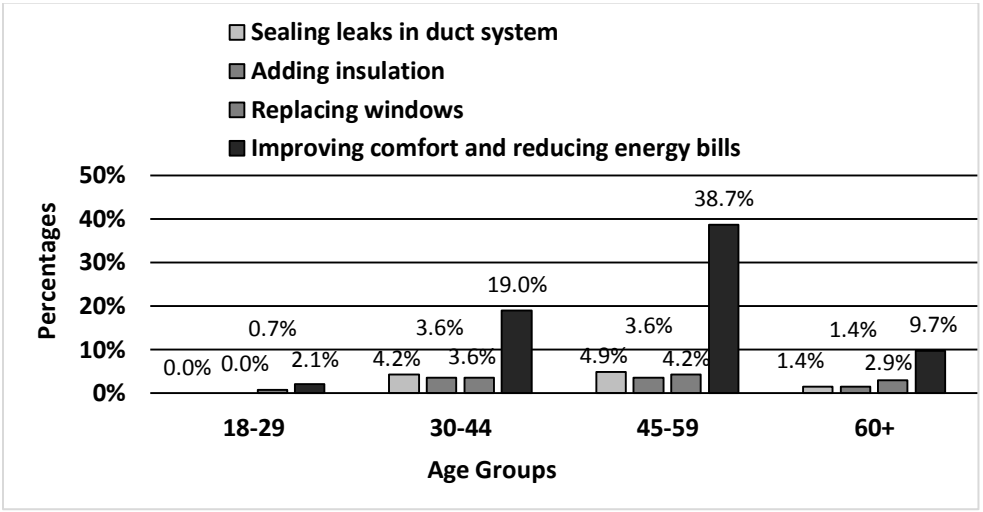

Figure 2: What does the term "weatherization" mean to you?

Energy Costs and Weatherization Modifications – Questions 8-14

Questions 8 through 14 established respondents existing energy costs and evaluated specific action thresholds to determine a willingness to make weatherization modifications. Question 8 addressed the average monthly utility cost (less water) for the respondent. The monthly average utility bills for all homeowners who responded to survey had 7.7% with bills less than $100 a month. The $100 - $250 range made up the majority of homeowners with 61.3% Over 26% of homeowners had bills in the $250 - $400 range and 4.9% exceeded $400 a month (See Fig. 3). As the weatherization modeling research showed, the higher the utility bills, the more substantial cost benefit opportunity

of weatherization work becomes. With 26.1% of homes having bills over $250 a month, there is the potential of need to perform weatherization adaptations.

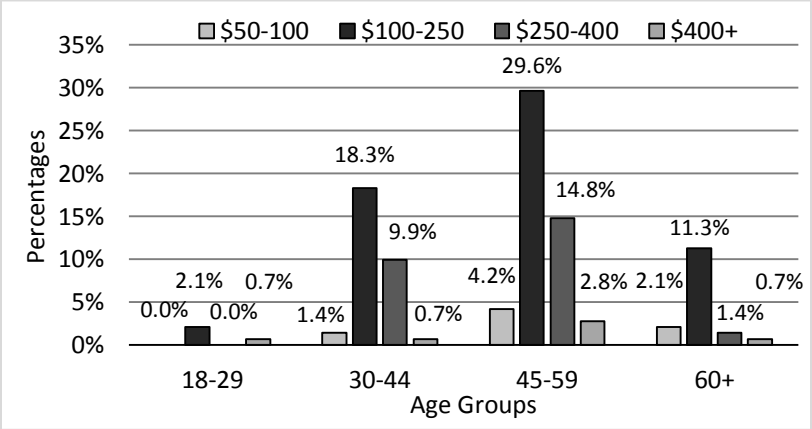

Figure 3: Average monthly energy costs

For homeowners that felt their energy costs are too high, 2% stated their utility costs were $100/month; 58.6% of bills were $100-$250/month, 32.4% were in the $250-$400/month range, and 7% stated their bills were over $400/month. These results indicate the threshold for "too high" is the $150-$200 range. According to the U.S. Energy Information Administration (2012), the average electric bill in eastern North Carolina is $157.91. As 60% of households in North Carolina use heat pumps, with only 25% using oil or propane heating, the electric average is a compatible amount for comparison. The amount is consistent with homeowners having bills higher than average and believing them to be too high. The group of homeowners with bills over $250 (39.4%) would be the target group benefitting the most from weatherization.

Question 9 asked respondents if they felt their energy costs could be reduced without loss of comfort. This was asked to determine if there was a negative connotation towards weatherization. 70% felt their bills were too high and 61.9% believed costs could be reduced without loss of comfort. This response is encouraging, as they believe weatherization work can improve their utility bills without a loss of comfort. Although almost 61.9% believed costs could be reduced without loss of comfort, when respondents having average monthly bills of $400+ are deducted, the percentage dropped to 54%. The homeowners with the highest bills were the ones least optimistic of a good comfort/utility bill reduction combination!

Respondents were asked in Question 10 to estimate what their annual energy bill could be reduced if an energy audit and weatherization work took place. Over 62% of all respondents believed they could save $101-$500 annually, with the level of "Less than $100/year" expected by 20.1% of the respondents. Respondents in the 45-59 age group expected the larger return on the investment of weatherization options at 30.3% (See Fig. 4). Our weatherization model showed than an average home can be easily improved with specific weatherization items to save $100+ per year. Out of all homeowners, 20.1% felt the savings would be less than $100 a year. This response represents a misinformed segment of the public when understanding the potential to save a substantial amount annually in energy costs. As the model shows, doing nothing but simply adding a thermal blanket to the hot water heater and changing out seven incandescent light bulbs with compact fluorescents can save about $105 a year. This is definitely an area where public education/information needs to be expanded in the quest to reduce the nation's energy consumption

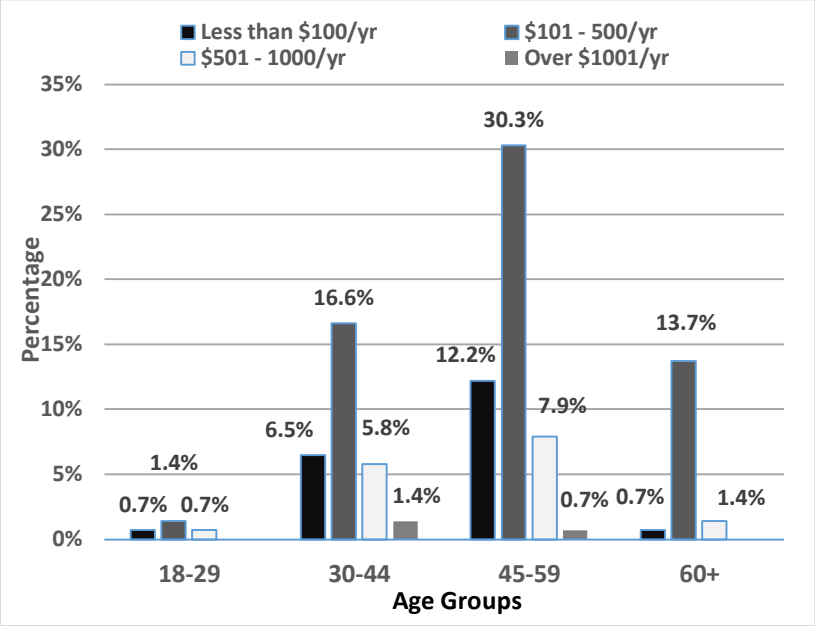

Figure 4: Expected annual energy costs reduction after weatherization

Questions 11 – 13 addressed a variety of cost savings scenarios to determine respondents understanding of the Return on Investment of weatherization options. When asked the value of weatherization work that had guaranteed savings, different responses were given to essentially the same question worded differently. Question 11 referenced to savings over one year, while the Question 12 dealt with the same annual savings in reference to five year savings. Question 11 ask the amount worth paying for weatherization if guaranteed a savings of at least $750/year, finding 35.3% of respondents would pay $750-$2000. When given the five-year guaranteed savings of at least $3750 or $7500 over ten years the respondents significantly increased the amount they would pay for the work with 38.9% willing to pay $2001-$3000. The $750-$2000 range decreased 30.3%. Question 13 asked respondents if it would be worth spending $3000 on the weatherization work if they were guaranteed $750/year in energy savings. Over 68% of the respondents responded in the affirmative. In all cases, the value given to weatherization work was noticeable higher by the 45-59 age homeowners.

In evaluating the responses, if individuals were guaranteed $750/year savings from reduced utility bills, 30.2% of homeowners would not make this investment. In ten years, these homeowners would save at least $6750 after the initial investment was paid back. This is assuming utility rates would not go up during this time. An opportunity to earn nine times the initial investment back in ten years is generally not considered. If the initial investment was $1875, the homeowners would realize a 100% return on their money in just five years. When contractors promote weatherization options and its value, the five-year savings should be stressed rather than the one-year savings.

Question 14 addressed low interest financing. Homeowners planning to stay in their home more than five years were only slightly more interested than all homeowners were as a group. Over 52% of homeowners would be interested in low interest financing for this type of work. Many areas of the country have developed models to tie the financing to the local utility company's bills (Electric & Gas Industries Association, 2012). The savings of the weatherization work essentially pay for the loan, after which the homeowner begins to realize the savings.

Discussion

Based upon the collected study data, the perceived value of weatherization in eastern North Carolina is low. None of the survey age groups gave reasonable value to "guaranteed" savings relative to actual costs of work. Only the 45-59 age fully understood the financial value of weatherization opportunities. In particular, the market segment of homeowners who feel their bills are too high, plan to live in their home more than five years, and pay more than $400 a month in utilities have the most to gain yet have the least understanding or desire to correct the situation. This core area represents an opportunity for contractors; however they must determine how to motivate these

homeowners to spend for the energy savings. Less than 16% of homeowners recognized the financial value of saving $750 a year for as long as they lived in the home. Those homeowners that would be the easiest to obtain large savings (over $400/month) were the least likely to understand or believe there was a viable alternative to high energy bills. The 60+ homeowners had the best overall understanding of the return on investment, and had a much greater understanding of the potential savings of weatherization work. This should be a primary audience for contractors to address when marketing weatherization updates.

Homeowner's experiences of reducing bills warrants further study for potential weatherization beneficiaries that have the greatest potential for a satisfactory financial outcome. For homeowners that are candidates to contract weatherization work, private contractors require a better focus on marketing construction options that improve comfort, reducing energy consumption and energy bills, and proving the investments as being positive. Too often, there is little public dissemination about available financial and social benefits available to the average homeowner.

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Appendix

Weatherization Survey Questionnaire

1) ***Do you own a home?***
a) Yes b) No

2) Do you plan to be in your home for more than 5 years?
a) Yes b) No

3) What is your age?
a) 18-30
b) 31-45
c) 46-60
d) 60+

4) What is your household income?
a) $15,000 – 30,000
b) $30,001 – 55,000
c) $55,000 – 80,000
d) $80,001 +

5) Do you think your energy bills are too high?
a) Yes b) No

6) Are you familiar with the financial term "Return on Investment"?
a) Yes b) No

7) What does the term "weatherization" mean to you as applies to your home (best answer for your home)?
a) Sealing leaks in duct system
b) Adding insulation
c) Replacing windows
d) Improving comfort and reducing energy bills

8) Estimate your monthly combined average gas & electric bills are? If you use LP gas, please include the cost of filling tanks into your average.
a) $50-100
b) $100-250
c) $250-400
d) $400+

9) Do you believe this cost could be reduced without loss of comfort?
a) Yes b) No

10) What do you estimate your annual energy bill would be if an energy audit and weatherization work were completed on your residence?
a) Less than $100/yr
b) $101 – 500/yr
c) $501 – 1000/yr

d) $Over $1000/yr

11) If weatherization work could guarantee you savings of at least $750/yr, what amount would you be willing to pay for the work?

a) $500 – 750
b) $751 – 2000
c) $2001 – 3000
d) $3001 – 5000

12) If you could be guaranteed a $3750 savings over 5 years or $7500 savings over ten years, what price would you be willing to pay for the weatherization work?

a) $500 – 750
b) $751 – 2000
c) $2001 – 3000
d) $3001 – 5000

13) If you could be guaranteed $750/yr in utility savings, would it be worth spending $3000 on weatherization work?

a) Yes b) No

14) If you wanted to perform weatherization work, but could not afford it, would you be interested in using an available low interest loan from a local bank or utility company to accomplish the work?

a) Yes b) No

15) ***Please add any comments you may have about survey, energy use, or weatherization.***