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Evaluation of a Holistic Energy Assessment Program

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Abstract

The residential sector is responsible for 22% of U.S. primary energy consumption and CO_2 emissions, annually, stressing the importance of building energy efficiency. Energy audits and assessments are commonly incorporated into energy conservation strategies. However, heterogeneity of homeowner behaviors and motivators has accompanied ambiguous conclusions on the effectiveness of energy audits. In response, the National Energy Leadership Corps (NELC), developed a holistic energy assessment approach tailoring information to homeowner motivators, with the goal of stimulating energy investments through informative personalized energy reports. A post-assessment survey, focusing on implementation, barriers to investment, and catalytic impact from the energy assessment, was developed and distributed to 82 houses that received an energy assessment. Statistical analysis of survey responses indicate homeowners' perception of skill and/or abilities and building envelope improvements are correlated to implementation rates. Homeowner prioritization of home improvements may also be related to energy improvements. Results from the survey and recommendations are presented including implications for energy education and energy service professionals in the design, engineering, and construction industry.

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Keywords: energy audit; assessment; residential; holistic; efficacy; homeowner; survey

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1. Introduction

The U.S. Environmental Protection Agency (EPA) estimates over 2 billion Energy Star certified appliances have been purchased since the program's inception in 1992 [1]. However, growth in the number of appliances and rechargeable devices (e.g. smartphones) in homes have partially offset these efficiency advances, where the residential sector continues to consume 22% of U.S. primary energy [2]. Meeting aggressive energy reduction goals requires a reversal of energy consumption trends. Energy audits and assessments are regularly integrated into energy conservation programs as a source of energy information for households. However, the efficacy of energy audits to impact household energy consumption has been questioned.

In response, the National Energy Leadership Corps (NELC) was developed with the aim of engaging college students in a residential energy assessment strategy. The NELC is intended to teach students about home energy efficiency and leadership and empower them to conduct home energy assessments in their community. The design of the program reflects the need for alternative models to personally engage homeowners in a holistic approach to home energy and also respond to the limitations of traditional professional home energy audit processes that are highly focused on motivating homeowners to invest in home energy improvements [3] and often conducted by energy management firms seeking to "sell" retrofit products and services such as insulation, new furnaces, and new windows. This research focuses on an application of the NELC in the region of Pittsburgh, Pennsylvania.

To assess the efficacy of the NELC program, a post-assessment survey was developed and distributed to 82 households that participated in a NELC holistic energy assessment. The survey focused on homeowner adoption of recommended energy improvements, perceptions on motivations to adopt, and catalytic impacts of the energy assessment.

2. Background of Energy Audits

2.1. Energy Audits

ASHRAE [4] defines three tiers of energy audits, starting at Tier I with visual inspection of the building and utility bills and progressively becoming more intensive; Tier II incorporates analysis of energy consumption and occupant discussion to identify problem areas. Tier III energy audits incorporate advanced field data collection (e.g. blower door testing) in conjunction with rigorous engineering analysis using building modeling software, aimed at identifying packages of improvement measures and accurate predictions of energy savings leading to investments. The NELC energy assessments are closely related to ASHRAE Tier II energy audits in that they combine end-use energy disaggregation methods, on-site building inspection, and the use of infrared thermography. However, the NELC approach places greater emphasis on in-person surveys and discussions to determine homeowner priorities, personal interests, and specific energy concerns in the home. Intentional efforts are also made to classify homeowners based on established market segments based on worldview and belief systems as described by The Shelton Group, describing four worldviews of energy efficiency consumers: cautious conservatives, concerned parents, true believers, and working class realists [5]. To engage these individuals, a holistic energy assessment approach was adopted by the NELC to (1) maintain a worldview-neutral approach to avoid alienating homeowners with strong values and tendencies, (2) adapt recommendations based on worldview, interests, and energy concerns of the homeowner, and (3) modify report style based on variable cognitive styles and worldviews of homeowners [6].

2.2. Energy Audit Efficacy and Determinants of Adoption

The effectiveness of energy audits is debated largely due to the low rate at which audits translate into action [7-9]. Through a national survey of homeowners receiving energy audits in the Netherlands, Murphy [10] examined the influence of energy audits on homeowners' energy efficiency adoption rates. From 3,737 respondents receiving an energy audit, only 19% stated the energy audit was influential in their decision to invest in energy efficiency,