THESIS

IDENTIFYING PERCEIVED BARRIERS AND BENEFITS TO REDUCING ENERGY CONSUMPTION IN AN AFFORDABLE HOUSING COMPLEX USING THE COMMUNITY-BASED SOCIAL MARKETING MODEL

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ABSTRACT

IDENTIFYING PERCEIVED BARRIERS AND BENEFITS TO REDUCING ENERGY CONSUMPTION IN AN AFFORDABLE HOUSING COMPLEX USING THE COMMUNITY-BASED SOCIAL MARKETING MODEL

Energy consumption in the residential sector can be significantly influenced by human behavior. However, only limited behavior change research exists that is aimed at reducing energy consumption in the affordable housing sector. This study seeks to implement the first two phases of the Community Based Social Marketing (CBSM) framework in an affordable housing setting. The goals of the research are to identify optimal behaviors for energy reduction and to identify perceived barriers and benefits associated with those behaviors, using an affordable housing facility in Loveland, Colorado as the case study. Five target behaviors and their leading barriers and benefits are established. By implementing this framework, this study also identifies potential issues and nuances in the CBSM process that researchers should take into consideration during future implementations of CBSM in affordable housing environments.

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CHAPTER 1: INTRODUCTION

Energy consumption is on the rise in the United States. Since 1980, the U.S. total energy consumption has risen from 78 quadrillion BTUs to 101 quadrillion BTUs in 2007. Although energy consumption in the residential sector has remained relatively stagnant at an average of 10 quadrillion kBtu per year since 1993, electronics, appliances and lighting have grown from an average of 24% of the household energy consumption in 1993 to 36.4% of the energy consumption in 2009. (EIA, 2011a). To compensate for growing energy demand for energy, the U.S. has increased its net energy imports from 12 quadrillion BTUs to roughly 30 quadrillion BTUs in that same time period (EIA, 2011a). Over 80% of the energy consumed in the U.S. was produced through the refinement of fossil fuels with the remainder generated from nuclear power or renewable energy sources (EIA, 2011c). This reliance on fossil fuels to supply a growing need for energy is contributing to climate change and its impacts (IPCC, 2007). Greenhouse gasses, which trap heat in the earth's atmosphere, are by-products of energy productions from fossil fuels. This increase in ambient temperature has been linked to changes in the earth's natural cycles (IPCC, 2007). As a result, it is necessary to look for ways to reduce energy consumption, especially within the residential sector.

From 1980 to 2010, the total energy consumption per year in the residential sector has grown by over 6,500 trillion BTUs per year (EIA, 2011b). Much of this increase can be attributed to the growth in the use of household appliances and electronics per household. The 2009 Residential Energy Consumption Survey (RECS) conducted by the Energy Information Administration shows that the number of televisions, personal computers and rechargeable

devices per home has risen dramatically in the past ten years (EIA, 2012). Although these devices and appliances are becoming more efficient, the increase in appliances per household and the amount they are used is off-setting the efficiencies gained which is causing more energy use overall. This phenomenon has become known as the rebound effect (A. Greening, Greene, & Difiglio, 2000).

Alongside the growth in energy consumption, energy prices have been volatile, causing strain on consumers. The fluctuating price and growing consumption of energy disproportionately affects residents of low-income or affordable housing as meeting minimum energy needs accounts for a greater proportion of the resident's income (Ruel, Garrett, Hawkes, & Cohen, 2010). When compared to middle income households, low income households spend 5-15% more of their monthly income on home energy expenses (Kaiser & Pulsipher, 2006). This higher percentage is in part a result due to the tendency of low-income housing to be older and less energy efficient than middle or upper income households (Nevin, 2010). These two factors contribute to the energy burden felt by residents in low-income housing. For families of low-income housing, the energy burden can lead to other struggles such as debt, nutrition deficiency and even homelessness (Hernandez & Bird, 2010).

Numerous government programs have been developed at various levels to provide incentives and programs to quell the increase in energy consumption at the residential level to address residential energy concerns including increasing demand and fluctuating utility costs. For example, at the federal level, the U.S Department of Energy provides programs such as the Weatherization Assistance Program (WAP) and the Low-Income Home Energy Assistance Program (LIHEAP) to implement building upgrades on existing low-income and affordable housing in communities throughout the U.S. The U.S. Department of Housing and Urban

Development also provides incentive for energy efficient homes through their energy efficient mortgage program where homebuyers and owners are provided financing options to install energy efficient features in their homes (HUD, 2011). State and local programs also focus on upgrading existing homes to make them more efficient with the goal of improving the homes energy efficiency. While energy efficient upgrades are essential to addressing energy conservation, they do not always lead to energy use reduction since they do not address occupants' behaviors. Since human behavior ultimately impacts the amount of energy consumed within a household, and can even offset increases in energy efficiency (i.e., the *rebound effect* discussed earlier), it is important to understand household occupants' behavior and how to effectively direct this behavior toward energy conservation (A. Greening et al., 2000).

Although the importance of occupant behavior and its impact on energy conservation has been realized, understanding human behavior and its interaction with the natural environment has proven to be complex. Multiple theories and models have been developed with the aim of identifying the factors that promote pro-environmental behavior and the most effective approach to creating a sustainable change within a target audience (Jackson, 2005; Wilson & Dowlatabadi, 2007). These theories range in their foundations from economics to psychology to sociology and include variables such as the context in which the behavior takes place, habits, personal and social norms and values (Simon, 1955; Azjen, 1991; Stern, 2000; Yates & Aronson, 1983). Previous research has focused on uncovering what determines pro-environmental behavior. This has revealed insights about the way attitudes, norms and context shape one's behavior. For example, Ajzen's Theory of Planned Behavior uses a person's beliefs and attitudes toward behavior as predictors of behavior. The Theory of Planned Behavior also includes perceived behavioral control as a key indicator of behavior. Although these insights lend evidence to why

behaviors are chosen, they do not provide a means for creating a change in behavior. Research is now being conducted to identify what approaches are effective to creating a pro-environmental change in a target community. A prominent theory in support of such approaches that has emerged is community based social marketing.

Community Based Social Marketing (CBSM) is a behavior change model with the goal of fostering sustainable behavior through a research-based, pragmatic process (McKenzie-Mohr, 2011). This process includes five steps: (1) selecting behaviors, (2) identifying barriers and benefits, (3) developing strategies, (4) piloting, and (5) broad-scale implementation. CBSM uses this process to identify the perceived barriers and benefits for each of the targeted behaviors and develops behavior change strategies in order to minimize the barriers and highlight the benefits (McKenzie-Mohr, 2000). Contrary to other behavior change theories, CBSM does not rely on increasing the target audience's knowledge or highlighting economic benefits in order to yield a change in behavior (McKenzie-Mohr, 2011). In the literature, many studies have provided evidence of the effectiveness of CBSM in practice, especially in the context of reducing home energy use (Abrahamse, Steg, Vlek, & Rothengatter, 2005; Ayres, Raseman, & Shih, 2009; Lokhorst, van Dijk, Staats, van Dijk, & de Snoo, 2010; McKenzie-Mohr, 2011; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007), however none were found that applied CBSM to residents of low-income housing

Statement of the problem

The issue of energy efficiency in low-income and affordable housing has been on the agenda of policymakers and government officials for decades. Programs such as LIHEAP and WAP provide federal funding for states to implement energy efficiency upgrades on households whose residents meet an income requirement. These programs typically provide measures such

as window upgrades, increasing insulation in the walls and attic, seal the building envelope through caulking and weather-stripping and upgrading mechanical and electrical equipment (USDOE, 2010). These upgrades are implemented with the goal of reducing the energy burden on households and/or operating costs by providing a more energy efficient house.

Although these programs and other state and local programs are implementing energy efficiency measures and reducing energy consumption to some extent, there is little effort to promote energy conserving behavior of residents. Further research is needed in a variety of settings to determine which measures and approaches are most effective for curtailing residential energy use through behavior change. Although CBSM has been applied in a residential setting, little application of CBSM to low-income housing has been found. There is a strong need for research in situations where residents are either not responsible or are only partially responsible for paying their utility expenses, as is often the case in low-income housing.

Purpose of the study

The purpose of this study is to learn more about the potential impacts of utilizing CBSM with residents of low-income housing and how CBSM engages residents to conserve energy. The scope of this study is to implement phases 1 and 2 of the CBSM process at a low-income housing facility in order to identify the optimal behaviors to target for the behavior change initiative and the perceived barriers and benefits of energy reducing behaviors. Phases 3 – 5 are not included because, prior to the start of research, it was determined that the researcher's time and resources could not support this full scope of research. Nevertheless, the performed research completes the foundational phases of CBSM to identify perceived barriers and benefits, and provides the opportunity to complete phases 3-5 in future research.

Research questions

This study aims to answer the following questions:

- What behaviors are targeted as a result of phase 1 from the CBSM process and do these differ from other behavior change campaign's target behaviors?
- What perceived barriers and benefits exist to fostering positive changes in energy conservation behaviors in an affordable housing environment?
- Do the perceived benefits and barriers identified during the focus groups align with other perceived benefits and barriers found in current research?
- What components of the CBSM process can be altered to better suit behavior change projects in the affordable housing community?

Delimitations

The target population for this study is residents of low-income housing who are in a rental situation where their water utility bills are paid by the housing authority but the occupants are responsible for paying their gas and electricity bills. Because this research focused on energy reduction, the fact that the housing authority pays the water bill should not affect the research. In general, building occupants who rent have fewer options regarding energy services and upgrades compared to residents who own their homes. For example, a building owner can install exterior wall insulation because he or she has the freedom to make decisions. When renting, the addition of insulation is ultimately the decision of the building owner. Furthermore, all survey participants were aware that the research was energy related so there was potential pressure to appear energy conscious. This is an issue, in general, with the CBSM process when dealing with behaviors that are not readily observable. Although the CBSM process is

transferable, the results of this project are only applicable to low-income rental housing residents where the study is conducted and are meant to add to the body of work on application of CBSM with low-income residents.

CHAPTER 2: LITERATURE REVIEW

Energy production and consumption is leading to increased concentrations of CO_2 in the atmosphere. This increase in energy production and consumption is causing an imbalance in the earth's natural and biological systems, which is leading to climatic and terrestrial discourse. In 2009, U.S. buildings accounted for roughly 35% of the total GHG emissions when electricity is distributed amongst economic sectors (EPA 2011). Of this 35%, nearly half of the GHG emissions were a result of energy consumption in the residential sector. By reducing energy consumption of the residential sector, there is a potential to significantly reduce GHG emissions.

A reduction in energy use in the residential sector may also alleviate the financial burden felt by many home owners and renters, especially those living in low income housing. According to the bureau of labor statistics' Consumer Expenditure Survey, tenants of rental housing spend roughly 6.5% of their total annual expenditures income, or $2,400, on home utilities (Bureau of Labor Statistics, 2010). By comparison, as discussed, such spending generally represents a higher percentage of residents of low-income housing annual income (5-15%). This energy burden on renters, especially of low-income housing, remains a barrier to homeownership (Bloom, Nobe & Nobe, 2011). A reduction in energy use at home may help to alleviate the energy burden and allow for income to be used for other necessities such as food and education.

Approaches to Reducing Energy Consumption in the Built Environment

Two common approaches to reducing energy consumption in existing buildings are (1) improved building systems, operations and management (O&M) and (2) addressing occupant behavior. Improvement of building systems can include improving HVAC systems,

incorporating more energy efficient lighting and electronics, and the utilization of renewable energy sources (ürge-Vorsatz, Harvey et al. 2007). This can also include the improvement of the building envelope by increasing insulation, sealing penetrations, and replacing old windows and doors. This approach has been implemented by various government programs seeking to reduce energy consumption of residences in general and low-income housing specifically (HUD, 2011). The second approach to reducing energy consumption addresses the energy use associated with occupant behavior. For example, campus' and office buildings are using dashboard technology that provides real-time building energy use data in a user friendly format to inform the occupant of their energy use. Some building managers are coupling this technology with information sessions to further the awareness of the building occupants. Of these two approaches, educating occupants on energy conservation tends to be less cost intensive and easier to implement when compared to upgrading the building envelope or improving the building systems. As a result, it may be beneficial to include occupant behavior in energy conservation plans.

Occupant Behavior

The impact of the occupant on energy use has been previously studied (Emery & Kippenhan, 2006; Seryak & Kissock, 2003; Sonderegger, 1978). In order to affect the human component of energy-use, occupant engagement campaigns have been introduced in settings ranging from university campuses to military housing facilities to offices. Founded in social sciences, occupant engagement aims to reduce the energy use, alter waste disposal habits and impact other sustainable behaviors within the built environment through occupant intervention and education (Melton 2011). Occupant intervention can take many forms, from simple signage demonstrating proper waste disposal to intricate metering that shows the occupants their energy-use in real time. Occupant engagement focuses on the people within the built environment and

their impact on energy use as opposed to the building itself, its mechanical systems and its efficiency measures. The following sections of this literature review will identify theories of what drives sustainable behavior and the specific framework used for occupant engagement in this study.

What is Behavior?

For the purpose of this study, the use of the word behavior pertains to the potential energy consuming and reducing behaviors within a household. These behaviors can be categorized into two types: curtailment (repetitive) behaviors and efficiency (one time) behaviors (Abrahamse et al., 2005). Curtailment behaviors involve ongoing efforts to reduce energy consumption such as hanging the clothes to dry instead of using the dryer. Efficiency behaviors are one-time actions such as purchasing energy efficient appliances. This distinction is important because different barriers exist to behavior adoption depending on the type of behavior being targeted.

Theories of Environmental Behavior Change

The field of study focusing on fostering sustainable behavior change is vast and inconclusive. Multiple theories have been developed or adapted to explain the process of human behavior regarding the environment (Kollmuss & Agyeman, 2002). One purpose of these theories is to better understand what influences and motivates humans to act pro-environmentally and to develop interventions to affect human behavior to generate more environmentally favorable behaviors. The following section reviews the development of behavior change theory and its application.

When comparing behavior change theories and approaches, it is important to distinguish between pro-environmental behavior intentions and attitudes versus actual behavior. Pro-environmental behavior intentions do not always translate into actual behavior change due to external and/or internal barriers, whether real or perceived, to performing the intended behavior (Costanzo, Archer, Aronson, & Pettigrew, 1986; McKenzie-Mohr, 2000; Owens & Driffill, 2008)

Rational Choice Theory

The field of environmental psychology began in the 1960's with the goal of understanding the intricate relationship between humans and the environment (Kollmuss & Agyeman, 2002). The earliest theory of this discipline postulated a progression of environmental knowledge leading to environmental concern which would eventually lead to environmentally positive behavior. Based on this theory, pro-environmental behavior could be fostered in people by simply providing information highlighting an environmental issue. From this information, a pro-environmental attitude would be instilled and lead to pro-environmental behavior. This line of thinking follows the rational choice theory which states that individuals will seek to act in a manner that maximizes the utility of a decision (Martiskainen, 2007; Simon, 1955; Wilson & Dowlatabadi, 2007). Put into a household energy saving context, the rationale follows the idea that if consumers are provided with information, they will be more informed on environmental matters and therefore can act in a pro-environmental manner as this would become the rational choice (Owens & Driffill, 2008). This theory was widely implemented during the residential energy-conservation movement of the 1970's by municipalities who relied on providing residents with information regarding the economic and environmental benefits of energy reduction in the household in order to alter attitudes and eventually behavior (Martiskainen,

2007). The implementation of this theory during the 1970's did not take into account the contextual and motivational barriers that varied amongst the targeted residents, which generally left the campaigns largely ineffective.

The rational choice theory assumes that behavior is a direct result of attitudes, which has been shown to be too simplistic of an approach to behavior change (Owens & Driffill, 2008). Multiple studies and field research have identified situations when information based campaigns and interventions have not been successful (Barr, 2003; Camerer & Loewenstein, 2004; Kollmuss & Agyeman, 2002; Wilson & Dowlatabadi, 2007). The lack of relationship between attitudes toward energy conservation and conservation behavior are thought to be the reason for a lack of success. In survey research conducted to identify the relationship between attitudes about energy conservation and actual energy conserving behavior, it was found that those who responded that conservation was the most important approach for improving the future of energy were no more likely than others to practice energy-saving behaviors (Costanzo et al., 1986). The poor correlation between pro-environmental attitudes leading to pro-environmental behavior is supported by other research and has resulted in further study to understand pro-environmental behavior in humans (Olsen, 1981).

Theory of Planned Behavior

An extension of the theory of reasoned action (Fishbein & Azjen, 1975), the theory of planned behavior explains behavior as a result of intentions, which are formed by attitudes, social norms and perceived behavioral control (PBC) (Ajzen, 1991). In the theory of reasoned action, Fishbein et. al (1975) identified attitudes and social norms as predictors of behavior intentions. The addition of PBC in the theory of planned behavior was included to address situations where an individual does not have complete control over volition (Ajzen, 1991; Ajzen

& Madden, 1986; Wilson & Dowlatabadi, 2007). Ajzen and Madden (1986) define PBC as "the person's belief as to how easy or difficult performance of the behavior is likely to be." This addition of PBC to the theory of planned behavior created a more robust model that could be applied to behaviors that were outside the control of the individual (Armitage & Conner, 2001). The theory of planned behavior postulates that the level of perceived behavioral control, the person's attitude toward the behavior and the subjective norms influencing a specific situation are all factors influencing the intention to perform a specific behavior. These three factors have been shown to explain a significant portion of the variance in predicating certain behaviors (Ajzen, 1991; Armitage & Conner, 2001).

The theory of planned behavior (TPB) is a model that has been widely applied and tested in the field of pro-environmental behavior including studies on recycling behavior, transportation selection, water conservation and energy consumption (Cheung, Chan, & Wong, 1999; Harland, Staats, & Wilke, 1999; Heath & Gifford, 2002; Lynne, Franklin Casey, Hodges, & Rahmani, 1995). Although some studies show the theory of planned behavior to be effective in predicting pro-environmental behavior, other studies yield mixed results concerning the effectiveness of the TPB as a predictor of behavior and often augment the three constructs in TPB with other factors including social and personal norms, environmental knowledge and past behavior (Cheung et al., 1999; Heath & Gifford, 2002). Such studies focus on the relationship between attitudes, PBC and intentions and focus little on actual behavior change. Rather, TPB focuses on understanding relationships between behavior causing factors and predicting the resulting behavior (Jackson, 2005). Since fostering a pro-environmental behavior change and measuring actual behavior changes are two goals of this project, the researchers determined TPB is not the best model to follow.

Value-Belief-Norm theory

The Value-Belief-Norm theory (VBN) combines research from Schwartz's (1977) norm-activation theory, personal values research and the New Environmental (ecological) Paradigm (NEP) developed by Dunlap and his colleagues (1978) to provide a linear model where each variable in the model directly affects the subsequent variable in the model and indirectly affects other downstream variables (Schwartz, 1977; Steg, Dreijerink, & Abrahamse, 2005; P. Stern, Dietz, Abel, Guagnano, & Kalof, 1999; P. C. Stern, 2000). The goal of this model is to explain why individuals chose to engage in pro-environmental behavior through a variety of behavioral indicators (P. C. Stern, 2000). With a foundation in previously developed behavioral theories, VBN seeks to identify the variables from the research with the greatest ability to predict pro-environmental outcomes. The VBN model has performed well when tested against variables used in other behavior theories. In a study by Stern and his colleagues (Stern et al., 1999), the VBN theory was compared to behavioral indicators from other theories to determine which set of predictors best explain three types of environmental intention. This study revealed VBN to have the best predicting power amongst the four total behavior predictor sets in the study (P. Stern et al., 1999).

Although the VBN theory has shown promise as a predictor of environmentalism, the behavior intent of environmentalism does not always lead to pro-environmental behavior (Gardner & Stern, 1996). Stern acknowledges this disconnect between environmental intention and environmental action and cites the Attitude-Behavior-Context (ABC) theory as a means for explaining the variability in behavior. The ABC theory postulates that pro-environmental behavior is a function of the individuals attitude toward the behavior and the context within which the behavior takes place (Guagnano, Stern, & Dietz, 1995). Stern (2000) explores four

causal variables that affect the impact of attitude and context. The first of these variables is attitudinal factors including norms, beliefs and values. Research has shown that attitudinal factors explain some portion of the variance in specific pro-environmental behaviors (P. Stern, et al., 1999). Stern points out that VBN theory includes social-psychological variables and has accounted for a significant amount of the variance in policy support for environmentalism, but not for committed activism (P. Stern et al., 1999). An additional variable is contextual forces. This external variable consists of institutional barriers, financial status, community expectations, availability to act and other external forces that impact behavior. The third causal variable is the personal capabilities of the individual including knowledge, skills, availability and other socio-demographic characteristics (P. C. Stern, 2000). Research has shown that personal capabilities rarely explain pro-environmental behavior (Stern, et al., 1999). The final causal variable is habit or routine where an individual must break an old habit to establish a new behavior. This also can influence the adoption of pro-environmental behavior because the individual is more comfortable with the habitual behavior which makes lasting behavior change more difficult (Stern, 2000).

Stern's VBN theory encompasses theoretical research and applies it to situations in order to attempt to explain variances in behavior and to determine what variables are at play. This theory has progressed into a set of principles aimed at changing environmentally degrading behavior. These principles acknowledge the complexity of behavior change and that different approaches are needed depending on the influencing variable. The principles laid out by Stern (1996, 1999, 2000) are similar to Community Based Social-Marketing, but remain theoretical whereas CBSM is a practitioner's guide for developing behavior change strategies.

To summarize, the theories discussed in this section have added greatly to the progression of understanding human behavior related to the environment and its determinants. Previous

research has shown that the economic rational theory of informing individuals and increasing knowledge about a specific situation to influence pro-environmental behavior is unsuccessful because behavior change is generally too complex to be induced by information alone (Abrahamse et al., 2005; Costanzo et al., 1986; McKenzie-Mohr, 2000; Owens & Driffill, 2008). The theory of planned behavior provides insight into the predictors of behavioral intention, but such intention does not always translate into action. The VBN theory aims to synthesize previous research efforts into a holistic model that explains pro-environmental behavior (P. Stern et al., 1999). Stern has developed principles for behavior intervention based on the VBN theory. The focus of CBSM is to take the known principles of behavior change and apply them in a pragmatic framework aimed at fostering sustainable behavior change (McKenzie-Mohr, 2011).

Community Based Social Marketing

Community Based Social Marketing (CBSM) is a framework for developing strategies to foster sustainable behavior change in a target audience (McKenzie-Mohr, 2011). A hybrid model developed within both the psychological and social marketing fields, CBSM asserts that a successful behavior change program identifies the barriers and benefits to a particular behavior and administers strategies specific to the target audience. These behavior change principles echo other pro-environmental behavior change scholars' principles (P. C. Stern, 2000).

CBSM can be viewed as an alternative to traditional information based behavior change campaigns that tend to be impersonal and information driven. There are two types of traditional approaches to altering sustainable behavior. The first approach is to provide information on a topic to illicit action by the recipient in accordance with what they have just learned. The underlying theory assumes that by changing a person's attitude towards climate change through educating them on the issue, their behavior will change in accordance with this new attitude

(Geller, 1981). The approach of increasing information and awareness is often implemented by policy makers for large scale campaigns. This approach has been found to be largely ineffective as there are many examples of pro-environmental attitudes not leading to pro-environmental behavior (Abrahamse et al., 2005; Costanzo et al., 1986; Olsen, 1981). One example of this divide between attitude and behavior is a study performed by Geller (1981). In his study, 40 participants attended an intensive workshop on household energy efficiency. A survey after the workshop revealed a greater awareness of energy use in the house and a greater appreciation and willingness to reduce energy use in the home. A follow-up survey administered six to eight weeks after the workshop found that only one of the participants had followed through with the recommendations of the workshop (Geller, 1981). Although awareness and information are important, this study, along with others, illustrate that pro-environmental attitudes and intentions alone do not necessarily lead to pro-environmental behavior. Geller suggests that workshops and informational approaches to residential behavior change should be supplemented by other techniques to motivate action after the initial information session. CBSM focuses on personalizing behavior change initiatives for a target audience by offering a broader set of techniques to choose from and tailor

The second approach traditionally used in behavior change campaigns is an economic self-interest approach. This approach, similar to the attitude-behavior approach, relies on the dissemination of information to inform recipients of the economic benefits of engaging in a behavior. This approach subscribes to the economic-rational theory that people will always choose the behavior of greatest economic benefit or the greatest utility to them individually (Yates & Aronson, 1983). By providing homeowners information on the economic benefits on insulating their attic, homeowners now have the information necessary to act in the most

"rational" manner. This approach has been implemented to promote pro-environmental behavior with poor results. One often cited example is that of the California utilities department spending 200 million dollars annually to advertise the benefits of energy efficient housing upgrades from an economic standpoint (Costanzo, et al., 1986). Although many resources have been dedicated to this endeavor, the results have been marginal frequently resulting in less money saved from energy reduction than the amount of money spent on advertising (Costanzo et al., 1986). In short, this approach oversimplifies pro-environmental human behavior to be a matter of providing financial incentives when in reality, it is far more complicated (McKenzie-Mohr, 2011).

Contrary to the two above approaches, CBSM utilizes a systematic approach to research what behaviors will have the most impact, what perceived barriers and benefits exist and then the development of strategies to engage the target audience at a more personal level to encourage sustainable behavior change. CBSM does not speculate as how to bring about behavior change; rather, it investigates the current status of the target audience by engaging them in surveys, focus groups and observations and develops strategies based on the information gathered through researching the target audience. This approach builds on the social-psychological perspective of behavior change by accounting for not only attitudes and beliefs but also contextual variables, norms and barriers to behavior change. Although a new approach to fostering behavior change, CBSM has been found effective in many applications such as increasing residential recycling rates, increasing the adoption of specific energy conservation measures and alternative transportation campaigns (Abrahamse et al., 2005; Kollmuss & Agyeman, 2002; McKenzie-Mohr, 2011; McMakin, Malone, & Lundgren, 2002; Reynolds, 2010). However, to date, it has not been used with residents of low-income housing.

The systematic CBSM framework for behavior change follows a five phase process. These phases are: (1) selecting behaviors, (2) identifying perceived barriers and benefits, (3) developing strategies, (4) piloting phase, and (5) broad-scale implementation and evaluation (McKenzie-Mohr, 2000).

CBSM and Low Income Housing

Previous research has shown that CBSM has delivered promising results when followed and implemented correctly (Marcell, K., Agyeman, J., & Rappaport, A. (2004); Kennedy, A. L. (2010)). To date, however, the research on CBSM applied in low-income housing settings is limited. The closest study to implementing CBSM in a low-income residential setting was conducted by McMakin et. al (2002), where CBSM was used to reduce energy use in military housing. The military housing structure is similar to that of the low-income housing structure where all buildings are owned by the government and utilities are often subsidized or paid for by the complex management. This study yielded promising results including a reduction of 10% in energy use over one year (McMakin et al., 2002). Although similar to low-income housing, further research is needed to inform policymakers and officials of the effectiveness of CBSM as a model for behavior change and that behavior change is a viable avenue for reducing energy use in low-income housing.

This research sets out to extend the current research in behavior based energy conservation measures to an affordable housing audience. As stated in the introduction and further iterated in the literature review, utility bills pose a disproportionate burden on residents of affordable housing. This utility bill burden could be reduced through behavior change for low to no cost; however, little research to date has been done on behavior change in an affordable

housing environment. This research is important as it begins the discussion and sets research in motion to better understand the intricacies of behavior change in affordable housing.

CHAPTER 3: METHODOLOGY

The methodology for this research follows the first two phases within the CBSM framework. The complete and systematic CBSM framework for behavior change is a five phase process. These phases are: (1) selecting behaviors, (2) identifying perceived barriers and benefits, (3) developing strategies, (4) piloting phase, and (5) broad-scale implementation and evaluation (McKenzie-Mohr, 2000). The first two phases of the CBSM process are discussed in detail below.

Phase 1: Selecting Behaviors

The first phase to any CBSM initiative is to properly identify which behaviors to target. The goal of this phase is to focus the behavior change campaign on the behaviors that have the greatest potential of yielding positive results. This not only makes for a more effective behavior change campaign, but also allows time and money to be allocated in a more informed manner. To better focus the behavior change effort, phase 1 follows this three step process: (1) identify the sector (e.g. transportation, commercial, residential, etc.), (2) list the potential behaviors, and (3) evaluate and compare behaviors based on potential impact, probability and current level of penetration within the target audience (McKenzie-Mohr, 2000, 2011). After performing these steps, the behaviors with the greatest potential to positively impact the campaign's goals are identified and these behaviors form the focus on the rest of the CBSM initiative.

The first step of phase 1 is relatively easy and is usually primarily constrained by budget, policy or the specifications of a grant. The two remaining steps frequently prove more difficult. For example, previous research has identified over 200 separate behaviors with the potential to lead to a reduction in electricity use in the residential sector (Hargroves et al., 2010). Such a

high number of potential behaviors can be cumbersome when trying to identify the most appropriate behaviors. To make appropriate behavior selection more manageable, the full list of behaviors should be reduced by identifying behaviors related to high impact areas. For example, a behavior change initiative focusing on reducing electricity use in households should identify the areas of highest electricity use and focus on behaviors in those areas (McKenzie-Mohr, 2011). Once a manageable amount of behaviors have been determined, the next step is to evaluate and compare these behaviors. This step entails collecting data related to various behaviors including the extent of the behavior's contribution toward reaching the campaign goal (variable 1), gauging the probability that the target audience will engage in certain behaviors (variable 2) and identifying the percentage of the target audience who are already engaged in a certain behavior (variable 3) (McKenzie-Mohr, 2011). Once data on these three variables have been gathered and averaged, the resulting numbers for each variable are then multiplied to get the net potential impact of each behavior. The behaviors with the highest *product* are the behaviors to target for the remainder of the CBSM phases.

Phase 2: Identifying Barriers and Benefits

Once the potential impact has been determined for each behavior, the next phase is to identify the barriers and benefits related to each behavior. The purpose of this phase is to objectively research the target audience's perceived barriers and benefits relating to the identified behaviors. It is important to approach this phase with no preconceived ideas about what barriers and benefits exist and to rely solely on the research methods (McKenzie-Mohr, 2011). Each behavior has unique and specific barriers that keep the target audience from performing the behavior (Reynolds, 2010).

Similar to phase 1, phase 2 includes a sequence of steps. These steps are (1) literature review, (2) observations, (3) focus groups, and (4) survey the target audience. The literature review is conducted to gain understanding of what has been done already regarding the targeted behaviors. This allows the researcher to use best practices from other behavior change campaigns and not reinvent the wheel. The observation step provides the researcher a deeper understanding of the target audience. Barriers that the audience may not know exist can be seen by an outside, objective person who is simply observing individuals as they partake in a specific behavior. The literature review and observations can also help develop meaningful questions for the focus group.

The focus group step involves interacting with a selected group of individuals from the target audience with the goal of uncovering barriers and benefits related to specific behaviors. The focus group can be a fruitful source of information and plays a key role in developing behavior change strategies. Following the focus group step, implementing a survey allows the researcher to reach more members of the target group, especially if sufficient information could not be attained during the focus group stage.

It is important to note that not all situations allow for all steps to be completed. For example, energy and water use within the home may not be readily observable. It should also be understood that the goal of this phase is to uncover barriers and benefits related to the specific behaviors identified during phase 1. If sufficient information can be gathered without performing all four tasks in this phase, then the researcher may use discretion to determine if all steps are necessary.

To perform and document the first two phases of CBSM, a mixed methods approach was applied in this research Mixed methods combines elements of qualitative and quantitative research methods, resulting in a more complete understanding of the phenomena being researched (Johnson & Onwuegbuzie, 2004).

A variety of research designs exist within the realm of mixed research. Mixed method research is usually characterized based on the dominance of either qualitative or quantitative research within the study and the sequencing of the research design (Johnson, Onwuegbuzie, & Turner, 2007). This research is a sequential quantitative + qualitative study with the designation of a sequential qualitative dominant mixed methods approach (Johnson et al., 2007). This designation shows that the study is a sequential approach using quantitative methods first and following with a qualitative approach that has a greater significance in the study. This type of approach is outlined in the CBSM process where phase 1 begins with an analysis of descriptive statistics gained through survey research to identify the target behaviors and phase 2 utilizes focus group research to uncover barriers and benefits to the identified behaviors.

Population

The population for this research was residents living in an affordable housing residential complex in northern Colorado. This complex provides housing for families at 40% to 50% of the national average median income. The complex consists of 9 buildings with 8 units each for a total of 72 units. The demographics of the residents include the elderly, young couples with children, young couples without children, single parents and single occupants.

Resident Surveys

The first phase of CBSM focuses on quantitative data collection to identify the most appropriate behaviors to target during the following focus groups. For this research, a behavior selection survey was used to inform which behaviors to carry into the second phase of the CBSM process.

The survey was administered by going door to door to each unit and administering the survey orally. The door to door administration method was selected in order to avoid eliminating members of the population who would not have access to a survey distributed via email.

The survey administration took place on three different visits to the housing complex by the researcher. On every site visit, the researcher knocked on every door in the complex and each resident that answered was asked to take the survey. To ensure multiple members of the same household did not complete a survey, a list was kept of the units that had completed the survey. This list did not contain names and was disposed of once the survey phase was complete in order to maintain the anonymity of the participants.

The survey questionnaire was developed by the researcher using the guidelines provided in phase 1 of the CBSM framework. The goal of this survey was to characterize resident's attitudes toward the behavior, the current participation amongst residents regarding the behavior and the behaviors impact on reducing energy consumption.

Survey results were aggregated and analyzed. A description of the analysis can be found in the following chapter, Analysis & Results. The resulting insights from the analysis were used to better understand the energy consumption patterns of the community and identify appropriate the behaviors to target during the following focus groups.

The data gathered from responses was analyzed to identify patterns through the use of descriptive statistics. Each behavior was given an average score for the current reported frequency of the behavior amongst the participants, the resident's willingness to perform the behavior if not engaging in it already and the potential energy reduction should the behavior be adopted. The overall potential impact of each behavior was determined by multiplying the average response for the frequency of each behavior and the average response for likelihood of engaging in each behavior by the overall potential reduction of energy use of each behavior. The behaviors with five highest overall scores were further analyzed during the focus group.

Table 1 presents a scenario from the behavior identification phase to illustrate the analysis process. The following description provides a step-by-step breakdown of the process used to develop such a table. The first column is a list of behaviors that can influence energy use within a household. The initial list of potential behaviors comes from a report from the Townsville, Australia government where over 200 residential behaviors that impact energy household use were identified (Hargroves et al., 2010). For the purposes of this research, however, this list was shortened substantially to only include behaviors specific to residents living in affordable housing in a rental situation. For example, insulating an attic is a behavior that reduces energy consumption but is likely not a behavior typical of the target audience so it was not included in the list of behaviors. The following are the behaviors that were analyzed as part of the survey:

Hot Water

1. Reducing shower duration to four minutes
2. Purchasing and installing low flow showerheads

3. Purchasing and installing low flow aerators for bathroom sinks
4. Washing clothes in cold water instead of hot or warm water
5. Reducing the temperature setpoint on the water heater to 120°F.
6. Purchasing and installing insulation for the water heater.

Kitchen Appliances

1. Only use dishwasher when full
2. Only use run dishwasher in economy more (energy saving mode)

Entertainment Equipment

1. Using powerstrips to turn off groups of electronics when not in use
2. Turn off all electronics overnight.

Laundry

1. Only wash clothes when the machine is full.
2. Hang clothes to dry instead of using dryer.

Heating and Cooling

1. Purchase and install thermal grade curtains to maintain desired ambient temperature.
2. In summer, open windows at night and close during the day to capture cool night air.
3. Reduce heat setpoint by 10 degrees when away from home and sleeping.

4. Increase the cooling setpoint when leaving the home.

5. Use fans as the primary cooling source in place of air conditioner.

Lighting

1. Use natural light instead of electric lighting during the day.

2. Turning off lights when not being used.

3. Purchasing and replacing incandescent bulbs with fluorescent bulbs.

Values in Column 2 in Table 1 represent the potential energy reduction, expressed in kBtus, for each behavior. The kBtu amount is assigned by the researcher and is intended to signify the potential amount of energy savings each behavior could yield if everyone in the project were to adopt the behavior and nobody was practicing the behavior before. These values are derived from engineering analysis, literature review and expert input. The numbers in columns 3 and 4 are gathered from the resident surveys. Column 3 is the average response from residents regarding the probability that an energy conserving behavior would be adopted. Column 4 is the average responses from the residents regarding their current activity as it relates to the energy conserving behaviors. Column 4 is derived by taking the average response and subtracting it from five as the survey scale is from 1-5 with a response of 1 representing never engaging in the behavior and a response of 5 representing the behavior is performed 100% of the time. For example, if the survey participants indicated that they were engaging in a behavior 60% of the time, which is represented by the number 3, then the number 3 would be subtracted from 5 leaving the response as a 2. A response of 2 indicates that only 40% of the surveyed

participants are not currently engaging in the behavior therefore only 40% of the total savings can be realized.

Table 1: Example calculations for Phase 1 - Identifying behavior

Behavior	kBTUs/unit	Probability (1-5)	Penetration (5-x)	Results
Hanging clothes to dry instead of using electric dryer	2410.20	2.36	2.07	11768.17
Reduce shower time to 4 minutes	3375.00	2.93	1.64	16237.88
Opening windows to cool house at night.	2149.56	4.29	1.50	13818.60

Once the data was gathered, the values were multiplied to get the overall potential energy reduction impact for each behavior where the higher the number, the more likely the behavior will yield energy savings.

Focus Groups

The original plan was to perform two focus groups of eight to ten people each. In order to recruit participants, the researcher supplied each residential unit with an informational flyer providing details of the scheduled focus groups. Participants were asked to RSVP with the apartment manager to maintain confidentiality as prescribed per the Institutional Review Board (IRB) approved methods. The residents who RSVPd for the focus groups were contacted by the apartment manager three days prior to the focus group to remind the residents and confirm participation. This recruitment method focused on generating participation as opposed to creating a randomized sample due to the expected difficulty of generating interest and attendance. The researcher provided $25 gift cards to King Soopers (a local grocery store) as

incentive for participation. Of the 72 units, ten people RSVPd for the first focus group and three attended. The second focus group had five attendees for a total of eight focus group participants.

Typically, focus groups in the CBSM process are limited to an hour and a half which allows for roughly three behaviors to be investigated when eight to ten participants are present. Due to the small number of attendees, time permitted that the focus group discussions were expanded to include additional behaviors.

A focus group facilitator was present for both focus groups. The main purpose of the facilitator was to moderate the focus group and allow the researcher to take note of both verbal and nonverbal cues from the participants.

The focus group was audio recorded for ongoing analysis purposes and all recordings were handled in accordance with the protocol submitted to and approved by the IRB. In addition to audio recorded notes, the researcher also took hand-written notes to capture not only spoken thoughts but also non-verbal communication.

The researcher analyzed the focus group results using multiple analysis methods to validate the focus group results and remove personal bias. The first step in analyzing the focus group data was to transcribe the participant's responses. From this written transcription of the focus group, the participants were organized in an excel database based on the participant's assigned number and the question number.

After transcribing the focus group discussion, the researcher used the template analysis method to analyze the data.

Template Analysis Approach

Template analysis is a popular method used to analyze qualitative data that is typically in the form of interview transcripts, focus groups transcripts and other textual data. The general process includes developing a coding template that summarizes important themes in the data. The coding template is developed early in the analysis process and is used to make meaning of the remaining textual data. A typical approach is to develop *a priori* codes based on the knowledge the researcher has regarding the research topic. Once a priori codes are identified, the researcher then develops the coding template based on the textual data. This development could include adding to, removing or altering the existing a priori codes. The natural progression of the template analysis promotes a hierarchal coding approach that begins with broad themes that are eventually narrowed to more specific themes.

The development of the initial coding template is based on a sub-set of the textual data. Once the initial template is solidified, it is then applied to the rest of the textual data. If text is discovered that does not comfortably fit any of the existing themes in the initial template, an alteration to the initial template might be needed. Once all the textual data has been analyzed and the initial template is finalized, this template now becomes the final template and is used to interpret the findings.

CHAPTER 4: ANALYSIS & RESULTS

The first two phases in the CBSM process were used to target behaviors and identify perceived benefits and barriers to these behaviors. The following chapter details the analysis and results of each step.

Phase 1, Step 1 – Determine focus of behavior campaign

It was decided to focus on household energy reduction within an affordable housing community. This decision was encouraged by leaders at the housing authority as energy use reduction is a goal of the authority.

Phase 1, Step 2 – Determine behaviors to include in analysis

The behaviors included in the survey (phase 1, step 3) were determined through the refinement of previous research. A list of residential energy reducing behaviors was reviewed to identify the behaviors that were not applicable to residents in a rental community. From the over 200 listed behaviors, only 20 behaviors were deemed applicable for this research. The selected behaviors can be found in appendix A.

Phase 1, Step 3 - Resident Surveys

Prior to conducting the surveys, the potential behavior impact value was determined for each of the potential behaviors. Each behavior was given a kBtu per person per year value that was used in part to determine the optimal behaviors to target. These values were determined by engineering calculations, industry accepted assumptions and data from previous research. Once the values were determined, they were entered into the data analysis tracking sheet that was used as an analysis tool for step 1.

The resident survey data was collected over three visits to the housing complex. A total of 33 out of a potential 81 residents were surveyed for a 40.7% sample rate of the population. Of the 33 surveys, four were incomplete and not included in the final data analysis, resulting in 29 completed surveys for the data analysis (35% sample rate).

The survey asked residents to respond to the following two questions:

1. How often do you engage in (X) behavior?

2. How willing or likely are you to adopt or engage in (X) behavior.

These two questions were asked for each of the behaviors that were determined to be applicable to this study. Both questions provided a scaled response for residents to select the answer that best fit their situation. The first question's responses included 0% or never, 25% of the time, 50% of the time, 75% of the time or 100% or always. Similar to the first question, the second question provided a scaled response for residents. The second question's responses were: not likely at all, somewhat likely, likely, very likely or already engaged in the behavior. Several residents expressed confusion regarding how to answer questions if they already engaged in the behavior in question.

The goal of the survey analysis was to identify the behaviors where the current behavior engagement was low and the likelihood or willingness to engage in the behavior was high. The answer series for both questions were given the numerical value of 1-5 with 1 being the low end of the response scale and 5 being the high end. A numerical value was given to each response in order to average the responses from each resident to get an averaged response for each behavior.

Once the surveys were completed all averaged values were entered into a spreadsheet for the analysis process. The analysis consisted of multiplying the three variables for an overall potential energy reduction value. See formula below:

Variable 1		Variable 2		Variable 3		Outcome
Estimated energy reduction of behavior	*X*	*Reported penetration of behavior*	*X*	*Reported willingness to engage in behavior*	=	*Predictor of behavior success*

Note the number calculated is not a measurement of the expected energy reduction but instead a predictor of the behaviors to target for a successful behavior change initiative. The behaviors with the largest total number were the behaviors predicted to have the most potential impact.

The following table ranks the top five behaviors with the greatest potential estimated energy reduction (variable 1). These figures were determined through engineering analysis, reviewing data gathered by industry leaders and reviewing similar studies.

Table 2: Top five behaviors based on potential energy reduction.

Behaviors	Annual Energy Reduction (kBtu)
Replacing incandescent bulbs with fluorescents.	3582.60
Avoiding the use of AC and using fans.	3550.50
Reducing heating temperature when sleeping and away by 10 degrees.	3500.00
Reducing the length of time spent taking a shower (to 4 minutes).	3375.00
Hanging clothes to dry instead of using a dryer.	2410.20

The following table shows the top five behaviors based on the reported current penetration the behavior had with the survey participants (variable 2). These figures represent the average response of the survey participants for each behavior. The higher the number, the less penetration the behavior had with the target audience. This is because these values were later multiplied with variable 1 and 3 to get final predictor of behavior success. If a behavior has a low penetration value, that behavior will have a relatively low predicted success when multiplied with the other variables. The greater the number, the less residents are currently engaging in this behavior, the greater the final predictor of success.

Table 3: Top five behaviors based on current potential for penetration.

Behaviors	Penetration (1-5)
Insulating the hot water heater with a thermal blanket.	2.79
Hanging clothes to dry instead of using a dryer.	2.07
Reducing the set point for the hot water heater to 120 degrees F.	1.86
Reducing the length of time spent taking a shower (to 4 minutes).	1.64
Only washing clothes when machine is full.	1.64

Note: Scaled responses range from 1 to 5. A response of 1 indicates the behavior is never practiced while a response of 5 indicates the behavior is practiced 100% of the time. In this case, the response is subtracted from 5 to get the raw penetration score (i.e. a behavior performed 100% of the time (a 5 on the scape) would equate to a 0 as there would be no potential energy savings from a behavior that is already being practiced 100% of the time. In this case, the lower the response is on the scale, the better the opportunity for energy reduction.

The following table shows the top five behaviors based on the reported willingness or likelihood to perform a specific behavior (variable 3). These figures represent the average response from the survey participants for each behavior.

Table 4: Top five behaviors sorted according to willingness to perform, based on survey response averages.

Behaviors	Likelihood (1-5)
The installation of low-flow aerators to reduce hot water usage.	4.71
In summer, opening windows at night and shutting during the day to reduce cooling loads.	4.29
Using the economy settings on the dishwasher.	4.29
The installation of water efficient showerheads.	3.93
Use natural light rather than electric lighting during the day.	3.93

Note: Scaled responses range from 1 to 5. A response of 1 indicates the respondent is willing to engage in the behavior 0% of the time while a 5 indicated the respondent is willing to engage in the behavior 100% of the time. The higher the average score, the more willing the audience is to engage in the behavior.

The following table shows the top five behaviors analyzed. These figures were determined by multiplying the behaviors potential energy reduction by the behaviors reported current penetration by the participants reported willingness to engage in the behavior. For a complete list of all the behaviors and their estimated potential impact, see Appendix C.

Table 5: Survey Results

Behaviors	Energy impact potential	Likelihood 1-5	Penetration 1-5	**Energy Reduction Potential**
Reducing the length of time spent taking a shower (to 4 minutes).	3375.00	2.93	1.64	16237.88
In summer, opening windows at night and shutting during the day to reduce cooling loads.	2149.56	4.29	1.50	13818.60
Hanging clothes to dry instead of using a dryer.	2410.20	2.36	2.07	11768.17
Replacing incandescent bulbs with fluorescents.	3582.60	2.71	1.14	11113.37
Washing clothes in cold water rather than hot or warm water.	2080.00	3.43	1.50	10697.14

Survey Discussion

Based on the survey research, the behavior with the highest potential energy reducing impact was reducing the length of time spent in the shower down to four minutes per shower. This behavior had a high energy reduction potential as well as minimal penetration in the current target audience making it a good behavior to target. However, the survey participants reported a willingness or likelihood to engage in this behavior at a roughly 59% participation rate, which ranked 10th out of the 20 behaviors. This percentage is likely higher than the actual participation rate as this value was self-reported and this behavior is an ongoing behavior that could compromise resident comfort. Regardless of the factors around the willingness component, the behavior was further analyzed in the focus group portion of the research.

Interestingly, no one-time action behaviors were among the top five behaviors for the greatest energy reducing potential. This could be attributed to a number of factors: 1) only 4 of the 20 behaviors were one-time actions, 2) the one-time action behaviors were poor in the energy reduction estimate category, and 3) the one-time action behaviors had associated cost and installation impacts. Factor three is more applicable to residents in rental housing than homeowners. Most one-time actions are behaviors that become part of the structure. Although they can be highly impactful in energy reduction potential, renters generally would not be interested in installing new windows or attic or wall insulation.

An interesting component of any survey research is the fact that the answers are self-reported which lends itself to a personal bias. Ideally, researchers would conduct additional observations to validate the reported tendencies of the targeted audience, but this research did not allow for such observations. Nevertheless the recorded average penetration and willingness figures suggest self-reporting bias may have occurred. For example, the average penetration value provided by survey participants was 1.29 which equates to over 75% penetration. The average willingness value was 3.10 which illustrates that survey participants are willing to engage in these behaviors over 60% of the time.

These relatively high percentages of penetration and willingness to engage suggests people may be overly optimistic about how able and willing they are to change their behavior. Another potential reason for the relatively high response values for the penetration and willingness questions is the survey itself. Based on the responses and interactions with the residents, the researcher observed that some participants were either mislead or confused by what the question was asking.

A concern of CBSM is that behaviors with a high energy impact have a better chance of being deemed an optimal behavior because the survey scale for energy reduction is infinite while the scale for penetration and willingness to engage is scaled one to five. This can be an issue if a behavior with a significantly high energy impact is in the study. Although this was not the case for this study, the researcher reviewed the data to ensure that the energy reduction impact did not disproportionately impact the top 5 behaviors.

In order to do this, the behavior with the highest energy impact was set equal to 5 to match the highest potential response of the willingness and penetration variables. The remaining behaviors were then set to the 1-5 scale by dividing the energy reduction impact by the result of dividing the largest energy impact result by five. In this case, the behavior with the highest energy reduction potential was replacing incandescent bulbs with CFLs with an energy reduction potential of 3,582.6 kbtu. This behavior is set to 5. The energy reduction potential was then divided by 5 to get 716.5 which was then used to scale the remaining behaviors to the 1-5 scale by dividing the energy reduction potential by 716.5. See below for the resulting scaled behaviors.

Table 6: Scaled energy data

Energy Reduction	Non-Scaled	Scaled
Replacing incandescent bulbs with fluorescents.	3582.6	5.0
Avoiding the use of AC and using fans.	3550.5	5.0
Reduce heating temperature when sleeping and leaving the home by 10 degrees.	3500.0	4.9
Reducing the length of time spent taking a shower (4minutes).	3375.0	4.7
Hanging clothes to dry instead of using a dryer.	2410.2	3.4

Turn off air conditioner when leaving the house.	2364.5	3.3
In summer, opening windows at night and shutting during the day to reduce cooling loads.	2149.6	3.0
Use natural light rather than electric lighting during the day.	2149.6	3.0
Washing clothes in cold water rather than hot or warm water.	2080.0	2.9
The installation of water efficient showerheads.	2025.0	2.8
Plugging electronics into a power strip and turning off when not in use by switching off the power strip.	1706.0	2.4
The installation of low-flow aerators to reduce hot water usage.	1500.0	2.1
Using the economy settings on the dishwasher.	1405.3	2.0
Installing and using curtains to provide a thermal layer between the window and the room.	1265.0	1.8
Reducing the set point for the hot water heater to 120 degrees F.	1200.0	1.7
Switching lights off when not in use.	1074.8	1.5
Insulating the hot water heater with a thermal blanket.	1050.0	1.5
Turning off computers overnight.	972.4	1.4
Only use the dishwasher when full.	602.3	0.8
Only washing clothes when machine is full.	572.0	0.8

When using the scaled results from above in the equation for identifying the most optimal behaviors to target, the top 5 behaviors do not change. This validates the findings and shows that the energy reduction potential figures do not have a disproportionate impact on the top 5 behaviors.

The final potential issue with the survey results is that the results are heavily weighted toward the potential energy reduction number since it is significantly larger than the other two factors. The energy reduction component does not have an upper limit, while the penetration and willingness components are on a scale of 1-5. Such discrepancy in scale could result in selecting behavior which might only be adopted by a few members of the target audience if it has a very high energy reduction potential. This issue can lead to less successful behavior change initiatives because the lower number of willing participants means the percentage of savings lost when one participant does not adopt the behavior is greater. Also, previous research suggests that the more participants in the target audience that adopt a specific behavior, the more likely they are to adopt other sustainable behaviors (Thogersen & Olander, 2003). This is known as the spillover effect. An effect that is less likely to occur if only a few participants adopt such a behavior.

Phase 2, Step 1 - Literature Review

The literature review was conducted in order to identify any existing research that focused on the five identified behaviors (see table 5) in an affordable housing community. This was done in order to understand the perceived barriers and benefits that had been found in previous research and explore those findings further in this research. Unfortunately, no previous research was found that focused on the five targeted behaviors in an affordable housing community.

Phase 2, Step 2 – Observations

The observation step was minimal for this research as the targeted behaviors were mostly not readily observable without intruding. The only behavior that was somewhat observable was

hanging clothes to dry. It was evident that no infrastructure was provided to hang clothes in the courtyard and no clothes were hanging on apartment balconies.

In all, the observation step was not a primary component of the research due to the nature of the targeted behaviors.

Phase 2, Step 3 - Focus Groups

This section discusses the focus group portion of the research including details about the focus group itself, an explanation of the analysis, the findings from the analysis, and a discussion regarding the focus group as a whole.

The solicitation for focus group participants began shortly after the targeted behaviors were identified. As mentioned earlier, recruiting focus group participants was expected to be difficult so an open solicitation to all units within the complex was undertaken to ensure the largest amount of participants. Unfortunately, this method is not random and could lead to misrepresentation of the target audience.

The initial plan was to host two separate focus groups of 8-10 people which would represent roughly 20-25% of the target audience. This did not occur. The first focus group consisted of 3 participants while the second focus group had five participants representing roughly 11% of the target audience.

Additionally, the participants who attended the focus groups appeared to not fully represent the diverse community of residents at the housing complex. During the door to door survey, the researcher met many of the residents and was able to gain an understanding of the resident's demographics. The community appeared to range from young families to single senior

residents. The attendees of the focus groups were all women and 7 of the 8 participants were 60 or older which did not match the diversity of the community observed.

The goal of the focus group was to identify the perceived barriers and benefits regarding the targeted behaviors. An additional goal was to understand the general attitude toward energy use in the home and what benefits went along with reducing energy consumption. The following script was used as a guide for conducting the focus group:

I. Engagement Questions

   a. How can you make an impact on how much energy your house uses?

   b. What are some benefits of reducing energy use in the home? (optional)

II. Exploration Questions (these were asked for each behavior)

   a. What are potential barriers to performing *behavior X?*

   b. What benefits do you see to performing *behavior X?*

   c. Are there changes that could be made that would make *behavior X* more desirable?

   d. If you performed *behavior X* in the past, can you tell me the reason you no longer choose to participate in that behavior?

III. Wrap-up Questions

   a. Is there anything else you would like to say regarding *behavior X* that we did not cover?

A facilitator was present to moderate the focus groups and allow the researcher to keep notes. The use of a facilitator also helped remove any bias the researcher had toward the subject matter as the facilitator was a doctoral candidate at Colorado State University with no other ties to the research.

Finally, all five of the behaviors identified to have the greatest potential were included due to the relatively low number of focus group participants which allowed for more time to discuss more behaviors.

Phase 2, Step 4 – Survey

The CBSM process states that the follow up survey should be conducted if additional information is desired and time allows for the second survey. The research would have likely benefitted from an additional survey but time did not allow for the development and administration of another in person survey.

Analysis

The researcher used the template analysis method to investigate the date gathered from the focus groups. The analysis consisted of transcribing the focus group discussions, developing codes, interpreting the residents' responses and putting them into the appropriate code categories and then analyzing the results.

The analysis of the focus group data first began with the researcher establishing *a priori* codes. These were developed after the focus group but prior to the data transcription. Although different behaviors were targeted, the common goal was to reduce energy use at home. Because there was a common end goal, one set of a priori codes was used for all five behaviors. This

provided a good foundation that would allow for flexibility and variation between the behaviors further in the analysis.

The a priori codes were determined by reviewing behavior change studies that focused on energy reduction and identifying the thematic barriers and benefits. Note that the a priori themes are broad in nature to allow for more specificity further through the research process. The following were the a priori codes determined for this study.

Table 7: A Priori Codes

Barriers to Energy Reduction
Lack of Motivation
Forgetting to Act
Lack of Social Pressure
Lack of Knowledge
Structural Barriers
Inconvenience
Benefits to Reducing Energy Use
Positive for Environment
Save Money
Habit
Generally good thing to do
Health

The above codes were used to develop the initial template. To begin, the sub-set of data was determined to be the two engagement questions and the text from the first behavior question from the first focus group. The data sub-set was limited to the first behavior in order to cause the researcher to pause and reflect on the reviewed data and make preliminary changes to the a priori codes. This was also a good stopping point to allow for the development of the second and third tier coding.

Similar to the a priori codes, the initial template codes were the same for all behaviors. This approach was acceptable for the first tier codes; however, the second tier codes varied amongst the behaviors as the barriers and benefits differentiated as the coding became more specific. The following is the initial template based on the first sub-set analysis:

Table 8: Initial Template Based on First Sub-Set

Barriers to Energy Reduction
Lack of Motivation
Lack of Knowledge
Structural Barriers (external)
Inconvenience
Physical Barriers (internal)
Easy: No barriers
Benefits to Reducing Energy Use
Save Money
Habit
Generally good thing to do
Health
Comfort

After the initial template was developed, the template was applied to each question to develop more specific themes as second tier codes. A table was developed for both the perceived barriers and benefits of each behavior. These tables show the results from the template analysis, including second and third tier codes, as applied to each behavior. Next to each secondary level code, a number has been provided which indicates the number of instances this thought was said or confirmed during one of the focus groups.

The following tables provide a summary of the template analysis. For each behavior, the number shown represents the total number of either barriers or benefits that were conveyed by the focus group participants. This total number was then broken down into the finalized codes

used for analysis. This process was repeated for the perceived barriers and benefits for each behavior. The summary table does not show the second tier codes for simplicity; however, the tables 10-19 show second-tier coding sets later in the analysis section.

Table 9: Summary of Perceived Barriers based on Template Analysis

Perceived Barriers	
4 Minute Shower	42
Lack of Motivation	2
Lack of Knowledge	9
Structural Barriers (external)	3
Inconvenience	16
Physical Barriers (internal)	12
No Barrier	0
Opening Windows	21
Lack of Motivation	1
Lack of Knowledge	0
Structural Barriers (external)	7
Inconvenience	7
Physical Barriers (internal)	6
No Barrier	0
Laundry in Cold Water	11
Lack of Motivation	2
Lack of Knowledge	1
Structural Barriers (external)	0
Inconvenience	4
Physical Barriers (internal)	0
No Barrier	4
Hanging Clothes	11
Lack of Motivation	0
Lack of Knowledge	0
Structural Barriers (external)	9
Inconvenience	2
Physical Barriers (internal)	0
No Barrier	0
CFL Bulbs	10
Lack of Motivation	0

Lack of Knowledge	4
Structural Barriers (external)	2
Inconvenience	3
Physical Barriers (internal)	1
No Barrier	0

Table 10: Summary of Perceived Benefits based on Template Analysis

Perceived Benefits	
4 Minute Shower	9
Save Money	3
Habit	0
Generally good thing to do	5
Health	0
Comfort	0
No benefits	1
Opening Windows	23
Save Money	5
Habit	0
Generally good thing to do	3
Health	4
Comfort	11
No benefits	0
Laundry in Cold Water	7
Save Money	3
Habit	3
Generally good thing to do	1
Health	0
Comfort	0
No benefits	0
Hanging Clothes	8
Save Money	2
Habit	0
Generally good thing to do	5
Health	0
Comfort	1
No benefits	0
CFL Bulbs	5

Save Money	3
Habit	0
Generally good thing to do	2
Health	0
Comfort	0
No benefits	0

Findings

The goal of the focus groups in CBSM, is to uncover the perceived barriers and benefits that the target audience associates with the pre-determined targeted behaviors and then use behavior change strategies to either overcome the barriers or accentuate the benefits, or both.

The first two questions posed during the focus groups were icebreakers used to generate discussion about energy use reduction. Although not directly associated with the target behaviors, there were some valuable insights and quotes that could be used to better understand the target audience's general disposition toward energy consumption in the home.

The first question asked participants how they can affect energy consumption within their home. Both focus groups responded by listing multiple examples of specific behaviors that could reduce energy consumption, many of which were in this study. This revealed that the target audience was knowledgeable of how energy is consumed in the home and how that consumption can be affected. The following are illustrative quotes:

- *"I put box fans in the windows to bring in the cool air at night. And I would do that and not run the air conditioning if my windows were easier to open and close. "*

- *"Well, and the other thing you can do is you can get those thermal curtain drapes. I have them in my bedroom because it really comes in hard in the bedroom, and that keeps it at least at a decent temperature in the bedroom."*

- *"But if you unplug appliances, because even though they're turned off they still drain off a little electricity. But, you know, that's more hassle than it's worth to unplug it and then plug it in.."*

- *"Another thing that I do is I take a bath towel and I roll it up, in the winter time, and put it along the sill."*

The second question asked participants to identify the benefits of reducing energy consumption at home. Although many of the responses included reducing utility costs, additional benefits were also identified. The responses to questions 1 and 2 proved instrumental in the development of the codes for the initial template. These codes in large part remained in the final template used for the analysis.

After the two initial icebreaker questions, the focus group facilitator turned the discussion to the pre-determined targeted behaviors. The following tables present combined results from the analysis of each behavior and how the analysis answers the initial goal of the focus group.

Table 11: Barriers to Reducing Shower Time

Barrier	***Second Tier***	***Occurrences***
Lack of Motivation		2
	Water cost covered by owner	1
	Lack of social pressure from peers	1
Lack of Knowledge		9
	View behavior as water conservation	7
	Product skepticism	2
Structural Barriers (external)		3
	Poor hot water distribution	3
Inconvenience		16

	Impractical to bathe in 4 mins	7
	Shower as comfort	9
Physical Barriers		12
	Physical limitations	8
	Women need longer showers	2
	Young people take longer showers	2
Easy: No Barrier		0
		0

Table 12: Benefits to Reducing Shower Time

Benefit	***Second Tier***	***Occurrences***
Save Money		3
	Cost reduction through water savings	3
Habit		0
		0
Generally good thing to do		5
	Water reduction is important	2
	Provided alternative ways to save water	3
Health		0
		0
Comfort		0
		0
No benefits		1
	No benefit to shorter shower	1

As can be seen in the tables above, the idea of reducing shower time to four minutes was met with strong resistance by the focus group participants. It was evident by both the responses and the general tone from the group that showers were a personal luxury that was above compromise. Many of the focus group participants contributed this feeling to the water taking too long to get hot, difficulty moving quickly enough to be out within four minutes and the feeling that the shower was a luxurious experience. This response strongly contradicts the

initially survey responses. This phenomenon is discussed further in the findings section of this chapter.

The overall comparison of reported barriers (42) to benefits (7) clearly shows that the focus group participants did not feel the behavior was as likely to be performed as was reported in the survey phase of the research. The following are excerpts from the focus group supporting the discomfort with shortening showers:

- *"Four minutes, that's barely getting the water hot because it takes a while for our water to heat."*
- *"And I don't shower every day, I mean, because I don't sweat. But, you know, when I shower I want, I want it to be a spa for me."*
- *"I know it uses more water but that is my treat to myself."*

The following tables summarize the focus group participant's responses when discussing the behavior of opening windows to allow for free cooling during warmer months.

Table 13: Barriers to Opening Windows

Barrier	***Second Tier***	***Occurrences***
Lack of Motivation		1
	Ok with paying for AC	1
Lack of Knowledge		0
		0
Structural Barriers (external)		7
	Difficulty opening windows	7
Inconvenience		7
	Difficulty opening windows	3
	Environmental discomfort	4
Physical Barriers		6
	Difficulty opening windows	2
	Lack of security	4

Easy: No Barrier		0
		0

Table 14: Benefits to Opening Windows

Benefit	***Second Tier***	***Occurrences***
Save Money		5
	Utility cost reduction	5
Habit		0
		0
Generally good thing to do		3
	Energy reduction is right thing to do	3
Health		4
	Benefit of fresh air	4
Comfort		11
	Air movement	5
	Benefit of fresh air	3
	Natural air	3
No benefits		0
		0

Focus group results suggest that behavior of opening the windows for free cooling is more popular behavior amongst participants. The total reported benefits (23) outnumbered the total reported barriers (21) by two; this behavior was the only case in the focus group where reported benefits outweighed barriers. This finding suggests that a behavior change campaign might succeed if focused on the opening windows behavior. During this behavior's discussion, both focus group's excitement level increased and the discussion became very positive when this behavior was being discussed. In general, the participants were not only excited about opening windows, but also interested in screen doors for use while they were at home. The most disruptive barrier found through the focus group was the difficulty experienced while trying to open and close the windows. Almost all participants expressed some frustration or difficulty with opening or closing with the windows which deterred them from opening or closing them

regularly, which could be attributed to the age of the participants. Further discussion can be found in the closing of this chapter.

The results of the reported benefits and perceived barriers of the focus group make this behavior a strong candidate to pursue for actual behavior change. The following responses from the participants illustrate their support for this behavior.

- *"I mean, you can turn off the air conditioning of course. I mean, that's key."*
- *"I like to have my windows open in the spring and the fall when it's not hot enough to turn on the air conditioning and the heat and it's just the fresh air."*
- *"It would be great if all of the apartments had screen doors."*

The following tables summarize the focus group participant's responses when discussing the behavior of using cold water for laundry instead of hot water.

Table 15: Barriers to Using Cold Water for Laundry

Barrier	***Second Tier***	***Occurrences***
Lack of Motivation		2
	Water is paid for by owner	2
Lack of Knowledge		1
	Product skepticism	1
Structural Barriers (external)		0
		0
Inconvenience		4
	Does not clean well enough	3
	Water temperature is never hot	1
Physical Barriers		0
		0
Easy: No barrier		4
	No problem with using cold	4

Table 16: Benefits to Using Cold Water for Laundry

Benefit	*Second Tier*	*Occurrences*
Save Money		3
	Improves clothing durability	1
	Save on utility bill	2
Habit		3
	already use cold water mostly	3
Generally good thing to do		1
	Reduce clothes shrinking	1
Health		0
		0
Comfort		0
		0
No benefits		0
		0

This behavior proved to be the least energizing to the participants of the five presented behaviors. Many of the participants reported that washing their clothes with cold water was something that they already did, at least some of the time. The breakdown of reported barriers to reported benefits was 11 to 7; however, 4 of the reported barriers fell under the category of Easy: No barrier. The most reported barrier was the inconvenience of washing clothes and they would not be clean, requiring another cycle.

The following tables summarize the focus group participant's responses when discussing the behavior of hanging their clothes to dry instead of using a dryer.

Table 17: Barriers to Hanging Clothes to Dry

Barrier	*Second Tier*	*Occurrences*
Lack of Motivation		0
		0
Lack of Knowledge		0
		0
Structural Barriers (external)		9
	Hanging clothes not allowed	6
	Negative connotation with hanging clothes	3

Inconvenience		2
	Difficulty hauling wet clothes	2
Physical Barriers		0
		0
Easy: No barrier		0
		0

Table 18: Benefits to Hanging Clothes to Dry

Benefit	***Second Tier***	***Occurrences***
Save Money		2
	Reduce dryer costs	2
Habit		0
		0
Generally good thing to do		5
	Clothes last longer	5
Health		0
		0
Comfort		1
	Fresh scent	1
No benefits		0
		0

Similar to the opening windows discussion, the participant's energy level rose when hanging clothes to dry was discussed. Many participants said they would like to hang their clothes to dry but that it was not allowed on the premises. Some participants reported that the reason clotheslines were not permitted onsite was to keep the complex from looking like tenement housing. Alternatives to outside clotheslines were discussed including hanging clothes on balcony bannisters and hanging clothing inside on clothes racks.

Overall, the group was interested in the possibility hanging their clothes to dry which was evident by the number of benefits (8) approaching the number of barriers (11). The majority of

the reported barriers were attributed to structural barriers that were outside of the resident's control.

The following responses from the residents show the desire to hang clothes and also the structural barrier of the housing authority not allowing clothes to be hung.

- *Speaker 3: And even if you had those pulley things, then it begins to look like a tenement. Speaker 2: Yeah, I think that's why they don't allow it.*
- *"I don't think they want to see a lot of clothes hanging outside."*
- *"I wish we could [hang clothes], because you know what, my mom does that and, um, it dries, she does it year round, and in the summertime it dries, like, within a half an hour."*

The following tables summarize the focus group participant's responses when discussing the behavior of replacing existing incandescent bulbs with CFLs.

Table 19: Barriers to Using CFL Bulbs

Barrier	***Second Tier***	***Occurrences***
Lack of Motivation		0
		0
Lack of Knowledge		4
	Product skepticism	4
Structural Barriers (external)		2
	Initial cost barrier	2
Inconvenience		3
	Wait for lights to power on	3
Physical Barriers		1
	Sensitive eyes	1
Easy: No barrier		0
		0

Table 20: Benefits to Using CFL Bulbs

Benefit	*Second Tier*	*Occurrences*
Save Money		3
	Reduce utility costs	3
Habit		0
		0
Generally good thing to do		2
	Energy efficient	2
Health		0
		0
Comfort		0
		0
No benefits		0
		0

This behavior was discussed last in both focus groups, which may have contributed to the low amount of reported barriers and benefits. The participants had all heard of the CFL bulb technology and a couple of residents had reported substituting their existing bulbs with the more efficient CFL bulbs. Those who have used the bulbs were somewhat happy with the results, reporting a monthly savings after changing out the bulbs. Although there was some support, some of the participants raised criticism regarding the lighting quality.

The summary table below shows each behavior and the one or two highest ranking barriers and benefits reported for that behavior during the focus groups. This table can be used as a starting point for behavior change strategy development.

Table 21: Behavior summary table

Behaviors	*Benefits*	*Barriers*
4 Minute Shower	Generally good thing to do	Inconvenience
		Physical Barriers (internal)
Opening Windows	Comfort	Structural Barriers (external)
		Inconvenience

Laundry in Cold Water	Save Money Habit Generally good thing to do	Inconvenience No Barrier Structural Barriers (external)
Hanging Clothes		
CFL Bulbs	Save Money	Lack of Knowledge

The next step within the CBSM process is to develop behavior change strategies that reduce the barriers and accentuate the benefits associated with the various behaviors. The full development of behavior change strategies is outside the scope of this project; however, in summarizing the findings, a discussion about what to do with these findings is necessary.

In beginning to develop the behavior change strategies, the researcher must first assess which of the behaviors from the focus group present the best opportunity for a behavior change strategy. This decision is dependent on the resources available to the researcher, the experience of the researcher and the amount of time available for strategy development and deployment. Based on the focus group participant's reaction to decreasing their shower time, it is unlikely that a successful behavior change strategy could be developed for this behavior. Alternatively, there was enthusiasm and a good benefit to barrier ratio for the opening windows behavior and the hanging clothes to dry behavior, which would likely make them favorable behaviors to target.

Once the behaviors have been selected, the next step is to analyze the benefits and barriers from the focus group and identify means of either eliminating the barriers or accentuating the benefits, or both.

Focus Group Discussion

The focus groups provided data that revealed many valuable insights into the current habits, and attitudes of the housing complex residents in regards to the behaviors in question. In addition to positive outcomes, the focus groups also provided lessons learned.

The first observation is the total number of barriers overwhelmingly outweighed the number of reported benefits. The 95 instances of barriers nearly double the 52 instances of reported benefits. Some of this imbalance may likely be attributed to the residents being renters as opposed to owners, which would remove many of the structural barriers. It should not be assumed that the residents were dissatisfied with the housing complex or their situation, as it was evident in the focus group that the barriers were behavior specific.

Another observation that was apparent in both focus groups was answer fatigue from the participants. Each focus group lasted an hour and a half and both followed the same script with the shower time behavior coming first and the use of CFL bulbs coming last. Overall, nearly 65% of the participant responses were addressed to the first two behaviors, which only make up 40% of the total discussed behaviors. The total responses to the reducing shower length behavior, 51, was over three times the amount of response received regarding using CFL bulbs, 15. Although the shower time discussion was more energized because of the topic, an equally energizing discussion was had regarding the hanging clothes to dry behavior which only garnered 19 responses.

To confirm whether or not this is actually answer fatigue, other focus groups should be conducted with the behavior order in the script reversed. If the response totals trail off for the final two behaviors, it might confirm fatigue. Additionally, the original plan was to only take

three behaviors into the focus group phase, which would have left less room for answer fatigue. The lesson learned is to shuffle the order of the behavioral questions from the focus group to focus group in order to avoid errant data due to participant fatigue.

An important component of any focus group analysis is the non-verbal cues offered by the participants. One nonverbal cue that was present in both focus groups was the energy and passion some behaviors evoked compared to other behaviors. Some of the reactions to behaviors were positive which shows a likelihood and desire to engage in these behaviors. The two behaviors yielding positive emotional reactions was opening the windows for cool air and hanging clothes to dry instead of using the dryer. It is likely that the behavior change campaigns for these two behaviors might have success within similar populations.

Alternatively, the behavior yielding a unanimous negative nonverbal response was shortening the length of shower to four minutes. Many of the nonverbal responses including laughing at the thought of a four minute shower, nodding their heads in disagreement and looking to each other for confirmation in their negative feelings. The nonverbal cues, along with the high number of reported barriers, indicate that regardless of the implemented behavior change strategies, the likelihood of success will be low due to the existing negative feelings.

Because the focus group participants were similar in age and gender, many of the responses may have reflected a similar viewpoint. For example, many participants expressed difficulty getting in and out of the shower which would make it difficult for them to shower in four minutes or less. This would likely be less of an issue for younger people, who have less trouble navigating the shower. A similar barrier that was often expressed was the difficulty of

opening and closing the windows. While it is likely true that the windows are difficult to open, it may also be true that the windows would be less difficult for a younger person to open.

A final insight provided by the focus group data is the comparison of the highest reported barriers and benefits. See the table below for a breakdown of each barrier and benefit by each coding section.

Table 22: Overall Barrier and Benefit Summary

Barriers	95
Lack of Motivation	5
Lack of Knowledge	14
Structural Barriers (external)	21
Inconvenience	32
Physical Barriers (internal)	19
No Barrier	4
Benefits	52
Save Money	16
Habit	3
Generally good thing to do	16
Health	4
Comfort	12
No benefits	1

As can be seen in the table, the total number of barriers nearly doubles the total number of reported benefits. This initially reveals a generally negative disposition toward the selected behaviors, however if the shower length reduction behavior is removed, the total number of reported barriers is reduced to 53 while the total number of reported benefits is only reduced to 43.

The most common reported barrier across the behaviors was inconvenience. Again, if you remove the shower reduction behavior results from the analysis, the leading overall barrier is

cut in half and moves into second behind structural barriers with 18 instances. This is significant and adds information to be considered when deciding which behaviors to focus on in the behavior change campaign.

The most common reported benefit across the behaviors was a tie between saving money and the behavior being a generally good thing to do. While this is true, the benefit of comfort was almost only reported for the behavior of opening the windows. This is in large part due to the participants reveling in the ability to allow fresh air into their homes.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

One goal of this research project was to identify the most appropriate behaviors to target in an affordable housing community to reduce the household energy consumption of the residents. The second goal was to identify the perceived barriers and benefits the residents held towards these targeted behaviors. The final goal was to reflect on the implementation of CBSM in an affordable housing setting and identify areas of importance for future researchers.

Goal 1: Targeting Behaviors

The goal of Phase 1 was to identify energy consuming behaviors that would be best to target based on the energy consumption characteristics of the housing residents. To begin, a list of 236 potential household behaviors was reduced to 36 behaviors based on the ability of tenants of rental housing to complete the behavior. This was the first observation from the research: when focusing the behavior change campaign on tenants of rental housing (affordable or market rate), the number of potential energy reducing behaviors is greatly reduced. The behaviors were then put into a survey that the researcher administered in person by going door to door. Each resident was asked their willingness to engage in a behavior and their current engagement with that behavior. The results of this survey, along with the determined energy reduction impact of the behavior were used to identify which behaviors had the greatest potential to reduce energy consumption. This is a unique component of the CBSM approach that allows for atypical behaviors to be evaluated quickly and with low to no cost. In the case of this research, the top five behaviors included typical behaviors such as using CFLs in place of incandescent and using cold water for washing clothes but also included atypical behaviors such as hanging clothes to dry.

The goal of phase 1 was to determine which behaviors were the most appropriate to target for the focus groups of phase 2. These behaviors were then carried on to the next step of the CBSM process.

Goal 2: Uncovering Barriers and Benefits

The goal of uncovering the resident's perceived barriers and benefits of performing the targeted behaviors is part of the equation of understanding where to focus the behavior change campaign. Focus groups were held in order to gain an understanding of the resident's beliefs towards these targeted behaviors. Once the focus groups were held and the data analyzed, a behavior change campaign could be held to accentuate the benefits while alleviating the barriers.

The focus group revealed that the barriers and benefits for each behavior varied greatly on the behavior, the person speaking and knowledge of the behavior's impact. The results of the focus group plainly identified the barriers and benefits the residents contributed to the various behaviors.

Goal 3: CBSM Implementation

An overarching goal of the research project was to implement the first two phases of community based social marketing framework in an affordable housing setting. The reason this was of interest was that while CBSM has been implemented in the residential section, the researcher had not seen any studies using the CBSM process to develop a behavior change campaign in the affordable housing sector. This sub-group within the residential population typically has a different set of circumstances that influence their decisions. Because CBSM uses a pragmatic approach, valuable information can be derived and then tested through repetition of the process.

This research project focused on the first two steps of the CBSM framework, setting up the project for strategy development. The implementation of the first two steps provided many insights regarding the difficulties and strengths of implementing CBSM. Specifically, five behaviors were identified as the behaviors with the most potential success to reduce energy consumption. The following shows the five selected behaviors, their predicted success and their percentage of the top behavior's success.

Table 23: Summary of Top Five Behaviors

Behavior	Total Success Predictor	% of Top Behavior
Reducing the length of time spent taking a shower (to 4 minutes).	16237.88	1.00
In summer, opening windows at night and shutting during the day to reduce cooling loads.	13818.60	0.85
Hanging clothes to dry instead of using a dryer.	11768.17	0.72
Replacing incandescent bulbs with fluorescents.	11113.37	0.68
Washing clothes in cold water rather than hot or warm water.	10697.14	0.66

For each of those five behaviors, the perceived barriers and benefits for each were uncovered during the focus groups. Based on the focus groups, it is recommended that three of the five targeted behaviors should be the focus of any future behavior change initiative. These three behaviors are:

- Opening windows for free cooling during the evenings of warm months: The responses toward this behavior were generally positive during the focus groups as

most participants reported enjoying the fresh air and reduced energy bills. The key barrier was the difficulty of opening and closing windows which can be addressed.

- Hanging clothes to dry instead of using dryer: The housing authority does not permit hanging clothes in the courtyard of on the balconies but residents expressed interest and willingness to hang clothes within their own apartment.

- Replace incandescent bulbs with CFLs: The main barrier for this behavior was product skepticism and dissatisfaction with the lighting quality. Providing information on CFLs and perhaps a sample bulb could be a good approach to encouraging this behavior.

Ultimately, CBSM provided a positive framework for setting the foundation for a behavior change campaign. The largest difficulties experienced throughout the research were the door –to-door survey, calculating energy impact of behaviors and the lackluster attendance for the focus groups.

The survey posed a problem initially when it was decided that to allow all participants an equal chance to complete the survey, it must be administered door-to-door because some residents did not have the internet. This is likely a common circumstance when focusing on housing that the researcher should consider when planning the research project. In addition to the administration effort, it was found that the survey instrument was not easily understood by the residents. Many times the researcher was asked to explain what the questions were asking and how to respond. This was likely a combination of the survey wording and the foreign subject matter for some of the residents. Because the survey was given door-to-door, the

researcher was present and able to clear up any misunderstandings; however, this could have impacted the answers of the residents so as not to disappoint the researcher.

The issues encountered during the survey phase could be addressed by simplifying the survey for clarity and identifying a centralized location for survey administration to eliminate door-to-door travel. An alternative that could work well is dropping off the survey with the residents and allowing them to return the survey once completed. In this scenario, it would be very important that the survey was clear and reliable and that the residents could be relied on to complete and return the survey. Prior to future research, it is recommended to pilot the survey and receive feedback before administering the survey to the target audience.

Next Steps & Conclusion

This research project set forth to create the foundation needed to develop behavior change strategies to reduce household energy consumption by the target audience. The behaviors have been evaluated for their ability to produce the greatest effect in the community and then the selected behaviors were further analyzed to get a better understanding of how they are perceived by the target audience.

The next steps for this research are to take the developed foundation and use it to create behavior change strategies, implement these strategies and test their effectiveness. These are the next steps in the CBSM framework.

Another continuation of this research is to repeat this process in another affordable housing community and compare the results. The lessons learned from this research could improve the outcomes and fluidity of future research. Additionally, the findings of this research

could be compared to similar research with a changed independent variable such as residents who pay for their utilities.

In conclusion, the initial research questions were addressed in the findings. Below is a summary of how these questions were addressed.

- What behaviors are targeted as a result of step 1 from the CBSM process and do these differ from other behavior change campaign's target behaviors? The following five behaviors were targeted as a result of step 1 based on their potential for energy reduction: Reducing the length of time spent taking a shower, In summer, opening windows at night and shutting during the day to reduce cooling loads, Hanging clothes to dry instead of using a dryer, replacing incandescent bulbs with fluorescents, washing clothes in cold water rather than hot or warm water. These behaviors differed greatly from other behavior change campaigns largely because of the residents were in a rental situation and the limitations that situation brings regarding which behaviors can be targeted. Although step 1 identified the behaviors with the best expected energy use reduction, the focus group gave a better insight into the attitudes of the residents toward some of the behaviors. The main takeaway was that while the survey is a good tool to identify and qualify behaviors based on research, it is best to carry a couple extra behaviors into the focus group sessions should contrary responses be found in the focus groups.

- What perceived barriers and benefits exist to fostering positive changes in energy conservation behaviors in an affordable housing environment? The answer to this question is discussed in detail in the focus group section of chapter 4. In short, the three most frequently identified barriers by residents were Inconvenience, Structural Barriers

(such as housing authority rules) and Physical Barriers (physical difficulty performing a behavior). The three most frequently reported benefits reported by the respondents were Save Money, Generally Good Thing To Do and Comfort. It is important to note that the prevalence of barriers and benefits fluctuates depending on the behavior.

- Do the perceived benefits and barriers identified during the focus groups align with other perceived benefits and barriers found in current research? Unfortunately, it was difficult to find existing research focused on the barriers and benefits or energy reduction behaviors in a resident setting. One group of researchers studied barriers to energy reduction in a dormitory in Canada. Similar barriers did arise in the dormitory research including structural barriers and discomfort (Stokes, Matto, Savan, & Kolenda, 2012). Although the barriers to behavior were not necessarily unique in the affordable housing research, the targeted behaviors themselves were not typically pursued behaviors. For example, in the dormitory research, many of the behaviors focused on turning off electronics and lighting. This research found that the residents were doing this already in large part and therefore the behavior was deemed not optimal. This is true when this research is compared to other studies as well.

  A beneficial result of this research is that the identified benefits and barriers to behaviors can be added to the existing research and serve as a repository for future behavior change campaigns. Developing a database of behaviors and their benefits and barriers that have been identified through research will allow for more robust research and can save time for future behavior change initiatives.

- What components of the CBSM process can be altered to better suit behavior change projects in the affordable housing community? As mentioned earlier, some of the key areas of focus for utilizing the CBSM approach in an affordable housing setting include attention to the types of behaviors targeted, adjusting the survey for door-to-door administration, carrying 4-5 behaviors into the focus groups if time permits as the survey results could be misleading, and following the focus group with intercept surveys should the focus group participation be sub-optimal. This final point is probably the most important; in fact, it is likely best for the researcher to forego the focus group and move directly to the intercept survey step. The case for this is that in an affordable housing setting, most of your target audience is within a close proximity to the researcher on site and would like yield better participation results. Many of the residents appeared to be pressed for time and did not have the ability to commit 1-1.5 hours talking about energy use. One potential negative of foregoing the focus group is losing the ability to fine tune the behavior selection as mentioned above.

Closing

The research project focused on implementing the first two steps of the CBSM framework in an affordable housing population to better understand what, if any, alterations or tweaks will be necessary to the CBSM framework for optimal application. Also, the identified behaviors and the perceived benefits and barriers associated with those behaviors were sought as these will add to the existing research as well as broaden the targeted behaviors beyond more typical targeted behaviors.

Overall, the research project was successful as phases 1 and 2 were completed and many valuable data were collected. Equally as valuable were the lessons learned regarding the

implementation of CBSM and the recommendations for proactively addressing these issues prior to beginning a behavior change initiative.

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APPENDIX A – LIST OF EXAMINED BEHAVIORS

Hot Water

7. Reducing shower duration to four minutes
8. Purchasing and installing low flow showerheads
9. Purchasing and installing low flow aerators for bathroom sinks
10. Washing clothes in cold water instead of hot or warm water
11. Reducing the temperature setpoint on the water heater to 120°F.
12. Purchasing and installing insulation for the water heater.

Kitchen Appliances

3. Only use dishwasher when full
4. Only use run dishwasher in economy more (energy saving mode)

Entertainment Equipment

3. Using powerstrips to turn off groups of electronics when not in use
4. Turn off all electronics overnight.

Laundry

3. Only wash clothes when the machine is full.
4. Hang clothes to dry instead of using dryer.

Heating and Cooling

6. Purchase and install thermal grade curtains to maintain desired ambient temperature.
7. In summer, open windows at night and close during the day to capture cool night air.
8. Reduce heat setpoint by 10 degrees when away from home and sleeping.
9. Increase the cooling setpoint when leaving the home.
10. Use fans as the primary cooling source in place of air conditioner.

Lighting

4. Use natural light instead of electric lighting during the day.
5. Turning off lights when not being used.
6. Purchasing and replacing incandescent bulbs with fluorescent bulbs.

APPENDIX B – SURVEY INSTRUMENT

Behavior Identification Survey

Hello! My name is XXXX and I am a student at Colorado State University. Your building manager mentioned that I would be coming to ask if you would participate in my energy use research. We hope to share our findings with building managers and tenants in order to reduce energy use within the building. I have a 5 minute survey regarding your energy use – I won't ask for your name and your apartment won't be recorded. Would you be interested in taking the survey?

Thank you in advance for your willingness to participate in this research. Any questions about this project can be directed to either:

XXX XXX

If you have any questions about your rights as a volunteer in this research, contact XXXX at XXXX.

Please record an answer for all behaviors found in the lists below.

1. How often do you perform the following behaviors in your household? Please select one answer per behavior.

Behaviors	**Never (0%)**	**Not Often (25%)**	**Sometimes (50%)**	**Often (75%)**	**Always (100%)**
Reduce the length of time spent taking a shower from current length to four minutes.					
Purchase and install water efficient showerhead.					
Install water efficient showerhead if showerhead is provided.					
Wash clothes in cold water rather than hot or warm water.					
Reduce the temperature of the water					

heater to 120 degrees Fahrenheit.					
Purchase and install a thermal blanket insulation on your water heater.					
Install thermal blanket insulation on water heater.					
Only use the dishwasher when dishwasher is full to capacity.					
Use the economy settings on the dishwasher for all wash cycles.					
Purchase power strip and plug electronics (TV, phone charger, etc.) into a power strip and turn off power strip when electronics are not in use.					
Plug electronics into a power strip and turn off power strip when electronics are not in use.					
Only wash clothes when washing machine is full.					
Hang clothes to dry instead of using dryer.					
Close curtains on the sunny side of the home in the summer to block the sun.					
Close curtains in the winter to minimize heat escaping to outside.					
In summer, open windows at night and shut windows during day to capture cool night air.					
Reduce heater temperature by 10 degrees while sleeping during the winter months.					
Turn air conditioner or heater off when leaving the house.					

Use electric blankets when sleeping and turning off heater at night.					
Use natural lighting (from windows) rather than electric lighting during the day.					
Turning lights off when not in use.					
Purchase and replace all incandescent light bulbs with fluorescent light bulbs.					

2. How likely are you to perform the following behaviors in your household? Please select one answer below.

Behaviors	**Not likely at all (0%)**	**Not likely (25%)**	**Somewhat likely (50%)**	**Likely (75%)**	**Very likely (100%)**
Reduce the length of time spent taking a shower from current length to four minutes.					
Purchase and install water efficient showerhead.					
Install water efficient showerhead if showerhead is provided.					
Wash clothes in cold water rather than hot or warm water.					
Reduce the temperature of the water heater to 120 degrees Fahrenheit.					
Purchase and install a thermal blanket insulation on your water heater.					
Install thermal blanket insulation on water heater.					
Only use the dishwasher when dishwasher is full to capacity.					
Use the economy settings on the dishwasher for all wash cycles.					
Purchase power strip and plug electronics (TV, phone charger, etc.) into a power strip and turn off power strip when electronics are not in use.					
Plug electronics into a power strip and turn off power strip when electronics are					

not in use.					
Only wash clothes when washing machine is full.					
Hang clothes to dry instead of using dryer.					
Close curtains on the sunny side of the home in the summer to block the sun.					
Close curtains in the winter to minimize heat escaping to outside.					
In summer, open windows at night and shut windows during day to capture cool night air.					
Reduce heater temperature by 10 degrees while sleeping during the winter months.					
Turn air conditioner or heater off when leaving the house.					
Use electric blankets when sleeping and turning off heater at night.					
Use natural lighting (from windows) rather than electric lighting during the day.					
Turning lights off when not in use.					
Purchase and replace all incandescent light bulbs with fluorescent light bulbs.					

APPENDIX C – COMPLETE SUMMARY OF BEHAVIORS AND POTENTIAL IMPACT

Rank	*Behavior*	*Impact*	*Willingness*	*Current Use*	*Total*
1	Reducing the length of time spent taking a shower (4minutes).	3375.00	2.93	1.64	16237.88
2	In summer, opening windows at night and shutting during the day to reduce cooling loads.	2149.56	4.29	1.50	13818.60
3	Hanging clothes to dry instead of using a dryer.	2410.20	2.36	2.07	11768.17
4	Replacing incandescent bulbs with fluorescents.	3582.60	2.71	1.14	11113.37
5	Washing clothes in cold water rather than hot or warm water.	2080.00	3.43	1.50	10697.14
6	The installation of water efficient showerheads.	2025.00	3.93	1.14	9091.84
7	Reduce heating temperature when sleeping and leaving the home by 10 degrees.	3500.00	1.86	1.36	8821.43
8	Plugging electronics into a power strip and turning off when not in use by switching off the power strip.	1706.00	3.36	1.43	8181.84
9	Avoiding the use of AC and using fans.	3582.60	3.43	0.57	7018.97
10	Turn off air conditioner when leaving the house.	2364.52	2.71	1.00	6417.97
11	Reducing the set point for the hot water heater to 120 degrees F.	1200.00	2.64	1.86	5889.80
12	Switching lights off when not in use.	1074.78	3.57	1.36	5209.39
13	Insulating the hot water heater with a thermal blanket.	1050.00	1.64	2.79	4805.36
14	Using the economy settings on the dishwasher.	1405.25	4.29	0.79	4731.96

15	Installing and using curtains to provide a thermal layer between the window and the room.	1264.96	2.36	0.64	1916.80
16	Turning off computers overnight.	972.42	2.71	1.43	3770.61
17	Use natural light rather than electric lighting during the day.	2149.56	3.93	0.43	3619.16
18	Only washing clothes when machine is full.	572.00	2.79	1.64	2617.78
19	The installation of low-flow aerators to reduce hot water usage.	1500.00	4.71	0.36	2525.51
20	Only use the dishwasher when full.	602.25	2.43	1.21	1776.02