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Designing and Implementing a Peer-to-Peer Led Behavioral and Energy Reduction Program for Low-Income Neighborhoods

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Abstract

Reduction in energy consumption from fossil fuels is a necessary step toward combating climate change as more and more studies are revealing the catastrophic outcomes if the current trends do not change. Residential programs generally managed by energy utilities promoting energy cost savings and reduced consumption are being enacted to decrease the greenhouse emissions. However, thus far, little to no measures have been taken to extend the reach of such programs to low-income communities. Reducing household energy consumption would be particularly beneficial for these communities as it would lower utility bills for low-income households who spend a substantially greater portion of their annual income on energy bills compared to typical households. While installation of energy efficient appliances and envelope modifications dominate the emphasis of these programs, there is substantial room for energy savings through behavior modification. This research seeks to determine the most effective techniques for promoting and realizing energy reduction behaviors in low-income communities based upon peer-to-peer methods. With a means to track and measure savings from behavioral modification using smart Wi-Fi thermostat and energy consumption data, preliminary results and takeaways from a pilot energy savings program for low-income communities were analyzed to evaluate effective education and intervention methods, complexities of understanding energy usage among low-income households, and factors associated with the effectiveness of the program to contribute to sustainable and resilient community development.

Dedication or Acknowledgements

I would first like to thank my advisors, Dr. Galli Robertson and Dr. Hallinan, for the continuous support, guidance, and knowledge they were able to provide. Additionally, I would like to express my sincerest gratitude to CleanEnergy4All and all the individuals who I had to privilege to collaborate with and who assisted with and contributed to my research.

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Background Research

Energy Justice

Research from the scientific community attests climate change as a paramount concern in the contemporary world and has identified humankind as a primary catalyst of the rising risks. According to the Intergovernmental Panel on Climate Change (2018), global temperatures have risen approximately 1ºC from human activity since preindustrial times (para. A.1). Modern society remains dependent on the production and consumption of substantial amounts of energy, and the energy sector plays a vital role in everyday life for a large share of the global population as well as in the economy. However, the result of this dependence is the emission of greenhouse gases, and the residential sector is responsible for a significant portion of the total energy consumed. Of the 5,130 million metric tons of carbon dioxide emitted by the United States in 2019, nearly 20% was from the residential sector (Energy Information Administration [EIA], 2020). These carbon dioxide emissions detrimentally impact the environment on a global scale. While the impacts from carbon emissions is spatially uncontrollable, they are unequally distributed such that vulnerable populations are the most acutely affected. Thus, the production, distribution, and consumption of energy is both a concern for environmental and social justice.

Energy justice looks at the energy sector from a social justice perspective to expand the scope of energy beyond the economics and societal benefits. It analyzes and reveals the significant human costs of energy and the injustices that have resulted from the increased demand and reliance on energy. The principle of energy justice has

numerous definitions, but generally, the principle stems from the theories of distributive, procedural, and recognition justice (Jenkins, 2016). According to Sovacool and Dworkin (2015), energy justice is defined as the following:

> The right of all to access energy services, regardless of whether they are citizens of more or less greatly developed economies. It encompasses how negative environmental and social impacts related to energy are distributed across space and time, including human rights abuses and the access that disenfranchised communities do or should have to remedies. (p. 441)

In regards to energy justice, there are two prominent ways in which distributive justice applies: (1) the spatial and temporal location of energy infrastructure and access to energy and (2) the benefits and the costs that accompany the production, distribution, and consumption of energy. The procedural component of energy justice concerns energy policy and decision-making processes that are just and transparent such that individuals have equal input and are equally represented and considered. Energy justice also includes recognition justice, which is the theory that emphasizes the necessity of properly identifying all forms of injustice within the energy sector and, therefore, is essential for achieving procedural justice.

Injustices exist in a variety of ways in the energy sector. Energy insecurity and energy burdens are two types of energy injustice that acknowledge that energy should be considered a basic human right. Energy insecurity refers to energy as an unstable and unreliable resource for vulnerable populations that are physically and/or financially disadvantaged. According to the U.S. Energy Information Administration's Residential Energy Consumption 2015 Survey (EIA, 2018, Table HC11.1 Household Energy

Insecurity), out of a total of 118.2 million U.S. households, 37 million were energy insecure, 25.3 million reduced or forewent food or medicine to pay utility bills, 12.8 million lived in unhealthy temperatures, and 17.2 million received disconnect or delivery stop notices.

Similar to energy insecurity is energy burden. The distinction between the two is that energy burden pertains exclusively to financial inequality in energy whereas energy insecurity pertains to financial, physical, and other inequalities and disadvantages. Specifically, energy burden is the percentage of a household's gross annual income spent on utility bills. This is a social injustice because underprivileged populations endure disproportionately high energy burdens. In the U.S., 25.8 million low income households experience an average energy burden of approximately 8.1%, over 3.5 times greater than that of non-low-income households, whose energy burden is approximately 2.3% (Drehobl et al., 2020). Furthermore, energy burdens are disproportionately higher for minorities and other marginalized populations. According to Drehobl et al. (2020), in comparison to 1% of non-low-income and 9% of non-Hispanic white households, 21% of black households experience severe energy burdens, which is defined as energy burdens where households spend at least three times more of their income on utility bills than the median household.

Because energy insecurity and high energy burdens most severely impact financially and racially disadvantaged populations, the energy injustice these households face is oftentimes coupled with food and housing insecurity. The aggregate of these injustices not only amplifies hardships but also contributes to and perpetuates intergenerational injustices in historically segregated and disenfranchised neighborhoods.

In many instances, low income neighborhoods consist of energy inefficient homes, and the households do not have the means and capabilities to upgrade and repair their homes to become more energy efficient. Primary barriers in improving energy efficiency include, but are not limited to, costs, available resources, time, and the challenges faced by affordable-property owners to prioritize, maintain, and repair energy-efficient upgrades (Samarripas & York, 2019, p. 2). Hence, coping with energy insecurity and high energy burdens can force households to live in uncomfortable, unsafe, stressful, and unhealthy conditions in order to pay their utility bills. This increases health risks and, ultimately, amplifies the burdens households endure. Some households also seek out alternative utility services and energy assistance programs with the goal of ameliorating energy injustices.

In the United States, there are two federally funded energy assistance programs that are intended to address these inequalities: The Low Income Home Energy Assistance Program (LIHEAP) and The Weatherization Assistance Program (WAP). LIHEAP is a program offered by the Office of Community Services through the Department of Health and Human Services that serves to help low-income households meet their energy needs. Services offered through these programs include bill payment and energy crisis assistance, energy-related home repairs, and weatherization, which is the process of making improvements and upgrades to increase a home's energy efficiency and resistance to weather changes (Office of Community Services, 2018). WAP is a program through the Department of Energy that offers eligible households weatherization improvements and upgrades to increase energy efficiency and, thus, reduce energy costs (Office of Energy Efficiency & Renewable Energy, n.d.). These programs aim to

alleviate the energy burden and aid energy insecure homes to reduce utility bills and also improve health and safety within a home.

There exists, however, a significant gap between the impact of the programs and the need of assistance. According to Bednar and Reames (2020), LIHEAP provides assistance to approximately only 25% of eligible households per year, and out of nearly 40 million eligible households, WAP has only been able to weatherize 7 million households. Barriers that prevent greater access to these programs include available funding, state level priorities, and the fact that the need for weatherization is significantly greater than the rate at which it can be implemented. With the programs' focus primarily on momentary relief, they also do not provide sustainable solutions to serve as a means of eliminating energy poverty. In addition, if residents fail to pay their utility bills, they are required to pay back the energy assistance benefits they have received. Thus, even when eligible, low-income residents are often deterred from accepting energy assistance through LIHEAP.

Energy behavior, defined as the habits, motivations, and values associated with energy consumption, is an important component of energy efficiency. However, it is often neglected and not a central focus of energy reduction initiatives. Incorporating energy behavior education and tactics into energy cost reduction programs can open the door to significant energy savings. This would be exceptionally beneficial for low-income populations who are not able to make energy efficiency upgrades and repairs and who are not able to receive sufficient assistance from pre-existing programs. Research suggests that adopting energy saving behaviors has the potential of reducing energy consumption by nearly 14% in the residential sector (Ouyang & Hokao, 2009, p. 718).

This indicates that energy behavior has the potential to advance efforts toward an energy just world through methods beyond energy efficiency and energy assistance programs alone.

Values and Motivation of Energy Consumption

Fundamental to understanding the extent to which environmentally conscious and energy saving behavior is implemented is individual values and motivations. To analyze the values and motivations associated with environmentally conscious and energy saving behavior, research was conducted to evaluate the findings of previous studies on residential energy consumption. Such research results in an exhaustive list of factors that influence values and motivations associated with energy savings behaviors. Hence, it does not provide a definitive approach to take but rather serves as a guide and basis of factors to be considered.

The intentions behind individual energy behaviors take numerous forms. Lindenberg and Steg (2007) propose behaviors and actions are driven by goals and how they are framed, referred to as goal frames. This theory postulates three goal frames: gain, normative, and hedonic. Gain goal frames are driven by protection and advancement, normative goal frames are driven by what is proper and acceptable, and hedonic goal frames are driven by the desire to feel better at a given moment. When applying these to environmentally conscious behavior, it is suggested that hedonic goal frames impact behaviors the strongest.

Intentions and goals alone, however, do not provide enough context for understanding environmentally conscious behavior. To analyze the gap between intent and action, additional factors such as education, skills, and demographics must also be

considered. A common finding in a meta-analysis conducted by Hines et al. (1987) indicated that in order for positive intention to lead to environmentally conscious behavior, cognitive knowledge and skills are essential. The most successful results were seen when individuals were not only aware of the problem and actions they could take but when they were equipped with the skills to effectively and successfully act. Furthermore, when the desire and intent to act in an environmentally conscious manner was lacking, the ability to act was more likely impacted by situational factors such as economic and social constraints. According to a study completed by Poortinga et al. (2004), "Attitudinal variables explained a mere 2% of variation in home energy use, the variation explained increased to 15% after taking into account several socio-demographic variables." This research, therefore, conveys the interconnected relationship between personal intention and desire, accessibility to knowledge and skills, and socio-demographics and the complexity of understanding and achieving environmentally conscious behaviors.

The sense of personal and social influence over environmentally conscious behaviors is a factor that must also be evaluated. In a meta-analysis completed by Hines et al. (1987), it was revealed that self-blame and internal locus of control tend to lead to and be associated with environmentally conscious behaviors. By taking personal responsibility, individuals are able to see and acknowledge that their actions are effective and impactful. In addition to internal influence, when individuals are exposed to social norms that promote such environmentally conscious behavior, their likelihood to engage in such behavior increases further, and they are more apt to modify current behaviors.

These research findings indicate the complex and dynamic nature of energy behavior that is dependent upon a multitude of factors. The aforementioned studies primarily focused on a range of demographics and are not indicative of how values and motivations may differ for low-income communities specifically. Nonetheless, these insights provide an understanding of how values and motivations are influenced internal and external factors and how they shape energy behavior.

Peer-to-Peer Education

Peer-to-peer education is a method in which a representative, educator, mentor, or coach of a specified program is of the same background and/or community as the participant. While this method has been implemented across a multitude of fields and demographics, little to no research exists for applying this method in underserved communities to modify energy behavior and decrease energy consumption.

The understanding behind the value of peer-to-peer methodology can be explained from a psychological standpoint. In a study analyzing the impact of peer teaching in medical education, psychologists suggest that the success of such teaching is linked to two factors: cognitive and social congruence (Ten Cate & Durning, 2007). The cognitive concept of learning is the process when new information is introduced to the brain and relationships and networks are established with pre-existing knowledge to adopt the new information. Thus, cognitive congruence implies that an individual is more apt to introduce information to their peer by minimizing the gap between new and pre-existing knowledge. In addition, social congruence explains that peer-to-peer is effective because peers are more vulnerable and less anxious with someone they relate to as compared to figures of authority and superiority, ultimately increasing confidence and the

ability to learn. The efficacy of peer-to-peer education has been studied in fields such as health, nutrition, and education to analyze and validate the benefits of peer-to-peer indicated by these psychological explanations.

A study completed at the University of California, San Francisco investigated the impacts of peer education and coaching among low-income patients with diabetes. Patients were recommended by clinicians to partake in training to become peer health coaches for patients with similar health backgrounds to determine if the role of a peer health coach would aid in the reduction of hemoglobin A1C (HbA1C) levels. While the retention of the peer health coaches decreased by over half from enrollment to the completion of the study, data from the training sessions revealed that 86.5% completed the training and 81.3% passed the final written and oral exams administered prior to health coaching. Among the patients who went through training, 28.1% graduated from college and 25% did not complete high school (Goldman et al., 2015, p. S38). Despite these factors, after six months of peer coaching, there was a significant reduction in HbA1C levels among patients receiving peer education support when compared to patients who did not participate (Thorn et al., 2013). This study revealed that low-income individuals with little to no advanced education can successfully complete and acquire necessary knowledge and skills to serve as peer educators who are able to significantly reduce HbA1C levels among patients.

Further, peer-to-peer research has been conducted in nutrition education in low-income communities. Developed by California's Public Health Department Nutrition Program, two programs, Head Start and Parents as Teachers, were created to increase the knowledge and improve behaviors and intentions for healthy and low-cost nutrition

among low-income parents (Marshak et al., 1998). The programs consisted of two nutrition classes offered to parents that were taught by fellow parents. To measure the effectiveness of the program and of the peer education method implemented, questionnaires were administered prior to and after the completion of the classes to gather data regarding content of the class as well as demographics. The results revealed that not only were parents overwhelmingly satisfied with the courses, but it also showed an increase in knowledge. According to the pre-class questionnaires, only 40.2% of participants were able to correctly identify low-fat foods which increased to 95.1% correct identification post-class (Marshak et al., 1998, p. 318). This program also revealed that optimal results were achieved when the peer-parent-teachers contributed to the structure of the program, which indicated an increase in commitment and personal investment. While the program did not study the long-term impact, it, nonetheless, confirmed that peer-to-peer education among low-income parents can successfully increase knowledge and intentions revolved around healthy eating.

The use of peer-to-peer education and support has also played a prominent role among a multitude of services for low-income pregnant mothers. People's Equal Action and Community Effort Incorporated (PEACE) and Early Head Start (EHS) are federally funded services that serve pregnant women and families with young children in Onondaga County, which has one of the highest infant mortality rates in the country (Canuso, 2003). In addition to home visits that the program already provided, they created Pregnancy Care Campaign (PCC). This program revolved around a variety of events where participating expecting mothers were educated and motivated to live healthier pregnancies through interactions with professional educators and peer mothers.

A primary goal of the PCC events was to allow the participating mothers to open up with other mothers in similar situations based upon the idea that "the knowledge of another person's experience helps inform one's own decision especially in making personal choices" (Canuso, 2003, p. 45). One study of the campaign followed first-year participating mothers and found that there were no low-weight births or premature infants as well as an increase in prenatal care among the mothers. Thus, this provides further confirmation on the role peer-to-peer education and mentoring can have among low-income communities and individuals.

The analysis of peer-to-peer based diabetes, nutrition, and pregnancy programs validates that behavior education and change can be achieved among low-income communities and individuals. This research examines if the same methodology can be used to realize significant energy cost savings through behavioral modifications, as there appears to be limited to no prior research investigating this application. Specifically, the present study outlines the development of a peer-to-peer energy reduction program for underserved communities, the preliminary results from a pilot program, and the knowledge gained during the pilot program, with the aim that these findings will amplify the impact of this program framework for future applications.

Program Description

Pilot Program Overview

This project focuses on the pilot program of a clean energy cooperative whose goal is to achieve energy and cost savings for low-income communities, specifically, in the Twin Towers neighborhood in East Dayton. Twin Towers is composed of members of Appalachian as well as African American and Latin American communities. Many households within the neighborhood live in financial poverty with over 50% of all households and nearly 67% of female led households living in government defined poverty and approximately 65% of the families renting their home (CleanEnergy4All, n.d.). Between 2009 and 2013, 84 rent-to-purchase homes were built to provide affordable housing as part of the Low-Income Tax Credit program, a tax credit for affordable housing directed toward low-income individuals in the United States.[1]

Among the 84 homes, similarly constructed three and four bedroom models were built for affordability with relatively high energy efficiency characteristics (East End Community Services, n.d.). The average monthly energy consumption of these homes, however, was at a comparable level of typical Midwest residences of similar size (EIA, 2018). Furthermore, there was a significant variance in energy consumption among households in the neighborhood, such that there was a fourfold difference in annual energy consumption between the lowest and highest energy consuming households. With

[1] Theoretically, the residents would be eligible to purchase their home after a 15-year time period in which tax benefits can be obtained by equity investors. Having lived there a long time, the residents would have accrued equity in the house, making purchase more feasible. However, a majority of the annual earnings of those living in the homes is less than ⅔ of the median income and much of this housing is generally transient with few residents living in the houses for more than five years. Thus, homeownership is rarely attained.

nearly identical structural and energy efficient features, it was evident that variations in energy consumption were expected to be dependent upon energy behavior.

The original goal for the clean energy cooperative was to make an initial investment and install Wi-Fi, smart Wi-Fi thermostats, and solar panels at no cost to the residents in these 84 homes. Through these investments, the intent was to reduce energy costs by an estimated 10% in the short-term and 50% in the long-term. To achieve these aims, the cooperative would use smart Wi-Fi thermostat data, building energy and geometrical characteristics, occupancy data, and energy and water consumption to generate machine learning models. These models provide continuous data for analyzing energy efficiency and identifying areas for improvement. In addition, employment opportunities were made available for community members through the role of a Peer-to-Peer (P2P) Energy Educator, who is the main source of communication with participating residents. There was also the long-term goal of creating positions for community members to be trained for energy efficiency upgrades and installations. Thus, the cooperative serves to lighten the burden of high utility bills and provide employment opportunities for the respective community.

Pilot Program Structure

The present study investigates the role of energy behavior in promoting energy savings among low-income residents through a unique approach that utilizes peer-to-peer education. Through research and analysis of previous studies, an action plan was formulated which detailed outreach to the community to invite residents to participate, hiring and training a P2P Energy Educator, managing the installation of Wi-Fi and smart Wi-Fi thermostats, delivering energy education, and distributing feedback to participants.

To educate and enact energy saving behaviors, a P2P Energy Educator was hired and trained to work with participants in the pilot program. While this role is intended to be filled by an individual from within the community, the first P2P Energy Educator was not a resident in the Twin Towers neighborhood. Nonetheless, they had shared lived-experiences and a deep understanding of the lifestyle of those they would be working with. They also had valuable experience in community development, which was a driving factor as to why they were chosen to fill this position for the pilot program. The goal was that they would use their experiences to connect with participants and establish a firm foundation for the position to be assumed by community members in the future.

Responsibilities of the P2P Energy Educator included contacting residents interested in participating, installing thermostats in homes, communicating and forging relationships with participants, and educating and collaborating with participants to achieve energy savings. In addition to the P2P Energy Educator, there was a technical undergraduate intern. This individual worked alongside the P2P Energy Educator to facilitate the installation of the smart Wi-Fi thermostats, assist with the energy education process, and be a technical resource for the households and P2P Energy Educator.

Once the program structure was developed and the P2P Energy Educator and technical intern positions were filled, the first step of implementation was to inform residents in the Twin Towers neighborhood about the program. The 84 rent-to-purchase homes were the focus of the pilot program because, as previously discussed, the homes were built with similar structural and energy efficient characteristics, yet there were significant discrepancies in annual energy consumption. Thus, there was opportunity for behavior-based energy savings among these houses. To contact residents, program flyers

were mailed to each resident with program details and a form to register. Additionally, the P2P Energy Educator and technical intern expanded their outreach by going door to door to familiarize residents with the program. Out of the 84 households, 21 initially signed up for the program, and, ultimately, 11 responded to follow-up communication and participated in the pilot program.

The P2P Energy Educator then followed-up with all participating residents to introduce themselves and begin the process of installing Wi-Fi and smart Wi-Fi thermostats in each participating home. Some households already had Wi-Fi, so these households instead received a gift card to a local grocery store. Before the P2P Energy Educator and technical intern began the energy education process, there was a period of approximately one month to collect baseline data for the purpose of comparing energy consumption before and after energy education. While baseline data was being collected, the P2P Energy Educator maintained regular communication with participants to further establish relationships and trust and to check-in and trouble-shoot any issues they experienced with their newly installed Wi-Fi and thermostats.

An Energy Walkthrough was then completed with each participating household after the baseline data collection period. In collaboration with the P2P Energy Educator, the technical intern prepared a checklist, informational handout, and energy consumption report, which were used as guides for the Energy Walkthrough. The checklist was composed of energy saving behaviors and practices categorized by room and type. It also included additional questions and points of discussion that were to be addressed during the Energy Walkthroughs. A comprehensive and condensed version of this checklist was created to serve as an informational handout for participants. To provide participants with

insight into how their energy consumption compared to those in their community, a report was generated that documented an individual home's energy consumption as well as the maximum, minimum, and average energy consumed in their neighborhood. Ultimately, the goal of the Energy Walkthrough was to begin the energy education process by introducing ways to reduce energy consumption, helping participants become aware of energy consumption patterns, and gaining an understanding of each household's specific needs and capabilities.

The Energy Walkthrough was primarily led by the P2P Energy Educator with the technical intern present to answer technical questions and be an additional resource and reference for educating participants. During each walkthrough, the P2P Energy Educator went over the energy consumption report with the participants. The checklist was utilized to discuss their current energy consumption practices, issues or concerns they had about reducing energy, and to walk through the house with the participants identifying energy reduction practices in specific rooms and for specific tasks. Lastly, an informational handout was provided to be used as a reference for the individual(s) present during the walkthrough and for any additional members of the household. These documents can be found in Appendix A.

The P2P Energy Educator followed a similar approach for each walkthrough but tailored the process as necessary to acknowledge specific needs and reactions of participants. Following the Energy Walkthrough, the technical intern documented the interactions and discussions with each participating household. A critical element of this documentation was to take note of home repairs or issues that were of concern for the

household and/or that were prohibiting a household from being able to adequately reduce their energy consumption.

Following the Energy Walkthrough, energy consumption data continued to be analyzed for the participating households. To document changes and progress and provide household's with feedback, monthly energy reports were created. These reports presented monthly household and neighborhood energy and cost savings based upon energy consumption from the same month of the previous year. The savings were then converted to metrics that would provide a better understanding of how the savings translate to everyday life. Some of these metrics included the equivalent number of phones charged, number of trees saved, gallons of gas, and number of meals based on the energy and cost savings. The energy reports also included a simple tip for additional ways residents could incorporate energy savings behaviors into their lives and homes (see Appendix A for an example energy report).

Regular feedback was incorporated into the program as a means to further establish communication and relationships with participants, build community engagement, provide additional energy education, and encourage the process of energy behavior changes, as described by the transtheoretical model of behavior change (Noar, 2017). The intent was to send energy reports to the participating households on a monthly basis. However, due to the timeline of the Energy Walkthroughs and logistical changes within the program, the energy reports were not consistently sent and discussed with participating households.

Program Status

After energy reports were sent to participating households with feedback based upon their response and energy behavior changes following the Energy Walkthroughs, the pilot program was temporarily put on pause to re-evaluate and measure progress of the program. Additionally, this time was spent adapting to the unforeseeable restrictions from the COVID-19 pandemic. This time allowed the program to be restructured and strengthened for a relaunch and more complete implementation of the program in the neighborhood. A new P2P Energy Educator was also hired during this time and completed training and preparation to work with the participating households. Currently, the energy reduction program is continuing to be implemented in the initial neighborhood. The methodology and outcomes of the pilot program are driving factors to maximize impact as the program evolves and expands and will be discussed in the following sections.

Pilot Program Assessment

This study takes a broad and interdisciplinary approach to assessing the processes and efficacy of the peer-to-peer pilot program. Assessment approaches include surveys of residents, home energy use data, collections of program notes, and interviews with program leaders.

Participant Survey

Energy saving behaviors and behavior modifications are very complex and dynamic in nature. This is evident from the psychological, physical, social, and situational challenges that numerous studies and analyses have presented. However, limited research exists that focuses on these topics solely within underserved and low-income communities. Surveys were, therefore, created and administered to participants in the pilot program. The purpose of the survey was to gain insight from participants on their current energy usage trends, initial impressions of the program, and values and motivations in regards to energy consumption. Furthermore, survey data provides information on individual needs and interests of participants. This can be used to facilitate future interactions, tailor the program to particular households, and understand nuances on the views and realities of residential energy use within the neighborhood. According to Fredericks et al. (2015), environmentally conscious behavior and the ability to modify behavior is influenced by socio-demographics, situational factors, and phycological and personal values. Thus, the survey was structured into three categories: demographics and general information, program experience, and values and motivations.

Survey Structure & Methodology

The portion of the survey evaluating the values and motivations of energy behavior was based on previous literature. These findings revealed numerous factors that are associated with and influence behavior change and environmentally conscious actions. Consequently, values and motivations must be analyzed from a holistic viewpoint that does not isolate single factors but instead examines the interconnected nature of all factors. These findings, therefore, were used as a guideline for the types of questions and topics to include in the participant survey when investigating energy behavior and the connection to personal values and motivations.

The survey was created based upon the survey structure used by Carrus et al. (2008) in a study conducted to evaluate recycling and public transportation behaviors. Because their study also analyzed environmental and behavioral actions, the questions addressed similar overarching topics but were tailored using the above findings for the purpose of this study.

Generating the survey for participants not only required research into the content of the questions but also required careful consideration for how the survey was structured. The survey included various types of questions such as rankings, agree/disagree, multiple choice, and free response. Each question was carefully analyzed to evaluate what question format to utilize, the proper language to use, and where to include the question within the survey. These considerations were taken to prevent discrepancies between participants' understanding of questions and to prevent responses from being influenced by the organization and framework of the survey. The complete survey can be found in Appendix B.

Results

Surveys were administered to participating households during the Energy Walkthrough with the P2P Energy Educator and technical intern. For completing the surveys, households were incentivized with a gift card to a local grocery store. In total, eight surveys were completed and analyzed for this study.

The survey results showed that out of the eight surveys completed, seven residents were aware of the Percentage of Income Payment Plan (PIPP) Program, an energy assistance program, two were enrolled in PIPP, and three were interested in learning more, as shown in Figure 1. Additionally, when asked to indicate current energy saving behaviors, the surveys revealed that many households were aware of and engage in energy saving behaviors in more than one way. This is revealed in Figure 2 in which lighting, heating and cooling, and washing and drying clothes all were marked by six or more households as ways they were already attempting to reduce energy consumption. Finally, Figure 3 shows that motivators for adjusting thermostats vary in importance but implies that personal and family comfort influences thermostat adjustments the greatest. To find results for all survey question responses, refer to Appendix C.

It is vital to note that due to the limited reach of the pilot program and number of responses, conclusions cannot adequately be drawn from the presented results. Rather, the responses serve as a means to further understand the implementation, development, and evolution of the program and to consider needs and characteristics of the neighborhood and households that otherwise may not have been observed.

Figure 1

Survey Responses: Energy Assistance Programs

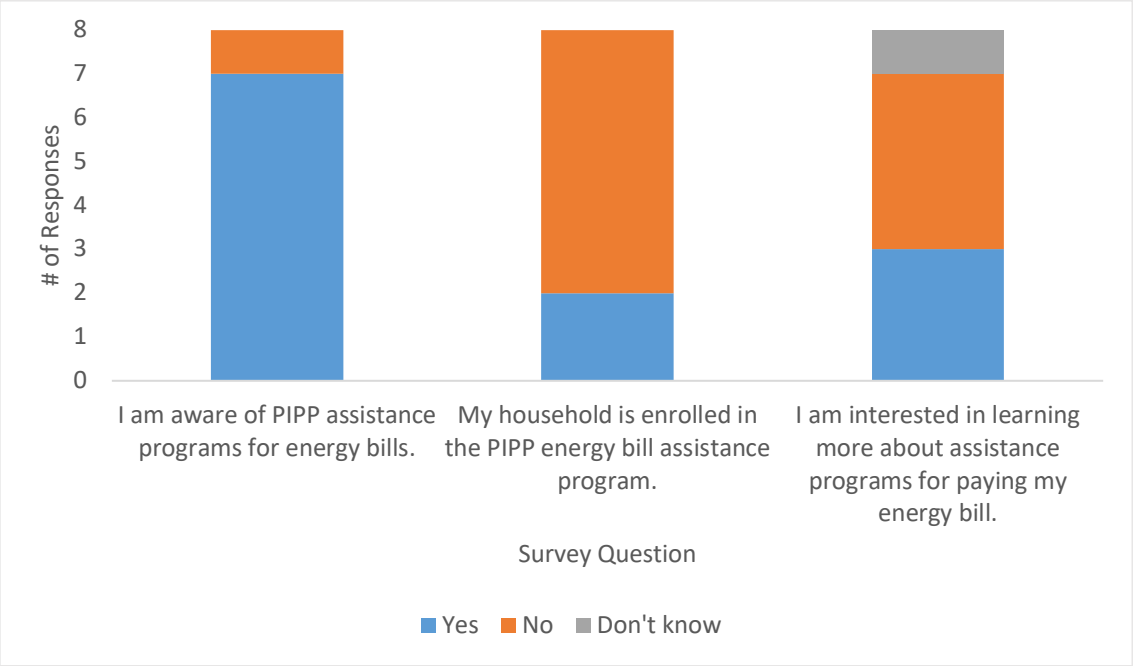


Figure 2

Participant Survey: Energy Behaviors

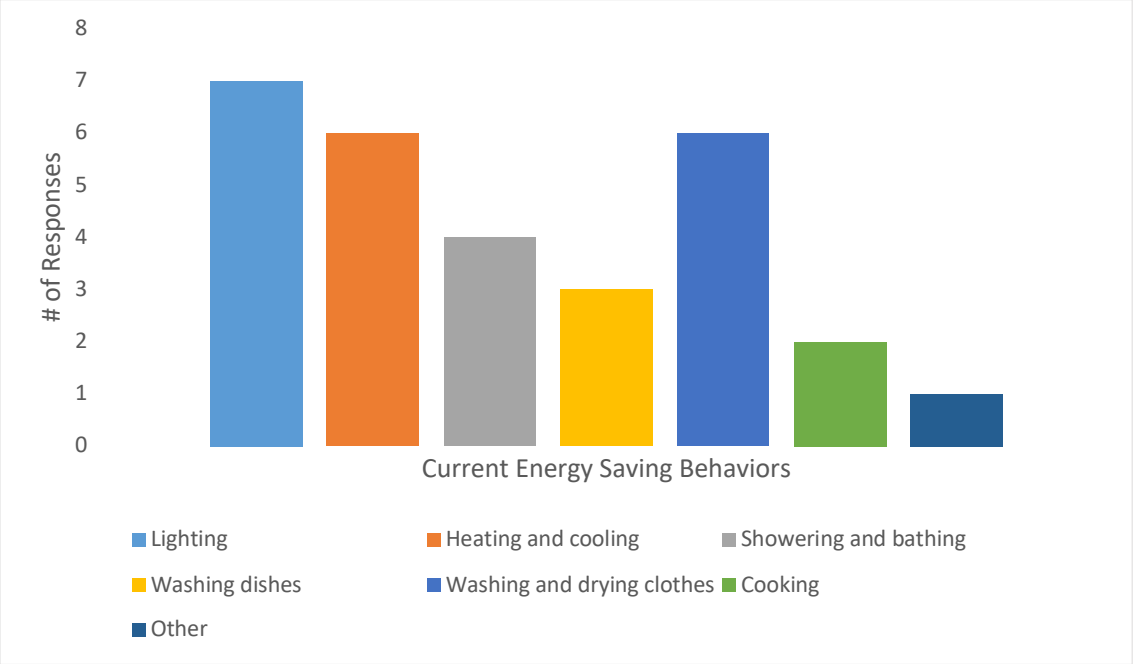
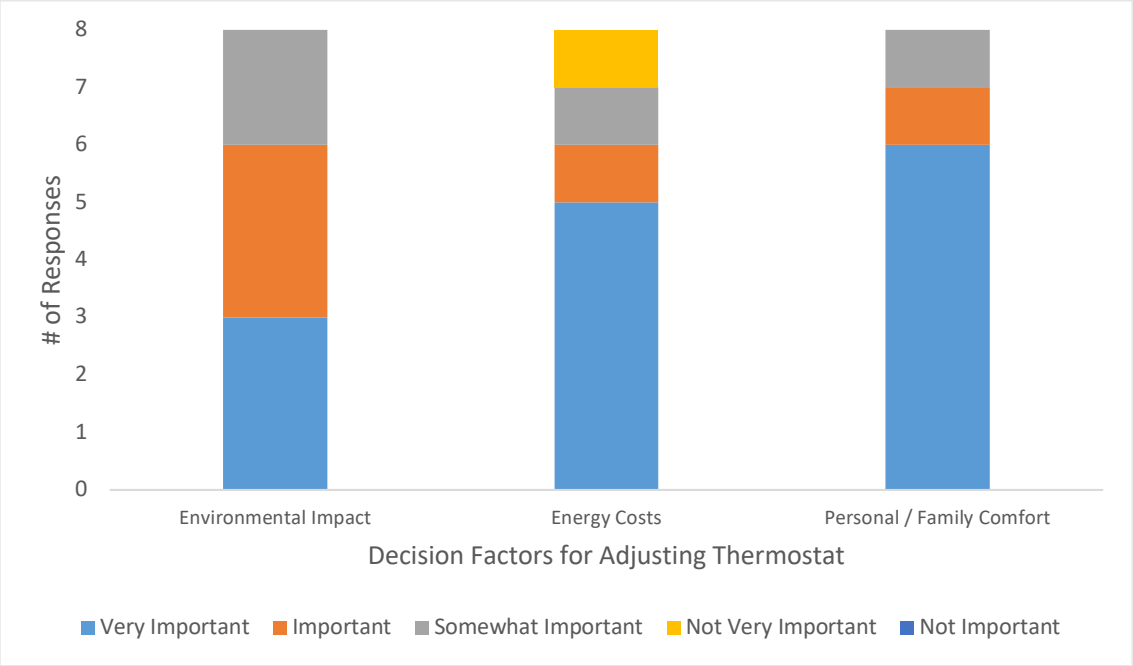


Figure 3

Participant Survey: Thermostat Motivators



Interviews

To analyze the internal processes, experiences, and takeaways of the pilot program, interviews were conducted with key figures involved in the program's development, implementation, and advancement.

Interview Methodology

Interviews were conducted with five individuals, each of who played a vital role throughout the pilot program. All interviews were conducted via Zoom, and each interviewee was asked a series of the same general questions as well as individualized questions based upon the nature of the work they completed and their contributions to the program. A list of the general questions can be found in Appendix D. The individuals

chosen to be interviewed all had different positions and were involved in various stages of the development, implementation, and advancement of the program.

Interviews were conducted to examine the perspectives and experiences of internal sources from each angle of the program. With certain individuals working on the technical and program logistics and others working on community development directly with the residents, these interviews would determine nuances between the experiences and views of each individual and trends among their responses. The ultimate purpose was to provide where focus should be and what characteristics must be reevaluated and reanalyzed as the program moves forward.

Interviewees

A total of five individuals were interviewed. Table 1 provides brief descriptions of each interviewee with their respective role and contributions in the program.

Table 1

Interviewee Role Descriptions

Position	Description (roles, responsibilities, and contributions)
P2P Energy Educator	The P2P Energy Educator was in charge of the interactions with residents and was the point of contact between the participating households and the rest of the program. The primary duty of this position was to serve as a mentor and peer to the residents and provide education on energy saving behaviors and tools. Relationship building was another key responsibility of this position which entailed relationships between the P2P Energy Educator and the residents and between the program and the residents. This individual was also responsible for the initial communication with households who signed up for the program; scheduled meetings for thermostat installations, Energy Walkthroughs, and all other interactions; assisted with thermostat installation; and maintained regular communication with residents

	to follow-up on meetings and address any questions. As the first P2P Energy Educator of the program, this individual assisted with the implementation and logistics of the pilot program.
Technical Intern	The technical intern worked closely with the P2P Energy Educator interacting with households but with a greater focus and background on the technical aspects of energy savings. This individual assisted with initial outreach and thermostat installations, created preparatory materials and documents for household interactions and Energy Walkthroughs, and kept track of technical related issues and concerns from interactions. As the first technical intern of the program, this individual assisted with the implementation and logistics of the pilot program.
Nonprofit Director	The nonprofit director was the director of the nonprofit in which the energy reduction program was implemented and developed through. This individual's role was focused on determining and navigating the role of the energy reduction program within the overall purpose of the nonprofit. This also included creating partnerships and connecting with other community organizations to further the work of the program.
Program Innovator & Energy Analyst	The program innovator and energy analyst was responsible for the ideation of the program with the intent to build capacity within the neighborhood. This individual introduced and proposed this program to the nonprofit director and was the primary figure in the development in the program and the early stages of partnership development. Additionally, the program innovator and energy analyst conducted analyses of the energy characteristics of the homes and of energy consumption for the households.
Program Coordinator	The program coordinator was a community partner working for the nonprofit overseeing numerous programs and initiatives. This individual began working with the program near the end of the implementation of the pilot program and transitioned into the role of overseeing the program. After the initial pilot program, this individual restructured the program and prepared for a new P2P Energy Educator based upon initial feedback and evaluation of

the program. Their work also focused on story development of the nonprofit and program to increase presence and awareness in the neighborhood.

Results

Upon completion of all interviews, an analysis was conducted to examine responses from all individuals. This resulted in five key areas and trends of takeaways, recommendations, and insight into the future of the program.

Community Empowerment and Sense of Control. One question asked each interviewee to describe their experiences and views on the success of the program. Their responses were derived from the limited results and evolution of the program beyond the initial pilot program. A common theme among the responses highlighted that residents were able to acquire a new sense of control and empowerment. According to the P2P Energy Educator, a success of the program was "having people understand they could take control of their utility bills by reading and understanding them." By learning about the relationship between behaviors and utility bills, residents were able to see that they could take control of their utility bills. This not only increased their sense of control in their understanding of their utility bills. It also showed them their role in addressing climate change as well as how they could take control of aspects of their lives beyond energy consumption, even if in what seemed to be simple and trivial ways. As explained by the program coordinator, "People understand they have more control in simple things in their lives than they think" and many do not actually know they can save money based on their thermostat, which then translates into curiosity of how and where else they can save money. The pilot program empowered residents to see their actions and behaviors as

a way to gain control of their utility bills and other areas of their lives. Thus, the program showed to impact the lives of the participating households beyond energy and the primary scope of the program.

Education and Training. The responses provided by the interviewees brought forth the crucial role of the education and training required by individuals working in the program and the areas in the pilot program where education and training needs were insufficiently met. From a general and program-wide outlook, more intentional training and knowledge was needed for individuals in the program, particularly for the P2P Energy Educator and technical intern. There were two primary areas in which further training was necessary. First, greater attention was needed on technical knowledge such as utilities, utilities bills, energy programs, and miscellaneous specifics on energy consumption and savings. Second, the P2P Energy Educator and technical intern expressed a lack of training and preparation on soft skills for their specific roles as well as the program as a whole. Such training and skills included communication and people skills necessary for working with individuals with different levels of technical expertise within the program and also the knowledge of how to properly and consciously communicate with community residents and understand appropriate language to use. Furthermore, the interviewee's responses indicated a goal to strengthen the opportunity to provide education to residents on utilities, utility bills, energy programs, and more, which is dependent upon the knowledge and education of those in the program.

With the P2P Energy Educator being the primary point of contact and the person in charge of conveying information and education materials to residents, there were specific details identified of what education and training is essential for this role.

According to the P2P Energy Educator, they did not feel adequately prepared to confidently and comfortably work and interact with fellow program developers and with residents. They suggested greater collaboration and education from program directors to feel more confident working with those in technical roles such as engineers and energy analysts. While the P2P Energy Educator's role is being a peer and mentor to residents in the program, it is vital for them to gain an in-depth understanding of the technical components of the program in order to increase self-confidence and amplify their impact when working with residents. As the P2P Energy Educator stated, "They're counting on me to know something… I should have answers." This includes the technical knowledge as previously indicated and also knowledge of other community programs and organizations, both energy and non-energy related. Discussing energy with residents revealed insight into why some households have high energy consumption, so the P2P Energy Educator should be able to provide knowledgeable recommendations and assistance such as how to get mattresses or warm clothing if that is prohibiting someone's ability to turn down their thermostat and reduce energy consumption.

Program Impact and Reach. Another common trend among responses was an understanding of the impact of the program within individual households and within the community at large. A predominant takeaway was the need to include all household members in the energy education process. While conclusive energy consumption changes and savings were not able to be made based on the limited time frame of the program, as well as complications stemming from COVID-19, this understanding was significantly driven by the fact that the household whose energy consumption clearly decreased after the Energy Walkthrough had all household members present during the walkthrough.

This was further highlighted by the feedback the P2P Energy Educator and the technical intern received from residents during the Energy Walkthroughs. The feedback they received revealed that while residents were receptive to the majority of the tips on ways to save energy in their homes, there were limitations and challenges in maximizing the impact and energy savings. For instance, the technical intern expressed, "Almost every home would make an excuse one way or the other of like, that's why I know that this [energy consumption] is high, and I think you are unmotivated by the fact that your window leaks." These same sentiments were echoed by the P2P Energy Educator, stating "The houses were not our variables… but in some ways, the houses were dramatically different… so I think a trend a lot was them blaming the insulation of the house or them blaming the kids for the usage." These insights, therefore, reveal the necessity of incorporating the entire household in the energy education process, as well as to other obstacles homeowners face to realize the impact of their actions and barriers that inhibit the savings they are able to achieve.

To reach the entire household it was also clearly expressed that the approach must carefully consider how information is conveyed to both the adults and children within households. According to the P2P Energy Educator, they were sometimes intimidated and concerned to come across as arrogant when discussing energy savings tips with adults because energy savings is inherently tied to one's finances and, therefore, can be a sensitive topic. Ultimately, positively impacting a resident's energy savings behavior is very complex, and best practices need to include entire households in the process and the aforementioned concerns that were revealed by the interviewees.

In addition to addressing the impact of the program on the household level, analyzing the impact on the community level was a critical factor that influenced the program's impact. As the program and energy education process began, it was quickly recognized that the time required to develop relationships and trust within the community is much longer than initially anticipated. According to the nonprofit director, "We learned early on that the approach is too simple. The idea that you could establish trust with a group, a new community interface for them and begin to change their behavior quickly was an incorrect assumption." Similarly, the program innovator and energy analyst said, "I had actually seen this initiative as being an example of how to combat climate change nationally with speed… and I think the greatest learning and impact that I've had is that it is slow and about developing relationships over the long term." It is evident that the program must first establish relationships and trust within the community to enable connections with households on an individual level, which takes time and must be a long-term endeavor. This must include not only relationships with community members but also with community organizations and programs. By doing so, the program and P2P Energy Educator can leverage the community's assets to collaborate and work with the community to assist in meeting the needs of the community and households. It is critical that the program and all partners acknowledge the amount of time required to establish relationships and that they have the bandwidth to do so.

Based upon the interview responses, a significant component of establishing relationships is improving the presence and familiarity of the program in the community, something that lacked in the initial implementation of the pilot program. According to the program innovator and energy analyst, "I guess I just didn't initially realize it would just

be so challenging to get people to sign up…. and so, it is clear that what we realized is you first have to have a relationship in order to potentially establish trust." This response not only reiterated the aforementioned requisite for relationships and trust but provides further insight into gaining interest in the program from the community. The interviews revealed that the program needed greater community involvement and exposure from the very beginning. It was suggested that in order to achieve this, the community must be part of this process to increase trust and familiarity and to ensure the program is driven by the community.

Lastly, the ability for this program to make a positive impact requires an in-depth understanding of the community. As indicated by the program coordinator, "This work needs to build to much greater system change, to energy democracy, and to what it means to actually be in charge of your neighborhood and its health and vitality… It's pretty unfortunate how much we didn't know." Through the interactions with the community, the reality of the systemic issues and unnecessary dependencies the community endured became apparent. Particularly, simple things that may not typically be questioned or considered must be part of the process. Thus, while maintaining the goal of reducing energy consumption, the program and those involved must have a broad and in-depth understanding of the perspectives and experiences of the community beyond energy and energy savings alone.

Program Requirements and Logistics. Mutual recommendations, perspectives, and critiques of the requirements and logistics of the program were also revealed through the interviews. A particular need that was identified was the need for reliable funding and financial support. According to the program innovator and energy analyst, "We just

realized that it is going to take time, and we've got to figure out a funding resource to help make that time feasible in the end." Thus, as a deeper understanding of the length of time required to establish community relationships and trust was acquired, it became evident that a greater funding source would be needed to create long-term and lasting community presence.

One element of the program that requires funding is the incentives residents receive for their participation. However, it was revealed that if these incentives continue in the future, they must be more intentional. This was clearly articulated by the P2P Energy Educator and their interactions with residents:

> I do believe that incentives work. I think that we could have done different things with the money that would have helped better if we were looking at it more individualized because we were looking at a broad spectrum... every single person that we're working with is dealing with different reasons why their bills are the way they are.

To meet the goals of the program and make the long-term presence financially viable, it is suggested that incentives be utilized in a more purposeful manner that further aligns with the needs of the program and the individual situations of the residents. Fundamentally, if financial incentives are offered, they must reward energy savings and serve individual household needs.

It was also revealed that a more detailed plan must be established for the implementation of the program. Based on the responses from the interviews, it is critical to have short-term and long-term plans that emphasize both the technical and conceptual elements of the program and that also are built on the understanding of what

sustainability means to the community. According to the program coordinator, "We need to know what it [sustainability] means to them based on their language and how they live on a day-to-day basis and adapt how we think it should be implemented in their neighborhood." Therefore, the program must balance the focus on the program specific goals of energy savings and on taking a holistic approach of what is needed to achieve community sustainability and resilience beyond energy. This implies that boundaries must be set on how far the program, as well as the role of the P2P Energy Educator, can veer off focus. Ultimately, for households to achieve energy savings, there are additional factors necessary to be acknowledged and included in the work.

Furthermore, the interviewees discussed the necessity to consider all angles of the program, of the community, and of any potential issues that may arise before beginning the implementation process. In order to do so, the program plans must not overlook simple characteristics and understandings of the community and require significant communication and collaboration with all individuals involved in the program and with community members. Finally, it was indicated that in order to meet these requirements and account for the details necessary for the implementation of the program, it is vital that plans established are adaptable and have the ability to evolve as new needs and understandings are discovered.

Program as Integrative and Collaborative. A final trend revealed through the interview responses is the necessity of the program being integrative and collaborative, which, while discussed in previous sections, deserves further emphasis and detail. To maximize community presence and build relationships and trust, feedback from the interviewees strongly suggested to not only establish partnerships with existing

organizations already operating within the neighborhood, but to also implement this program into the work of an existing organization already trusted, rooted in, and represented by the community. By having the program under the umbrella of such an organization with well-established community presence and partnership, the time and work required to build new, long-term relationships and trust will be mitigated.

Other recommendations for taking a more collaborative approach included having the community identify a P2P Energy Educator, creating opportunities for youth and high school students to get involved, and having the outreach and presence of the program be completed by community members themselves. According to the program innovator and energy analyst, "I would also encourage the community to identify a peer to peer person who they would want to hire to manage the program, and we would actually manage the program through that organization… it would be transparent, they would be seen as the enablers of their community." The initial belief was that the pilot program addressed the need of community engagement by having a P2P Energy Educator with similar experiences and by incorporating the program into the work of a nonprofit. However, these sentiments reveal the depth at which this must be done and indicate the recommendation of redirecting some practices within the program to be driven and operated by the community itself.

Finally, insight from the individuals involved in the development and implementation of the program highlighted the potential for the program to serve as an opportunity for broader community development and work beyond energy savings. According to the program coordinator, "It just starts the conversation for future work that is much bigger than just saving a few dollars in your home. Like, what is it going to be

[to build] a truly sustainable and resilient self-sufficient neighborhood." Thus, future programs should not focus on energy and energy cost savings alone but should, instead, integrate with other goals and needs of the community and community organizations. This was further emphasized by the idea that the program can provide the impetus to create greater system change and advance the efforts underway to achieve greater community resilience.

Preliminary Home Energy Use Results

To evaluate energy savings and acquire quantitative insight from the implementation of the pilot program, an energy analysis was conducted utilizing energy consumption data of participating households.

Energy Use Analysis Methodology

The analysis was conducted with monthly energy data from the participating households. A total of 11 households participated in the program; however, only eight households were included in this analysis based upon corresponding energy data available from the previous year. To evaluate the impact of the Energy Walkthroughs, monthly energy data for three months following the Energy Walkthroughs was collected, January through March of 2020. These results were then compared with the energy data for the same three months from the previous year, January through March of 2019. Monthly energy consumption and savings were analyzed on an individual household level and as an aggregate of the total energy consumption among the participating households. The energy data was also utilized to evaluate the cost and environmental impact of household and total energy consumption. Data equivalencies were calculated based upon average residential electricity rates of 11.79 ¢/kilowatt-hour (total costs for

generation, distribution, and transmission) and the national weighted average CO_2 emission rate of 1558.8 lbs. CO_2/megawatt-hour (National Renewable Energy Laboratory, n.d.; Environmental Protection Agency, 2019).

It is important to note that due to the limited sample size and data period included in the analysis, the subsequent results are not conclusive and do not serve as a means to determine findings on household energy consumption and on the successes or failures of the pilot program. Rather, the goal of this analysis is to provide preliminary results of household energy consumption to evaluate trends among participating households, the impact of the Energy Walkthroughs, and areas where the program can be strengthened and revised as it further evolves.

Results

Comparisons of the household energy usage summed over the three month period following the Energy Walkthroughs and the monthly energy savings are shown in Figure 4 and Figure 5. Out of the eight households included in the analysis, three showed energy savings and the remaining seven showed increases in energy usage. For each month of energy data collected in 2020, the household averages were 760, 630, and 665 kilowatt-hours respectively, slightly greater than averages for 2019 energy data. Analyzing the energy savings for each house during each month of available energy data, there was a maximum energy reduction of 53.17% and a maximum energy increase of 88.76%.

Figure 4

Total Household Energy Usage for 3-Month Period

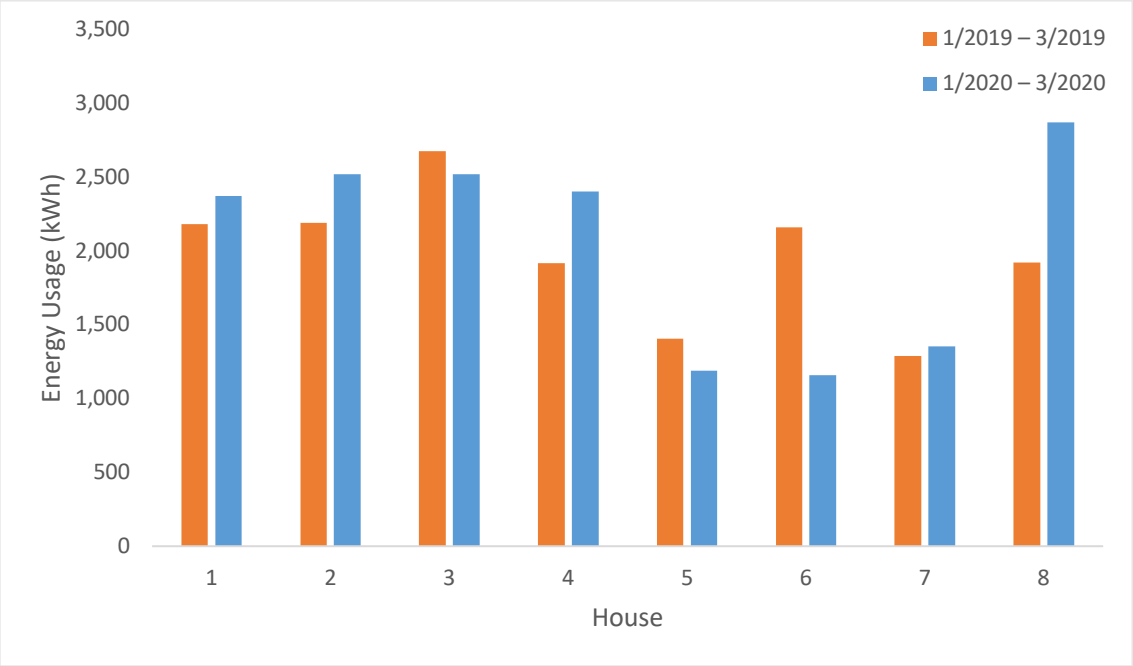
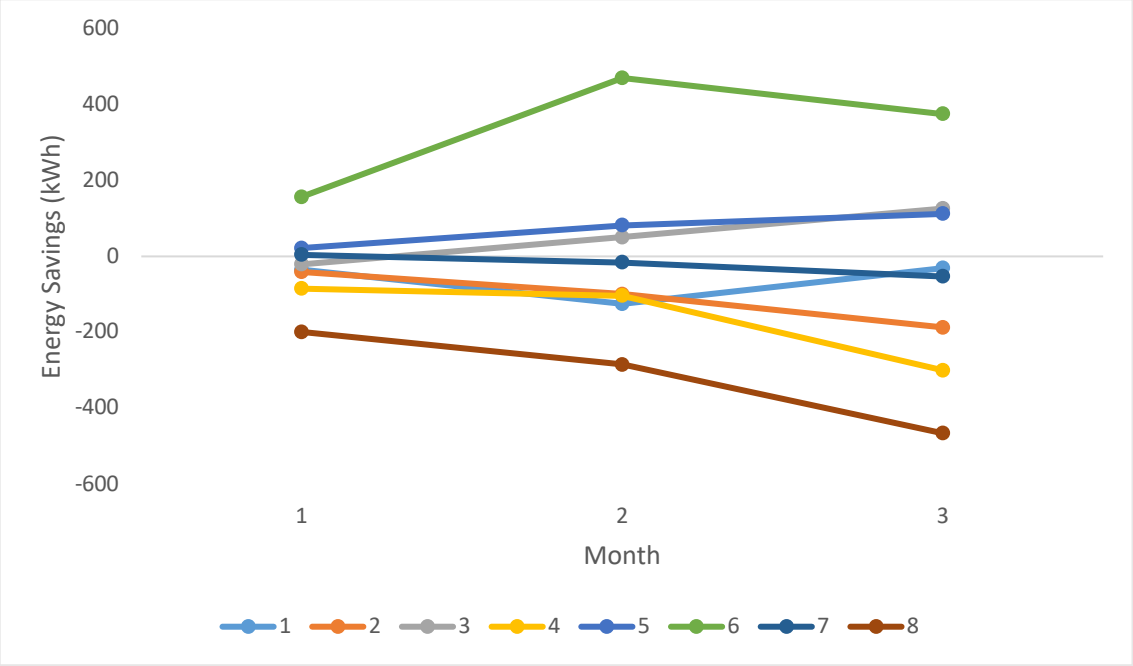


Figure 5

Household Energy Savings (3-Month Period Post-Energy Walkthrough)



Summing the energy usage of all participating households, energy changes between 2019 and 2020 were less appreciable as shown in Figure 6**.** Overall, the participating households experienced an energy increase of 4.11% over the three-month time period from 2019 to 2020. However, this amount is within the uncertainty of predicting savings. This equated to a total energy increase of 648 kilowatt-hours, equivalent to a cost of $76.40 and 1,010 lbs. of CO_2 emissions (see Table 2). As evident in Figure 4, one household, house 8, was an outlier in terms of the extent of energy increase with a total increase of nearly 950 kilowatt-hours, negating a large portion of the energy reduction achieved by other households. Furthermore, the aggregate energy consumption reveals the greatest energy increase was seen during the third and final month included in the analysis.

Figure 6

Total Energy Usage – 2019 and 2020 Comparison

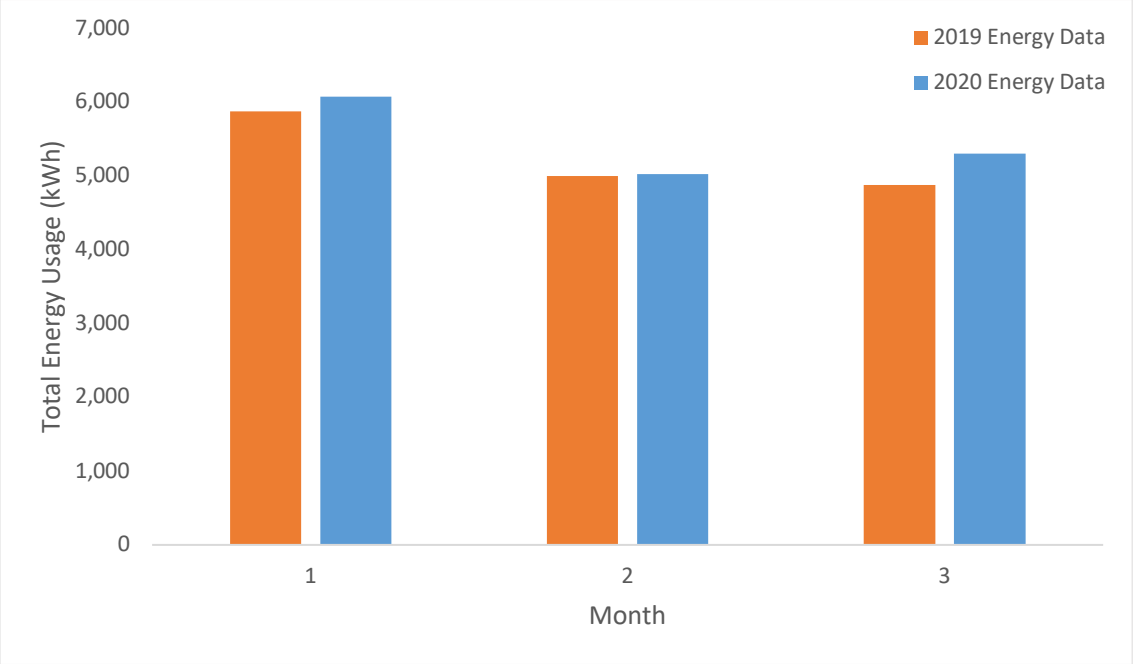


Table 2

Household Savings (Total for 3-Month Period)

House	Energy (kWh)	Cost ($)	CO_2 (lb)
1	-191	-$22.52	-298
2	-327	-$38.55	-510
3	156	$18.39	243
4	-489	-$57.65	-762
5	216	$25.47	337
6	1,002	$118.14	1,562
7	-65	-$7.66	-101
8	-950	-$112.01	-1,481
Average	-81	-$9.55	-126
Total	-648	-$76.40	-1,010

Discussion

Insights and preliminary results from the pilot program reveal how it can be strengthened and improved as it evolves and expands in the future and in order to help inform scaling and expansion beyond the initial neighborhood. The following discussion is based upon the presented results, insight from previous research studies, and additional feedback and observations from the pilot program.

Maximizing Program Impact

A primary takeaway from the interview responses, which was confirmed based on the results of the participant survey and energy data, was the need to improve the impact of the program on a community and household level. While the need to establish community relationships and trust was known to be a challenge and essential component of the program from the beginning, the time required and the steps necessary to achieve strong and impactful relationships was underestimated. Gaining community interest and commitment to the program was a critical challenge the program faced as made evident through the limited number of household sign-ups, number of households who actually participated in the program, and the feedback from individuals within the program, such as the P2P Energy Educator and technical intern. Establishing a robust presence in the neighborhood is, thus, a vital component that should be the focus of the program before beginning energy education on a household level.

In addition, the importance of providing energy behavior education to all members within a household was revealed. This was shown anecdotally to influence the ability for households to achieve energy savings. This is supported by the results of the

participant surveys, interview responses, and energy data. While the available data and responses are limited, household members indicated that the ability to modify energy use habits in their household was more easily attainable for themselves and more difficult for others within their household, as shown through survey responses. This was further validated based upon the experiences the P2P Energy Educator and technical intern had interacting with participating households during the Energy Walkthroughs and also upon the energy data, in which the household with the most significant energy reduction had all household members present during the walkthrough. It is, therefore, clear that moving forward, a goal of educating households on energy savings behaviors should be a collaborative process among all household members that is tailored to the diverse range of household compositions and roles of household members. It must be acknowledged that implementing this recommendation is complex and poses numerous challenges because of the diversity of households within low-income communities.

Understanding Program Reach

Preliminary results revealed gaps in the ability to accurately understand and analyze the available and limited data. One significant challenge the program faced from the onset of the implementation of the program was gaining interest within the community for households to sign-up and participate – limiting the reach of the program and the ability to properly evaluate results.

With 11 participating households out of the 84 households in the neighborhood who were contacted and informed about the program, it was uncertain as to what appealed to those 11 households and what barriers existed that hindered greater interest. As previously discussed, strong community presence and trust is an indicator for gaining

interest and engagement. However, evaluation of survey and interview responses and energy data revealed further insight into potential factors that should be explored further in the future. The participant surveys indicated that those reached in the program potentially do not endure as high of energy burdens as anticipated based on responses to questions covering topics on utility bill costs and assistance programs. This raises the question of whether energy burdens are not exceptionally severe in the neighborhood reached or if among all the households in the neighborhood, those with less severe energy burdens were those who opted in to participate in the program. It may be suggested that households with the most severe energy burdens do not have the bandwidth to participate and that the challenges and realities of living in financial poverty limit participation.

As a greater understanding of the reality and inconsistency of living in financial poverty became apparent, additional considerations were revealed in regards to properly analyzing energy consumption and understanding the capacity for households to modify energy behavior. The energy analysis conducted with preliminary energy consumption data showed a significant decrease for one household and a significant increase for another household (house 6 and 8 shown in Figure 4, respectively) when comparing the three-month period following the Energy Walkthrough to the same three-month period from the prior year. The remaining households included in the analysis experienced slight increases or decreases in energy consumption. However, to accurately understand these and future results, certain characteristics and situational occurrences must be incorporated to accurately understand the data for each household. This would include factors such as changes in the number of household members, significant lifestyle changes, and change in employment and the accompanying work schedule.

Furthermore, comparing energy consumption before and after households begin energy education implies baseline energy consumption would be stable or typical for a household. The experiences and observations by the P2P Energy Educator, the technical intern, and other program contributors, however, revealed the inconsistency of living in financial poverty, which may result in inconsistent energy consumption within households based on both behaviors and lifestyle. Additionally, some of the households do not and are not able to live in one home or neighborhood for long periods of time. This adds additional challenges for analyzing data and establishing trust and relationships with individuals.

Furthermore, as previously revealed, the greatest increase in aggregate energy use among the eight households occurred during the third month following Energy Walkthroughs. This could indicate that implementing energy savings behaviors and modifying behaviors declines over time. The third month, however, corresponded to the beginning of stay-at-home orders set in place in response to the COVID-19 pandemic. It is, therefore, evident that the impact of external factors and situations beyond control of the households and communities must be included and examined when analyzing energy consumption data.

Ultimately, this understanding indicates that educating households on energy behaviors and analyzing energy consumption data must account for the inconsistency some households endure. To accurately incorporate this into the work of the program, further research and community insight will be essential, which could include interviews of participating households from the pilot program.

P2P Energy Educator

The role of the P2P Energy Educator is a central feature of the energy reduction program. By utilizing a peer-to-peer methodology, the program aims to provide energy savings education to households through comfortable and trusting relationships with an individual with similar backgrounds and experiences. Executing this model, however, requires further understanding of who can effectively serve as a peer-educator, which is more than simply having similar backgrounds and experiences. The P2P Energy Educator for the pilot program understood the lifestyle's households were experiencing based upon their own background. However, they lacked the understanding of such experiences as an adult and as a member of the specific community, impacting their ability to fully connect with residents and feel comfortable in their role as a peer-educator. This revealed that greater care must be taken when selecting an individual to fill the position of the P2P Energy Educator. Potential ways to address this concern include having the P2P Energy Educator be a resident from the community, seek out individuals who are already deeply trusted and respected within the community, and have community members nominate and elect individuals for the position.

Before working with households, introductory preparation for the P2P Energy Educator is crucial to ensure they are equipped with skills and knowledge necessary to feel confident and comfortable when interacting with participating households. A more formalized and intentional on-boarding process is recommended based upon experiences from the first P2P Energy Educator and other program contributors. This process may include education and training on energy, utilities, and applicable residential programs; introductions to and meeting with a variety of local organizations; regular and consistent

collaboration and communication with other program organizers; and attending numerous community events and outreach.

Once the P2P Energy Educator begins interacting and meeting with individuals, it is important to establish a robust tracking and communication process. Working with multiple households, there are details the P2P Energy Educator must remember and stay on top of in order to tailor the program to specific needs and to establish greater trust and relationships with residents. Creating a system in which the P2P Energy Educator is able to track and take notes from interactions with households will ensure there is consistency between visits and between households. A vital component of this is tracking and taking note of any barriers that may be preventing households from being able to achieve energy savings and make energy behavior modifications.

Finally, as the P2P Energy Educator position further evolves and develops, it will be beneficial to specifically define all responsibilities in greater detail and set boundaries for the position. Energy and utility bills can be a very personal subject matter for households because of its relation to money and financial security. This can bring an array of interconnected factors into the conversation of what impacts and influences a household's energy behaviors and energy consumption. However, there must be a boundary established as to what they are capable of working on and achieving as a P2P Energy Educator and for the program at large. It must be determined how far the work of the individual is able to veer off focus of energy savings to ensure other needs are still being addressed. This also includes distinguishing boundaries between the P2P Energy Educator and the residents to establish and maintain a trusting relationship while not going beyond their responsibilities in the program and staying within the lines of serving

solely as the peer-educator. Clearly defining and understanding the responsibilities of the P2P Energy Educator is necessary for the individual themselves, other individuals working in the program, and residents. Based upon feedback and experiences from the pilot program, this will increase confidence in the P2P Energy Educator and their ability to have a greater impact on the program and lives of those participating.

Additional Recommendations

Based upon the results and outcomes of the pilot program presented in this study, there are additional recommendations and ideas for the future of the program and its framework beyond what has been previously addressed. Firstly, the program must take a holistic approach to finding energy savings and assisting households to modify energy behaviors. The use of incentives showed positive feedback and responses among residents. One way to address needs and burdens endured by individual households and what may prevent them from being able to reduce energy consumption is to establish intentional standards and practices for the use of incentives. It is expected this would maximize the impact of the program by focusing efforts on the goals of both the program and individual households. To expand the work beyond energy behavior and energy savings alone, it is recommended that program coordinators carefully and methodologically establish a plan and defined boundary of what the program is capable of incorporating into their work. Finding this balance will require strong program management and organization that is established at the onset of the program. Such management must also be maintained to ensure the program sustains its mission while creating greater resilience within the community.

Additionally, as this study reveals, community engagement and presence are key to its success and value. There is a strong recommendation to collaborate and establish partnerships with existing community programs and organizations that have the capacity to contribute to the program's efforts or are able to amplify and support the program's presence in the community. However, these efforts should not focus only on incorporating the program into the community but also on incorporating the community into the program. Making the program be driven by the community itself. For instance, a community focus and leadership group could be established to hear insight and perspectives from community members on program logistics and how to tailor the program to specific communities and their needs and aspirations.

To engage residents of all ages, additional programs and processes could be established for younger community members. The position of the technical intern could become an internship program to provide employment opportunities and skills and knowledge training for young adults and youth in the community. Partnering with community programs would also provide the opportunity to incorporate energy savings education in pre-existing youth programming for younger children in the community. Working with community partners also would present the possibility of creating a community art project or display to track and present energy savings in the community. This has the potential to amplify interest, engagement, and motivation through a visual display made by the community to highlight the collective impact of energy savings on a community level.

Finally, it is recommended to reconsider and modify the energy education approach. A potential option to explore would be to begin the energy education process

through community and group events in an effort to establish greater understanding and trust of the program. Feedback from this study and insight provided by previous studies indicate benefits of this approach by providing a casual setting for community members to socialize while also being introduced to the energy reduction program. It would be particularly valuable for the P2P Energy Educator to establish and/or strengthen relationships with the community and individual community members. From this setting, individuals would then be able to sign-up for one-on-one interactions and meetings with the P2P Energy Educator to individualize energy savings behaviors and gain a further understanding of how to make it feasible in their lives. Working on a community level first would decrease intimidation or discomfort on behalf of residents and the P2P Energy Educator that is associated with discussing what can be personal and sensitive topics and working in resident's households. Furthermore, this approach provides the opportunity to expand access to education to individuals who may not feel comfortable or may not have the capacity to work with a P2P Energy Educator on a more personal level.

Conclusion

Achieving residential energy savings through energy behavior modifications and a peer-to-peer education methodology in underserved communities is a complex and dynamic process, as presented in this study. It is evident that such a process requires robust community relationships that must be consistent and long-term. Because the timeframe necessary for establishing such relationships is beyond the scope of this study and the accompanying limited quantity of data, conclusive results cannot properly and effectively be drawn. However, the feedback, outcomes, and preliminary results presented provide insight into methods that contributed to the successes and drawbacks of the pilot program as well as recommendations to strengthen and scale the structure of the program.

This study indicates that a peer education approach is beneficial for gaining a genuine and individualized understanding of household barriers that exacerbate energy burdens. Areas identified as ways to increase the impact of the program include taking a holistic approach while maintaining the mission of the program, expanding the reach of the program on a household and community level, establishing a detailed and intentional long-term and short-term plan for implementation, and incorporating the community into the program itself. Further research and studies will be necessary, however, to determine the impact of the program and effectiveness of the preliminary feedback, results, and takeaways long-term. Ultimately, this study demonstrates that the framework of a peer-led energy reduction program has the potential to not only reduce household utility bills

but, if properly implemented, to contribute to the development of sustainable, resilient, and empowered communities.

References

Bednar, D. J., & Reames, T. G. (2020). Recognition of and response to energy poverty in the United States. *Nature Energy, 5*(6), 432. https://doi-org.libproxy.udayton.edu/10.1038/s41560-020-0582-0

Canuso, R. (2003). Low-Income Pregnant Mothers' Experiences of a Peer-Professional Social Support Intervention. *Journal of Community Health Nursing, 20*(1), 37. http://search.ebscohost.com.libproxy.udayton.edu/login.aspx?direct=true&db=edsjsr&AN=edsjsr.3427838&site=eds-live

Carrus, G., Passafaro, P., & Bonnes, M. (2008). Emotions, habits and rational choices in ecological behaviours: The case of recycling and use of public transportation. *Journal of Environmental Psychology, 28*(1), 51–62. https://doi-org.libproxy.udayton.edu/10.1016/j.jenvp.2007.09.003

CleanEnergy4All. (n.d.). *Prototype – Twin Towers, East Dayton, Ohio*. CleanEnergy4All. https://cleanenergy4all.org/project/twin-towers-neighborhood/

Drehobl, A., Ross, L., & Roxana, A. (2020, September). *How High Are Household Energy Burdens?* American Council for an Energy-Efficient Economy. https://www.aceee.org/sites/default/files/pdfs/u2006.pdf

East End Community Services. (n.d.) *Housing and Economic Development*. East End Community Services. https://www.east-end.org/housing-and-economic-development

Energy Information Administration. (2018, May). *Residential Energy Consumption Survey (RECS): 2015 RECS Survey Data*. U.S. Energy Information Administration. https://www.eia.gov/consumption/residential/data/2015/

Energy Information Administration. (2020, September 30). *U.S. Energy-Related Carbon Dioxide Emissions, 2019.* U.S. Energy Information Administration. Retrieved November 5, 2020, https://www.eia.gov/environment/emissions/carbon/

Environmental Protection Agency. (2019). *Greenhouse Gases Equivalencies Calculator – Calculations and References.* United States Environmental Protection Agency. https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

Frankowski, C. (2019a). *Energy Education Walkthrough Checklis*t [PDF file].

Frankowski, C. (2019b). *Resident Walkthrough Summary* [PDF file].

Frederiks, E. R., Stenner K., & Hobman, E. V. (2015, January). The Socio-Demographic and Psychological Predictors of Residential Energy Consumption: A Comprehensive Review. *Energies, 8*(1), 573–609. https://doi-org.libproxy.udayton.edu/10.3390/en8010573

Goldman, M. L., Ghorob, A., Hessler, D., Yamamoto, R., Thom, D. H., & Bodenheimer, T. (2015). Are Low-Income Peer Health Coaches Able to Master and Utilize Evidence-Based Health Coaching? *Annals of Family Medicine, 13*, S36–S41. https://doi-org.libproxy.udayton.edu/10.1370/afm.1756

Hines, J. M., & And Others. (1987). Analysis and Synthesis of Research on Responsible Environmental Behavior: A Meta-Analysis. *Journal of Environmental Education, 18*(2), 1–8.

http://search.ebscohost.com.libproxy.udayton.edu/login.aspx?direct=true&db=eric&AN=EJ356035&site=eds-live

Intergovernmental Panel on Climate Change. (2018). *Special Report: Global Warming of 1.5ºC – Summary for Policymakers*. https://www.ipcc.ch/sr15/chapter/spm/

Jenkins, K., McCauley, D., Heffron, R., Stephan, H., & Rehner, R. (2016). Energy justice: A conceptual review. *Energy Research & Social Science, 11*, 174–182. https://doi-org.libproxy.udayton.edu/10.1016/j.erss.2015.10.004

Lindenberg, S., & Steg, L. (2007). Normative, Gain and Hedonic Goal Frames Guiding Environmental Behavior. *Journal of Social Issues, 63*(1), 117–137. https://doi-org.libproxy.udayton.edu/10.1111/j.1540-4560.2007.00499.x

Marshak, H. H., de Silva, P., & Silberstein, J. (1998). Evaluation of a peer-taught nutrition education program for low-income parents. *Journal of Nutrition Education, 30*(5), 314–322. http://search.ebscohost.com.libproxy.udayton.edu/login.aspx?direct=true&db=agr&AN=IND22013961&site=eds-live

National Renewable Energy Laboratory. (n.d.). *Dayton Electricity Rates*. Electricity Local. https://www.electricitylocal.com/states/ohio/dayton/#ref

Noar, S. (2017, January 25). Transtheoretical Model and Stages of Change in Health and Risk Messaging. *Oxford Research Encyclopedia of Communication*. https://oxfordre.com/communication/view/10.1093/acrefore/9780190228613.001.0001/acrefore-9780190228613-e-324

Office of Community Services. (2018, November 16). *LIHEAP Fact Sheet*. Administration for Children & Families: U.S. Department of Health & Human Services. https://www.acf.hhs.gov/ocs/resource/liheap-fact-sheet-0

Office of Energy Efficiency & Renewable Energy. (n.d.). *Weatherization Assistance Program*. Energy.gov. https://www.energy.gov/eere/wap/weatherization-assistance-program

Ouyang, J., & Hokao, K. (2009). Energy-saving potential by improving occupants' behavior in urban residential sector in Hangzhou City, China. *Energy & Buildings, 41*(7), 711–720. https://doi-org.libproxy.udayton.edu/10.1016/j.enbuild.2009.02.003

Poortinga, W., Steg, L., & Vlek, C. (2004). Values, Environmental Concern, and Environmental Behavior. *Environment & Behavior, 36*(1), 70–93. https://doi-org.libproxy.udayton.edu/10.1177/0013916503251466

Richard, S. (2020). *Energy Report* [PDF file].

Samarripas, S. & York, D. (2019, April). *Closing the Gap in Energy Efficiency Programs for Affordable Multifamily Housing.* American Council for an Energy-Efficient Economy. https://www.aceee.org/sites/default/files/publications/researchreports/u1903.pdf

Sovacool, B. K., & Dworkin, M. H. (2015). Energy justice: Conceptual insights and practical applications. *Applied Energy, 142*, 435–444. https://doi-org.libproxy.udayton.edu/10.1016/j.apenergy.2015.01.002

Ten Cate, O., & Durning, S. (2007). Dimensions and psychology of peer teaching in medical education. *Medical Teacher, 29*(6), 546–552. https://doi-org.libproxy.udayton.edu/10.1080/01421590701583816

Thorn, D. H., Ghorob, A., Hessler, D., De Vore, D., Chen, E., & Bodenheimer, T. A. (2013). Impact of Peer Health Coaching on Glycemic Control in Low-Income Patients With Diabetes: A Randomized Controlled Trial. *Annals of Family Medicine, 11*(2), 137–144. https://doi-org.libproxy.udayton.edu/10.1370/afm.1443

Appendix A

Energy Education Materials & Reports

Figure A1

Energy Walkthrough Checklist, page 1 of 2 (Frankowski, 2019a)

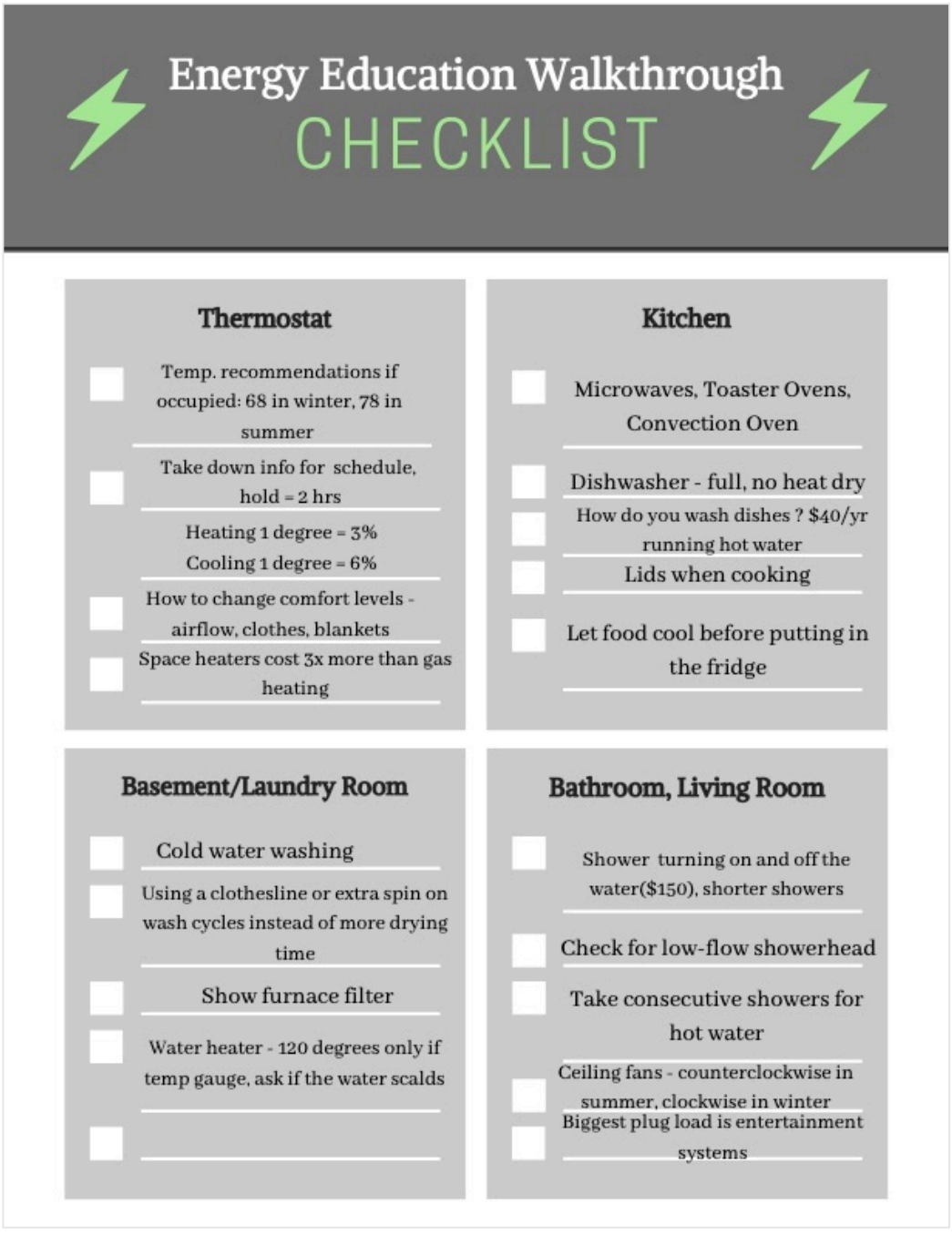


Figure A2

Energy Walkthrough Checklist, page 2 of 2 (Frankowski, 2019a)

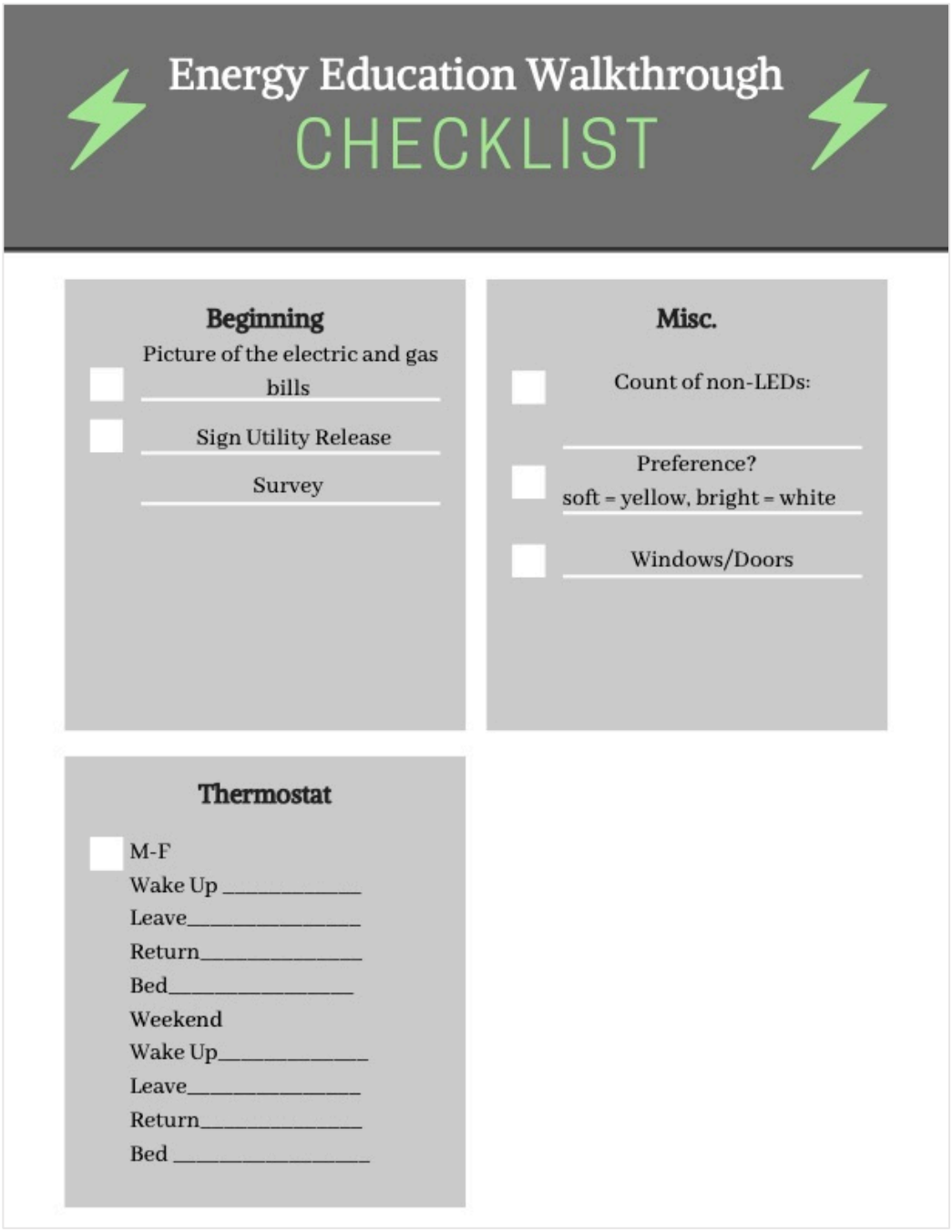


Figure A3

Resident Energy Walkthrough Summary (Frankowski, 2019b)

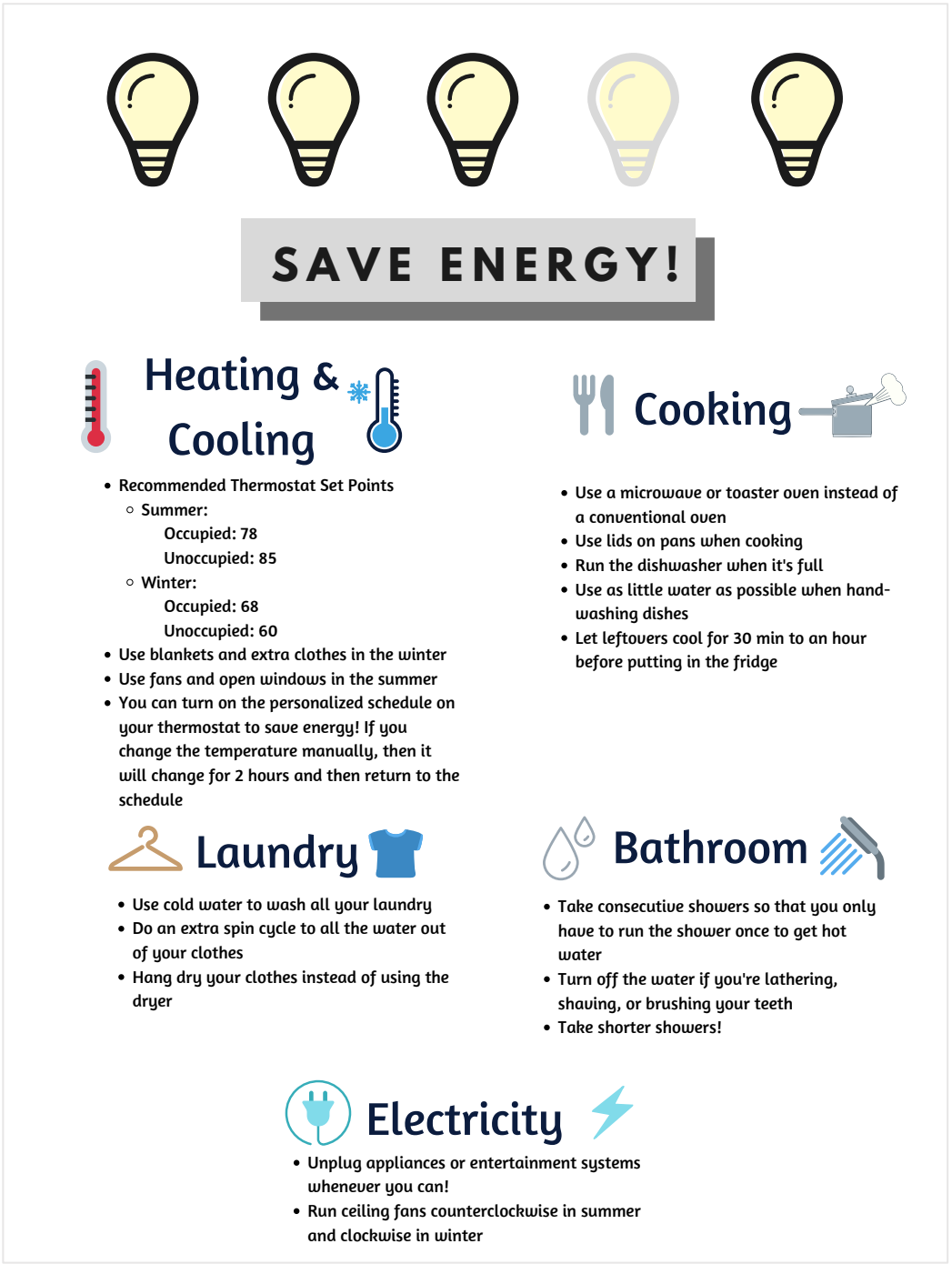
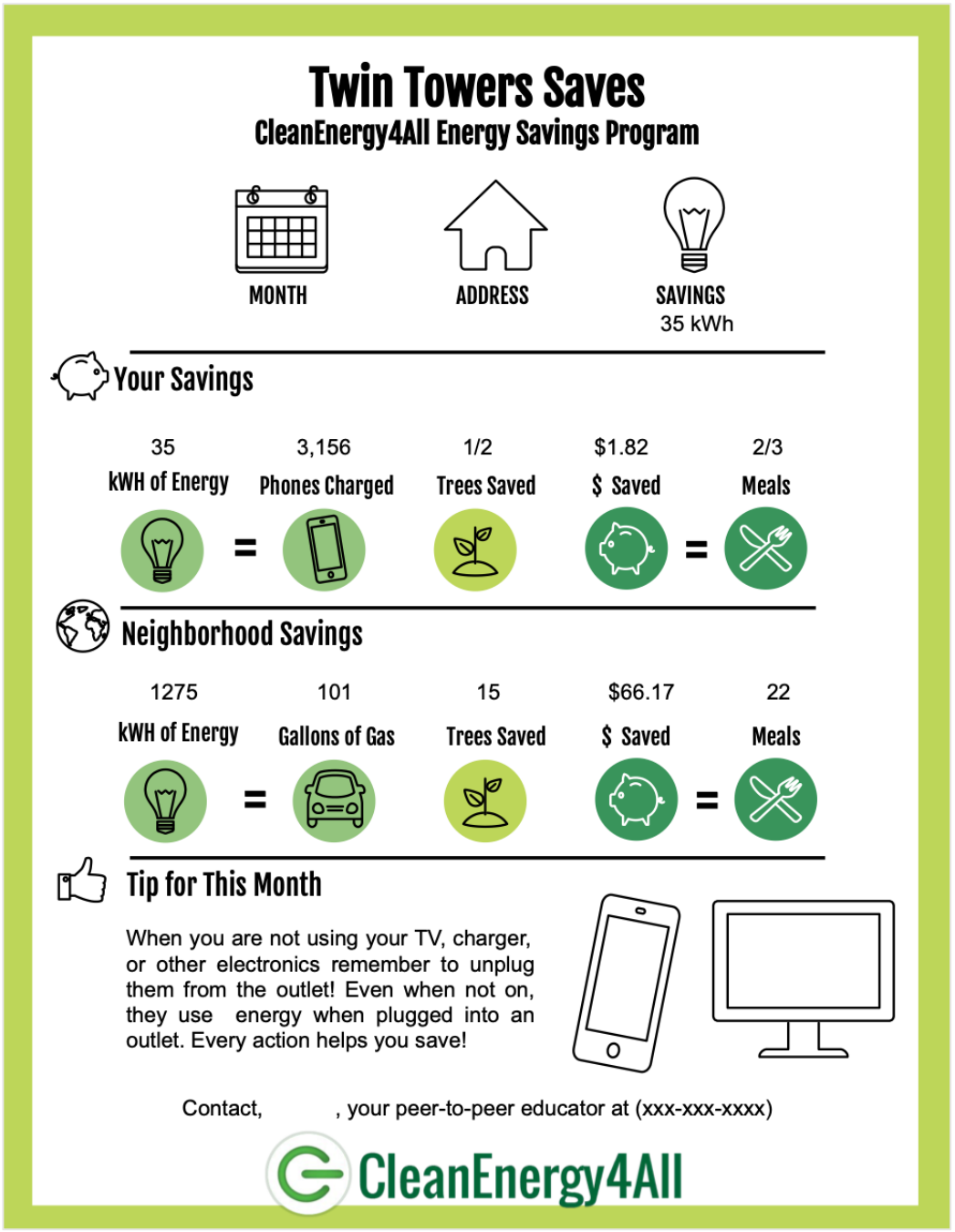


Figure A4

Monthly Energy Report (Richard, 2020)



Appendix B

Participant Survey

What is your highest level of education?

- ○ Some High School
- ○ High School Diploma
- ○ Two-Year College or Professional School
- ○ Some College
- ○ College Degree
- ○ Other _____

Which of the following statements best describes the employment status of the primary source of income for your household?

- ○ Not working at this time
- ○ Part-time or hourly work (less than 15 hours per week)
- ○ Part-time work (15 to 34 hours per week)
- ○ Full-time work (35 or more hours per week)
- ○ On temporary leave
- ○ In school or training
- ○ Other

In general, at least one person is home during daytime hours.

- ○ Often
- ○ Sometimes
- ○ Never
- ○ Don't know

In general, at least one person is home during nighttime hours.

- ○ Often
- ○ Sometimes
- ○ Never
- ○ Don't know

I worry about my monthly energy bill.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree
- ○ Don't know

In general, my monthly energy bill is _____ (dollar amount).

I have had my power or gas turned off within the last five years.

- ○ Yes
- ○ No
- ○ Don't know

I am aware of PIPP assistance programs for energy bills.

- ○ Yes
- ○ No
- ○ Don't know

My household is enrolled in the PIPP energy bill assistance program.

- ○ Yes
- ○ No
- ○ Don't know

I am interested in learning more about assistance programs for paying my energy bill.

- ○ Yes
- ○ No
- ○ Don't know

My experience with the installation of my new thermostat was _____.

- ○ Positive
- ○ Neutral
- ○ Negative
- ○ I was not present
- ○ Don't know

Overall, my new thermostat is _____.

- ○ Very easy to use
- ○ Easy to use
- ○ Somewhat easy to use
- ○ Somewhat difficult to use
- ○ Difficult to use
- ○ Very difficult to use
- ○ Don't know

I knew how to change the temperature settings on my previous thermostat.

- ○ Yes
- ○ No
- ○ Don't know

I adjusted my previous thermostat settings to save energy.

- ○ Often
- ○ Sometimes
- ○ Never
- ○ Don't know

I know how to change the temperature settings on my new thermostat.

- ○ Yes
- ○ No
- ○ Don't know

How often do you adjust your new thermostat?

- ○ Multiple times per day
- ○ Once per day
- ○ Several times per week
- ○ About once per week
- ○ Several times per month
- ○ Never
- ○ Don't know

How important are the following in your decisions about adjusting your thermostat?

	Very Important	Important	Somewhat Important	Not Very Important	Not Important
Environmental Impact	○	○	○	○	○
Energy Costs	○	○	○	○	○
Personal/ Family Comfort	○	○	○	○	○

I have a good understanding of how to save energy in my home.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree
- ○ Don't know

There are many ways to save energy in your home. Please check any area(s) where you are currently trying to save energy.

- [ ] Lighting
- [ ] Heating and cooling
- [ ] Showering and bathing
- [ ] Washing dishes
- [ ] Washing and drying clothes
- [ ] Cooking
- [ ] Other

Our household uses fans, open windows, or both to keep cool in warmer months.

- ○ Often
- ○ Sometimes
- ○ Never
- ○ Don't know

Our household uses space heaters to keep warm in cooler months.

- ○ Often
- ○ Sometimes
- ○ Never
- ○ Don't know

I work hard to reduce my home energy use.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree
- ○ Don't know

People I know work hard to reduce their home energy use.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree
- ○ Don't know

It is _____ to change my own energy use habits in my own home.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult
- ○ Don't know

It is _____ to change energy use habits of other people living in my home.

- ○ Very easy
- ○ Easy
- ○ Somewhat easy
- ○ Somewhat difficult
- ○ Difficult
- ○ Very difficult
- ○ Don't know
- ○ Not applicable

It is important to me to reduce energy use for environmental reasons.

- ○ Strongly agree
- ○ Agree
- ○ Somewhat agree
- ○ Somewhat disagree
- ○ Disagree
- ○ Strongly disagree
- ○ Don't know

For me, reducing energy use is

Bad (1) – Good (5)	1	2	3	4	5
Harmful (1) – Helpful (5)	1	2	3	4	5
Useless (1) – Useful (5)	1	2	3	4	5

What is your level of interest in learning more about reducing your home energy use?

- ○ Very interested
- ○ Interested
- ○ Somewhat interested
- ○ Not interested
- ○ Not interested at all
- ○ Don't know

What is your household's first language? _____

How many adults live in your residence? _____

How many children live in your residence? _____

What is your gender? _____

What is your age? _____

What is your race? _____

Appendix C

Participant Survey Results

Table C1

Demographics Survey Results

Survey Question	Response	(%)
What is your highest level of education?	Some High School	12.50%
	Two-Year College or Professional School	12.50%
	Some College	25.00%
	College Degree	50.00%
Which of the following statements best describes the employment status of the primary source of income for your household?	Not working at this time	12.50%
	Full-time work	87.50%
In general, at least one person is home during daytime hours.	Often	50.00%
	Sometimes	25.00%
	Never	25.00%
In general, at least one person is home during nighttime hours.	Often	100.00%
I worry about my monthly energy bill.	Agree	12.50%
	Somewhat agree	87.50%
I have had my power or gas turned off within the last five years.	Yes	12.50%
	No	87.50%
I am aware of PIPP assistance programs for energy bills.	Yes	87.50%
	No	12.50%
My household is enrolled in the PIPP energy bill assistance program.	Yes	25.00%
	No	75.00%
I am interested in learning more about assistance programs for paying my energy bill.	Yes	37.50%
	No	50.00%
	Don't know	12.50%

What is your household's first language?	English	100.00%
How many adults live in your residence?	1	75.00%
	2	25.00%
How many children live in your residence?	1	37.50%
	2	12.50%
	3	37.50%
	4	12.50%
What is your gender?	Female	100.00%
What is your age?	20-29	12.50%
	30-39	75.00%
	60-69	12.50%
What is your race?	Black	87.50%
	White	12.50%

Note. Only responses that received results are shown; N = 8

Table C2

Program Experience & Energy Consumption Survey Results

Survey Question	Response	(%)
My experience with the installation of my new thermostat was _____.	Positive	75.00%
	Neutral	25.00%
Overall, my new thermostat is _____.	Very easy to use	50.00%
	Easy to use	50.00%
I knew how to change the temperature settings on my previous thermostat.	Yes	100.00%
I adjusted my previous thermostat settings to save energy.	Often	37.50%
	Sometimes	50.00%
	Never	12.50%
I know how to change the temperature settings on my new thermostat.	Yes	87.50%
	No	12.50%
How often do you adjust your new thermostat?	Multiple times per day	37.50%
	Several times per week	12.50%
	About once per week	25.00%
	Never	25.00%

Note. Only responses that received results are shown; N = 8

Table C3

Values & Motivations Survey Results

Survey Question	Response	(%)
How important are the following in your decisions about adjusting your thermostat? - Environmental Impact	Very Important	37.50%
	Important	37.50%
	Somewhat Important	25.00%
How important are the following in your decisions about adjusting your thermostat? - Energy Costs	Very Important	62.50%
	Important	12.50%
	Somewhat Important	12.50%
	Not Very Important	12.50%
How important are the following in your decisions about adjusting your thermostat? - Personal/Family Comfort	Very Important	75.00%
	Important	12.50%
	Somewhat Important	12.50%
I have a good understanding of how to save energy in my home.	Agree	37.50%
	Somewhat agree	62.50%
There are many ways to save energy in your home. Please check any area(s) where you are currently trying to save energy.	Lighting	87.50%
	Heating and cooling	75.00%
	Showering and bathing	50.00%
	Washing dishes	37.50%
	Washing and drying clothes	75.00%
	Cooking	25.00%
	Other	12.50%
Our household uses fans, open windows, or both to keep cool in warmer months.	Often	75.00%
	Sometimes	25.00%

Our household uses space heaters to keep warm in cooler months.	Sometimes	12.50%
	Never	87.50%
I work hard to reduce my home energy use.	Agree	62.50%
	Somewhat agree	37.50%
People I know work hard to reduce their home energy use.	Agree	37.50%
	Somewhat agree	25.00%
	Somewhat disagree	12.50%
	Strongly disagree	12.50%
	Don't know	12.50%
It is _____ to change my own energy use habits in my own home.	Easy	50.00%
	Somewhat easy	50.00%
It is _____ to change energy use habits of other people living in my home.	Very easy	12.50%
	Easy	25.00%
	Somewhat easy	12.50%
	Somewhat difficult	50.00%
It is important to me to reduce energy use for environmental reasons.	Agree	75.00%
	Somewhat agree	25.00%
For me, reducing energy use is - Bad (1) - Good (5)	4	12.50%
	5	87.50%
For me, reducing energy use is - Harmful (1) - Helpful (5)	4	12.50%
	5	87.50%
For me, reducing energy use is - Useless (1) - Useful (5)	1	12.50%
	4	12.50%
	5	75.00%
What is your level of interest in learning more about reducing your home energy use?	Very interested	25.00%
	Interested	37.50%
	Somewhat interested	37.50%

Note. Only responses that received results are shown; N = 8

Appendix D

Program Interview – General Questions

1. Tell me about your role with the P2P program. What has this experience been like for you?
2. From your perspective, what has been most successful about the program?
3. How about challenges? Can you describe anything that has been difficult or has created challenges for the program or your work?
4. The original goals of this program were to show that low-income communities are capable of changing energy behaviors to save energy and, ultimately, reduce utility bills. Do you feel that the program is achieving these goals? In what ways? What do you think should be done to achieve these goals moving forward? If not, how do you think the program has shifted focus?
5. Moving forward, what should the biggest priority be? What is the most important next step?
6. Is there anything else you'd like to share about your experience working with the program, or anything else you think I should know?