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An Assessment of Home Energy Efficiency in Kalamazoo

Alexis Coutts
Western Michigan University, couttsali@yahoo.com

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An Assessment of Home Energy Efficiency in Kalamazoo

Alexis M. Coutts

Advisor: Dr. Denise Keele
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Abstract

The purpose of this study is to assess the status of home energy efficiency in Kalamazoo as well as the reasons why (or why not) a homeowner adopts energy efficiency and what their incentives and barriers are. In order to address these questions this study first relies on a literature review to offer insight on this complex topic and reveal the main incentives and barriers to energy efficiency already found by homeowners. Next a survey is completed by a total of thirty participants, fifteen homeowners from two separate neighborhoods of Kalamazoo, using socioeconomics as a variable. Where Milwood neighborhood acts as the lower socioeconomic income area and Westnedge Hill acts as the higher socioeconomic area. These questions are further explored during the survey using two educational prompts, which are also being tested as effective educational tools or not. An energy efficiency brochure, which was created by the Kalamazoo Climate Change Coalition. The brochure acts as an educational catalyst for homeowners of all demographics, providing information on adoptions of all prices and expertise levels. As well as an educational metaphor which assesses whether the term “climate change” has a negative bias on survey answers. The four study hypotheses include two questions regarding the influence of socioeconomics on home energy efficiency and another two regarding the educational prompts effectiveness. The responses gained from both the higher and lower socioeconomic class neighborhoods were then analyzed and further studied. Ultimately one hypothesis concerning socioeconomics was proven true while another was found false, and both educational hypotheses were found inconclusive at this time. Results of this study found Kalamazoo residents have a good understanding of energy efficiency along with a general concern for climate change but overcoming found barriers, such as time and money, will be the next step in the advancement of home energy efficiency.
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Assessment of Home Energy Efficiency in Kalamazoo

Introduction

When we power our lives by burning fossil fuels - like coal, oil, and natural gas – we release a tremendous amount of carbon dioxide into the atmosphere, which in turn are disrupting and warming our climate. In the United States, most homes rely on obtaining energy from power plants that burn fossil fuels to provide heat, electricity and other necessities. All of these energies, when used inefficiently in homes can often result in mass amounts of unnecessary energy waste. By adopting home energy efficiency measures, homeowners can decrease energy waste, the amount of fossil fuels that must be burned to operate their homes, and save money. What is impeding more people to take these measures?

The Kalamazoo Climate Change Coalition was founded in 2012 by the Kalamazoo Nature Center and comprises community leaders, representing over 50 organizations, businesses, and governmental entities. The KCCC focuses on local work to combat climate change by reducing, and working to eliminating, our consumption of fossil fuels. It is composed of six working groups, each related to a sector of our community. These working groups are: 1) Green Infrastructure, 2) Transit, 3) Sustainable Food, 4) Blueways/Greenways, 5) Storm Water Action Group (SWAG), 6) Energy Efficiency (KalamazEE).

KalamazEE (Kalamazoo Energy Efficiency) is a group that focuses its efforts at energy efficiency. In 2015 the group used their expertise on the subject and partnered the Western Michigan University Design Team to create a home energy efficiency brochure. Inside the brochure one can find in-depth detail about certain adoptions that can be used in the home,
individual costs per device and savings per year of each. These adoptions accommodate a spectrum of price ranges for all incomes and even include installations that can be done by the homeowner. The purpose of this brochure is to be an educational catalyst for homeowners of all demographics. The home energy efficiency brochure had its first round of prints and distributions for this research, in March 2015.

The intent of this study was to answer, “What is the status of energy efficiency adoption in Kalamazoo?” This question along with sub questions relating to the reasons why (or why not) a homeowner adopted, what their incentives and barriers were, were further explored by gauging the effectiveness of educational prompts and the influence of that knowledge on decision-making. The brochure was one educational device, and this study also assessed whether the term “climate change” has a negative bias on survey answers. To answer these questions, I collected data from homeowners in Kalamazoo, Michigan. This study will benefit the KCCC, more specifically KalamazEE by helping us better understand what motivates homeowners to reduce their fossil fuel consumption, energy bills, and improve their homes.

Energy and the Environment

Transitions of energy sources, uses and efficiencies occurred over human history. For example, the invention of post windmills can be dated back to the eleventh century where they originated from a secluded area of Europe and quickly gained popularity (Wind Power Development, 2015). Historically, windmills have been used for pumping water and food production, it wasn’t until the late nineteenth century that windmills began being used for generating electricity (Wind Energy Foundation, 2016). While they were originally created for human convenience and not as a renewable or energy efficiency device as they might be termed
today, windmills represent a transition both away from renewables and now back to renewables. As time progressed, the correlation of energy waste and greenhouse gas emissions became clear, prompting change in energy standards.

The effects of climate change on Earth have necessitated the need for yet another transition or shift of energy use. “Rampant” CO2 emissions are added into Earth’s atmosphere and oceans through anthropogenic causes and are detrimental to ecosystems (Frameworks Institute, 2014). In order to decrease the rampant CO2 emissions humans must take action that promotes positive change and environmental protection.

Alarmingly, fossil fuels such as coal, oil, and natural gas make up over 80 percent of the sources of US energy (Figure 1). Whereas renewable energies only make up 10 percent of energy consumption and 13 percent of electricity generation (U.S. Energy Information Administration, 2015). Our society relies heavily on non-renewables where oil, coal, and natural gas produce 84 percent of the United States energy (Figure 1). Decisions not only need to focus on a shift of energy sources, but would also have to include increasing our energy efficiency (The National Academies, N.D.). Energy-efficiency adoptions are often affordable solutions in reducing the consumption of fossil fuel use. By increasing awareness and using education about energy efficiency, it could be a useful tool to reducing fossil fuel consumption, resulting in decreased greenhouse gas emissions and another step towards mitigating climate change.
Energy Efficiency in the Home

Residential homes are a large consumer of energy in the United States and particularly in the state of Michigan. By investing in home energy efficiency homeowners would be able to decrease their energy waste which in turn decrease greenhouse gas emissions. These adoptions would also allow homeowners in some cases to lower their utility bills each month. However, understanding where we are currently getting our energy from allows us to see the untapped potentials of renewable energies and energy efficiency adoptions.

Similar to the overall national US energy use, renewable energy accounts for a very low percentage of energy sources in Michigan as well (Figure 2). Nationally (see Figure 1 above),
renewable energy accounts for only 10 percent of the used energy in the United States, with biomass comprising 50 percent of that. In Michigan (see Figure 2 below), these results are mirrored with renewables being used far less and when used biomass being the preferred choice.

**Figure 2. Michigan Energy Consumption Estimates. EIA**

**Michigan Energy Consumption Estimates, 2013**

Source: Energy Information Administration, State Energy Data System

Residential energy use in Michigan accounts for 27.2% of all use (Figure 3), so any efficiencies gained in home heating, electricity or other uses would reduce the overall use and impact. Home energy efficiency adoptions would be able to reduce this percentage while also benefitting the homeowners.
Michigan has a higher number of “older” homes than most other states. (U.S. Energy Information Administration (b), 2009). The U.S. 2000 Census revealed that 78 percent of Michigan’s homes used natural gas for heat (U.S. Department of Energy (g), N.D.). These older homes, often considered less energy efficient, factor into the state’s overall energy use of 123 million Btu (British thermal units) of energy per home each year. This average is 38% higher than that of any other state (U.S. Energy Information Administration (b), 2009). Antrim Field, a major resource of natural gas located in the northern region of the Michigan Basin, may be one of the factors contributing to Michigan’s natural gas dependency (U.S. Energy Information Administration (c), N.D). Although it reached peak production in 1997, Antrim Field, still ranks
as one of the top 100 gas producing fields in the nation (U.S. Energy Information Administration (c), N.D). Access to this field may be a contributing factor to Michigan’s higher percentage of natural gas usage.

Increasing home energy efficiency is one method in which every American can directly reduce their consumption of energy that originates from fossil fuels. Many homeowners do not realize the amount of energy wasted by not having proper windows, insulation, appliances, and other adoptions. While overconsumption of energy is an issue that adds to climate change, home energy efficiency is a simple and effective way to decrease unnecessary energy consumption. It alone will not solve our energy crisis, but will help reduce energy consumption in tandem with seeking sustainable, renewable energy sources.

**Concepts & Modes of Energy Efficiency**

If homeowners are expected to install energy efficient devices, they first need to be educated on the concept of and terms surrounding energy efficiency. The Lawrence Berkeley National Laboratory clarifies that while often used interchangeably, energy efficiency and energy conservation are not the same concept, defining energy efficiency as “using less energy to provide the same service” (Lawrence Berkeley National Laboratory, 2016). Conservation is the act of making conscious decisions to reduce your energy use. Energy efficiency is very different from conservation, adoptions are designed to not consume the excess energy in the first place. Installing LED light bulbs is one example of adopting energy efficiency, while turning off the light when exiting a room is an example of energy conservation (Lawrence Berkeley National Laboratory, 2016). Many types of energy efficient adoptions have been designed to prevent home energy waste. These adoptions can go by many names, under the broad umbrella of
“energy efficiency” common terms include: retrofits, installations, devices, and implementations, however all of these terms mean the same thing. While often “efficiency” gets categorized with “consumption” or “conservation” these terms do not mean the same thing and for the sake of home energy efficiency they should not be used together.

The types of energy efficiency adoptions used in the home to decrease energy waste can vary greatly and range from simple do-it-yourself projects to more complex installations that would necessitate the hiring of a contractor or trained professional. An example of an easy and affordable adoption pertaining to the water heater would be an installation of a low-flow shower head. These efficient heads flow at 1.5 gallons per minute where as normal shower heads can flow at up to 5 gallons per minute (U.S. Geological Services (a), N.D.). An example of a more complex adoption would be a tankless water heater, which can be expensive to purchase and install. While these are costly they last longer than a conventional water heater and waste less energy. (U.S. Department of Energy (h), N.D.). Costing upwards of $2,500 with savings of at least $100 a year these could take anywhere from 25 years to pay off but a tankless water heaters lifespan can be anywhere to 30 years or more (U.S. Department of Energy (h), N.D.). Initially, an expensive investment, the price savings, over time may eventually be offset in decreased energy use.

In 2014 Forbes magazine offered several recommendations to help educate home energy consumers. Forbes first recommendation is the installation of smart thermostats. Smart thermostats are energy efficiency adoptions, which track and mimic heating and cooling patterns resulting in the “smartest energy savings” for its consumers. Forbes reports that over 40 percent of an energy bill comes from heating and cooling costs. At $200 per unit, these adoptions are not
only energy efficient, but are seen as a smart financial investment by many. Forbes’ second recommendation, the use of LED lighting versus other, less energy efficient, is already widely adopted installation. Next were energy management systems, which allow you to use a remote to control the energy being consumed in your home while you are away. The most common way that people use this is with their smart phone, the system is bought then software is downloaded onto your phone. Energy star appliances are fourth, these are certified appliances which are energy efficient and will pay for themselves in savings over just a few short months. Forbes reports that phantom power is one of the most common energy wasters around the home. In order to combat this a charging station can be purchased for the home, these devices automatically power themselves off if not used after a couple of hours. The final suggestion is the use of a smart power strips, which are very similar to charging stations. These strips allow multiple devices to be charged and also to be powered off simultaneously (Forbes, 2014).

Home energy audits are the first step in combating the energy waste that Michigan’s older homes are extremely susceptible to, these begin the home energy efficiency process. An energy audit “assesses how much energy a home consumes, and evaluates measures to make the home more energy efficient” (Environmental Protection Agency, 2015). Upon completion of an audit, adoptions are suggested that increase the home’s energy-efficiency. While suggested adoption costs will vary and are typically regained in the form of home energy savings, a number of payment methods are available for the initial acquisition of suggested adoption installations. A survey of home energy auditors found that 57.6% of homeowners used cash for energy-efficient adoptions, when combined with credit cards, 70% of these same homeowners paid using their own financial resources (Palmer et al. 2011). The same study found that finance
programs account for only 17% of the payment methods, suggesting the affordability of the energy-efficient adoptions (Palmer et al. 2011). These programs, however, would not be so readily available to homeowners if it weren’t due to the long history of governmental involvement with energy efficiency.

**Energy and Governmental Programs**

The recognition of the link between energy and the environment is clear in the environmental movement, subsequent public awareness, and in the resulting polices adopted at both the state and federal level of government in the US. Governmental programs can be a main incentive for homeowners to invest in energy efficient adoptions. These programs for residential homes allow easier accesses to the energy efficiency adoption process for homeowners who previously may not have had the financial means for adoptions.

On April 22, 1970 the United States celebrated its first Earth Day. The intent of Earth Day was to create an awareness of environmental issues, and support protection of the environment. The Environmental Movement coalesced in the 1970s decade with the passage of landmark legislation including: The Clean Air Act of 1970, The Clean Water Act of 1972, The Endangered Species Act of 1973, the establishment of The Environmental Protection Agency, as well as several other environmental protective initiatives. Environmental studies emerged in university curricula and most major environmental groups “were born.” (Lemann, 2013). The environmental movement made people aware of the detrimental effects of pollutants and excessive consumption and waste of resources on the planet and led to action to combat these problems. The effects of climate change on Earth have necessitated the need for a change of energy use.
Since the environmental decade the United States has taken steps to regulate energy use and fossil fuel emissions. The 1970’s was a time of realization, from this the first United Nations (UN) conference was held on the environment in 1972 (Keele, N.D.). Many non-binding agreements spurred from the environmental decade and the UN’s conferences such as the UN Framework Convention on Climate Change and the Kyoto Protocol of 1997(Keele, N.D.). Later the Energy Policy Act of 1992 allowed for the creation of a “competitive wholesale electricity generation market” and also exempt wholesale generators (EWG’s), a new “category of electricity producer.” (U.S. Energy Information Administration (a), N.D.). The environmental decade of the 1970’s paved the way for today’s sustainable achievements. At our most recent UN conference 196 countries came to an agreement on the next steps for regulating emissions, in the context of climate change, this level of environmental protection would not have been possible without the first UN conference fifty years ago.

While laws and regulations have been put in place to manage energy use and decrease waste the problem still remains. Energy use including production, consumption, conservation and efficiency remains a central concern. Over consumption of energy on both state and nationwide levels occurs commonly. Unfortunately, the issues from the environmental decade are still present but policy put in to place in the 1970’s created an opportunity by setting a framework for modern day policy on climate change.

Federal acts place standards on appliances used in homes and buildings which are implemented by the Building Technology’s Office (BTO), since 2009 they have issued thirty-four standards. (U.S. Department of Energy (b), N.D.). In 1974 California became the first state to place standards on appliances. The Energy Policy and Conservation Act (EPCA) of 1975 was
enacted shortly after. The EPCA was the national level enactment which created a federal program. In 1979 was amended, and the Department of Energy (DOE) was given responsibility for setting consumer product standards. The start of the EPCA also marked the beginning of the Appliance and Equipment Standards Program, then the National Appliance Energy Conservation Act (1987). From this, numerous household appliances received minimum efficiency standards. (U.S. Department of Energy (e), N.D.)

During the George W. Bush administration, the Energy Policy Act of 2005 was enacted (American Council for an Energy-Efficient Economy, N.D.) By placing new energy standards on 16 appliances, and allowing tax incentives for owning efficient appliance, this law reduces consumption of energy 2 percent by 2020, this amounts to 1.4 trillion cubic feet of natural gas and 63,000 MW peak electric savings (American Council for an Energy-Efficient Economy, N.D.) This law projected to have 15 million metric tons of carbon reductions which amounts to $20 billion reductions on consumer energy bills. (American Council for an Energy-Efficient Economy, N.D.)

Today, the Appliance and Equipment Standards Program regulates 90 percent of home energy use products, 60 percent commercial energy use, and 30 percent industrial energy use. (U.S. Department of Energy (b), N.D.). Together these products add up to over 50 products. (U.S. Department of Energy (b), N.D.). Because of the creation of the National Appliance Energy Conservation Act of 1978 the United States has avoided approximately 2.3 billion tons of unnecessary carbon dioxide, previously produced by appliance emissions. (U.S. Department of Energy (e), N.D.). By 2020 this number will rise to 3.9 billion, suggesting energy efficiency as an economical priority greatly benefits the planet. (U.S. Department of Energy (e), N.D.).
Energy Efficiency on the Federal Level

The main consumer of our nation’s energy is the federal government which is why programs like the Federal Energy Management Program (FEMP) were created (U.S. Department of Energy (a), N.D.). FEMP’s main objective is to give agencies the “information, tools, and assistance they need to meet and track their energy-related requirements and goals,” it acts as a match maker to find agencies their best fit for funding (U.S. Department of Energy (a), N.D.). FEMP provides education courses in partnership with the Institute of Building Sciences that can be accessed online, these greatly benefit Energy, Water, and Sustainability Managers at the mid-level of Federal agencies (National Institute of Building Sciences, 2016). These online courses give managers the accurate and up to date energy efficiency information (National Institute of Building Sciences, 2016). Federal agencies, large or small, would be able to utilize FEMP for their energy or water needs.

The Weatherization Assistance Program (WAP) through the U.S. Department of Energy uses an allocation formula that allows low income households to attain funds for home weatherization. Houses are given a greater equity for warm climates and minimized for colder climates. Three factors are assessed as part of the allocation formula before money is distributed to the states: population, climatic conditions, and residential energy (U.S. Department of Energy (i), N.D.). Each home can be given up to $6,500 for energy improvements (U.S. Department of Energy (i), N.D.). Another federally funded program is Low Income Energy Assistance Program (U.S. Department of Health and Human Services, 2016) which assists families with their home energy needs. They do this by not only helping out with financial burden of monthly energy
costs, but also during times of weather related crises and with the home weatherization process (U.S. Department of Health and Human Services, 2016).

Voluntary Programs are also an option for cities that want to take a more benevolent approach to the energy waste issue. The Home Performance with ENERGY STAR (HPwES), offer retrofit programs that, with the help of local sponsors, will do “whole-house” energy efficiency installations. Usually a “neighborhood blitz” approach will occur in segments of low income neighborhoods. In 2005, 70 Texas contractors participated in an HPwES program through Austin Energy who provides the municipal utilities for this area. These contractors completed 1,400 projects with a peak savings of more than 3,000 kW. (Energy Star (a), N.D.)

Table 1. Energy Efficiency Programs and Their Incentives
The above table shows other federal programs available in the United States that pertain to energy efficiency (U.S. Department of Energy (c), N.D.). There are many sectors that residents must fit into in order to be eligible for funding. Residents are funded through grants, tax credits, and loans once they complete energy efficient adoption processes required.

### Programs at the State Level

Essentially every state offers assistance programs specifically for their residents. These programs can easily be researched and accessed online. Most of them fall under one of three categories: Weatherization assistance program, Low income assistance program, Energy
Efficiency Program. (Benefits.gov, N.D.). Additional programs are also available for citizens who fit within certain categories, such as veterans, senior, disabled persons, Native Americans, and rural America. These programs offer loans based on individual needs through individual departments. (USA.gov, N.D.).

Michigan Saves is an example of a state level energy assistance program. A nonprofit organization, it provides financing and incentives to Michigan residents for energy efficient adoptions. Originating with a grant provided by the Michigan Public Service Commission (MPSC), Michigan Saves continues to assist residents using grants and partnerships with private sector lenders (Michigan Saves, N.D.). The assistance process begins with an authorized contractor estimate of the homeowner’s needs. If approved loans ranging from $1,000-$30,000, are made available for the completion of recommended installations (Michigan Saves, N.D.). Michigan Saves is applicable for residential, but also for commercial and municipal use. In addition to loans, Michigan Saves also offers grants for adoptions.

There are also grant programs on top of loan programs. An example of a Michigan-based grant program is funded through the U.S. Department of Energy’s State Energy Program (SEP). This financial incentive is offered to local government, nonprofit schools, and state government and is available for adoptions such as: water heaters, furnaces, heat pumps, programmable thermostats, weather-stripping, insulation, windows, LED lighting and other adoptions. (U.S. Department of Energy (c), N.D.) These grant programs look for education or outreach programs that help businesses or communities and programs that help to promote energy efficiency. To participate in these programs applications must be submitted and grant money will be allocated (U.S. Department of Energy (c), N.D.).
Home Energy Efficiency Adoption

Different approaches have been taken regarding the best way to apply home energy efficiency. By doing these the incentives and challenges of home energy adoptions have been revealed. Common themes have emerged themselves that seem to be the main incentives for residents to make their home energy efficient. These are monetary savings, improved health, and overall concern for the environment.

Challenges and barriers seem to present themselves more often during the energy efficiency adoption process. Common challenges were: personal behaviors and lack of trust, lack of education, and the overall price of the process. These challenges are faced in the United States and are also present in programs from other countries. Together these challenges present the United States with an energy efficiency gap

Incentives of Individual Adoption

Saving money is a primary incentive to be energy efficient in the home. If every household in the Midwest reduced their energy consumption by 15 percent each year, savings would be $80 in electricity bills (or 500 pounds of coal) and CO2 emissions equal to 1,400 miles driving a car. (Xcel Energy Inc, 2011.). These savings take financial pressure off of households who struggle with energy bills, allowing them to use the savings elsewhere. Examples of these adoptions and savings are low flow shower heads, providing up to $100 a year in savings, light timers providing $100 a year, attic insulation saving anywhere from $100 to $600 a year, and duct insulation which give savings from $100 to $200 a year. Commonly energy use and savings potential is underestimated (Dietz, 2010) which prohibits the full understanding of energy efficiency so households do not invest in these types of adoptions.
Not only saving money but also receiving money entices homeowners to adopt energy efficiency. This can be done through tax credits through companies such as the IRS and Energy Star. From 2009 to 2014 the IRS used the American Recovery and Reinvestment Act, a tax incentive that credited homeowners for investing in energy efficient adoptions (IRS, 2015). The tax incentive was called the Residential Energy Property Credit, it allowed for 30 percent credit of all qualifying energy efficient installations. (IRS, 2015.). Energy Star uses a federal tax credit which also covers 30 percent of the energy efficiency installation costs for qualifying appliances. (Energy Star (c), N.D).

Studies have found that psychology also influence homeowner’s decisions on energy efficiency. Residents make attitude-behavior decisions regarding their homes energy consumption (Stern, 1992). An example of this is the effect word of mouth information can have if you trust the source it comes from. One study hypothesizes that some homeowners are so influenced by what their peers have done that they will install energy efficient adoptions based of trust and reference instead of if they were educated on their own with the incentive to save money. (Stern, 1992). Another example is the home energy rating systems (HERS), these systems rate homes on their energy efficiency with the hopes that home buyers gravitate towards the more energy efficient option (Stern, 1992). The HERS use both the behaviors of contractors and consumers to promote success, “the most successful programs get that way by informal, applied psychology.” (Stern, 1992). Concluding that psychology plays an essential role when attempting to persuade homeowners to invest in energy efficiency.

Decreasing carbon pollution and maintaining a healthy atmosphere is another incentive. Burning oil and wood can cause the creation of fine particulate matter which is harmful to human
health. This can be decreased as a result of being energy efficient. Reducing mass energy waste will also offer cleaner air conditions for citizens in crowded cities (Office of Climate Change and Energy (b), N.D.). International Energy Agency reports “energy efficiency retrofits in buildings (e.g. insulation retrofits and weatherization programs) create conditions that support improved occupant health and well-being, particularly among vulnerable groups such as children, the elderly and those with pre-existing illnesses. The potential benefits include improved physical health such as reduced symptoms of respiratory and cardiovascular conditions, rheumatism, arthritis and allergies, as well as fewer injuries” (Romm, 2014.).

A genuine concern for the environment can also act as a positive incentive for home energy efficiency. A survey of 473 homes in Switzerland found that the residents who were most responsive were those who realized energy consumption impacts climate changes (Alberini, Banfi, Ramseier, 2013). An argument arises that overconsumption can occur after homeowners install small adoptions because homeowners feel they have done “their part” for the environment. To counter argue this, energy efficiency education will only further inspire these homeowners and give them a sense of accomplishment, leading to larger reductions of energy waste (Dietz, 2010).

**Challenges of Individual Adoption**

Personal behaviors and trust play a major role in the barriers for home energy efficiency. “When trust sours, the probability of adopting positive climate change behavior diminishes.” (Gifford, 2011). This mistrust may come from numerous places, but in any form it acts as a barrier against energy efficiency. For example, in the United States politics has a mostly negative effect on energy efficiency. Reduction in energy cost and “energy independence”
actually holds a greater support from the conservatives but when the concept is linked to climate change this is when energy efficiency becomes opposed by this group (Dietz, Leshko, McCright, 2013). The unfortunate truth is that there is not a complete consensus about climate change in the scientific community, thus creating trust issues for our general public (Dietz, Leshko, McCright, 2013). The behavior of basing beliefs off of a political group instead of one’s personal beliefs prohibits the effectiveness of energy efficiency campaign. It is important to provide the correct information, ultimately this is what will not only correct beliefs but the behaviors of people standing in the way of energy efficiency (Dietz, 2010).

Ensuring that the energy efficiency information comes from a known trusted source is important for ensuring homeowner education. A barrier may come from a bias the homeowner might have against a company or organization. A study done in New York City tested these biases by distributing various stationary containing information about electric bills to test their effectiveness (Stern, 1992). The study sent out two sets of brochures, containing the same information, with two different organizations affiliated. One of which was the New York State Public Service Commission while the other was the nearby electric company (Stern, 1992). The results of this study indicated only the brochures affiliated with the New York State Public Service Commission were used, these homeowners saved seven percent on their electricity bills while the local electric company participants had no savings (Stern, 1992). A similar study done in Minnesota offered homeowners free insulations, all provided through the County and done by the same company, but delivered on three separate letterheads (Stern, 1992). The three letterheads were: 1) the private company’s name, 2) the private company with mention of the County’s role, 3) the following but additionally signed by the chairman of the County Board of
Commissioners (Stern, 1992). Regardless of the free service, the third letterhead received thirty-one percent of responses, where the second option received eleven percent, and the first only six percent (Stern, 1992). This study also found that tenants preferred insulation while landlords preferred furnace installments proving that there is also a major disconnect between the home dweller and the homeowner in these situations. It is assumed that a lack in energy efficiency implementation by homeowners in New Zealand is due to poor marketing and information asymmetry (Phillips, 2012).

Lack of education also hinders the effectiveness of home energy efficiency. Education must be strengthened in a couple areas including the savings obtained through energy efficiency and the process of home energy efficiency adoption. A common concern is that energy efficiency will encourage people to consume more (Tollefson, 2011). This could be an issue if the education is not handled correctly, the overall goal is to teach lasting sustainable practices. Energy efficiency is equated to the “tune ups” on a car, our society tends to underestimates their necessity but they keep your vehicle running at the most efficient performance, and most underestimate the savings by three times the actual amount (Dietz, 2010). Studies have hypothesized that the reason energy efficiency is not as prevalent in homes is due to the lack of education of homeowners (Alberini, Banfi, Ramseier, 2013; Dietz, 2010; Sorantana, Marriott, 2010; Palmer et al. 2011).

A study which surveyed 479 home energy professionals inquired about the issues revolving around the adoption process (see Palmer et al. 2011). Results concluded that audits are necessary to having a “well-functioning processes” and the home energy professional who were surveyed believe they aren’t being done for a number of reasons: trust of the information given
to them, cost of energy efficiency adoptions, not know what home audits are, and not having high enough energy bills to need them. That same study showed that 26 percent of professionals believed too much government money is allocated towards installations of energy efficient adoptions and not enough goes towards the communication about these programs (Palmer et al. 2011). One study suggests that these programs, like loans and subsidies, are reliant on two variables: knowledge and attitudes (Stern, 1992). Knowledge concerning the government programs is only effective if the homeowner is actually aware these programs are available to them (Stern, 1992). If this is the case and homeowners aren’t aware of these programs, the government should be implementing a more effective awareness campaign. The second variable, “attitudes inappropriate,” would apply if the homeowner avoided these programs as a result of not wanting more debt (Stern, 1992). When government programs are framed inaccurately these variables combined will make them unsuccessful. This same study found that type of message conveyance influenced homeowners differently, information given through video produced 20 percent more energy savings than the same written information (Stern, 1992). Government programs as well as other programs that “promote investment” must simplify the shopping process for consumers in order for them to be effective (Stern, 1992).

Price is a challenge in the case of home energy efficiency adoptions. To overcome this barrier, the installation company could also be the lenders, this way the homeowner would get instant installations and the company would profit from the “payback period.” This concept was tested and unfortunately failed. The hypotheses was that there is a failure in home energy efficiency implementations because of a lack of education and also an equal lack of capital investments for improvements. The authors of this study proposed the increased usage of a
market-based residential energy services company (RESCO’s) in order to promote the implementations. A RESCO would audits the home to assess their needs, then they promise them a 10% energy savings and then do installations that save up to 25% of energy. The homeowner then enters a contract with the RESCO which would allow a “payback period” which in order to be profitable would need to be approximately 8 years long. From this agreement the homeowner receives free installations while decreasing their energy bill. RESCO gains the remaining difference of 15% energy savings bill. This study revealed that the actual “payback period” would have to be 35 plus years in order the RESCO to make a profit. This market is not profitable, thus the reason why installation companies don’t get involved in the loan process. (Soratana, Marriot, 2010)

The adoption process of home energy efficiency can be expensive, acting as a challenge for residents. Adoptions do accommodate a spectrum of price ranges but in order to receive maximum savings a full weatherization process should be done. Home weatherization is expensive. Barriers for homeowners are the upfront costs, actual savings received from energy expenses, and the time spans that these savings would be realized (Alberini, Banfi, 2013). Although energy efficiency gets a bad reputation in the industrial world, many managers concern themselves more with the initial costs of the adoptions and less with the overall savings they’ll receive (Chai, Yeo, 2012).

Methodology

The purpose of this study was to analyze the current status of home energy efficiency in Kalamazoo by conducting door-to-door data collection in two demographically different Kalamazoo neighborhoods. Interview questions (Appendix A) focused on the adoptions
undertaken (or not), the perceived barriers and challenges of adoption, and the role of educational prompts. A section of this study also assessed if excluding the term “climate change” from climate change education changed the effectiveness of the method. Door-to-door interviews were conducted with an educational prompt, a brochure produced by the Kalamazoo Energy Efficiency (KalamazEE), a Kalamazoo Climate Change Coalition (KCCC) working group, describing current energy adoptions and incentives. This brochure was designed to have a self-teaching, self-explanatory design. Results were analyzed for differences between the neighborhoods and for influence of the educational prompts.

Starting in the month of February, door-to-door interviews occurred over the span of three weeks on Saturdays and Sundays from noon to four and took anywhere from five minutes to an hour. Participants had the option of either being orally interviewed or reading the questions on their own. They also had the option of doing an in person survey or taking the survey on their own and having the surveyor return to their home once they had completed it to retrieve the survey. For the privacy of the interviewee, the interviews were not recorded and all data collected was stored in the principal investigator’s office, 3426 Friedmann Hall, in the Department of Political Science. In order to protect subjects this study has not recorded names, keeping participants anonymous. The only personal information collected was the home address that was used for the interview. This information was required for data analysis in the results of this study.

This study was approved for the use of human subjects by the HSIRB (Appendix A)

Subject Recruitment
The City of Kalamazoo is comprised of 22 neighborhoods, all of which differ in socioeconomic statuses (Figure 4). In 2013 the median age of Kalamazoo residents was 34 and household income was $33,766. (“Kalamazoo County, 2013). The subjects for this study were recruited randomly through door-to-door interviews in two of these Kalamazoo neighborhoods. For this study I interviewed a minimum of thirty homeowners from two different neighborhoods, one upper (Westnedge Hill) and one middle class (Milwood), using income as the primary determining variable.

Figure 4. Kalamazoo Neighborhoods – Western Michigan Library

Adapted From: City of Kalamazoo
Millwood neighborhood represents a middle income area, with a median income of $40,902. While Westnedge Hill represents a higher income area, with a median income of $73,000. A minimum of fifteen targeted homes were surveyed in each neighborhood. A residential street off of the main transect was chosen as the site of the survey locations. Fulford/Moreland Street being the main street chosen for Milwood. While Rose Street was surveyed for Westnedge Hill, as it is located in the sub-portion surveyed, located East of S. Westnedge and North of Cork Street. (Figure 5 & 6) Any side street, still within boundaries of the neighborhood, off of Rose and Fulford/Moreland St. could also be surveyed. See below google maps of both Westnedge Hill and Milwood neighborhoods.

Figure 5. Westnedge Hill- Rose St. (Adapted From: Google Maps)

Figure 6. Millwood Neighborhood- Fulford/Moreland St. (Adapted From: Google Maps)
While participants were randomly chosen from pre-selected main transect streets, participants had to meet certain mandatory inclusionary criteria including: homeowner, over the age of twenty-one, in either Milwood or the section of Westnedge Hill neighborhoods. Additionally, participants would not be selected if they were outside of the random selection, even if they were to show an interest in the study. Homeowners who agreed to be interviewed first needed to sign the consent form agreeing to answer the 16 pre-approved questions. If the participants had any questions, my contact information was available on the consent form.

**Survey Data Analysis**

The data collected for this study was recorded in Excel and quantified to report a response rate and the mean, median and range of responses to each question. The open ended survey questions have been used to gather a synopsis of ideas that will be recorded. After reviewing the data obtained from the surveys, research comparisons were made by looking for patterns, along with the development of metaphors.
Hypotheses

Fifteen interview questions from the energy efficiency educational prompt and one additional question from a climate change prompt were used during the interviews (Appendix B). These questions mainly focused on the perceived barriers and challenges of energy efficiency adoptions. The Westnedge Hill neighborhood was hypothesized to have little to no barriers as it is a higher socioeconomic area. While Milwood was hypothesized to have a more realistic survey pool, as it represents the middle class neighborhood. Surveying these two neighborhoods with these questions addressed four study hypotheses:

1) “Higher socioeconomic class neighborhood as represented by the residents of Westnedge Hill are more likely than the middle class neighborhood of Milwood residents to have already adopted energy efficiencies in the home.”
2) “Higher socioeconomic class neighborhood as represented by the residents of Westnedge Hill are more likely than the middle class neighborhood of Milwood residents to have access to the incentives of adoption including time, money, awareness of programs.”
3) “Higher socioeconomic class neighborhood as represented by the residents of Westnedge Hill are more likely to respond to the educational prompts (brochure and climate change metaphor) and respond with higher likelihood that they would now install energy efficiency than the middle class neighborhood of Milwood residents.”
4) Climate change perception can be changed using educational methods that exclude the use of the term “climate change.”
Survey Results

In total thirty homeowners participated in this study. Fifteen completed surveys came from Milwood, the lower socioeconomic neighborhood, and the other fifteen came from Westnedge Hill, the higher socioeconomic neighborhood. Of the two subject recruitment methods (may need to more briefly remind the reader of this: Participants had the option of either being orally interviewed or reading the questions on their own. They also had the option of doing an in person survey or taking the survey on their own and having the surveyor return to their home once they had completed it to retrieve the survey, twenty five (83%) of participants in each neighborhood chose the latter method. While this increased participation in the study, participants who chose this method expanded less on their answers, opting for more basic “yes/no” answers instead of the interviewed participants who expanded upon their answers in detail. These “yes/no” responses made interpreting the data difficult. Administered surveys, in person, allowed for questions to be addressed and more detailed answers.

Knowledge and Adoption

Respondent’s answers to adoption demographic questions one, two and five on familiarity, products and whether they adopted are presented in Table 3. Each question is further divided and discussed as a comparison between the two neighborhoods. All questions represented in Table 3 were prior to the reading of any educational prompts so are considered the baseline gauge of knowledge and practice in these neighborhoods for Kalamazoo.

Table 3. Survey Question Results (Prior to Reading Brochure)
When responding to whether or not they were familiar with energy efficiency programs, and what their knowledge of energy efficiency was, over half of the total participants (57%) responded that they were. Participant responses in both neighborhoods were also very similar, where nine participants in Westnedge Hill (60%) and eight participants in Milwood (53%) agreed they had a good understanding of energy efficiency programs. Thus, out of the total thirty participants a majority (57%) felt educated and four of these knowledgeable participants (two from each neighborhood), mentioned that they received their information through Consumers Energy. Only a total of three participants (10%), two from Westnedge and one from Milwood, responded that they were not familiar at all. Slightly more Milwood residents (40%) than Westnedge residents (27%) of responded that they were only somewhat knowledgeable.

Almost all residents (90%) responded that they were familiar with purchasable products that lowered energy bills. Results were similar between the neighborhoods, fourteen Westnedge Hill homeowners (93%) and thirteen Milwood homeowners (87%) indicating they were familiar with such devices. A total of only three respondents (10%) indicated they were somewhat familiar.

* N/A is used for homeowners who did not answer the question.
familiar, with the Westnedge Hill participant indicating they were unsure of these products only because they did not know brand names.

Almost all (90%) of the total participants had made an energy efficiency adoption in the last five years. Results were similar between the neighborhoods with fourteen Westnedge Hill homeowners (93%) and thirteen Milwood homeowners (87%) indicating they had made an adoption of some type. I further evaluated this question by dividing the adoptions into classifications, major and minor. Major adoptions are larger, such as: windows, insulation, air conditioning units, roofing, new doors, appliances, etc. Minor adoptions classify as: lighting, programmable thermostats, plastic window covering, weather door strips, etc. The higher socioeconomic class neighborhood, Westnedge Hill, had nine residents (60%) with major adoptions whereas Milwood had ten (67%). Contrastingly four Westnedge Hill homeowners (27%) had minor adoptions where only two Milwood homeowners (13%) had them. One Westnedge Hill homeowner did not go into specifics but did answer “yes” they had done home energy efficiency adoptions. Another four homeowners (27%) responded that they had made adoptions but they were not as major, i.e. plastic covering, door strips, LED lights, programmable thermostats, etc. Similarly to the last question one homeowner just responded “yes” to the question and another responded that they had not made any adoptions in the last five years. Whereas Milwood residents responded to this question with ten homeowners (67%) making major energy adoptions in the last five years, i.e new appliances, windows, air conditioners, insulation, and/or new roofs. One homeowner even answered that they had landscaped their lawn in an energy efficient way, so they required less air conditioning in the warmer months. Only two homeowners (13%) answered they had done minor energy efficient
adoptions, i.e. lightbulbs. And the last two (13%) responded that they had not made any energy efficient adoptions in the last five years.

**Hypothesis 1**

Thus these survey results from the first set of questions as depicted in Table 3, lead me to reject hypothesis 1. Instead, I conclude that higher socioeconomic class neighborhood as represented by the residents of Westnedge Hill are *not* more likely than the middle class neighborhood of Milwood residents to have already adopted energy efficiencies in the home. Thus, rather than finding a difference, most Kalamazoo residents surveyed were familiar or at least somewhat familiar with energy efficiency programs, and almost all were familiar with products that could lower their energy bills and had made some type of adoption to one of these in the last five years. And although the higher socioeconomic neighborhood did have a slightly higher number of homeowners familiar with products the lower socioeconomic neighborhood had a higher pool of homeowners who had made major adoptions.

To gauge residential understanding of price and savings of energy efficiency adoptions the question concerning cost and potential savings of a low flow shower head was included in the survey. Typically a low flow shower head costs $4 and has the potential savings of $100 yearly. Typically the cost of this adoption is over estimated and the potential savings is under estimated.

Only two out of the thirty homeowners (.07%) knew the correct answer to this question. Westnedge Hill resident’s answers varied to this question. Only one homeowner from Westnedge Hill was in the general range for the cost of the adoption and knew/guessed the potential savings correctly. Similarly only one homeowner from Milwood neighborhood also had the correct number for both cost and savings. Of the rest of the Westnedge Hill participants,
four homeowners (27%) overestimated the cost but did know/guess the savings potential of $100, three homeowners (45%) were in the general range for the cost of the adoption but overestimated the savings potential of it. And only one homeowner (.07%) from Westnedge Hill overestimated the cost and under estimated the potential savings. Slightly under half (45%) of the Milwood homeowners overestimated the cost and under estimated its potential savings. Five homeowners (33%) were correct in guessing that the potential savings amounted around $100 but overestimated the cost of the adoption. And one homeowner answered quite frankly that he would never purchase one so he didn’t want to answer this question.

**Education**

Participants were next asked to review the brochure and then respond to questions about the educational content of the brochure, its influential abilities and whether or not homeowners now felt compelled to adopt energy efficiency. Table 4 presents the education related questions, the homeowners individual responses, as well as the cumulative responses to these questions.

**Table 4. Survey Question Results (After Reading Brochure)**

<table>
<thead>
<tr>
<th>Question</th>
<th>Westnedge Hill Neighborhood Response</th>
<th>Milwood Neighborhood Response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you find this brochure educational &amp; containing enough info?</td>
<td>“Yes” 14</td>
<td>“Somewhat” 1</td>
<td>“No” 0</td>
</tr>
<tr>
<td>Did the brochure change your mind about energy efficiency?</td>
<td>“Yes” 5</td>
<td>“Somewhat” 0</td>
<td>“No” 8</td>
</tr>
<tr>
<td>Would you now install adoptions?</td>
<td>“Yes” 13</td>
<td>“Somewhat” 0</td>
<td>“No” 0</td>
</tr>
</tbody>
</table>

A majority (70%) of total respondents found the energy efficiency brochure both educational and containing enough information. However, there were differences between the neighborhoods responses with almost all of Westnedge Hill participants (93%) and not quite a
majority of Milwood participants (47%) finding the brochure both of these things as well. The one unsatisfied Westnedge Hill homeowner felt that while the brochure was informational an additional list of websites including adoptions and their comparison prices would be helpful. Another five Milwood homeowners (40%) found the brochure somewhat educational, feeling that it was only a “starting point” and “would only provoke homeowners to do their own research.”

A majority of all participants (63%) indicated the brochure did not change their mind about energy efficiency. There was a difference between the neighborhoods responses with two-thirds of the Milwood participants (73%) and slightly more than half of Westnedge Hill participants (53%) indicating the brochure did not change their mind. Many homeowners expanded on their answers to explain the reason the brochure did not change their mind was because they were already supportive to start with. For example, homeowners answered, “No—because I was already on board.” This reasoning (that they answered no because they did not need their minds changed) is further buttressed by respondents answers in Table 3. Only five out of the thirty homeowners (17%), all from Westnedge Hill neighborhood, responded yes it had changed their mind. Five homeowners (33%) responded, “yes” this changed their mind, but all three of them had also done home energy adoptions in the last five years. Another two (13%) responded “yes,” but neither of them had made any home energy efficient adoptions in the last five years. One homeowner responded with general comments instead of answers such as “staying alert” and “gave me energy efficient ideas

A majority of all participants (63%) would now install home energy efficiency adoptions. Again in this set of questions there was a difference in responses between neighborhoods with
the vast majority (86%) of Westnedge Hill residents indicating yes and only 40% of Milwood residents responding in the affirmative. Only four of the Westnedge Hill homeowners (27%) responded that they would but there were factors restricting, such as money, time, and payback investments. And only one Milwood resident (.07%) responded he would do these adoptions if money wasn’t a barrier.

**Hypothesis 3**

After assessing the following data there is strong support for my hypothesis stating the higher socioeconomic class neighborhood (Westnedge Hill) would be more likely to respond to the educational prompt – concerning the brochure- and have a higher likelihood to now install energy efficient adoptions than the lower socioeconomic neighborhood (Milwood). With the majority (86%) of Westnedge Hill agreeing they would now install after education with the brochure and less than half (40%) of Milwood indicating they would.

All homeowners who participated in this study were asked a set of questions that first gauged their feelings towards climate change. Then they were asked to read a climate change metaphor that assess if removing the term “climate change” altered perceptions or feelings of the topic. This metaphor explained our changing climate in terms of a “heat trapping blanket” surrounding Earth.

A slight majority (57%) of the homeowners believed in climate change and were concerned about its effects. A slightly larger majority of Westnedge Hill homeowners (60%) responded in some variation that they believed and were concerned with the effects of climate change. Similarly eight homeowners (53%) of Milwood neighborhood felt climate change was caused by mankind, most mentioning concern for not only our environment but also our
economy. The remaining minority homeowners (40%) from Westnedge Hill claimed they were familiar with climate change but chose to take no stance on the topic. Even less homeowners (27%) from Milwood had this similar belief that the consensus behind climate change wasn’t the truth. One believed it was mainly caused by natural cycles with human enhancement, another thought it was too politicized and the truth was skewed, and two thought that the issue was too big for individuals to have impacts on. Finally the last participants from Milwood responded with one homeowner saying they were familiar with climate change but knew very little about it and the last homeowner chose to not answer the question.

The answers of these two neighborhoods regarding initial climate change perceptions were very similar. Although the lower socioeconomic neighborhood expanded on their answers in more detail than the higher socioeconomic neighborhood did, making data analysis easier. Majority of these neighborhoods however were familiar and receptive of climate change, some even expressing deep concern about it. Slightly more than half of the homeowners (53%) disagreed that their perceptions of climate change were swayed after hearing the educational metaphor. Similarly slightly more than half of Westnedge Hill homeowners (53%) were in disagreement that the educational metaphor changed their perception. Three of these homeowners (20%) were already concerned about climate change and five (33%) homeowners were already knowledgeable about the topic, explaining why their perceptions were not changed. A slightly higher number of homeowners (67%) from Milwood also felt that their perceptions of climate change were not influenced by the educational prompt. Of these homeowners six (40%) responded that their perceptions were not changed because they already viewed climate change as an important issue in today’s society, another two (13%) responded that they were
knowledgeable of the issue and because of this their perceptions were not changed. Finally the last two (13%) responded their feelings were simply not changed by this. There was a slight minority (13%) of Westnedge Hill homeowners who felt their perceptions were changed after hearing this prompt, and one participant responded that it “helped them to better understand the causes of climate change.” One Westnedge Hill homeowner felt this was a better educational prompt for young people, while another claimed it left them feeling “sad and hopeful of change.” Only one (.07%) Milwood homeowner felt that the prompt changed their perception of climate change. Another Milwood homeowner responded that the prompt left them “feeling guilty.”

**Hypothesis 4**

In regards to my hypothesis that climate change perception could be changed by excluding the term “climate change” from educational methods. Only two out of thirty (.07%) participants responded “yes,” that their feelings or perceptions were changed after the climate change educational prompt. But, almost half (43%), thirteen out of the thirty participants, wrote that they already had a good understanding of climate change and believed it to be true before exposure to the educational prompt. The exact same amount of homeowners (53%) from both neighborhoods, disagreed that the educational metaphor on climate change was effective in swaying their perspectives on the topic. Similarly the same number, only one homeowner from each neighborhood agreed that this changed their minds. Because of this I am unable to determine if the higher socioeconomic neighborhood, Westnedge Hill was more or less receptive to this educational prompt than the lower socioeconomic neighborhood, as they had almost identical answers.
Incentive-Barrier Ranking

A set of common challenges and incentives were compiled from the literature. Participants were asked to rank their perception of the strength of the incentive or barrier on a numerical scale where 1 = least important and 5 = most important. Shown below are the results of Westnedge Hill and Milwood neighborhoods ranking one (least important) and five (most important) when considering home energy adoptions. “Question 6” addresses homeowners who have installed energy efficiency adoptions within the last five years and asks them to rank what their most important incentives to do so were. “Question 7” addresses homeowners who have not installed energy efficiency adoptions within the last five years and asks them to rank the barriers or challenges for why they have not. And “question 4” asks the homeowners to re-rank these incentives and barriers using the same numerical ranking system after they have been exposed to the educational brochure, in hopes that the education has changed what is most/least important to them.

<table>
<thead>
<tr>
<th>Westnedge Hill Neighborhood</th>
<th>Time</th>
<th>Money</th>
<th>Incentive Programs</th>
<th>Climate Change</th>
<th>Morality</th>
<th>Technical Knowledge</th>
<th>Knowledge of Incentive Program</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeowners who’ve made adoptions in the last five years</td>
<td>2.89</td>
<td>2.91</td>
<td>2.55</td>
<td>3.70</td>
<td>3.55</td>
<td>4.11</td>
<td>3.50</td>
<td>0.00</td>
</tr>
<tr>
<td>Homeowners who’ve not made adoptions</td>
<td>5.00</td>
<td>2.00</td>
<td>1.00</td>
<td>N/A</td>
<td>N/A</td>
<td>5.00</td>
<td>5.00</td>
<td>0.00</td>
</tr>
<tr>
<td>After educational brochure ranking</td>
<td>3.27</td>
<td>2.83</td>
<td>3.00</td>
<td>3.58</td>
<td>3.70</td>
<td>3.36</td>
<td>3.13</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Table 5: Ranking Average of Incentives/Barriers for Home Adoptions

<table>
<thead>
<tr>
<th>Milwood Neighborhood</th>
<th>Time</th>
<th>Money</th>
<th>Incentive Programs</th>
<th>Climate Change</th>
<th>Morality</th>
<th>Technical Knowledge</th>
<th>Knowledge of Incentive Program</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeowners who've made adoptions in the last five years</td>
<td>3.00</td>
<td>4.00</td>
<td>2.88</td>
<td>3.67</td>
<td>3.29</td>
<td>3.22</td>
<td>3.38</td>
<td>1.00</td>
</tr>
<tr>
<td>Homeowners who’ve not made adoptions</td>
<td>5.00</td>
<td>1.00</td>
<td>4.00</td>
<td>N/A</td>
<td>N/A</td>
<td>2.00</td>
<td>3.00</td>
<td>N/A</td>
</tr>
<tr>
<td>After educational brochure ranking</td>
<td>3.44</td>
<td>3.90</td>
<td>3.17</td>
<td>3.56</td>
<td>4.13</td>
<td>3.56</td>
<td>3.29</td>
<td>2.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Mean: Both Neighborhoods</th>
<th>Time</th>
<th>Money</th>
<th>Incentive Programs</th>
<th>Climate Change</th>
<th>Morality</th>
<th>Technical Knowledge</th>
<th>Knowledge of Incentive Program</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homeowners who’ve made adoptions in the last five years</td>
<td>2.94</td>
<td>3.45</td>
<td>2.71</td>
<td>3.68</td>
<td>3.42</td>
<td>3.67</td>
<td>3.44</td>
<td>0.50</td>
</tr>
<tr>
<td>Homeowners who’ve not made adoptions</td>
<td>5.00</td>
<td>1.50</td>
<td>2.50</td>
<td>N/A</td>
<td>N/A</td>
<td>3.50</td>
<td>4.00</td>
<td>N/A</td>
</tr>
<tr>
<td>After educational brochure ranking</td>
<td>3.36</td>
<td>3.37</td>
<td>3.08</td>
<td>3.57</td>
<td>3.91</td>
<td>3.46</td>
<td>3.21</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Question 6

When asking homeowners who have installed energy efficiency adoptions within the last five years to rank the least and most important incentives to do, climate change (3.68), morality (3.42), money (3.45), technical knowledge (3.67) and knowledge of incentive programs (3.44) were ranked the most important variables. However, out of both neighborhoods climate change ranked the most important incentive for these homeowners to adopt energy in the last five years. Similarly to the overall ranking the lower socioeconomic neighborhood, Milwood, ranked climate change as being the most important incentive to adopt as well. The higher socioeconomic neighborhood, Westnedge Hill, ranked technical knowledge as being the most important incentive for home energy efficiency adoption. Morality was another strong incentive.
between the two neighborhoods, with a total mean of 3.42. A general concern for the environment and saving money were also heavily voiced by Kalamazoo residents. Participants wrote about the environment, such as “I am concerned for my children’s sake,” “I hate seeing water wasted, it’s so bad for the Earth. I am the water police at my house!”, and “I am a biologist so I am well educated on all of this and very concerned about the environment.” And participants wrote about saving money, for example, “we initially made these fixes around the house to lower our very high utility bill” and “we went with the energy efficient windows because we knew they would save money each month.”

Question 7

When asking homeowners who had not done any energy efficiency adoptions in the last five years the largest barrier that presented itself for both neighborhood homeowners in this study was time. As expected, both neighborhoods also ranked time individually as the highest barrier for making adoptions. However, the higher socioeconomic neighborhood, Westnedge Hill also ranked technical knowledge and knowledge of incentive programs as equally important barriers to making energy efficiency adoptions. A significantly low amount of homeowners (20%) wrote in their survey that price was a barrier but “money” was ranked as one of the most important variables considered when adopting energy efficiency. A small portion, five of the homeowners (33%) who felt price was a barrier were from the higher socioeconomic neighborhood, Westnedge Hill and only one (.07%) was from Milwood.

Hypothesis 2

I am able to make conclusions regarding my initial hypothesis that higher socioeconomic neighborhoods, represented by Westnedge Hill would be more likely to have access to the
incentives of adoption including time, money and awareness of programs than lower socioeconomic neighborhoods, represented by Milwood. Table 5 depicts Milwood residents ranking time and money as both being more important deciding factors when considering whether or not to adopt home energy efficiency. The higher socioeconomic neighborhood, Westnedge Hill, did not rank these variables as high meaning they were not as big of barriers for these residents. However Milwood residents ranked program knowledge just slightly higher on their importance scale, indicating they knew more of the existing programs than Westnedge Hill. There was one contradiction in my study during earlier question, when asked if homeowners would now install adoptions after being educated four Westnedge Hill participants answered that money and time were barriers while only one Milwood participant had this concern. However based on the numbers from Table 5 it’s very possible that more Milwood participants had these concerns and just did not physically write in the survey other than the incentives and barriers ranking question. With this I find moderate support that the higher socioeconomic neighborhood did indeed have better accesses to the mentioned incentives.

Regarding the question which asked the homeowners to re-rank the incentives and barriers after they’ve been exposed to the educational brochure, there were trends with morality and technical knowledge as well as money. In both neighborhoods the rank of importance for technical knowledge and money decreased and the rank of importance for morality increased after the homeowners were exposed to the educational brochure. Milwood neighborhoods biggest increase was in morality, homeowners ranked this incentive at a 3.29 before and a 4.13 after. As homeowners from both neighborhoods increased their rank in morality they decreased their rank of importance in climate change. Westnedge Hill’s biggest decrease in barriers was
technical knowledge which declined from 4.11 to 3.36 after being exposed to the educational brochure. Although this question may appear to be more education related it was more beneficial in this grouping of similar “ranking questions” as it allowed me to see how homeowners felt about incentives and barriers before and after the educational brochure. The information gleaned from this data only strengthens my hypothesis on not only education being effective but on barriers, such as time and money being more prevalent in lower socioeconomic neighborhoods.

Unfortunately question 2 “did this change your mind about energy efficiency” was one of the questions that was misunderstood by participants who filled out the survey on their own. This was mainly perceived with confusion by the large number of homeowners who had prior installed energy efficiency in their home. Many did not understand why I was asking them if they had already install energy efficiency into their home. A common response to this answer was “no, because I already agreed with it” which made analyzing data on the brochure difficult. This also holds true for the climate change educational prompt, many homeowners already agreed with the content.

Regarding “question 3” which asks participants if they would now install energy efficiency after the educational prompts, a total of half the homeowners (50%) responded that they would. More than half, nine homeowners (60%) responded “yes” from Westnedge Hill. While only six homeowners (40%) responded “yes” from Milwood. But five homeowners (33%) in Milwood neighborhood responded that they already had installed and would continue to install efficient adoptions regardless of the education from the brochure.
Assessing the effectiveness of the educational portion of this study is difficult. Due to the delivery method and the lack of interpersonal communication, I am unsure of how the educational material was conveyed. The brochure was left with the homeowner and the climate change metaphor was hopefully read and understood. But the participant’s receptiveness of this educational material could not properly be gauged due to the lack of interaction and vagueness within written responses. As a result the hypothesis question regarding the higher socioeconomic neighborhood being more receptive to the educational material as opposed to the lower socioeconomic neighborhood could also not be properly assessed.

Discussion

The purpose of this study was to assess the status of home energy efficiency awareness and adoption in Kalamazoo, the reasons why (or why not) a homeowner made energy efficient changes, and whether educational prompts could influence adoption or awareness. Seeing as Michigan does have a higher number of older homes, these add to the state’s overall energy use of 123 million Btu (British thermal units) per home/year, which is 38 percent higher than any other state (U.S. Energy Information Administration (b), 2009). The inherent assumption underlying this research was that I would provide recommendations for improving energy efficiency awareness and adoption in Kalamazoo. However, instead this study showed that homeowners in both Milwood and Westnedge Hill neighborhoods were already extremely aware of and implementing home energy efficiency adoptions. Moreover, the expectation of differences in awareness and practice by socioeconomic class were not borne out in this experiment as the residents of Westnedge Hill were not more likely than the middle class neighborhood of Milwood residents to have already adopted energy efficiencies in the home.
Thus, rather than finding a difference, most Kalamazoo residents surveyed were familiar or at least somewhat familiar with energy efficiency programs, and almost all were familiar with products that could lower their energy bills and had made some type of adoption to one of these in the last five years.

Although the status of awareness and adoption were already high in these neighborhoods in Kalamazoo, this study did go further and also assess the incentives and barriers that homeowners face when attempting to make home energy efficiency adoptions. A literature review revealed that the main challenges of making adoptions were personal behaviors and trust, lack of education, and cost. The main incentives identified were saving money, tax credits, morality, a concern for the environment and its health benefits. Participants in this study confirmed some of these challenges and incentives described in the literature, but contravened others.

With the higher number of older homes in Michigan, adding to a 38 percent higher average of Btu’s used per home each year (U.S. Energy Information Administration (b), 2009), one reason that many of these homeowners possibly made adoptions could have been due to outdated fixtures or appliances. If the homeowner was either unhappy with the aesthetic of the old fixture or appliance, or it simply needed to be updated out of necessity many of the upgrades would have been energy efficient. For example, old Michigan homes could have single pane windows, which are extremely energy inefficient, just by installing double pane windows this is immensely increasing the energy efficiency of the home.

Several studies concluded home energy efficiency was not adopted due to lack of homeowner education (Alberini, Banfi, Ramseier, 2013; Dietz, 2010; Sorantana, K, Marriott,
2010; Palmer et al. 2011). The majority of Kalamazoo residents in these two neighborhoods indicated they already were knowledgeable and the vast majority (90%) said they knew about products. However, one limitation of this study is that we were simply asking people to relate their own perceived level of knowledge and awareness which could be overestimated. When participants in this study were asked a follow up question about a specific product (low flow shower head) almost no one could correctly identify the cost and benefits of the product. Thus, although Kalamazooites respond they are knowledgeable, a knowledge gap could certainly still exist.

This study attempted to further tease out the role that education plays in homeowner energy efficiency adoption, however the methodology of the project failed to provide clearcut answers. Homeowners who were shown the brochure by the researcher versus those who looked at it on their own had two very different experiences. Not administering the survey, in-person, prohibited me from getting better answers on the effectiveness of the educational brochure, clouding my results and understanding. A slight majority (53%) of participants indicated the brochure did not change their mind because they were already supportive and knowledgeable and had adopted practices. Had I been administering the survey in-person I may have been able to answer any questions on the brochure or misconceptions about energy efficiency they may have had. Other instances of homeowners skipping questions they may have had confusion on or leaving vague answers to questions that needed more detail left me with the conclusion that I could not at this time assess the education aspect of my study. My absence from the survey administration process lead to a lack of interpersonal education in this study.
Although it seems Kalamazoo is progressive on these issue, the education gap and the role further education could play is unclear. However, all other research would indicate that this gap could be further remedied by increased education and awareness campaigns in Kalamazoo. There also is a difference in your respondents who say they are supportive of the environment – this is not the same as actually be educated. Similar to the educational brochure, due to the administrative process, with a large majority of the homeowners choosing to read the questions themselves instead of me being the one to “educate them,” using the climate change metaphor as an educational prompt was inconclusive. Homeowners were not supposed to know that this was a metaphor about climate change until the question at the very end was asked of them, and without my administering this prompt they could have easily skipped right to the question first.

Several studies (Gifford, 2011, Stern, 1992) concluded that homeowners would need to get their information from a trusted organization, company, or word of mouth in order for it to be viable. Human nature automatically surrounds information with skepticism unless trust is associated with the source. For example, this study did not ask about political affiliations which are often able to influence awareness over any education (Dietz, Leshko, McCright, 2013) due to just the source of the information. Thus there is a need for information to come from trusted sources. The brochure utilized in this study was endorsed by the Kalamazoo Nature Center, a local recognized organization. Homeowners had also gained their previous home energy efficiency education through Consumers Energy material, meaning this was at least a trusted source in the community.

Another prevalent barrier in the literature were money, time and the price associated with home energy efficiency adoptions. Participants in this study confirmed these challenges. Survey
data depicts the homeowners who had made adoptions in the last five years of Milwood neighborhood ranking money as much more important when considering home energy efficiency than the Westnedge Hill homeowners did. Showing that the higher socioeconomic neighborhoods, who were adopting energy efficiency, did in fact find money as less of a barrier of doing so. However the variable time did not show as much of a gap between these two neighborhoods who had made adoptions in the last five years, which is why there was only moderate support for my hypothesis that time and money were more prevalent in higher socioeconomic neighborhoods. What this variable ranking did reveal that was unexpected was among the homeowners who had not made adoptions in the last five years. Both neighborhoods, high and low socioeconomic, ranked time as a “5” for importance when adopting energy efficiency, contrastingly both also ranked money as extremely low importance. Revealing that the homeowners who had not made adoptions in the last five years biggest barrier is time. Future measures must be taken to ensure that Kalamazoo homeowners can install energy efficiency in a way that is less time consuming. For example, the Consumers Energy giveaway box program, which gave homeowners low effort and cost adoptions for free that they could install in their home (i.e. LED lightbulbs). This would insure that these homeowners who have not been adopting are actually exposed to low effort adoptions they can make that will be less time consuming, addressing the barrier of time from my study.

Concern for the environment (climate change) and morality, came out as very high in Kalamazoo. Morality was unexpectedly ranked very high in both neighborhoods among homeowners who had made adoptions in the last five years. But both of these results varied however when ranked before and after exposure to the educational brochure. When homeowners
were asked to rank the importance of these variables before the brochure “climate change” was ranked higher importance than morality in both neighborhoods. But after exposure to the educational brochure both neighborhoods ranked “morality” as being a more important reason for home energy efficiency adoption over “climate change.” Possibly homeowners felt more morally obligated to install home energy efficiency after the educational brochure and when asked to re-rank the variables unfortunately they prioritized all the other variables higher than climate change. In my literature there is an emphasis on how important time and money is to homeowners (Alberini, Banfi, 2013). Of all four variables, time, money, climate change, and morality, the only variable that ranked higher than the rest was “money” and it only did so in the lower socioeconomic neighborhood. Climate change and morality outranked time and money in the higher socioeconomic neighborhood and they also outranked time in the lower socioeconomic neighborhood. This is very encouraging to know that that homeowner’s beliefs on climate change and moral decisions are a top reason for why they are adopting home energy efficiency.

A final thought about why so many homeowners in Kalamazoo may have had preexisting knowledge on the topic of home energy efficiency is the university presence in the town. Being home to both Western Michigan University and Kalamazoo College could play a role in the increase knowledge of Kalamazoo’s citizens. Either because these homeowners graduated from these universities themselves, had children that did, or were exposed to some sort of knowledge through these entities. University presence could provide greater amounts of knowledge to the homeowners in this area about home energy efficiency.
Limitations to the Study

There were multiple limitations to this study including the lack of interpersonal time spent with the participants, the limited amount of data collected for this study, and possible biases surrounding the participant’s answers.

The first set of limitations was linked with the homeowners who chose to fill out the survey on their own instead of under the guidance of the researcher. These participants made up the majority of the study. These homeowners were found to have more trouble understanding the questions and in turn chose to skip answering them. Another problem with some of the unattended participants were less detailed responses, either being very vague or choosing a simple “yes/no” answers for an in depth question. However, this was not the case for the situations where the researcher administered the survey. Finally, without the researcher administering the survey, the usefulness of the educational prompts were reduced and thus results on the impact of education were largely inconclusive.

This study does not depict an accurate representation of Kalamazoo as it only surveyed thirty total homeowners. Future research should involve more homeowners who are willing to be interviewed in a face-to-face setting, this way a level of education can be assessed. Another option would be a prepared survey that homeowners would mail in once they completed, however this would involve more monetary funds and would have similar issues in homeowner’s responses as this study. If this study were to be continued the representation should come from more homeowners in Kalamazoo as well as increased neighborhoods of Kalamazoo.

The final limitation encountered during this process was the possibility of homeowners not being truthful with their answers which would ultimately bias my study. There is a
likelihood that some of the lower socioeconomic participants were overestimating their level of knowledge on home energy efficiency out of embarrassment for a lack thereof. There is also the likelihood that the lower socioeconomic participants did not have all the energy efficiency adoptions they listed but knowing it was the “social norm” to have some of these installations, (i.e. windows, kitchen appliances, washer/dryer) they wrote them anyways. This was apparent in my data results when the lower socioeconomic homeowners (Milwood) ranked price as being one of the most important factors when considering home energy efficiency, yet more higher socioeconomic owners (Westnedge Hill) physically wrote cost was a barrier for making adoptions. This could be an indicator that Milwood residents were too uncomfortable to write down that money was an issue for them whereas the ranking system was easier to disclose this information.

Conclusion

Energy consumption in the home plays a tremendous role in the greenhouse gas emissions into Earth’s atmosphere. As my earlier research found that 27.2% of all energy use in Michigan came from residential energy (Figure 3), adoption of home energy efficiency would allow homeowners to greatly decrease the energy waste that came from homes while also lowering utility bills and financial stress. Unfortunately most Michigan homes are considered less energy efficient due to the greater amount of older homes in Michigan compared to other states (U.S. Energy Information Administration (b), 2009). But homeowners can do their part to help mitigate the effects of climate change by taking steps to install home energy efficiency adoptions.
We have observed that there is a general concern for climate change in Kalamazoo and along with that an understanding of home energy efficiency among the homeowners. With 90% of homeowners making energy efficiency adoptions in the last five years and 53% of surveyed homeowners having an understanding and concern about climate change. What if all Americans were like Kalamazoo citizens, what kind of impact could this make on the energy and carbon problem? From doing smaller do it yourself adoptions that combined add up to installing major appliances that make a large impact on a home’s energy consumption, these are the choices that American’s can make in their home that will ultimately lower their personal greenhouse gas contributions.

As of 2013 the median household income for Kalamazoo was $33,766, whereas the United States median income was $52,250 (City-Data, 2013). A similar gap can be seen with the median ages, with Kalamazoo’s in 2013 being 25.3 years old and the United States was 37.6 (City-Data, 2013). With Kalamazoo having a younger median age than the United States, especially having two universities located in the city, this may be one reason why the area is more progressive and receptive towards home energy efficiency and sustainable living. Also considering Kalamazoo has a lower median income than the United States, proving that if home energy efficiency is doable on the lower Kalamazoo budget other areas in the United States with higher median incomes should be able to adopt.

This being said, overcoming the barriers of home energy efficiency is extremely important moving forward in the fight against decreasing greenhouse gas emissions and mitigating climate change. Including finding ways to further educate homeowners on home energy efficiency and its potentials. This study revealed that homeowners were receptive to
trusted forms of adoptions such as the educational brochure and materials provided by Consumers Energy. Now we must continue to utilize these known sources and also find other ways to get educational materials into the homeowner’s hands and minds.
References


Appendix A: HSIRB Approval Letter

Date: December 16, 2015

To: Denise Keele, Principal Investigator
Alexis Coutts, Student Investigator for honors thesis

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number 15-12-29

This letter will serve as confirmation that your research project titled “An Assessment of Home Energy Efficiency in Kalamazoo” has been approved under the expedited category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note: This research may only be conducted exactly in the form it was approved. You must seek specific board approval for any changes in this project (e.g., you must request a post approval change to enroll subjects beyond the number stated in your application under “Number of subjects you want to complete the study”). Failure to obtain approval for changes will result in a protocol deviation. In addition, if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

Reapproval of the project is required if it extends beyond the termination date stated below.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: December 15, 2016
**Appendix B. Door-to Door Survey Questions**

**General Demographics**

1) Do you rent or own this home? (If “rent” they will not be asked to participate in study)

2) How long have you lived here? (circle your answer)
   - a. >3 years
   - b. >5 years
   - c. >7 years
   - d. >10 years

3) Age:
   - a. 20-29
   - b. 30-39
   - c. 40-49
   - d. 50-59
   - e. 60-69
   - f. >70

4) Income:
   - a. <$10,000
   - b. $20,000-$29,000
   - c. $30,000-$39,000
   - d. $40,000-$49,000
   - e. $50,000-$59,000
   - f. $60,000-$69,000
   - g. $70,000-$79,000
   - h. $80,000-$89,000
   - i. $90,000-$99,000
   - j. >$100,000

**Adoption Demographics**

Interviewer: “I would now like to ask you a set of questions to gauge your adoption and understanding level.”

1) Are you familiar with energy efficiency programs? What is your knowledge of energy efficiency?

2) Are you familiar with products you can purchase that will lower your energy bill?

3) How much do you think a low flow shower head costs? How much money do you think it saves you per year?
4) Are you familiar with climate change? What is your perception or feelings towards climate change?

5) Have you made any, and what type of, home energy efficiency adoptions in the last 5 years?

6) If you answered “yes” to the previous question, why? Research indicates there are main reasons for residents installing energy efficient adoptions in their home, please rank each reason below, on a scale from 1 (least important) to 5 (most important) as the reasons you have or would install adoptions in your home
   a. Time
   b. Money
   c. Incentive Programs
   d. Climate Change
   e. Morality
   f. Technical Knowledge
   g. Knowledge of Incentive Programs
   h. Other:

   Can you offer any further explanation?

7) If you answered “no”, why not? What barriers or challenges Research indicates there are main reasons for residents not installing energy efficient adoptions in their home, please rank each reason below, on a scale from 1 (least important) to 5 (most important) as the reasons you have not or would not install adoptions in your home
   a. Time
   b. Money
   c. Incentive Programs
   d. Technical Knowledge
   e. Knowledge of Incentive Programs
   f. Other:

   Can you offer any further explanation?

**Educational Prompt #1**

**Interviewer:** “I would now like to share a home energy efficiency brochure with you and ask you for your feedback.”

1) Did you find this brochure educational on home energy efficiency? Was this enough information?
2) Did this brochure and education change your mind about energy efficiency?

3) Would you now install home energy efficiency adoptions?

4) Why or Why Not? Using a rank order, 1 being most important and 5 being least important, which order now influences your decisions to have energy efficient adoptions in your home?

   a. Time
   b. Money
   c. Incentive Programs
   d. Climate Change
   e. Morality
   f. Technical Knowledge
   g. Knowledge of Incentive Programs
   h. Other:

   Can you offer any further explanation?

**Educational Prompt #2**

**Interviewer:** “Thank you so much for participating in this study. Do you have time for one more prompt and question? If you do, I would like to present you with one more educational prompt and then follow up with a question assessing your feelings on it.”

**Heat Trapping Blanket Metaphor**

Our Earth’s atmosphere acts like a heat trapping blanket, taking energy from the sun and keeping our planet warm so our oceans, forests, and grasslands can produce habitats for humans and wildlife. Carbon dioxide is in our atmosphere and is one of these heat-trapping molecules. Regular carbon dioxide is what we breathe out and what plants breathe in, giving us back oxygen. We call this the regular carbon cycle. However, as we power our lives (transit, heating our homes) we burn fossil fuels, like coal, oil, and natural gas. These fossil fuels have accumulated in the Earth’s crust over millions of years, and when we burn it, we are adding way too much carbon dioxide to the atmosphere. It is making the blanket too thick with this excess carbon dioxide, also called rampant carbon dioxide. In response our native species are becoming too stressed, our oceans are becoming too warm and acidic, and our climate is changing too fast. In order to stop this unnatural climate change, we need to reduce our fossil fuel consumption, and the best place to start is at home.

1) Was your perception or feelings towards climate change changed after hearing this?