2-2016

Sustainable Living for the American Middle Class

Renee M. Bacon

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SUSTAINABLE LIVING FOR THE AMERICAN MIDDLE CLASS

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SUSTAINABLE LIVING FOR THE AMERICAN MIDDLE CLASS

A Master Thesis

Submitted to the Faculty

of

American Public University

by

Renee Bacon

In Partial Fulfillment of the

Requirements for the Degree

of

Master of Science in

Environmental Policy & Management

February 2016

American Public University System

Charles Town, WV
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DEDICATION

I dedicate this thesis to my children and husband. Without their support, patience, love and understanding, the completion of this work would not have been possible. Thank you for letting me work my weekends away.
ACKNOWLEDGMENTS

I wish to thank the teachers within the APU community for their support, help and guidance. Their answers to my questions has been most appreciated. Dr. Elizabeth D’Andrea was particularly helpful in providing help with my qualitative methodology.

I have found my coursework throughout the Environmental & Policy Management program to be eye-opening, stimulating, thought-provoking and rewarding with the tools with which to take my interests and career to a new level in the future.
The pressure that Americans and businesses feel to ‘go green’ and live sustainably has grown over the last 50 years. Political movements, treaties between countries and the media have highlighted the need for Developed Countries to curb their use of fossil fuels; reduce, reuse, and recycle more; drive more efficient vehicles; manage their land more sustainably; consume more environmentally friendly products; and eat in a more sustainable fashion. This mounting pressure has steered residential owners toward the purchase of more energy efficient and natural products for their homes. The main issue is whether or not the average American household can afford all of the technologies and methods that are available at this point in time. The cost to implement all key energy efficient measures within the average American household appears to be out of most households reach and financial capabilities. It will be up to the average American to pay more for environmentally-friendly products, as well as use what little savings they can gather to invest into sustainable technologies within their home. Most Americans will find this very difficult to do-- choices will need to be made about technologies that offer the biggest effects and positive payout in the end.
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Introduction

Can the average middle-class American household afford to purchase and install sustainable energy technologies and insulate their homes to save on energy costs? This question will be examined in its entirety, based on current costs, technology availability and practicality in three sample areas of the United States. Certain technologies will be examined, priced out, and compared to the average income level of the area. Time needed to maintain several sustainable technologies will also be examined, as well as maintenance required to maintain such infrastructure on the home property. Single family homes will be the primary residences examined in this study.

The mental shift that is currently underway in Developed Countries involves several key factors that help to influence further focus on the ‘green movement’ and helping the environment instead of harming it further. With the focus on slowing global warming and controlling greenhouse gases, it’s no wonder that governments and political machines have had a large influence on the public’s and businesses view of how they spend their money on their homes and buildings. In order to better understand the terms Green versus Sustainability, a few traits should be highlighted here. First off, ‘Green’ refers to only environmental improvement; focuses on individual components; appeals to the realist/reformist political ideology; promotes individual changes and practices on smaller scales; and desires continuous progress on an incremental measurement scale (Yanarella et al, 2009). Environmental sustainability on the other hand focuses on environmental health, vitality and social justice; encompasses the whole system and seeks changes on a large scale; is innovative, and visionary in nature; seeks to implement scaled steps that would allow for continues future progress on a broad scale; desires to make changes on city regions scales (does not focus merely on individual changes) (Yanarella et al, 2009). As you
can see from these descriptions, the two concepts are very different, yet both will be discussed throughout this paper.

*Figure 1: Green versus Sustainability (Yanarella, Levine, Lancaster, 2009)*

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Green</th>
<th>Sustainable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relation to sustainability</td>
<td>Only one leg (environmental improvement)</td>
<td>All three legs (environment health, economy vitality, social justice)</td>
</tr>
<tr>
<td>Focus</td>
<td>Individual components</td>
<td>Interplay of individual components and whole system</td>
</tr>
<tr>
<td>Tactics/strategy</td>
<td>Tactical application of activities that involve “picking low-hanging fruit”; promoting individual changes and reforms to make world less unsustainable</td>
<td>Strategic discovery of the proper scale that will make successive policy steps and actions easier and less costly by designing and implementing a sustainable, self-balancing system</td>
</tr>
<tr>
<td>Political orientation</td>
<td>Conventional, “pragmatic realist,” reformist</td>
<td>Innovative, visionary, revolutionary (“going to the roots”)</td>
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<tr>
<td>Scale</td>
<td>Individual devices, products, indicators, practices, buildings as most tractable level for greening</td>
<td>City region as the level at which human and social disequilibriums and ecological insults can be dynamically rebalanced</td>
</tr>
<tr>
<td>Risks or excesses</td>
<td>Greenwashing</td>
<td>Utopian fantasizing or top-down authoritarian policy action</td>
</tr>
<tr>
<td>Definition of success</td>
<td>Infinite progress of incremental improvements</td>
<td>Reduction of ecological footprint to a city region’s fair Earth-share</td>
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Many have questioned the motivation to build and turn existing structures into ‘green’ or sustainable properties. Human’s built environments actually account for about 40 percent of total global energy usage and one-third of all greenhouse gas emissions on Earth (UNEP Sustainable Buildings & Construction Initiative, 2009). In the USA alone, all of the buildings account for 39 percent of total energy use, 68 percent of electricity consumption, 12 percent of water consumption, and 38 percent of carbon dioxide emissions (US EPA, 2014). Some environmental
benefits of going ‘green’ include enhancing (not merely protecting) the regions biodiversity and ecosystems, improving air quality and water quality, reduce waste in all forms and conserving and restoring natural resources that have been depleted. (US EPA, 2014). Other benefits that focus on the economics of the situation include efficient life-cycle performances for products and processes, reducing operating costs, improving productivity and creating and expanding on markets for green services and products (US EPA, 2014). And finally, there are many social benefits to incorporating sustainable infrastructure into our society. These include improving everyone’s overall quality of life, enhancing aesthetic qualities of our home and work lives, minimizing the disturbance and stress felt by local infrastructure, and enhancing human comfort and health (US EPA, 2009).

When we describe Green building, there are many features and functions that are taken into account. Environmental effects examined include waste, air and water pollution, indoor contamination, Stormwater runoff, noise and heat islands (US EPA- Green Building, 2014). When looking at energy consumption, the factors of energy and water use, and material and natural resources use are weighed and balanced according to ideal living situations. When the built environment is taken into consideration for new and existing buildings, the siting, construction, design, overall maintenance and renovation factors are looked at (US EPA- Green Building, 2014). Green building research is a constant focus of several US governmental agencies. The EPA is one of these, and one of their largest focuses with research deals with energy and atmosphere factors (over 70 percent overall) (US EPA- Green Building, 2014). This shows how vital these two factors alone are to the creation of a more sustainable society.

Some people may ask what some benefits to green building really are. Do they really make a difference in the overall scheme of things? The answer is yes. According to the US
General Services Administration, green construction uses 26 percent less energy, requires 13 percent less in maintenance costs over the life of the structure, 27 percent higher occupant satisfaction and a reduction of 33 percent in carbon emissions (Rethink Renovations, n.d.). According to the construction industry, green building is expected to climb from 17% of construction sales in 2011 to 29-38 percent in 2016. The reasons for this include consumers desire to save money long-term, increase their property value, gain a competitive edge when reselling, and to help rental property owners increase their long-term profit margins (Rethink Renovations, n.d.).

According to many leading sources, many consumers and builders are focusing on renovating older properties to be green instead of only building brand new homes and buildings. Researchers have found that renovated building savings are between 4 and 46 percent over newly constructed buildings of equal energy performance levels. This is because brand new homes and buildings still incur a large carbon debt during construction, and it takes between 10 and 80 years for that debt to be ‘repaid’ to the environment (Sifferlin, 2012). For the purpose of this study, single-family residential home renovation and new construction will be examined. Three areas of the USA will be used as examples of personal middle-class incomes levels, average home property values and green home renovation costs and technologies. New green home construction will also be examined and compared to the nations average middle-class income levels. This will help to determine the ability of the average American to pay for either new or existing ‘green’ home building costs, and how practical it is for the government, environmentalists and the public to expect such large changes.
Literature Review

This study is important because it will examine whether the average American household will even be able to afford ‘green’ home renovations (or new construction), or whether this goal is out of their reach financially. There are many papers and websites that promote green ideas, that give reasons for the move in this directions, and that give suggestions about which technologies and methods are the best for getting the desired results. But many examples featured online cost well above the average homeowner’s ability to pay for these technologies and renovation services. This paper will examine three areas throughout the United States: an urban home in California, a rural home in Alabama, and a suburban home in Michigan. By comparing technologies that fit each of these three area best, and pricing out the costs for each comparable form of service, the overall costs will be added up and compared against the average income level for each of the areas. The overall result will be a conclusion about how able middle class Americans are to truly afford a sustainable home. These conclusions will help to shape suggestions about which technologies are absolutely necessary for saving money and helping the environment, and which technologies could wait a number of years before implementation. The conclusions will also help direct builders and remodelers, as well as homeowners, as to which services are most vital for the largest environmental and personal benefit. The government could also benefit from this research by focusing on vital technologies in certain climatic regions, and offering specific incentives to homeowners who choose to undertake the most effective environmental-saving renovations and additions.

This thesis topic and paper will help to directly fulfill the requirements and goals of the M.S. in Environmental Policy & Management, because it directly focuses on how able humans really are to afford and implement the best environment-saving technologies, so to implement the
most optimal changes in Developed Nations, including inside the USA and around the world. There is almost nothing more important to keeping our environment safe and reversing the damage than finding out how to aid humans in creating a more sustainable home within a city, state and country-wide scale.

There are 7 main points in which renovations can improve a home in a sustainable fashion. These include 1) minimizing the amount of resource use and preserving the habitat in the area 2) lowering energy consumption and carbon dioxide output 3) conserving the optimal amount of water in the home over its life cycle 4) creating natural local habitat in areas that have been adversely affected 5) creating a healthy indoor environment for the occupants 6) reducing the size of homes so that efficiency is at its optimal level for the number of occupants and 7) designing homes to use local resources at an optimal level and to run as efficiently as possible throughout its life cycle (Positive Footprints, n.d.). By focusing on these main points of sustainable home renovation in the three sample areas listed above, a relative comparison can be done and the most useful and sustainable technologies can be identified for each type of home and region. This research will aim to solve the question about whether or not the average middle class American can afford a complete or even partial renovation with sustainable technologies and methods.

The average consumer tends to have a large variety of perceptions about what it means to ‘go green’ and what benefits a sustainable home might afford to the people inside and for the environment outside. After all, if consumers and their perceptions are not accurate and not on board with the idea of ‘greening’ their homes, then this discussion would end right now. So getting consumers to ‘buy-into’ the concept of energy reduction and smart appliances is vital in the overall success of the green-living movement. According to a study done on exposing focus
groups to already-equipped sustainable home infrastructure, there were a variety of reactions from the participants, which could also more than likely be assumed for much of the general population in Developed Nations. In this study, 4 focus groups with 29 total participants were exposed to a full furnished and equipped smart home, where variable energy tariffs, smart metering, smart appliances and home automation were the key feature being judged and analyzed by participants. Overall, the people displayed positive feelings towards the efficiency of the technologies, and they liked the fact that they would be able to save a significant amount of money using the current technologies on the market. The one issue that participants has trouble with in the green home was the fact that flexibility was often not as possible as with a ‘normal’ home. The fact that families and individuals would have to adapt their own behaviors to fit certain energy tariffs was hard for some to accept. They felt that this adaptability on their part would be limited, and wanted the ability to use more energy when it was in fact needed (Paetz et al, 2011). The participants did like the idea of saving electricity and making a tangible dent in their carbon footprint, and the possibility of using renewable energies to have an even greater impact was a desirable concept to the participants also. Time-of-use tariffs and load-dynamic tariffs were presented as electricity regulation options, and the participants thought that load-dynamic tariffs (energy use staying under a certain threshold each day) were more useful and flexible that the other option (Paetz et al, 2011). Most participants believed that coordinating a whole household to regulate energy use during each part of the day was futile, and that the cognitive effort needed for this would not be feasible in the long run. Smart meters were presented as an option to participants, and many (20 out of 29) said they would consider buying this type of meter only if there were financial incentives to do so, since these meters mainly only help the utility companies and not the consumer. Smart appliances were also presented as
options, and the study participants were on board with purchasing these lower energy-using appliances, as long as they were not too limited in when they could be used. For example, a change in a TV’s energy consumption would be less flexible (i.e. - night watching) than when people could start their dishwasher. Most participants did not want their normal routine to be disrupted more than they needed to be (Paetz et al, 2011). Finally, this study also showed participants three options for an efficient home automation system. None of the participants liked the idea of an outside company having control of when appliances ran, so the resident-controlled system was favored overall by about half of the participants. The idea of having at least some control in when energy is used was a necessity for most of the people questioned (Paetz & Dutschke, 2011).

What these study results showed researchers was that personal preference, money savings, controlling one’s own house, and perceived inconvenience each played a huge role as to whether people would even buy-into the new energy-efficient technological gadgets coming onto the market today. This point is vital to the success of the overall green movement. If the pro’s do not outweigh the con’s in the respects just cited, then the conversion to energy efficiency in millions of homes will be slower than desirable. These facts must be taken into account by the government, businesses, retailers and environmental education organizations. Marketing as well as options given to consumers will be key in the success of this kind of massive undertaking.

**Theoretical Framework/Approach**

When examining topics of great importance, it is vital to link the topics to actual studies done by theorists and leading experts in the environmental field. Although many theories and postulates exist in the scientific community, there are two that directly relate to how humans
view the environment, and how they choose to interact with it based on various factors and influences.

One environmental theory that will be examined is Gifford’s Social Dilemma System Model, where individuals and groups of people view resource use along a continuum of pure self-interest, though pure community interest. Many factors influence how a person views their role in the environmental realm—some influences include interpersonal, dilemma awareness, geophysical and governance. These influences determine where a person falls in the spectrum of environmental concern (Gifford, 2008).

A second environmentally-based theory is Paul Stern’s Value Belief Norm (VBN) Theory (2000). This theory focuses on the idea that individuals are driven to enact pro-environmental behaviors based on their personal norms. This feeling of obligation to act in a certain way takes into account the perceived adverse effects on the items that people value (nature, animals, waterways, land, etc.). This theory states that personal values are what lead to a person’s environmental beliefs (Stern, 2000).

Robert Gifford (2008) has narrowed his focus on how and why people respond to pressure to change their environmental habits. Over the years, Gifford has identified 30 different influences, and a more wide-ranging model was made to show how different factors are connected. The main components that influence environmental concern include Interpersonal influences, decision-maker influences, governance influences, geophysical influences, dilemma awareness, technological influences—and then the small components of these varied factors lead to the overall decision-maker strategies, which in-turn lead to decision-maker outcomes and environment outcomes.
Although these links have proven accurate, it is a challenge for psychologists to discover ways in which certain influences can be encouraged over time, so that certain positive environmental behaviors can be promoted and implemented to greater extents over time (Gifford, 2008).

The second theory being examined for applicability to this investigation is Paul Stern’s (2000) view on environmentally significant behaviors, and what can create and influence them in human interactions within everyday life. Stern defines environmentally significant behaviors as a
variety of actions, which include environmental activism, non-activist public behaviors, private-sphere environmentalism and environmental organization support. Depending on which attributes people feel a connection to from an earlier age, they will be most likely to continue connecting to the environment with these personal ‘norms.’ As seen in Figure 2, the values that influence our perceptions on the environment include biospheric, altruistic and egotistic (Stern, 2000). These values are instilled in us as we grow, think and develop, and become several things to us internally. The values may morph into our ecological worldview, affect how we learn to value certain natural features or objects, and can establish we identify ourselves with the ability to have a positive effect on the natural structures that we value. These developed values turn into our personal norms, and influence how we can positively help the environment. From these established norms, each person can then take environmentally positive actions and behaviors that fulfill the need to positively affect the Earthly features that we value most (Stern, 2000). What Stern ultimately stresses is that it’s the consequences that activate a person’s personal norms (and which are adverse consequences), triggers a person’s personal responsibility to take some type of corrective action. These corrective actions manifest in a variety of ways, and with a variety of intensities and commitments.
Both of the above stated theories help to show how humans are influences to affect the environment in a variety of ways, and for a variety of reasons. As with all theories, each person fits differently into the structure an intensity of the applicability of each component. Each person has different childhood and adult experiences, and therefore will have a large variety of viewpoints, values and will take many different actions. Hence the need in this paper to observe and categorize if and how a middle-class American can afford to create an environmentally friendly (sustainable) residence, and if the average American will even spend the money or take the time to implement such measures in the first place.

**Hypotheses**

Sustainable home infrastructure with current technologies and methods is within financial and technological reach for the average American.

The significance of this thesis paper is that there are 133,957,180 housing units in America as of 2014, with a median *household* income of $53,046 (US Census Bureau, 2015). When we exclude the upper and poverty-level classes of households, we are left with the
influence that many tens of millions of middle class American homes have on the environment. So the question becomes not one of *should we try* to live sustainably, but *can* the middle class even afford to do so, and what technologies are available that are *worth* investing in. By establishing that middle class Americans either can or cannot afford to implement several sustainable home solutions, and if so, which solutions are best for efficiency, cost, time and practicality, a more clear conclusion about realistic middle class expectations can be drawn from this research. At present time, fossil fuels are generally cheaper to use over their lifetime. Renewable energies still lack the infrastructure for large-scale use, so their initial costs are higher and need large investments initially (Renewable Energy Resources, 2015). The following is a cost comparison for both renewable and nonrenewable energies in 2015:

<table>
<thead>
<tr>
<th>Power Plant Type</th>
<th>Cost $/kW-hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>$0.10-0.14</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>$0.07-0.13</td>
</tr>
<tr>
<td>Nuclear</td>
<td>$0.10</td>
</tr>
<tr>
<td>Wind</td>
<td>$0.08-0.20</td>
</tr>
<tr>
<td>Solar PV</td>
<td>$0.13</td>
</tr>
<tr>
<td>Solar Thermal</td>
<td>$0.24</td>
</tr>
<tr>
<td>Geothermal</td>
<td>$0.05</td>
</tr>
<tr>
<td>Biomass</td>
<td>$0.10</td>
</tr>
<tr>
<td>Hydro</td>
<td>$0.08</td>
</tr>
</tbody>
</table>

Figure 4: Adapted from US DOE (Renewable Energy Resources, 2015)

By making renewable energies more efficient and affordable over time, middle class Americans should be able to better afford these sustainable technologies. Additionally, when Americans understand that these technologies could save money over time (which is better than breaking even) and possible even make money, people *will* start choosing the most
environmentally-safe and cost-effective solutions. CBS Money Watch (2014) states that more than 1/3 of all 30-50 year-old adults have saved no money for their retirement. This means that the “sandwich generation” (those taking care of aging parents and their children) will have even less money to save and spend on costly renewable or sustainable technologies (CBS Money Watch, 2014). It is of utmost importance that the most practical and influential sustainable products be purchased and installed in America’s homes. The problem is that the average person has no idea what should be done first, second, third, etc., in order for their investment to make a difference and be worthwhile. Businesses that ‘sell’ supposedly sustainable services are often viewed with skepticism and distrust about the businesses ultimate goal of making a profit. And it take many hours of research for consumers to understand the various technologies, and what is best for their own situation and budget constraints. Hence, there is a great need for not only the technology to catch up to the price-point of the average American, but also for an analysis to see if the average American can actually afford (without incurring large amounts of debt) to implement several sustainable (or at least more environmentally-friendly) techniques, methods and technologies, in order to have the effort to be worth it in the end.

**Research Design Methodology**

The methods I will use to collect data include: 1) focusing on three parts of the United States (South- AL (rural), North- MI (suburban), West- CA (urban)) where climatic conditions are more unique, 2) getting prices for the most practical and effective sustainable technology to be installed at each of the three locations, 3) Finding the most practical, proactive and sustainable energy methods/measures for each location, 4) taking a look at the overall costs to upgrade a house to be approximately 75% sustainable on its own, 5) comparing similar goals for each of
the three locations, so that big picture (whole-country) comparisons are as equal as possible and
6) a content analysis of the information that was gathered.

Each of the three locations will have price quotes for a practical renewable energy from 3
similar companies for each technology examined. The costs for more energy-saving technologies
and products will be priced out at three Lowe’s in the three specified areas (above). As equally
as possible, the same components will be chosen, priced and added into each locations total. The
overall price costs for each of the three locations will be compared to the average middle-class
income of each location. The overall costs at the three locations will also be compared to the
countries average income, so that a broader view of affordability for the country can be assessed.
Federal and state incentives, loan programs and tax breaks will be identified also. An overall
view of total costs will be examined to determine affordability for average public citizens.

A review of current public perceptions of sustainable energy will also be undertaken, to
see where the ‘average’ person falls within the environmental-perception scale (Paetz et al,
2011). Values and motivations within the anti-consumption movement will also be examined to
see what motivates people to care and spend more money on protecting the environment (Black
& Cherrier, 2010).

Other studies and experiments that evaluate which materials and methods are the most
efficient, lower cost and practical will also be examined. These other topics to be reviewed
include: Urban living and sustainability (Plevak, 2012); water conservation (Shah, 2012); other
energy efficiency measures (Shah, 2012); living buildings (Jossi, 2013), and positive-energy
homes (Miller & Buys, 2012). All of these methods have the potential for completely changing
how efficient and useful many of the sustainable energies truly are, and because of this, will be touched upon as options in certain locations only.

**Findings/Results/Discussion**

Efficiencies of various materials and technologies will be examined in each of the three study locations (Shah, 2012). Prices will be stated as it is deemed ideal in each location, but will be compared relative to the average income in each middle-class area. New home building technologies and methods will also be examined (Sozer, 2010) to discover exactly how efficient new constructions can be made for middle class citizens. As data is collected for each of the three locations in the USA, a comprehensive assessment will be undertaken, so to compare technologies and methods that are ideal for each location. This will help highlight where in the country the costs are highest and where they are more affordable.

There are many options that each of the studied locations have available to them. The renewable energy technologies that could be used almost universally include: biomass, wind power, solar power, hydropower and geothermal energy. Since a home’s energy has a large influence on overall cost, effectiveness and practicality, there will be a short review of each in the following paragraphs.

As far as the practicality of solar power in each of the three locations studied, the colder, snowy climates pose the most problems with solar efficiency and usability. Normally, solar power can be gathered and used in even cold locations. The one big downfall is that is even a small amount of snow accumulates on the solar panels, the sun cannot be collected and the energy will not be produced. This is a big problem in the winter with the homes in the top half of the Unites States. There is currently research being done by MTU in Michigan, Colorado and
Wyoming, to assess the energy output of solar panels that have varying amounts of snow on them. The ability of the snow to slide off panels, as well as angle at which they are installed, would also affect energy collection in snowy climates (Accuweather, 2015).

Hydropower is only available in areas that are somewhat near to rivers, lakes or oceans. There are dozens of technologies that now adapt to certain locations and conditions around the world. Overall, there are both large-scale hydropower facilities, as well as microhydropower applications. Ideally the larger hydropower power plants offer better efficiency and capabilities than microhydropower, but new technology developments are closing that gap. Overall, 6 percent of our countries power comes from hydro technologies, with 70 percent of renewable energy created by hydropower (OEERE, 2013). When focusing only on small microhydropower systems, the most traditional way to create power is through run-of-the-river systems. These do not require large storage reservoirs, and require: a conveyance, a regulator, an alternator, wiring for the electricity, and a turbine or pump (OEERE, 2013). They are only useful for areas near waterways.

Biomass energy is fairly popular in areas there wood, corn, discarded food and even garbage is available. Biomass is considered stores energy, and as such needs to be burned or changed in order to become a liquid fuel (EPA, 2015). Wood burners, oils (biodiesel), corn and sugarcane (ethanol) and waste-to-energy technologies have proven useful and efficient to widely varying degrees. One negative of this technology is that carbon dioxide is returned to the air when the plants are burned (EPA, 2015).

Wind energy is ideal only in certain locations, and is oftentimes done on a commercial scale for an energy utility. Wind energy is most abundant off the coasts of our continents, as well
as through the middle of our country (Dakota’s down through Texas). As far as small wind
turbines go, it is possible to save a large amount of money each month on a home electrical bill.
These small turbines typically save between 50 and 90 percent off the ‘normal’ utility bill
(Bergey Wind Power, 2012). Factors like high uses of air conditioning and speed of wind greatly
affect how much benefit a household will gain. Most homes who use wind to offset their costs,
typically use a 5-15 kilowatt windmill. An average home-sized windmill has a rotor diameter of
23 feet and is around 80-100 feet tall, and has a price tag of at least $90,000+ after shipping and
installation (Bergey Wind Power, 2012).

Finally, geothermal energy is that which is gathered from deeper underground, for use in
a home’s heating and cooling needs, as well as for hot water for the home. The best area’s for
gеothermal energy is the left half of the country, particularly within and to the left of the Rocky
Mountains. There are also select spots in the South and East that are favorable for this type of
home energy (Renewable Energy World, 2015). The positives about this energy are that it’s
clean and sustainable, with several designs that can accommodate smaller pieces of land or
certain terrain conditions. This technology can function on both large and small scales, but this
paper will focus on small applications.
The second large item which has a huge effect on home sustainability, and that will be examined further is the type and best method for updating a home’s insulation in the roof and outer walls. Adding extra insulation to both older and newer homes will pay for itself within just a few years (Energy, n.d.). Along with adding in additional (high R-value) insulation where it’s needed, there will also be areas that will need air sealing. The U.S. Department of Energy has a Zip Code Calculator that allows homeowners to calculate how much of an R-value specific areas need (Energy, n.d.).

The type of insulation a homeowner needs depends on where the insulation will be placed, as well as the R-values that will be necessary. There are various types of insulation, and many positives and negatives to each. Blanket (batts and rolls) are good for stud and joist
Spacing and are rather inexpensive. A second type is concrete block insulation, and is often used in new homes and major renovations. A third type is foam board or rigid foam, which is sprayed into unfinished walls, floors, ceilings and low-slope roofs. Additional types of insulation include: insulating concrete forms, reflective systems, rigid fibrous insulation, sprayed foam and structural insulated panels (Energy, n.d.).

The following figure shows the R-values for various types of insulation, according to their respective thicknesses when laid down. As the chart shows, the thicker a homeowner can lay down the insulation, the better for overall home efficiency.

*Figure 6: Home Energy Library*- [http://smud.apogee.net/res/reinrva.asp](http://smud.apogee.net/res/reinrva.asp)

<table>
<thead>
<tr>
<th>Material</th>
<th>11&quot;</th>
<th>13&quot;</th>
<th>19&quot;</th>
<th>22&quot;</th>
<th>30&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose Fill</td>
<td>5.0&quot;</td>
<td>5.5&quot;</td>
<td>8.5&quot;</td>
<td>8.5&quot;</td>
<td>13.0&quot;</td>
</tr>
<tr>
<td>Fiberglass</td>
<td>3.5&quot;</td>
<td>4.0&quot;</td>
<td>6.0&quot;</td>
<td>6.0&quot;</td>
<td>9.0&quot;</td>
</tr>
<tr>
<td>Rock Wood</td>
<td>3.0&quot;</td>
<td>3.5&quot;</td>
<td>5.5&quot;</td>
<td>5.5&quot;</td>
<td>8.5&quot;</td>
</tr>
<tr>
<td>Cellulose</td>
<td>5.0&quot;</td>
<td>6.0&quot;</td>
<td>10.5&quot;</td>
<td>10.5&quot;</td>
<td><strong>14.5&quot;</strong></td>
</tr>
<tr>
<td>Vermiculite</td>
<td>3.5&quot;</td>
<td>4.0&quot;</td>
<td>7.0&quot;</td>
<td>7.0&quot;</td>
<td>8.5&quot;</td>
</tr>
<tr>
<td>Batts/Blankets</td>
<td>3.5&quot;</td>
<td>4.0&quot;</td>
<td>7.0&quot;</td>
<td>7.0&quot;</td>
<td>8.5&quot;</td>
</tr>
<tr>
<td>Fiberglass</td>
<td>3.5&quot;</td>
<td>4.0&quot;</td>
<td>7.0&quot;</td>
<td>7.0&quot;</td>
<td>8.5&quot;</td>
</tr>
<tr>
<td>Rock Wool</td>
<td>3.5&quot;</td>
<td>4.0&quot;</td>
<td>7.0&quot;</td>
<td>7.0&quot;</td>
<td>8.5&quot;</td>
</tr>
<tr>
<td>Riged Board</td>
<td>3.0&quot;</td>
<td>3.5&quot;</td>
<td>3.5&quot;</td>
<td>5.5&quot;</td>
<td>7.5&quot;</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>2.0&quot;</td>
<td>2.0&quot;</td>
<td>2.0&quot;</td>
<td>3.5&quot;</td>
<td><strong>5.0&quot;</strong></td>
</tr>
<tr>
<td>Urethane</td>
<td>3.0&quot;</td>
<td>3.5&quot;</td>
<td>3.5&quot;</td>
<td>5.5&quot;</td>
<td>7.5&quot;</td>
</tr>
</tbody>
</table>

The R-value (thermal resistance) of each type of insulation depends on the thickness and type of material. According to Figure 4, the estimated cost (installed) per square foot, extra costs, improved energy efficiency and years for the product paying for itself are presented.
Energy efficiency can come in many variations throughout a home. Highly efficient appliances such as washers/dryers, dishwashers, refrigerators, hot water heaters, microwaves, televisions, computer set-ups and home thermostats have a large influence on how much energy is being pulled from the single home ‘grid,’ both when in use and when not turned on. A home thermostat is also a smart investment, and new technology now allows homeowners to adjust the home temperature with an app on their phone. This allows for both electricity and heat to be conserved for use until it’s absolutely needed.

Other home energy technologies that will be examined further include highly efficient home hot-water heaters, LED lighting and the installation of efficient double-paned windows. Choosing a great hot-water heater will be dependent on criteria that include: fuel type and cost; the size for your household, energy efficiency and its costs to run and maintain the heater. The conventional tanks are very common in households— they hold plenty of hot water, but this technology costs more money to keep all that water hot and ready-to-go. Other options include tankless or on-demand heaters, heat pump water heaters, solar water heaters and tankless indirect water heaters. Since the average family spends between $400-600 per year heating their water,
which is the 2\textsuperscript{nd} largest home expense for a family, the costs and benefits of an efficient system can add up over time (Energy.gov (Energy Saver), n.d.).

*Figure 8: Types of Water Heaters (Energy.gov)*
According to the above chart, the best options are a tankless system (8-34% more efficient than conventional; works with electricity, natural gas or propane), a heat pump system (2-3 times more efficient; works with electricity, geothermal and natural gas systems) or a solar system (50% more efficient; works with homes that operate solely on solar energy) (Energy.gov, n.d.).

Home lighting costs make up 25 percent of a home’s energy budget (Eartheasy, n.d.). Both LED (Light emitting diode) and CFL (compact fluorescent lights) light bulbs have changed the way and the amount of pollution released for home lighting needs. LEDs are very small and efficient, and last a very long time (up to 10 times longer than CFLs). They are also curable (don’t break as easily as CFLs), are cool to the touch (unlike CFLs), are mercury-free (unlike CFL’s), use a lower wattage of energy, are cost effective over time, and are great as portable lights (Eartheasy, n.d.).

Windows also are vital to keep energy efficiency high throughout all climates and seasons. When choosing a window, triple-paned windows are best, and there are many double and triple-paned types that are now Energy Star rated.
In general, non-metal frames are best, especially those with HSG Low-E ratings (High solar gain, low E (with argon gas)) (Efficient Windows Collaborative, 2015).

Figure 9: Triple-pane window composition. Source: franzosoenergysolutions.com, 2012.

Figure 10: Comparison for various paneled-window types. Source: finehomebuilding.com, 2015.
Cool metal roofing is also quickly becoming popular for homeowners to install when their roofs shingles need replacement. These metal roofs save homeowners money by keeping homes warmer in the winter and cooler in the summer. These roofs save households up to 40 percent of their traditional energy bills, and are also very environmentally friendly. These roofs are also ideal for rainwater capture and reuse, since asphalt shingle roofs contain many known toxins.

Figure 11: Metal roofing set-up. Source: Diychatroom.com, 2010.

HVAC systems are also important to home energy efficiency. Many homes (especially newer constructions often have systems that are unnecessarily large for their homes (since the
new home designs have envelopes that are much more highly efficient now). The smaller the unit, the more efficient it is and the lower the costs are to run them each year. The most efficient HVAC systems will only cost $120- $300 to operate each year (Energy Star, 2015).

*Figure 12: HVAC system set-up. (Greenlivingideas.com, 2014)*

There are also many natural and smaller measures that can be taken to reduce energy use and costs also. Home orientation is very helpful in this area- cooler climates want to maximize their exposure to direct sunlight, and will also take advantage of cross-breezes in the summer. Warmer climates want to block direct sunlight from their home, while also getting a good cross-breeze for natural cooling. Other ways to save on home energy include changing out furnace filters monthly, getting regular furnace inspections, turning off/blocking the heat to rooms not in use, using efficient curtains or blinds, lowering home temperatures during the day and at night, caulk/seal all windows, doors and fireplaces, keep unnecessary lights off, keeping A/C to a minimum in the summer, using fans to spread cool and warm air, using reflective window film, install water-saving showerheads, sink faucets and toilets, run the dishwasher and laundry.
machine only when full, use cooler water whenever possible, installing low-irrigation lawn watering systems, using rainwater collection systems and grey water systems, using renewable materials (i.e.- bamboo) when replacing floors, cabinets, countertops, carpets, patios, etc., replace inefficient appliances, and get rid of ‘extra’ lights and small appliances (PowerHouse, 2015).

Water conservation has become a huge cost and technological issue in many parts of the United States. The typical home (in warmer climate states) uses over half of their yearly water outdoors rather than inside the home. Outdoor sprinkler systems and outdoor water ‘waste’ (leaving the hose running) make up around fifty-nine percent of the total home water consumption budget (Envirohaven, 2015). In cooler climates, the outdoor number is slightly less, but is still significant. Of the remaining forty-one percent, toilet use and clothes washer use making up twenty percent, and leaks, faucets, showers and dishwasher-use, making up the other twenty-one percent.

*Figure 13: Residential water use. Source: American Water Works Association Research Foundation.*
One very successful solution to the issue of water waste is to install a grey water reclamation system. The goal of a system of this size is to filter, store and then reuse bathroom sink water, shower water and laundry water (with safe, environmentally friendly cleaners) for later reuse in a greenhouse, or to water lawns and landscaping (Envirohaven, 2015). These systems are especially useful in the south and west of the United States, where water resources are limited. Depending on the uses the grey water in a home is intended for, costs can range from $700 (laundry to landscape only) to $4,000 for a full-home pump system (Greywater Action, n.d.). In areas where average rainfall occurs, a rainwater harvesting system would instead be the preferred method of water reuse and recycling (Envirohaven, 2015).

*Figure 14: Grey water uses in a residential home. [www.homeevol.com](http://www.homeevol.com)*

Rainwater harvesting can be utilized in any area that receives lower to high rainfall each year. It is estimated that 1 inch of rainfall on a 2,000 square foot roof equals 1,250 gallons of
water, each time this occurs. Since a family of 4 uses around 400 gallons per day (indoors and outdoors), the capture of rain would reduce the stress put on the larger communities water system, and save money over the course of many years (Water Sense- EPA, 2015). Since tens of thousands of gallons of perfectly usable rainwater are lost to the groundwater supply or to drain runoff each year, there is a huge benefit to capturing and reusing rainwater for various uses. Along with in-home use, captured rain water can also be collected in rain gardens and for wildlife (Texas A & M, n.d.). Most states do not regulate the quality and systems used on an individual level. Therefore, it is up to a contractor or an informed individual homeowner to investigate and find a system that best fits each individual homeowners needs. There are many ways in which rainwater can be captured, stored, cleaned and then used. Water is usually collected on a roof surface (metal roofs are preferred), then gathered into a central area by way of gutters and downspouts (Texas A & M, n.d.). Next, a proper storage set-up is required, with safety being the number one goal for the water and those who will use it. Treatment of the water is the next step, and this actually starts with the roof materials and pretreatment of the water before it even enters the tank. After-storage treatment (using filters and disinfectants) is the final important step to using clean water in the home. The final component of a rainwater harvesting system is the redistribution of the cleaned rainwater. More infrastructure will need to be put into place if the cleaned water is for human consumption, versus only for outdoor plants, grass and greenhouses (Texas A & M, n.d.). Following are some visuals of rainwater capture on a residential property.

*Figure 15: Underground storage- Rainwater Harvesting System. (Climate Culture Communications Lab, 2013)*
Figure 16: Above-ground residential water capture. Containmentsolutions.com
The costs for a residential harvesting system are between $3,000 and $10,000 depending on the size of the storage tank(s) being used.

Another topic that is important for both new and refurbished homes is that of choosing the most environmentally friendly type of wood. Forests across the world are being cut down at a record-rate over the last few decades, and the use of this wood in developed and developing countries is not a sustainable practice. Of the 7.5 billion acres of virgin forests that once existed on the Earth, only half still exist today. The practice of logging (clearcutting) further threatens seventy percent of these remaining forests. Each year, 40 million more acres are logged, and up to ten percent of our Earth’s trees are endangered (Davis, Astin & Lee, 2014). There are several steps that can be taken by homeowner’s and businesses that would help slow the process of clearcutting, and still help homeowner’s to use the best choices of wood. The first step in the purchase of wood is to look for those types that are certified by the Forest Stewardship Council (FSC). These products have been grown and harvested responsibly through every cycle of the processing process (Davis, Astin & Lee, 2014). Additionally, wood that is certified Earth-friendly through other (smaller) organizations: those labeled “Smartwood” and “Green Seal” (from the Rainforest Alliance) are two more reliable labels. Avoiding tropical hardwoods and those woods gathered from irreplaceable old-growth forests (mahogany, teak, redwood, Douglas fir, western cedars) is also highly recommended (Davis, Astin & Lee, 2014). Products that are made from reclaimed or ‘rediscovered’ wood are also preferable over virgin-forest wood. And finally, going wood-free is also a recommended practice-- there are literally dozens of recycled plastic-wood substitutes (Trex, SmartDeck, Plastic Lumber, Polywood) that are of high quality, yet make a much smaller impact on the Earth’s forests in general (Davis, Astin & Lee, 2014).
Another method of conserving overall household energy used (and the garbage created by it each day) is through biowaste management and vermicomposting. According to The Atlantic (Thompson, 2012), 2.6 trillion pounds of garbage is thrown away in the world each year. Most of this comes from Developed Countries, with just under half of the total amount being of ‘organic’ in origin.

*Figure 17: Global Solid Waste Composition. (The Atlantic, 2012)*

When organic material is put into landfills, it usually is so compacted (and piled layer upon layer) that air cannot reach it, and it will not break down and rot away over time. This creates an epidemic of worldwide garbage dumps that have materials that could be naturally broken down over time, but now cannot. The easiest solution to this is to educate businesses and citizens of developed countries, so that they can manage the organic portion of *their own* waste.
Items like paper and organic materials (food scraps, grass clippings, paper) can be composted, and even can be included in vermicomposting (the use of worms to break down organic material).

*Figure 18: Regular composting of organic material. Source: Realfarmacy.com (n.d.).*
Regular composting can be done in almost any residence, and with every business. It can be done in the ground, in a basic container, or in a more elaborate system. It is free to do, and there are many benefits to having healthy, new soil to use after the waste has broken down (for lawn care, flowers and gardens). Another method that is even quicker and more efficient (and natural) is called vermicomposting. In warmer climates this can be done outside, but cooler climates need to move the container inside a building during the cold months. Certain types of worms break down organic scraps very quickly and efficiently, and create a nutrient dense soil that can be especially beneficial to plants, gardens and flower beds (just like natural ground soil is ‘cleaned’ over time). This method is popular because there is very little odor over time, but can only be used on smaller scales because worms will take weeks to compost a smaller bin-full of scraps (depending on the size and number of worms).

Vermicomposting can be a great addition to reducing household waste (and waste haul-away costs) and creating a healthier environment.

The following chart was created to better outline the choices and costs of certain environmentally friendly home options. There are three cities examined, with practical technologies for each area being focused upon. Keep in perspective that the average combined household income in the USA is $53,046.
Figure 20: Results Chart for 3-City Cost Comparison

<table>
<thead>
<tr>
<th>Technology used (most costs from Lowe’s - includes installation also)</th>
<th>South (AL)- Rural cost</th>
<th>West (CA)- Urban Cost</th>
<th>North (MI)- Suburban Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Energy Source</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Solar</td>
<td>$23,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geothermal</td>
<td>$22,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomass (wood)</td>
<td></td>
<td></td>
<td>$14,000</td>
</tr>
<tr>
<td>15 Windows/2 doorwalls/3 entry doors</td>
<td>$11,000</td>
<td>$11,000</td>
<td>$11,000</td>
</tr>
<tr>
<td>HVAC system</td>
<td>$3,800</td>
<td>$3,900</td>
<td>$3,800</td>
</tr>
<tr>
<td>Metal Roof</td>
<td>$20,000</td>
<td>$20,000</td>
<td>$24,000</td>
</tr>
<tr>
<td>Appliances (Refr/St/Dry/Dr)</td>
<td>$3,600</td>
<td>$3,600</td>
<td>$3,600</td>
</tr>
<tr>
<td>Hot Water Heating System</td>
<td>$1,300</td>
<td>$1,300</td>
<td>$1,300</td>
</tr>
<tr>
<td>Water Collection/Reuse System</td>
<td>$2,800</td>
<td>$2,800</td>
<td>$2,800</td>
</tr>
<tr>
<td>Insulation (roof/outer walls/overhangs)</td>
<td>$1,200</td>
<td>$1,200</td>
<td>$2,500</td>
</tr>
<tr>
<td>Home thermostat</td>
<td>$350</td>
<td>$350</td>
<td>$350</td>
</tr>
<tr>
<td>Fans in each room (7)</td>
<td>$1,400</td>
<td>$1,400</td>
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<tr>
<td>LED lights/fixtures (motion-detecting)</td>
<td>$400</td>
<td>$400</td>
<td>$400</td>
</tr>
<tr>
<td>Low-flow faucets/shwrhds/toilets</td>
<td>$2,900</td>
<td>$2,900</td>
<td>$2,900</td>
</tr>
<tr>
<td>Renewable Flooring (bamboo)</td>
<td>$5,800</td>
<td>$5,800</td>
<td>$6,200</td>
</tr>
<tr>
<td>Energy Star TVs (3)/Computers (2)</td>
<td>$2,600</td>
<td>$2,600</td>
<td>$2,600</td>
</tr>
<tr>
<td>Low-Irrigation lawn watering w/ timer</td>
<td>$2,200</td>
<td>$0</td>
<td>$2,200</td>
</tr>
<tr>
<td>Inspect HVAC/change filters/clean vents</td>
<td>$1,000</td>
<td>$1,000</td>
<td>$1,000</td>
</tr>
<tr>
<td>Radiant Home heating system</td>
<td>$2,300</td>
<td>$2,300</td>
<td>$3,300</td>
</tr>
</tbody>
</table>

**TOTAL COSTS for 1-time installation**

<table>
<thead>
<tr>
<th>South (AL)- Rural cost</th>
<th>West (CA)- Urban Cost</th>
<th>North (MI)- Suburban Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>$84,650</td>
<td>$83,550</td>
<td>$83,350</td>
</tr>
</tbody>
</table>

*Projects that will help, but are not vital unless replacement is warranted.*

Average household income in the USA: $53,046

This chart demonstrates many important things. The first is that there are a large variety of sustainable upgrades that both new and revitalized homes can include in their energy and home design plan. The second is that some features or technologies have not only a larger impact than others, but that some technologies are a great deal more expensive than others. The third
item is that the average household income is only $53,046. The fourth fact that be gathered here is that certain energy technologies, and certain methods are better suited for some environments versus others (Warm climates vs. cold). This will slightly affect the total overall costs of each example’s outlook, but it is logical that certain locations within our country require certain unique needs.

Whether a homeowner is building a new home, or is updating an older residence, the fact of the matter is that renewable technologies and sustainable methods costs a large amount of money versus what the average American household makes per year. The fact was also stated above is this writing that one-third of all 30 to 50 year-olds have saved no money for retirement (CS Money Watch, 2014). When looking at total adult savings, 26 percent of all adults have no cash set aside for emergencies, the average American’s bank account contains around $4,400 (but 41 percent of adults don’t even have $500 saved up), and the average personal savings rate is 4.4 percent of a household’s income (down from 10.5% in 2012) (Lake, 2015). Additionally, 38 million households live paycheck to paycheck, the baby boomer generation has the best savings track-record, and 59 percent of Americans say that running out of money is their biggest fear (Lake, 2015). These money statistics will have a large effect on whether or not a household chooses to invest more money for sustainable technologies.

The statistics on income growth and economic inequality are even more staggering. The University of California at Berkeley estimates that between the years 2009 and 2012, the top 1 percent of income earners brought in 95 percent of all income growth during that time. The states with the greatest disparities in average incomes are New York and Connecticut, with the top 1 percent of earners earning incomes that are 48 times larger than those in the bottom 99 percent (Sommelier & Price, 2015). In fact, in 4 of the states in the U.S.A. (Michigan, Nevada,
Wyoming, Alaska) only the top 1 percent of earners saw a rise in income between 1979 and 2007, while the income of the other 99 percent fell during that timeframe (Sommeiller & Price, 2015). This shows a much larger and more disturbing trend in the ability of the average American to not only save more money, but earn more of the economic growth that each state is experiencing differently.

These above facts combined with the knowledge that the average American household debt is $117,951 (the home mortgage accounts for $95,000 of that and credit card debt accounts for $2,200 of it), and that 24 percent of American workers postponed their retirement in order to earn more money, leaves many to believe that sustainable technologies and energies are not at the forefront of many Americans minds (Statistic Brain Research Institute, 2015).

Although much of the data shows that many Americans are prepared (financially or mentally) for investing in sustainable technologies, there are many example of positive-energy homes throughout the world. The need for these types of homes is demonstrated through the fact that 30-50% of emissions reductions are possible by homeowners, by the year 2020 and through the use of current technologies, designs and management systems (Miller & Buys, 2012). The European Union aims to create a zero-energy building requirement by 2019, which is defined by the US Department of Energy as a residential building that greatly reduces its energy needs through efficiency gains and renewable energy technologies (Miller & Buys, 2012).

Since so many people live in urban settings, the role of the design process is crucial in the development of imaginative and usable buildings on all size scales. Designers, planners and builders first and foremost need to be up-to-date with implementing large-scope sustainable technologies. Modeling programs that incorporate new features, methods and technologies are
important in creating a cohesive and workable solution to our urban residential problems (Miller & Buys, 2012). Residential ecovillages have been developed and tested in many places throughout the world. The example given here will be from Queensland Australia, which incorporates a 270 acre parcel of flat land (20 percent for housing, 50 percent for environmental reserves, and 30 percent for horticultural and recreational needs), and has a sub-tropical climate (Miller & Buys, 2012). The developers of this site want to inspire further sustainable living, and show planners and builders how it can be done. The housing part of the land was broken into 144 sections, with greenways set up for increased social interaction in the community. Gardens were implemented in each lot, and vehicles were allowed on the outer edges of each home (versus the inner edges like most U.S. subdivisions). Maximum home footprints and general home locations were fixed, and an Integrated Design Process (concept, pre-design, design, construction, evaluation) was used for maximum sustainable benefit. All homes also had their own metering and control system that allowed for resource monitoring (Miller & Buys, 2012).

The 144 homes that were built needed to conform to several goals: 1) using the lowest overall energy possible (beginning to end) 2) maximizing the thermal capabilities of the overall home 3) minimizing energy demand from all areas of the home and 4) enhancing energy and water system performance (Miller & Buys, 2012). A thermal simulation software program was used both before and after home construction was done, and meters for the lighting, temperature, electrical use, heating/cooling, refrigeration, potable rainwater and hot water, gas consumption, and temperature and humidity were used in each home. These helped closely monitor consumption daily, monthly and through all the seasons (Miller & Buys, 2012).

Looking at an individual house in this community, the end-result was a 9 out of 10 star rating (the predicted outcome). It was a 75 percent improvement over the minimum 5-star rating
that was mandatory across Queensland. Greenhouse gases were also calculated for each home, as well as emissions from the vehicles driven. The results were that for 96 percent of the year, the home’s living room temperature ranged from 64 degrees and 82 degrees, which did not require the use of mechanical equipment. Energy was gathered through the local grid, and 59 percent was used for general power, 36 percent from refrigeration and 5 percent for lighting (Miller & Buys, 2012). The home itself created a positive energy benefit of 2.77 MWh (the energy created was larger than its consumption), and the biggest influencers in energy efficiency for the home were the home design, appliances and service choices. The home actually had a very little seasonal variation in both the use of electricity and the creation of solar power (Miller & Buys, 2012). This whole experiment proves that it is possible to design, find materials for, and build a community where the set-up and the homes are made to be sustainable and Earth-friendly. If it can be done on this smaller scale, there is no reason that planners and designers in all countries cannot use smart-design to lower the carbon footprint that each home has on the planet.

There are many other examples of super-efficient homes and communities throughout the world. The “Waste House” at the University of Brighton in the UK is built with 90 percent discarded waste. This waste includes 20,000 toothbrushes, 4,000 DVD cases, 2,000 floppy discs and 2,000 used carpet tiles (Williams, 2014). This home proves that all waste can be reused in order to construct new creations for new uses. Vietnam has created an uber-cheap house named the S-House, which costs $4,000 and is made of locally-produced (grown) materials. It is very basic but is easy to set-up, move and transport (Williams, 2014). The ZEB Pilot House in Norway is said to produce three times more energy than it uses, leaving plenty of energy to charge an electric vehicle and other electronic devices (Williams, 2014). A final example of another innovative home is in New York City and is called the Tighthouse. It gives a great
example of energy-efficient renovation of a 100+ year-old home, and includes 2 solar hot water panels, PV panels, a very efficient HRV (heat recovery system) which helps to clean the indoor air (Williams, 2014). These individual homes are just some of the hundreds that have been made around the world. They represent environmental innovation and forward-thinking, and will be stepping stones to creating a mainstream method for creating houses, neighborhoods, and whole cities in the future.

There are also many sustainable communities popping up across the United States. As more of these places are created the knowledge-base and costs of each home will continue to get lower. Northampton County, Virginia is an ideal model of a small town which has turned to sustainable improvement as it builds and renovates. This community has achieved many goals since its creation: developing the tourism industry while protecting the natural resources and cultural heritage of the area; building up the aquaculture and seafood industries while helping to improve the water quality; expanding the agricultural industry and also protecting land and animal habitats; and finally building up an area that is eco-tourist friendly and has a high quality of living (Rand, 1997).

Another example of a sustainable community is in a highly urban area: Los Angeles, California. It is called the Los Angeles Ecovillage, and is run by forty people and covers a two-block radius. There are several older apartment buildings within the two blocks, and low to very-low income families reside here. The rent brought in is enough to help retrofit the buildings with environmentally-friendly improvements. The community is highly involved in the ecovillage, and the 40 organizers of the group constantly do outreach programs with and for those throughout the community (Los Angeles Eco-Village, n.d.). The core values of the eco-village include 1) learning from nature and living ecologically 2) celebrate and enjoy all endeavors
undertaken 3) help each other and the planet through social action 4) spread compassion to all present, and nurture relationships 5) create a community through cooperation forgiveness and giving on one’s time or talents 6) learn, act and teach from and for each other and 7) provide ongoing opportunities for participation and stewardship (Los Angeles Eco-Village, n.d.). These two larger community examples help show how responsible living can be done, even by those very low on the socioeconomic status ladder. It simply takes those who are willing to grow, learn and invest in lower-cost yet efficient technologies and methods.

Discussion

There are a variety of tax breaks and incentives for certain sustainable technologies also. Although many tax breaks and tax credits are intended for businesses, there are some that are offered to homeowners as well. For 2015, the items that qualify for a tax credit include Geothermal heat pumps, solar energy systems and small wind turbines (30% of the cost for each of these), and both existing and new construction homes apply. There is also a 30% credit for installing fuel cells (Hydrogen energy). These credits are set to expire at the end of 2016 (Energy Star, 2015).

There are also a large amount (and variety) of state tax credits and incentives. One example is for the state of California. There are over 120 credits for Californians that range from water conservation, to home energy, to general energy-efficiency. In Michigan, there are just over 18 residential credits-- and many of these focus on renewable energy creation, appliance efficiency and whole-home efficiency (Energy (Tax), 2015). In the third state examined about, here are only 12 tax breaks for residents. These tend to focus on all the renewable energies, heat pumps, home design, appliance efficiency and insulation (Energy (Tax), 2015). In short, there
would definitely be assistance with the purchasing of renewable energy products, as well as with some other energy efficiency measures. An estimated $3,000 to $15,000+ could be saved in many states depending on what technologies are purchased. But even with these tax breaks, the average American household would still need to contribute almost $70,000 over the course of several years in order to bring their home up to the ‘environmentally efficiency’ standard. The one saving grace may be the PowerSaver Loan program that the federal government offers: it covers smaller efficiency projects; a second mortgage for larger energy projects; and energy rehab loans for new or refinanced homes (Energy (Tax), 2015).

Based on the fact that the average household makes just over $53,000, each would have to set aside a significant amount of money in order to make these improvements within a 5-10 year time-frame. CBS Money Watch (2014) reported late last year that one-third of all working-age Americans haven’t saved any money towards retirement yet. Sixty-nine percent of those in their 20s and thirty-three percent in their 30s and 40s haven’t even begun to save for their future. Based on these numbers, it would seem fruitless to hope or plan on adults between 20 and 50 having saved very much money at all. Especially when you consider these sustainable technologies are not really necessary, but are instead voluntary and more costly, with a slow return-rate of money over time. This would seem to indicate that lower (and more competitive) prices are necessary for renewables and energy-efficient technologies to truly take off and be the more desirable choice for those who need to purchase or replace things in their home.

The key to moving the sustainable movement forward is education. As people become more educated and are given the chance to appreciate and care for different aspects of the Earth, they develop an appreciative and protective nature over the value that the Earth, water, soil, air and resources hold. It is up to adults to grow their own knowledge, so to pass this to future
children, family and friends. It is also key to educate both our future and present teachers, so that they can spread vital information to the youngest minds, who will one day run the world.

Community events are crucial for a large amount of residents to ‘jump’ on-board with the sustainable idea, and to contribute within their own home.

Another key to creating residential sustainable living conditions will be continual investment into new technologies, methods, laws and initiatives. The local, state and federal government must keep enacting environmental laws, regulations and incentives, so to keep the people’s carbon footprint lower, and to incentivize the use of sustainable home building methods. Both private and public organizations and businesses must also do their part to educate others, as well as add monetary contributions towards finding and testing new sustainable technologies that are on the market. This will create incentive to think outside of the ‘box’ and revolutionize how residential dwellings are constructed and run.

Homeowners will also need to take personal responsibility for their choices. They should be encouraged (by cost, durability, convenience and aesthetics) to choose the more ecologically-friendly options available through the retailer of their choice. Looking for woods and products stamped with an official “Green” seal will help homeowners to make better choices for their construction and remodeling needs. A basic understanding of green methods and processes by not only store and company employees, but by homeowners themselves, is somewhat vital in the push to create green dwellings.

Finally, businesses themselves can lead by example and not only sell more sustainable products, but also become more sustainable themselves. Pollution and natural resource exploitation (in all forms) is a serious problem that needs to be addressed more vigorously.
Business energy use and efficiency also should be streamlined for maximum environmental benefit and cost savings.

*Figure 21- Average energy use for businesses, in their buildings. (Energex, 2015)*

Both small and large business facilities can do their part to lower their total resource use and implement the most efficient features, which will end up as a cost savings in the long-term outlook. It will be up to everyone on this planet to take both small and large measures to reverse the trend of energy and resource waste.

**Summary**

There are many sustainable home and small building options available today. Ideally, everyone would build new both and update their homes to be sustainable, so that Developing Countries could reign in their energy use, and so that average citizens could slowly change their living space over to environmentally friendly technologies and methods of conservation. The big
problem relates to money—how is the average American family going to pay for these valuable upgrades? Looking at the national median household income, there are tens of millions of families that make around $53,000 per year. Based on previous discussions in this paper, any type of savings done by families is for retirement, and is not usually put towards environmentally-friendly home options.

The overall costs for economical and energy efficient upgrades in a home is between $83,000 and $85,000. With the average household income in California being $61,320; the average in Michigan being $51,992 and Alabama’s median household income being $34,135 (the national average is around $53,000), there just isn’t much incentive or much of an opportunity for middle class American households to truly invest in environment-savings technologies as they are today.

The state and federal tax breaks do make it a little easier for families to pay in small amounts, but these environmental upgrades are seen as ‘wants’ not ‘needs’ to many families. Of course most would love to make a positive contribution to the world. At this point in time though the economy isn’t wonderful, the costs of investment are so high (along with the sacrifices they would require), nor do most have the money to invest in technologies that make the world a better place. Following are several recommendations that would help encourage Americans to invest larger amounts of money into environmentally friendly technologies and methods as time passes.

Education for all socioeconomic classes, as well as for those in charge, is crucial for the successful mindset and implementation of sustainable methods. Community support and participation will help lead to larger and more successful sustainable cities and towns. Those
who help to plan, design and construct homes and communities will be integral to the successful implementation of sustainable communities.

The government, private and public companies will need to take a leading role in the spread of both sustainable knowledge, research and development of products and the passing of ordinances, guidelines and laws that will help to encourage people to buy the right products, practice the most sustainable techniques and sell the items that are the best for the Earth and its resources.

**Recommendations**

All Developed Countries tend to be more educated about certain issues, and therefore better understand the positive and negative effects that humans have on our land, water, air and natural resources. It is normal for many of us to aspire to leave our planet a better place because we were have become a positive part of it. Families are used to weighing opportunity costs to determine if certain activities or purchases are in the family budget. Households do this with environmental choices each day of their life—usually with the smallest of issues: whether to drive or walk somewhere, whether to recycle their cardboard and plastics, whether to buy that newer vacuum that they don’t especially need. But when the cost of (for example) putting a metal roof on a house is 5 times more expensive than an asphalt roof, most people tend to balk at the idea of living sustainably. There are several recommendations that would better ensure the average American citizens can afford to purchase, and WANT to invest in sustainable technologies. First, there has to be a reduction in the price of environmentally-friendly technologies, whether it’s through larger and more comprehensive tax breaks/credits or through lower initial costs (Yes! Magazine, 2008). Second, the infrastructure of new subdivisions and
cities must be planned and implemented strategically (Yes! Magazine, 2008). It is very hard to replace the larger components within a household—it is more efficient to build houses, buildings and communities correct in the first place. Third, those who are more highly efficient with their energy usage should receive benefits that encourage them to be even and more smarter and efficient consumers. It seems logical that households would try harder to conserve energy if they received lower energy rates or other perks. Fourth, certain environmentally negative activities, purchases and technologies need to be more expensive, or have a higher taxes associated with them. This would encourage households to explore other options and take a leap into the unfamiliar. Fourth, cities and suburban areas should build and encourage the smart use of energy (Yes! Magazine, 2008). This is possible through the environmental education of planners, designers, architects and builders. If those who build our houses, subdivisions and cities were thinking long-term, many changes would make these areas for sustainable. And lastly, innovation has always been a signpost of the American way of life. Both individuals and companies need to try new methods and develop new technologies to become more energy efficient. Oftentimes, it is the regular consumer who has an idea, tries out variations, and creates a new way of living through technological innovation. At other times, new technologies are discovered through funding and years of trial-and-error. Both of these need to occur in order for the most optimal solutions to become realized.

The key is for the average citizen to make small improvements over time, especially when money is an issue. It may take decades, but in the end, a small effort is better than no effort at all. Technology will always be improving, prices will usually always be going down, and the education of our society about the negative effects of pollution and resource waste needs to be instilled in each new generation. By focusing on the positive aspects of living sustainably (and
keeping the costs competitive), society will help insure that the average American household will
to some extent, be able to implement small ‘green’ measures methodically over time. The
alternative is a polluted and wasted Earth, and no one will enjoy the negative effects of that
outcome. Like Ha-Joon Chang has said “People 'over-produce' pollution because they are not
paying for the costs of dealing with it.” When humans don’t need to account for their destructive
behavior, then things will not change. It’s only when accountability is demanded for everyone’s
actions, that the Earth as we know it will continue to survive for thousands of more years.
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