Understanding energy efficiency problems in residential renter single family homes in Meadville, Pennsylvania by a case study analysis

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Submitted in fulfillment of the senior thesis requirements of the Department of Environmental Science at Allegheny College and approved by the senior thesis committee.

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Title: *Understanding energy efficiency problems in residential renter single family homes in Meadville, Pennsylvania by a case study analysis*

Abstract: With climate change being one of the biggest environmental problems our world is currently facing, data shows that reducing (rental) residential energy use is one way to lower greenhouse gas emissions (UOCS, 2008; C2ES 2009; Kapsalaki et al 2011; Agnew, 2012; Crate et al, 2016). This project is a case study analysis looking at addressing the landlord and tenant dilemma, specifically in Meadville, PA. To solve this issue four solutions are investigated: use of incentives and rebates, more education on the topic, increased green building codes, and green leases (Abrahamse, 2005; Ástmarsson et al., 2013; Bird et al, 2012; Bright et al, 2014; Reames, 2016). Then based off criteria in Meadville, PA a solution is suggested which is a combination of several analyzed solutions. It is an informational packet split up into four different parts: why this is environmentally important, no cost changes, cost changes, and being aware of incentives. As a subsection of cost changes it would explain the idea of Green Leases, which is where the landlord pays for the energy efficiency upgrades and raises the monthly rent, but the energy bill the tenant pays will go down (Ástmarsson et al., 2013).

Introduction:

Climate change is one of the biggest environmental problems our world is currently facing (UOCS, 2008; Agnew, 2012; Crate et al, 2016). Climate change is a result of greenhouse gas emissions being released into the air from human production, which then make it harder for the Earth to cool by trapping energy in the atmosphere and allow for a higher average temperatures (McMichael et al, 2006; Rogelj, 2013; EPA, 2017). Not only will climate change affect our environment, but it will also negatively impact human health (Epstein, 2005; Haines et al, 2006; McMichael et al, 2006). One of the biggest contributors to climate change is energy use (EPA, 2016). Since 1966 and prior, we have gotten the majority of our energy from oil, followed by coal, then natural gas (Chu et al, 2012).

In developed countries, buildings (commercial and residential) account for 30 to 40 percent of the energy demand (C2ES 2009; Kapsalaki et al 2011). This translates to buildings contributing about 40% of our energy-related CO2 emissions into our atmosphere (C2ES 2009; Kapsalaki et al 2011). In 1950, American homes used 720 million kilowatt-hours (kWh) of energy, whereas in 2012 that number has jumped to 3.65 billion kWh (Tarantola, 2014). Our residential energy usage is primarily going to heating, cooling and air conditioning (HVAC), followed by lighting, and water heating, (C2ES, 2009; DOE, 2008). Because such a large portion of energy use in America goes towards residential use, a key way to reduce greenhouse gas emissions is by reducing residential energy use (Kapsalaki et al, 2011).

Of all residential zones roughly 34% are rented, making renters a significant demographic overall residential energy use (DMData, 2010; Obrinsky, 2016). For US homeowners, 48.2% of heating fuel went to utility gas, followed by 38.2% to electricity (Census, 2015). In renter properties, this was switched with electricity leading at 49.3%, and utility gas second at 41.0% (Census, 2015). This difference is important to note as the changes to reduce energy in owned homes could be different from rented homes. According to 2015 census data, 28.5% of renters live in single detached homes, followed by 31.3% of renters living in 10 or more attached apartments (Census, 2015). Over the years, low income renters have put a disproportionately large share of their monthly income to paying the energy bill (Fernald, 2013).

Since the majority of energy in rental areas goes to heat, refrigeration and lighting, all of which are necessities, there is little change in energy bills in households regardless of monthly income (Fernald, 2013). This and other items listed above is why lowering the monthly energy bill of renters is important.

Convincing the landlords why it is important to make more energy friendly upgrades in their properties is one of the biggest home energy environmental issues (Ástmarsson et al., 2013). Since tenants are generally the ones who pay for energy they have a bigger incentive to lower their bill, however since they do not own the property the tenants are not generally the ones paying for said upgrades (Ástmarsson et al., 2013). Essentially the biggest barrier is lack of economic incentives for landlords to improve energy efficiency (Ástmarsson et al., 2013). If there remains to be no incentives, it is imperative that the energy upgrades and pricing changes be laid out so everyone involved is on the same page (Ástmarsson et al., 2013). This is called the landlord dilemma.

This has been a problem for a long time, with articles on this topic dating back to the late 1980s and early 1990s (Costanzo et al., 1986; Sutherland, 1991). The article "Market Barriers to Energy-Efficient Investments" brings up this issue; as Sutherland (1991) says that discussions about policies should focus on reducing, or if possible eliminating "market barriers so that an economically efficient level of conservation could be achieved" (Sutherland, 1991 p. 15-16). He argues that the way the market was set up, it did not support energy efficiency upgrades. Purchasing energy upgrades for your home is one way to make overall upgrades cheaper and easier. The point of this study is not to tell landlords, for example, what type of insulation they should get, but rather why it is worth it for them to get a more environmentally friendly insulation.

If a landlord is going to spend money making the property more energy efficient, they will need to increase rent, which will not make the tenant happy. However, the energy bill should go down as a result of the changes, so in a perfect situation the tenant would be paying the same or less than prior to any of the changes. In a survey conducted by Hope et al, (2014) in the UK, researchers found that when asked why landlords didn't do more energy efficient improvements, 60% said because of high upfront costs, 40% said there was no personal benefit, 47% said that

tenants seems perfectly happy with the energy efficiency of their homes, and 13% said there was an uncertainty over actual cost savings gained from improvements (Hope et al, 2014). It is hard to ignore these findings when looking for data to incorporate into my comp and finding a solution.

One thing to mention is the effect of energy labeling in rental properties. According to a study done in the UK, Energy Performance Certificates on rental properties do not have a significant effect on market rent and market value, however this was a study done overseas, and only mentioned energy certificates (Fuerst et al, 2011). In the UK Energy Performance Certificates are needed for every building that is built, sold, or rented, illustrating an energy performance rating from A (most efficient) to G (least efficient) (Gov.UK, 2016). The rating includes information about the property's energy use and typical energy costs, as well as suggestions for how to reduce the energy use and how to save money in the property (Gov.UK, 2016). However the exact use is not important for this study, rather the fact that having the certification did not affect market rent and market value of the home. Additionally in more recent studies there was a correlation between the energy efficiency of a home and the value per square meter of the property (Fuerst et al, 2015; Hernández et al 2015). There has been more support for that claim that renters are willing to pay more for a higher energy efficient property (Carroll et al, 2016). A study that looked at if energy labeling had an effect on the amount of energy consumed, found that pointing out economic savings was the biggest factor when reducing energy used (Newel et al, 2013). Seeing endorsed labels such as "Energy Star" also encouraged more sustainable practices, but overall it was economic knowledge of reasons that led to the biggest behavioral changes (Newel et al, 2013).

The majority of people who rent are low income. This impacts how much money tenants are willing to spend and how motivated they are to provide the money for these changes (Dillahunt, et al, 2010). A study by Dillahunt (2010) analyzed 26 low income rental houses. The study interviewed both the tenants and the landlords in a small town in the Southern U.S. and a metropolitan area in the Northeastern U.S. (Dillahunt et al, 2010). Many tenants indicated that one way to get the landlords to be proactive is knowing your rights as a tenant (Dillahunt et al, 2010). Additionally, the study found that when landlords are responsible for paying the energy

bill, they are more likely to be proactive around energy efficiency measures (Dillahunt, et al., 2010). Ultimately this study suggested that the best way to overcome this energy problem is active communication between the landlords and the tenants (Dillahunt, et al. 2010). This communication includes technology communication, which can make overall communication easier (Dillahunt, et al. 2010). One example from the landlord perspective that could be told through better communication is informing tenants that rather than turning up the heat, they could add more clothing, and if/when heaters break to inform the landlord as soon as possible (Dillahunt, et al. 2010).

Several readings have pointed out that a lack of effective policy that engages the landlords is one of the main causes of the landlord dilemma (Hope et al, 2014; Williams, 2008). Their solution to this problem is to further understand the motives to make an effective incentives plan so they are tailored to them and actually work (Hope et al, 2014). When landlords across the United States were interviewed about what would incentivize them to make their properties more energy efficient, they said they were motivated by three variables (Williams, 2008). The first was the type of metering the building has, as it impacts the split incentive program (Williams, 2008). Split incentives is when both parties have different incentives or goals (Gillingham et al, 2010; Williams, 2008). The second is the size of the landlord's holdings, as landlords with a bigger holdings typically have a higher capital and information, and therefore have more interest to be involved in efficiency programs (Williams, 2008). The final variable was "time horizon", as it largely impacts "the owner's motivations for investing in efficiency: those who hold on to their buildings for a long time pursue efficiency to increase annual cash flow, while those with more short-term interests seek to increase their property's "capital value" (Williams, 2008, p. 19-20).

As much of the research has pointed out, there is little governmental incentive to solve this problem. Recently the "Better Buildings Act of 2014" was passed by the House of Representatives, which works with landlords and tenants in commercial spaces by encouraging them to improve the energy efficiency of their buildings (Hess et al, 2015). It states that with the Sector of Energy, they will lease "documents that designate a federal agency as a landlord or tenant that encourage building owners and tenants to invest in cost-effective energy and water

efficient measures" (Energy Efficiency Improvement Act, 2014). While this does encourage the use of more energy efficiency in buildings, it does not require anything rather it just suggests it. However many of these policies, and even the possibility of them are varied by the views of the elected official on the area (Hess et al, 2015). This also mainly targets commercial places rather than residential.

Another current policy is the Minimum Energy Performance Standards, which has made some progress in many rental housing places thus far (Williams, 2008). However it pointed out that while policies that focus on appliances are effective, there are still many other parts of a home that require energy so that alone can't fix the problem (Williams, 2008). Williams (2008) also suggests that the way to overcome this is by governmental incentives. Additionally there are currently no policies in Meadville that directly deal with this issue (Ástmarsson et al, 2013).

Meadville is a city located in Crawford County in northwest Pennsylvania. With a population of just over 13,000, 46.3% are owner-occupied housing (Census, 2015). The median gross rent between 2010 and 2014 was $614 per month, making it well below the US average (Census, 2015; TownCharts, 2016). Because of Meadville's harsh winters, renters will spend a fair amount of money on heating their homes. 85% of Meadville homes use utility gas to heat their homes, 10% use electricity, and the remaining 1% use bottled tank or LP gas (TownCharts, 2016).

Looking at the percent of household income that goes to rent, Meadville is relatively high compared to other cities in Crawford county; as 19% of the population have between 30% and 40% of their income go to monthly rent, and 25% of Meadville renters have over 50% of their income go towards it (TownCharts, 2016). As much of the research has pointed out looking at who pays utilities (energy) is very important in how to overcome the problem. In Meadville 81% of the tenants pay their utilities, whereas the remaining 19% have utilities included in their monthly rent (TownCharts, 2016). Within the median rental price of $500 to $749, 37.6% are studio/one bedroom, 39.3% are one bedroom apartments, 44.9% are two bedroom apartments, and 29.2% are three bedroom apartments; additionally 57% of the homes in Meadville are one unit detached (TownCharts, 2016). The age of the building is also important to point out, which will be brought up in more detail later.

The end goal of this project will be to pull together strategies from several articles that suggested how to overcome this landlord-tenant dilemma, analyze them, and suggest a plan for Meadville.

Methods:

To complete this study, I will be doing a literature review of journal articles discussing the best methods for overcoming the landlord and tenant issue of becoming more energy efficient. There are many journal articles that say the best method, but by analyzing multiple articles, and strategies I will find the best possible way to overcome this issue. The articles I will be using can be found in my results and sources. Data will be presented primarily in case study format, as each article will be summarized and analyzed on its own. It will be analyzed by looking at their effectiveness in six different categories which are: tenant impacts, landlord impacts, city impacts, environmental impacts, cost, and logistical feasibility. I will support them based off the data listed in the articles themselves, and referencing them with information relevant to Meadville. The way the data will be presented and how I will pick which data is dependent on the criteria about Meadville and others listed in this paper. Reading these studies will also help me gain a good background on fully understanding this issue.

After examining the different studies and seeing what they have each suggested, I have filed them into 4 different solutions. Each solution will be analyzed based off six characteristics: tenant impacts, landlord impacts, city impacts, environmental impacts, cost, and logistical feasibility. These categories were decided after discussion with my comp advisor and after the knowledge of the background information listed in the introduction. No program would be successful if it loses money, which is why cost is one of the categories. For a successful solution it is also important for the solution to be logistically feasible and easy to implement so that it is actually utilized. Additionally looking at the environmental impacts is vital as the whole idea of this project is to reduce the environmental impact and energy used in rental homes. Lastly both the landlord and tenant need to be analyzed as they are the two main individuals involved. In the discussion section is where I will make a suggestion for which approach will work best in Meadville given the above analysis and the criteria/data about Meadville.

In the end this study will focus on overcoming this issue in single family homes in Meadville, Pennsylvania. Since there is not an overwhelming amount of data on this specific criteria, data is analyzed for all studies posted on the landlord tenant energy dilemma, and any related topic. It will then be analyzed for criteria relevant to this area. An example of relevant criteria is data/studies about single family rented homes, ones that are successful, and connections between other studies and the needs of Meadville. Based off Meadville renter data, all solutions will assume that the tenant pays for the energy bill. The solutions must take into account any existing policies related to energy, money incentives, renters, and other related topics, however there is very little policy in Meadville about this topic.

I will evaluate these for what is the best option by the understanding I gathered while doing preliminary research and gaining an understanding about this problem as a whole.

Once I get all of the preliminary results in, I will analyze all of the suggested strategies by looking at their effectiveness in the six different categories. Once analyzed I will suggest the best option, which might be just one solution, or a mix of several. To decide this I will look at the landlord and tenant benefits, the city benefits, the environmental benefits and impacts, and the cost and logistical feasibility of each option.

Results:

Current Policies in Meadville:

When looking at possible solutions it is necessary to take into account relevant and current policies in Meadville, which are listed below. *All information is from"Code Publishing: Meadville Municipal Code"*

Law "1310.08: Causes of action" states that when doing renovations in rental properties that any changes to the property that "substantially affect the peoples involved need to be shown about said changes. When these changes are made, the person proposing them has to let the other party know 30 days prior to beginning these changes". This is an important law as many of the solutions involve updates to the homes in Meadville and this act requires the landlord to inform the renter about said upgrades beforehand.

Law 913.05 discusses the liability for bill payment, stating that "Owners of real property served by the sewer system shall be responsible for the sewer rentals or charges established and imposed herein for sewer services rendered to any tenant or occupant of such property.".

Act 1301.02: Purpose and authority "promotes, protects and facilitates"… "solar energy" … "preservation of the natural, scenic and historic values in the environment and preservation of forests, wetlands, aquifers and floodplains.".

There are no specific policies that discuss renter energy efficiency and the landlords, the basis of this project. This is important to take into account when proposing a solution, if policy based - it will be completely new to Meadville municipality codes.

Case Studies:

All of these solutions are assuming that the tenant pays for the energy, water, and general utility bills, and the landlord is responsible for paying for upgrades. This is based off the renter data available in Meadville and general renter data (Ástmarsson et al, 2013; Census, 2015). Any upgrades that are less than $100, or can be easily removed from the home such as new light bulbs, will be purchased by the tenant. This was chosen based off data household incomes for renters and previous data mentioned in the above introduction, and the fact that purchases under $100 will generally move with the tenant from property to property (Grande, 2009; Williams, 2008).

1. Incentives/rebates for landlords for purchasing appliances.

Background: Described as the most effective way to overcome this problem in one study, increasing legislative requirements is one approach (Ástmarsson et al, 2013). One study found that compared to individuals that own homes, renters are significantly less likely to own energy efficient refrigerators, clothes washers, dishwashers and lighting (Davis, 2011). While getting more energy efficient appliances would theoretically let landlords charge more for rent, it is hard to see this with such large upfront costs (Davis, 2011). However taking advantage of reimbursements could help offset some of these charges, as the Department of Energy has said they will refund $300 million in rebates for Energy Star appliances (Davis, 2011; Hunter, 2009).

This solution is essentially the landlord taking advantage of rebates and legislation in appliances and purchasing them for their properties for the tenant's use. It is motivated by rebates, and the price depends on the specific rebate.

One example of this is discussed in "A community-based approach to low-income residential energy efficiency participation barriers" (Reams, 2016). This paper looked at the Green Impact Zone (GIZ) in Kansas City, Missouri, which "was an ARRA-era, national model for place-based investment, demonstrating how concentrating resources in an area with decades of disinvestment and neglect could lead to significant, sustainable improvements." (Reames, 2016). This policy proposed using $200 million for "green-based urban renewal project in five co-located low-income, majority African-American neighborhoods" (Reames, 2016). This had a big focus on weatherisation, employment and training, infrastructure, energy efficiency, urban agriculture, public safety and community service, and youth (Reames, 2016). In the end they found several issues as well as benefits, which will be discussed below.

Tenant Impacts: This specific study found the tenant was more informed about what was a reasonable request for energy upgrades, increasing the comfort of both the landlord/tenant relationship and property (Reames, 2016). Some tenants were worried that their rent would increase due to the necessary weatherization upgrades this policy suggested (Reames, 2016),

Landlord Impacts: In some situations the landlords were required to cover up to 50% of the costs related to weatherization of the property, which brings up the split incentive issue as it becomes an "unprofitable proposition" (Reames, 2016). However to increase weatherization of rental homes involved in the study (as owned homes were also part of this study) had a discount incentive created for landlords where "the shared cost of weatherization by landlords was substantially reduced to only 5% for dwellings with less than five units" (Reames, 2016). To encourage fellow landowners to participate in this a stakeholder in this study made a video saying all of the benefits that could come out of participation, including informing tenants of reasonable energy upgrades requests to ask their landlords (Reames, 2016).

City Impacts: One issue found in the Kansas, MO example is in the beginning of creating these policies and getting the word out to people was making "green relevant' (Reames, 2016). Additionally in their town meetings these energy initiatives took a backseat to more pressing

topics such as social and economic issues the town was facing (Reames, 2016). This can be overcome by showing the connection between environmental upgrades and saving money (economics), but it was difficult to show and convince town members of this vital connection (Reames, 2016). Getting a tax like this approved on the local level could take a long time in government, especially in a place like Meadville that doesn't have any similar policy in place currently (CodePublishing, 2015).

Environmental Impacts: This solution did not list specific numerical data on environmental impacts in the study. However it did mention that along with economic benefits they emphasized why this was important environmentally (Reames, 2016).

Cost: Similarly to environmental impacts, it did not list any specific cost savings, however it did emphasis how money was saved. It did take money into consideration, for example as mentioned above changing the initiative to work better economically for landlords as it was originally designed for homeowners.

Logistical Feasibility: This has potential for policies to be difficult to understand and implement for the landlord or tenant to fully take advantage of (Hovi et al, 2009; Reames, 2016). While cost wise this is one of the stronger solutions, the feasibility could be a nightmare of red tape and difficult to take fully advantage of; so making sure there are no loopholes is also important (Reames, 2016).

2. Education for landlords and tenants on why energy efficiency is important

Background: One paper analyzed 38 different studies that looked at the effectiveness of different types of educational interventions and their success to reduce household energy conservation. While this is aimed at homeowners rather than renters it is still the act of using education to reduce energy consumption which is this suggested solution. Looking at behaviors related to household energy consumption, there are two different kinds: efficiency behaviors and curtailment behaviors. The more effective one in actually reducing one's environmental impact and saving money is efficiency behaviors, which involves, for example, purchasing new insulation for a home. On the other hand curtailment behaviors are repetitive efforts to reduce energy, such as lowering the thermostat temperature (Abrahamse, 2005).

Abrahamse (2005) looked at expressing information about household energy consumption through workshops, mass media campaigns and tailored information. Workshops where attendants were given information about measures they can take to save energy lead to "higher levels of concern about the energy crisis, to an increase in knowledge about energy conservation, and stronger intentions to adopt energy-saving measures". The information did influence the determinants of energy use but it did not change behaviors. Mass media campaigns, such as when President Carter went on television to encourage Americans to lower their thermostat due to the potential gas storage, were for the most part unsuccessful. The next intervention looked at was tailored home audits, which were very personalized with specific information. This varied in success, as some studies found 20% reductions in electricity usage, where another study found no reductions after home energy audits. A study that looked at giving continuous feedback to households about where they are spending the most money on their electricity bills found a 12% reduction in energy. One method of expressing education discussed in the paper is when the US Department of Energy mailed out 4.5 million booklets with energy saving tips and a shower flow control device (Abrahamse, 2005).

Above information is taken from: "Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. Journal of environmental psychology, 25(3), 273-291."

While the specific article that studied the booklets was more about comparing the different groups within the study, it still did have important information on the affects it had (Hutton et al, 1981). In the pamphlet it listed eleven free or inexpensive tips homeowners can do to reduce their energy bills which dealt with: "water-related energy conservation, insulation and caulking of out-of-the-way places, and appliance efficiency" (Hutton et al, 1981). In each of the tips it had an "explanation, including graphics, on how to use the tip, how much would be saved, and appropriate cautions on installation" (Hutton et al, 1981). While the majority of the households did use the tips, one reason for not using them was prior knowledge of these tips as they had already been doing them (Hutton et al, 1981). Overall this intervention was successful and found actual energy savings. While there are many different ways to educate people, the booklet will be analyzed below.

Tenant Impacts: The original study focused on all households and not just renters, however the booklet sent out was successful (Hutton et al, 1981). The majority did accept and utilize the tips, which can be associated with numerous benefits which will be listed in the discussion (Hutton et al, 1981).

Landlord Impacts: This did not list any specific landlord impacts as it was focused on overall households.

City Impacts: As this is not a specific citywide policy there are no immediate benefits other than, assuming it's successful, lower emissions for the city.

Environmental Impacts: They found that compared to households that did not receive the booklet and shower head, they reported having an energy savings and implemented the suggested energy-saving tips. However while the study did say energy was saved it did not say specific data on how much energy was saved (Hutton et al, 1981).

Cost: The study did not get very specific in actual money saved, other than if implemented the tips could result in 25% savings on energy bills (Hutton et al, 1981).

Logistical Feasibility: Finding a way to get this information to the landlord and tenants will be the most difficult, as well as handing out the information in an effective way that will actually work. The booklet in this study was sent out by the U.S. Post Office, additionally there were paid advertising campaigns on television, radio and newspaper ads (Hutton et al, 1981). It did not list any difficulties in giving out this information.

3. Building codes updated

Background: Building codes can be updated that target energy efficiency, and since they are legal codes they must be done. However building codes are only really applied with new construction or major renovations (Bird et al, 2012; Williams, 2008). Along with improving building codes, having an increase in the number of energy labeled products (such as EnergyStar) can be lumped with updated building codes (Williams, 2008). One study found that upgrading building codes was one of the most effective ways to overcome this problem (Ástmarsson et al, 2013). Some examples of building codes already in use in the United States involve codes that "require high

levels of building energy efficiency and LEED (leadership in Energy and Environmental Design) Certification and are created by the U.S. Green Building Council" (Bird et al, 2012).

Tenant Impacts: One negative aspect of this is the landlord could put off general maintenance on the house in order to avoid having to further upgrade the property for the required energy efficiency upgrades proposed by the building code (Bird et al, 2012). Additionally since this only applies to new construction not many rental homes will be affected from this, therefore not affecting the life of the tenant (Bird et al, 2012; Williams, 2008). This could result in higher rent due to higher construction and maintenance (Bird et al, 2012). However if this is actually utilized the tenant would see an increase in way of life due to energy efficient upgrades (Hernández et al, 2015).

Landlord Impacts: As these will be necessary upgrades, this has a large impact on the landlord. However since these are generally only necessary with new buildings/construction this could cause the landlord to postpone general maintenance on the house in order to save money and avoid these necessary upgrades. This solution has also been criticized for low income rentals as "the vast majority of low-income rental housing is not new construction", and therefore they will never get the benefits from the upgrades (Bird et al, 2012).

City Impacts: This has a large city impact as building codes are made by the city, and hence will require the government's assistance (FEMA, 2015). If the city employees don't see the importance of this the codes could be weak and not cause much of an impact on the city (Reames, 2016).

Environmental Impacts: This study mentioned as a result of the updated building codes more energy efficient certified homes, such as LEED (Bird et al, 2012).

Cost: The study mentioned that it is expected to have higher rent prices due to higher construction and maintenance costs, which can result in a bias against low-income renters (Bird et al, 2012).

Logistical Feasibility: Similarly to new incentives and rebates, this could be a "red tape" nightmare for landlords to understand and see where the upgrades are needed. This study also mentioned that since "green building codes are a regulatory mandate" that "they are opposed by the National Association of Home Builders and are opposed by citizens who have concerns for

freedom and 'environmental fascism'" (Bird et al, 2012). Acts that are voluntary are more likely to be adopted and used by individuals, as well as gain political support (Bird et al, 2012).

4. "Green Leases" where the landlord pays for upgrades and then charges more for rent

Background: This is a general idea that has been touched upon in nearly every solution however it is worthwhile to mention as its own solution without any other topics. The idea of green leases is when the tenant and landlord both decide to lower consumption, and the tenant accepts that there will be a higher monthly rent, however knowing that with time their overall monthly costs will go down (Ástmarsson et al, 2013). One study that analyzed 26 retail spaces with green leases found that 18 had some sort of environmental benefits (Bright et al, 2014). However this study also concluded that the sample size was too small and no real conclusions on green leases could be made as they are a relatively new idea (Bright et al, 2014).

Tenant Impacts: This has one of the greatest tenant impacts as when done correctly it will not drastically increase the monthly payments of the tenant (Ástmarsson et al, 2013). Additionally once the new upgrades are payed off by the tenant's increased rent, the rent could then go back-down and the tenant would end up saving money (Ástmarsson et al, 2013). Other benefits include increased living conditions with a more energy efficient home (Hernández et al, 2015).

Landlord Impacts: The landlord has a bigger impact than the tenant as they will have to front the money for the upgrades, however with increased rent charges per month they will get their investment paid back eventually (Ástmarsson et al, 2013). Other impacts include being informed about worthwhile upgrades to invest in, and then actually implementing them which could be time consuming.

City Impacts: This does not have any direct city impacts as it does not involve changing any laws or taking advantage of rebates.

Environmental Impacts: This study did not mention any direct environmental impacts.

Cost: Since this solution looks directly at finding ways to lower the costs, this is a cost effective solution, or easiest way to get your money back without the red tape government policies and building codes could propose.

Logistical Feasibility: Since this does not deal with any government laws or incentives, logistically it is relatively easy (Reames, 2016). It is just between the landlord and tenant so the logistics will be greatly improved with a good landlord and tenant relationship. The landlord and tenant can sit down and figure out what is the best method for how exactly to take advantage of this, making it personal and effective. The hardest part of this will be explaining to both parties why this solution makes sense both economically and environmentally.

Discussion:

It is important to look at each solution at more of a general scale, and the pros and cons of each one with more sources as there are other aspects to take into consideration. For example when looking at implementing more incentives and rebates (first analyzed solution listed above) these upgrades will result in a higher property value and could allow the landlord to charge higher payments for rent (Carroll et al, 2016). This solution has the most for the landlord to benefit to fix this problem, as they are getting effective appliances at a discounted price, increasing their capital and investment in the property, and can increase the rent (Fuerst et al, 2015; Hernández et al, 2015). To take advantage of the tax rebates they won't get the money until their taxes are paid off the following year, which could be a drawback (Casey, 2015).

This can greatly improve the life of the tenant as they will receive new appliances, and their energy bill will go down as a result of the energy efficient upgrades (Allcott et al, 2010). The exact upgrades will depend on what the rebates cover, and what ones the landlord decides to take advantage of. Data has shown that lack of effective incentives is the biggest reason for this energy issue so hypothetically this should be the answer to solve this (Ástmarsson et al, 2013). However one negative aspect of this is that just because the incentives and rebates are there does not mean the landlord will take advantage of them (Williams, 2008). If the landlord does increase the rent, making sure it is a fair amount increased is vital, as the tenant should be informed that the upgrades were purchased at a discounted rate and therefore the rent should be increased with that in mind. (Dillahunt, et al. 2010).

When looking at Meadville this is a viable solution as it targets low income individuals which is the majority of Meadville citizens. However there are currently no local rebate programs, so they would have to either be new or implemented from the national scale. One would hope the policy would be designed for the benefit of the environment, and while it depends on the exact policy, it is hard to imagine a policy that would be detrimental to the environment. Since this solution looks directly at finding ways to lower the costs, this will be a cost effective and cheap solution, and an easy way to get your money back (Casey, 2010). In one study on why landlords didn't invest in energy efficiency upgrades, 60% of landlord said because of high upfront costs, so ideally using rebates would help landlords change their mind on that aspect (Hope et al, 2014).

Several of the solutions either directly or indirectly deal with adding new appliances/ energy upgrades the the property. A study done in New York City found that energy efficiency upgrades increased renter's sense of health and safety, reduced energy costs, and improved thermal comfort (Hernández et al, 2015). Residents had both direct and indirect benefits. As well as the three main benefits listed above, some direct benefits included more consistent heat, more control over the temperature, and improved in-home comfort level (Hernández et al, 2015). Indirect benefits (indirect meaning benefits not expected) included improved property value, reduced stress and anxiety, and improved tenant-landlord relationships as there were less complaints (Hernández et al, 2015).

However there were some negative consequences that are important to note when looking at the big picture and ways to understand and overcome this issue. Some direct and indirect issues included damage to property as a result of the upgrades, fear of increased rent due to building improvements and energy efficiency upgrades, economic energy insecurity, and some poor relationships with landlords (Hernández et al, 2015). These negative impacts were only reported by a few of the study participants, and 19 out of the 20 participants had a least one direct benefit (Hernández et al, 2015). It is almost possible after looking at all the positive impacts of improving efficiency in rental properties that the landlord makes the tenant pay for these changes. Overall, the payment needs to be laid out so every party is on board about initial upfront costs, and later on savings (Dillahunt et al, 2010). The main direct tenant benefits are

greater knowledge about how energy in their home works and using that to lower their energy impact (Zsóka, 2010).

Looking at education as a solution, the information would have to be given out some way and this would most likely include the help of the government, unless an outside group comes in to assist (Anderson et al, 2004). In a study that analyzed the success of government run energy audits and the rate that the individuals took advantage of the energy upgrades, it found that roughly half of them were adopted (Anderson et al, 2004). Being informed about why it is important to make rental homes more energy efficient is important, additionally economic knowledge did lead to behavioral changes in energy behavior (Newel et al, 2013). One great aspect of education as a solution is that it is involved solely with being knowledgable of energy audits and how to save energy by doing things such as turning off your lights and setting your thermostat at the right temperature, which cost virtually nothing. These benefits are apparent with more knowledge of how energy works in these homes, as they are likely to make behavioral changes when being more aware (Zsóka, 2010).

The next suggested solution was building codes. Building codes have many good things about them, however there are also numerous negatives. Cost wise the exact price will depend on what the building codes aim at changing but this is one of the more expensive solutions as by law it requires upgrades and payments made for new construction. Since this does not directly deal with taking advantage of rebates, this assumes that all upgrades will be paid at the full price. This could put a large economic burden on the landlord who would be held responsible for the upgrades. Building codes are associated with renovation, which means new materials, energy towards construction, and more waste (Plataforma, 2009). However there are new ways to go about construction in a more environmentally friendly manner, but these methods can be more expensive. Using low embodied energy and cost effective materials in the building construction are ways to reduce the energy consumption related to construction, and the overall energy footprint of the building itself (Bansal et al, 2014).

My Proposed Solution for Meadville:

The ideal solution will be a combination of several of the solutions listed above

(Ástmarsson et al, 2013). There is no one perfect solution as each one has positives and negatives to them. For example while taking advantage of rebates sounds like a great plan, it could be a red-tape nightmare and turn individuals away from taking advantage of them. Building codes would be great, but since they are only generally used with new construction, and looking at the houses in Meadville they would not be utilized to their full potential. Additionally unless the new building codes require an effective method of construction the landlord does not necessarily need to upgrade in the most environmentally friendly manner, causing unnecessary harm to the environment. However since building codes are necessary, looking at the long term benefits could outweigh the initial effects as in the long run the upgrades would help the environment. Green leases have a lot of potential, but starting to motivate the landlord and tenant that while they will see a larger upfront cost, knowing that in the end it will pay off will be hard to get across.

Given that above statement, I propose that the solution in Meadville involves mainly an educational part to it. This will be important for both economic and environmental reasons. The educational solution is an older method for energy efficiency so it also has the most valid data for success. I also propose education is involved in the solution as there are many different ways to educate people, and people learn many different ways. Being able to customize this is extremely helpful as it can be tailored to Meadville renters. While Meadville is like other towns, it will be unique in the sense that it is tailored to a town that experiences all four seasons, it has above average low-income renters, and older homes.

In the end I will propose a combination of informing individuals of economic incentives, education, and green leases however this will all be given out in an informational pamphlet. The reasoning behind not choosing updated building codes is the lack of economic incentives and it is only used for new construction. Looking at Meadville's housing data, 43% of the homes (both rented and owned) were built in 1939 or earlier, and only 1% were built between 2000-2009 (TownCharts, 2016).

I propose the informational packet be split up into five different parts: why this is environmentally important, no/low cost changes/upgrades, being aware of incentives, what green leases are, and a small part about how climate change works. Another benefit of this type of

solution is regional efforts to combat climate change can bring attention to a town if it's efforts are successful (ClimateAdapt, 2015). This is apparent when looking in the news about any policy that is working to combat climate change, whether it be through transportation efforts, or overcoming the landlord and tenant dilemma. If a city is looking to have good publicity, this is a great way to do this (Kim, 2010).

The first part of this informational packet will be why this is environmentally important. While economic reasons will most likely motivate them more (which will be listed in a later section), this part is important because the ultimate goal of this project is to reduce the environmental impact of residential rental properties in Meadville, PA. By having the renters and landlords know how much they can help their environment by partaking in the the following tips is important. Information in this section would include much of the same information listed in the above introduction. Data would include a very simple and brief overview of how climate change works and why we need to stop it. Then it go into how much housing is contributing to climate change, then breaking it down even further on how renters are affected by it. I would then say what is going to happen if we don't change our actions quickly, how the atmosphere will continue to warm, weather will get more extreme, and more (Riebeek, 2010). One of the facts that will hopefully really make individuals in this area change their behavior is seeing how climate change will affect agriculture (Riebeek, 2010).

The second section will inform renters on no to low cost solutions they can do to reduce their environmental and economic impact. The informational pamphlet will have examples such as: the importance of turning off lights, using cold water whenever possible, and other similar tips. This is beneficial as this does not require interaction between the landlord and tenant, which has proven to be difficult at times. I hope to provide roughy 5 changes tenant's can take, and provide general money saved and how much they are helping the environment by doing so.

The third section in this will be highlighting different economic incentives in place that they can take advantage. Since there are not currently any in Meadville they will be on the more national scale, such as the ones put out by Department of Energy and EnergyStar. This section can be updated if new policies are made, renters and landlords will be aware. The reasoning behind this section is to go around all of the "red-tape" and really break down how these rebates

work, and then make sure renters in Meadville are aware of them. Data has shown that is one of the reasons individuals do not take advantage of these resources is due to lack of awareness and not being able to understand them. This section of the informational packet aims at overcoming this issue. One example of what will be in this section is a rebate offered by the Pennsylvania electric company "Penelec". While they offer several different rebates, this example will focus on a $25 rebate for a dehumidifier. In its lifetime an EnergyStar dehumidifier can power a full sized refrigerator for three months with the energy it saves versus a typical dehumidifier. (PennPower, 2017). While this is focusing on the dehumidifier, the online application is the same for all of the approved Penelec and EnergyStar appliances. By entering basic information online such as address, electric supplier, information on the humidifier you purchased, the applier should receive the rebate within 90 days (Penelec, 2017). After mock-completing it online, it took me less than 10 minutes, and you were able to get several rebates on the same application, for a total of $200 available in rebates from just one site (Penelec, 2017).

The fourth section will explain green leases. Since this is a new idea people in Meadville are unaware of this. The idea that at a lower overall cost, the landlord could update their property and the tenant could live in a more comfortable home for a slight price increase. For this section I will simply explain it, and whether the landlord and tenant chose to use this is up to them. An exact example of what would be in this section is an example with a refrigerator that is between 16.5-18.9 cubic feet and has the freezer on the top. A new EnergyStar refrigerator from Lowe's with those parameters costs $599.00 (with $75 in rebates available!), (Lowe's, 2017). Assuming the property currently has a refrigerator from 1990-1992, the household can earn back $638 back in just 5 years, making a profit of $39, which will continue to increase each year (EnergyStar²). However, at nearly $600 the landlord will have a difficult time fronting this money, which is where the idea of Green Leases comes in. The tenant would see a $10.63 decrease in their monthly energy bill with the new appliance, and by the landlord increasing the monthly rent by $9.00 a month, therefore having the tenant save $1.63 per month (EnergyStar²), the landlord can earn back their investment over the next 10 years. The landlord would benefit from an increases property value, and essentially getting a new refrigerator for their property for free.

Other things to point out that could be included in this solution is having the information in this packet available in local places, such as the Market House and churches. Looking at ways to send it out will need to be discussed with the Meadville government, to first identify rental properties and seeing what public data is available on their addresses.

One last part I would suggest is giving this information to the Meadville government to encourage them to take the steps to make more local incentives. As much of the data has pointed out, increased government incentives is one of the biggest barriers, and is a great way to solve this. I do not want to focus my solution just on hoping the government implements new initiative to fix this issue, but it would be worthwhile to inform them of these findings and hope that they would do something about this issue in the future.

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