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A More Sustainable Future: Energy Efficiency Policies in Buildings

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Abstract

Energy efficiency is often times the most cost effective solution towards reducing energy demand. Energy usage in buildings accounts for upwards of 40% of the total energy consumption in the United States, as well as the vast majority of the growth in energy demand. Despite this buildings are often not built to be energy efficient, causing the residential and commercial sector to paying for hundreds of millions dollars on unnecessary energy use. The reason for this is the many market failures including: risk, lack of information, and access to capital. Looking at policies by the United States and China attempting to fix these market failures, it is found that most policies were at least cost effective in increasing energy efficiency. The most effective policy tended to be those intended to increase consumer information, possibly because of the supplementary effects in which previous information policies are retained in consumer minds and further information serves to create a more sophisticated knowledge base. It is also found that the major problem in almost all policies was full compliance, showing the need for additional enforcement.

1.0: Introduction to Energy Efficiency

Through the world's development, there has been a constant trend of continued energy use through increased electricity demand. As increasing energy costs and the massive environmental harms of greenhouse gases have been realized, there has been a call for better energy efficiency practices. The basic principle of energy efficiency is achieving the same amount of useful output while reducing the amount of energy consumed. Figure 1 shows that increases in energy efficiency are by far the most cost-effective way to increase electricity production, which is needed as economies throughout the world continue to expand. While it may be problematic measuring the exact dollar amount of savings through energy efficiency, investments in efficiency can be an effective way to increase production and keep up with energy demands. The most important feature of improving energy efficiency is not only that it is a cost effective method to reduce energy usage; but, also that most energy efficient appliances and policies will result in less global emissions.

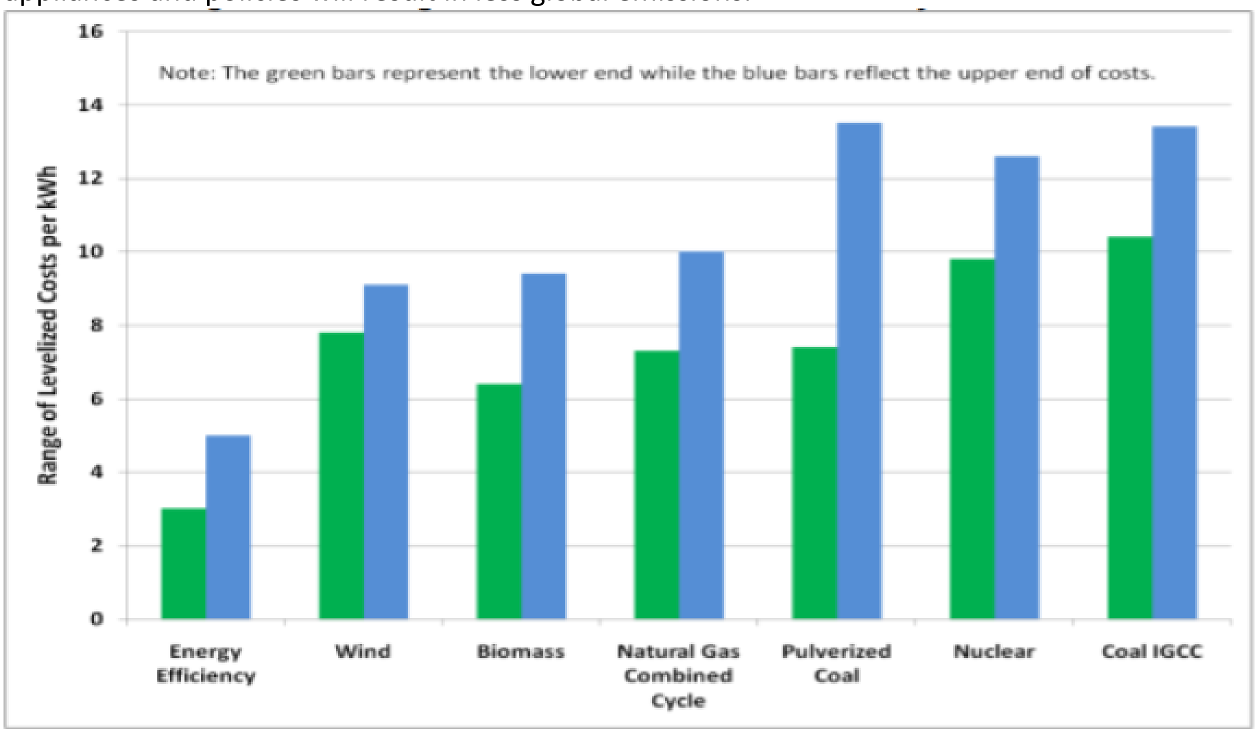

Figure 1: Graph showing the range of costs linked with electricity generation (Source: Laitner, et al. 2012)

The precursor to the energy efficiency movement was energy conservation, in which less energy is used through reductions in the amount of services used. The ideas found in this concept were important during the 1973 oil crisis, in which Americans had to go through highly inflated gas prices. One way to counteract this problem was simply reducing the amount that an individual drove, thus reducing the amount of gas they required. There were numerous governmental policies taken during this time such as gasoline rationing and the prohibition of speed limits higher than 55 MPH. These policies were only somewhat effective, siting gasoline savings of under 1% (history.com, 2019). Many people view energy conservation and energy efficiency as the same concept, when in reality conservation requires individuals to reduce their services used. This causes energy efficiency to be much more beneficial to the individual consumer, as energy efficiency investments allow them to enjoy the same level of service at lower energy costs. Throughout the last four decades, as the conservation discussion was reduced for energy efficiency in many cases, the United States "economic output expanded more than three times…, while demand for energy grew only 50%" (Alliance Commission on National Energy Efficiency Policy, 2013). The difference between energy growth and economic growth will not be entirely due to energy efficiency as there can be some economic growth with much lower energy use through the use of renewables or shifts towards service economies away from industrial economies (effects which will only be noticeable in recent years). Energy efficiency will still have played a majority role in the lower amounts of energy growth. Americans, in general have become more prosperous over the years, and the assumed correlated growth in energy use from this increase in wealth and economic development has been diminished due to energy efficiency and productivity expansions. The Energy Policy Act of 2005 was one of the first major energy laws that set energy efficiency provisions as a key motivation. It included efficiency regulations for large appliances such as freezers, national consumption standards on buildings and commercial equipment, along with incentives for voluntary improvements; which resulted in energy savings of 0.7% of energy use in the United States (Alliance Commission on National Energy Efficiency Policy, 2013). These numbers do not seem quite the large, but energy efficiency has only become a truly important discussion recently, and as more actions are taken to encourage efficiency, improvements will continue.

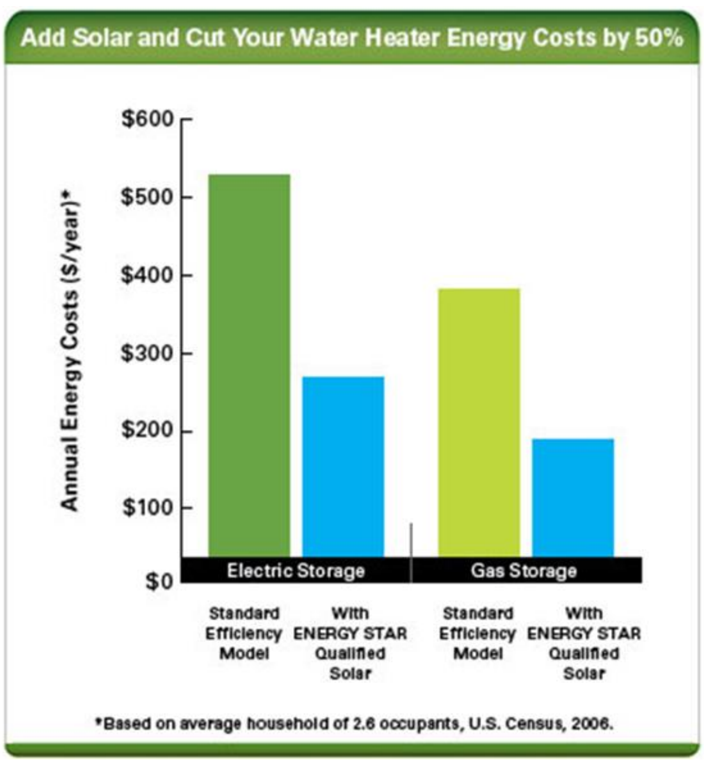

Figure 2: Graph showing potential energy savings through switching to an efficient solar water heater (Source: energy.gov).

The concept of reducing energy use through energy efficiency is in the consumer point of view important because it leads to savings. As energy savings are reduced through energy efficient investments, monthly energy bills will naturally be reduced as the consumer receives the same level of service they are used to while still using less energy. The best way to visualize savings is with a concrete example, Figure 2 shows the annual costs of a standard water heater and a more efficient solar model. In just this one appliance switch there can be seen savings in annual energy bills of over $300. Water heaters themselves can cost from $300 for cheaply made inefficient varieties, to over $3,000 for large and cost efficient ENERGYSTAR models. With annual cost savings of $300, in 10 years the energy savings from buying an efficient model make up the price for the appliance completely. Most water heaters can last longer than 10 years, meaning that additional cost savings from that point forward is money they have gained through this investment. Investment in energy efficiency can provide many benefits and has continued to grow up to the present; but, important questions arise; such as, is there enough investment into energy efficiency?

2.0: Problems Maximizing Energy Efficiency

One area of energy efficiency that is often overlooked is building design. In the U.S. households and commercial buildings make up 40% of total energy use, making buildings more impactful than any other sector of the economy (U.S Dept. of Energy, Energy Efficiency Trends in Residential and Commercial Buildings). By improving building design efficiency, all forms of energy services required for building use can be run with less energy use. Even with building use taking up such a large proportion of energy in the U.S, they are often not built with energy efficiency in mind. Some building designers may view energy efficiency as a minor issue that will not have a large impact on their plan or overall cost levels. This is an incorrect assumption, since of the costs of a typical office building, 19-29% can be from energy use (E Source Companies LLC, 2002). For an average sized office building this is often over $30,000 spent on energy every year. With even more potential energy use from high energy intensity buildings such as certain industries. Some designers may also have the assumption that building efficient buildings costs significantly more than other buildings. This has been refuted in studies, with findings showing that green buildings cost at most around 2% more than normal buildings (Matthiessen, et al., 2007). The idea that efficiency investments are not made even though they would lead to savings is known as the energy efficiency paradox. This is seen throughout all aspects of efficiency investments, stating that "cost-effective energy efficient technologies based on simple net present value calculations at current prices enjoy only limited market success" (Qiu and Grebitus, 2014). The reasoning behind this paradox, and why the energy efficiency of designing and renovating buildings is not more sought after, is the multiple economic barriers and market failures in place throughout society. The institutional framework also leads to these problems through the "actors who play a role in this [building design] process have perverse incentives that reward inefficient practice" (Lovins, 1992). As all these failures of society and the market combine, the result is far less investment in energy efficiency than what would be cost effective. This leaves nations throughout the world spending far more on energy than what would be efficient and lowers the capital available for investment in other areas.

One major barrier in place for all energy efficiency investments across any nation with the ability to afford efficiency investments, is risk. Since it will often take a few years of energy savings to see a positive return on the initial higher investment put down for an energy efficient appliance or renovations in a house, individuals may be reluctant to make the investment in the first place, even if it would save them money over a time span of multiple years. This reluctance could reflect uncertainty in the market or could be due to efficiency investments having higher risk than other investments such as government issued bonds. In an experiment using the multiple price list method, in which individuals are given multiple choices in terms of expected value payouts and expected risk, it was found that consumers who were more prone to being risk adverse, invested far less in energy efficient technologies (Qiu and Grebitus, 2014). This is a problem that reflects another barrier of efficiency, lack of information. Individuals and corporations will not invest in energy efficiency if they are not aware of the benefits these investments would bring. In a study focusing on surveys of CFO's it was found that most use payback analysis instead of net present value (NPV) in determining investments (Jackson, 2010). When using NPV, an investment is profitable when the discounted sum of money you save from the investment is greater than the initial amount you paid for the investment. This method is preferable to the more common payback analysis because payback analysis does not have a way to differentiate between short term and long term investments. Payback analysis is often used because it is simple to understand, but the use of this analysis process without the consultation of other methods can result in businesses not investing in energy efficiency, even when it would be beneficial because the payback analysis does not show all of the potential benefits throughout the years. Payback period does not account for the time value of money, in which interest rates are incorporated into multiyear investments. This makes it an ineffective method for calculating energy efficiency, as the benefits in this sector extend far beyond the initial year, making the discount rate important. Payback periods also ignores cash flows from the project itself, thus if you make money through energy efficiency investments, this money is not accounted for in future analysis.

The issues of payback analysis in businesses can, to a lesser extent reflect on individual consumer habits as well. Most individuals do not go out of their way to generate NPV or payback analysis, but they will often have a general idea of what purchases they plan to make. If every individual had to go through analysis towards the money they would save through energy efficiency, there would be far more investment in this sector. The lack of information that many consumers have as to the benefits of energy efficiency is a massive barrier that is preventing nations around the world from being more efficient. Even if someone is educated as to the benefits of energy efficiency in general, they may not be aware of what they personally could do to improve their effective energy use and begin saving money. This imperfect information also has the potential to drive efficient products out of the market; if no one understands that making a specific purchase or home renovation would save them money in the long run, they will not make the purchase. Individuals may not educate themselves on energy efficiency because they view it as something that is being pushed by the environmental movement for reducing emissions, and do not think that individual action will have an impact. This shows one of the other reasons, being that consumers could just be ignorant of potential savings and not have a reason to educate themselves. Even if utilities are producing consumer information policies, individuals may see it as a corporate scheme to reduce energy use and not understand that there is true value in energy efficiency. Another major factor is that individuals may not believe that they have enough spare time or that energy efficiency is not worth the time spent learning about it. These actions while at times can be reasonable for an individual if they have no information, result in them paying more money than they need to for energy simply because they did not educate themselves. This idea could slow production of an efficient appliance or home renovators who specialize in energy efficiency, because there is less demand for these services than there should be in an efficient market with no failures.

Even if a society can fully inform their customer base about the benefits gained from investment in energy efficiency, there is still major barriers in place, such as access to capital. Even if a consumer or business can understand that they will make money from a certain energy efficient building design or large appliance installation, they may not have the initial funds available to make the ideal investment. This effect will naturally be felt more heavily by individual consumers and small businesses, that are less likely to have large funds available to use for potentially high cost energy efficiency investments.

The ability to acquire funds through loans is an important aspect of energy efficiency, but small businesses and individual consumers will often find that it is difficult to find loan opportunities for efficiency investments. Even when a loan is made available, it is often provided with a high interest rate; this is because for "most banks, lending to small businesses, especially in the lower dollar range, is costly and risky" (Mills and McCarthy, 2014). To fix this problem the banks loan out at high interest rates, which will force individuals on the fence towards energy efficiency investments to decide against the investment due to the burden of paying back at a higher rate. For businesses in general, it is found that energy efficiency investments are "classified as discretionary business maintenance projects, which are given a lower priority than either essential business maintenance, such as replacing a failed pump, or strategic business development investments, such as a new manufacturing plant" (Sorrell, et al. 2001). This is a problem because it can result in there being less research into energy efficiency, as it is seen as more important to invest in other areas of the business instead. The savings found in energy efficiency are often small at first and begin to add up over time and as more investments are introduced. This could influence behavior in that small earnings through efficiency upgrades are seen as being less profitable than potential big earnings from new development. The idea that big projects are more profitable has been shown to be false, as projects that require large capital are often seen to have a lower rate of return than smaller ones (Ross, 1996). Even with data against large project investment, the potential to make huge profits will likely continue to draw people in power away from efficiency and towards more hypothetical projects. What all these factors result in, is a society where energy efficiency is often overlooked and where it can be difficult to finance efficiency investments even when it is desired.

What barriers to energy efficiency show are the market failures that are in place, effectively stifling investment into efficiency. These problems are visible in markets throughout the world, with differing magnitudes of impact. In areas with poorer infrastructure, such as developing countries, these barriers to energy efficiency will still be in place, but to a higher degree (Sorrell, et al. 2001). In these countries, even if programs are put into place to attempt to fight against these market failures, the infrastructure will inhibit movement of information and there will be less available funds to loan out than what can be seen in developed countries.

Education campaigns will be less effective in areas where all citizens do not have consistent internet access. In developing countries there are usually fewer regulations that must be met or policies encouraging energy efficiency for new buildings or renovations. Education of effectiveness of energy efficiency investments will also be lessened as individuals in these areas may have less free time to research or lack the methods to research to the same degree as highly developed countries that require energy usage to be marked on many appliances. Higher investment into efficiency would lead to a richer and more environmentally friendly society. The problem is how to mend barriers to efficiency, and what policies tend to find success in encouraging energy efficiency investments

3.0: Energy Efficiency Policies in the U.S.

When it comes to policies to encourage investment in energy efficiency investments, there are two broad categories. Push policies are plans to weaken and remove the market failures that come about from the previously mentioned barriers to efficiency. Pull policies instead focus on making energy efficiency more affordable for the consumers contemplating making the purchase (Nejat, et al. 2015). In recent years, the most important sector to ensure that there are successful policies in place to encourage efficient energy use is in buildings. This is due to many factors, including that buildings can often be overlooked, as individual appliances and vehicles are the usually first thought when considering energy efficiency. The building sector also accounted for “87% of the growth in electricity sales between 1985 and 2006” (Doris, et al. 2009). There are many potential policy decisions that could be made that are supposed to improve efficiency; but, what is important is not only putting the policy in place but also monitoring and ensuring that it actually causes the desired significant increases in efficiency investments.

3.1: Building Energy Codes

When discussing energy efficiency policies in buildings, the most common policy that is used involves building energy codes. These are different from many of the other policies because they involve the design of the building, rather than directly attempting to fix efficiency uses after a building is already in use. The basic idea of building energy codes is to set a minimum efficiency standard that buildings must ensure they meet when constructing a new building or renovating a current one. This is important because major efficiency improvements will not often be implemented without having major construction of some kind going on. It is very expensive to upgrade a building for no reason other than to improve energy efficiency, while it is comparatively much more manageable to make improvements in conjunction with other construction. By 2035, it is estimated that 75% of buildings in the U.S. will either be new or renovated during this time frame (U.S. Department of Energy, Building Energy Codes Program). By having building energy codes, ideally all these buildings will be at a set minimum energy efficiency level. Building energy code design has recently moved from local jurisdiction, to design by state governments. Instead of design, the local governments are now almost always in charge of building code enforcement (Doris, et al. 2009). Basic design ideas that are considered when deciding specific building energy codes include: the introduction of thermal provisions, various air conditioning systems, ventilation, and lighting flows. The intensity of these codes can be vastly different based on the how stringent the local area is with their energy efficiency regulations. The differences can be even more pronounced when looking at energy codes across the world. There is no official federal enforcement of building energy codes since they are usually designed by the state. Figure 3 shows the levels of energy efficiency states have achieved in commercial buildings, with darker green being the most energy efficient state building codes.

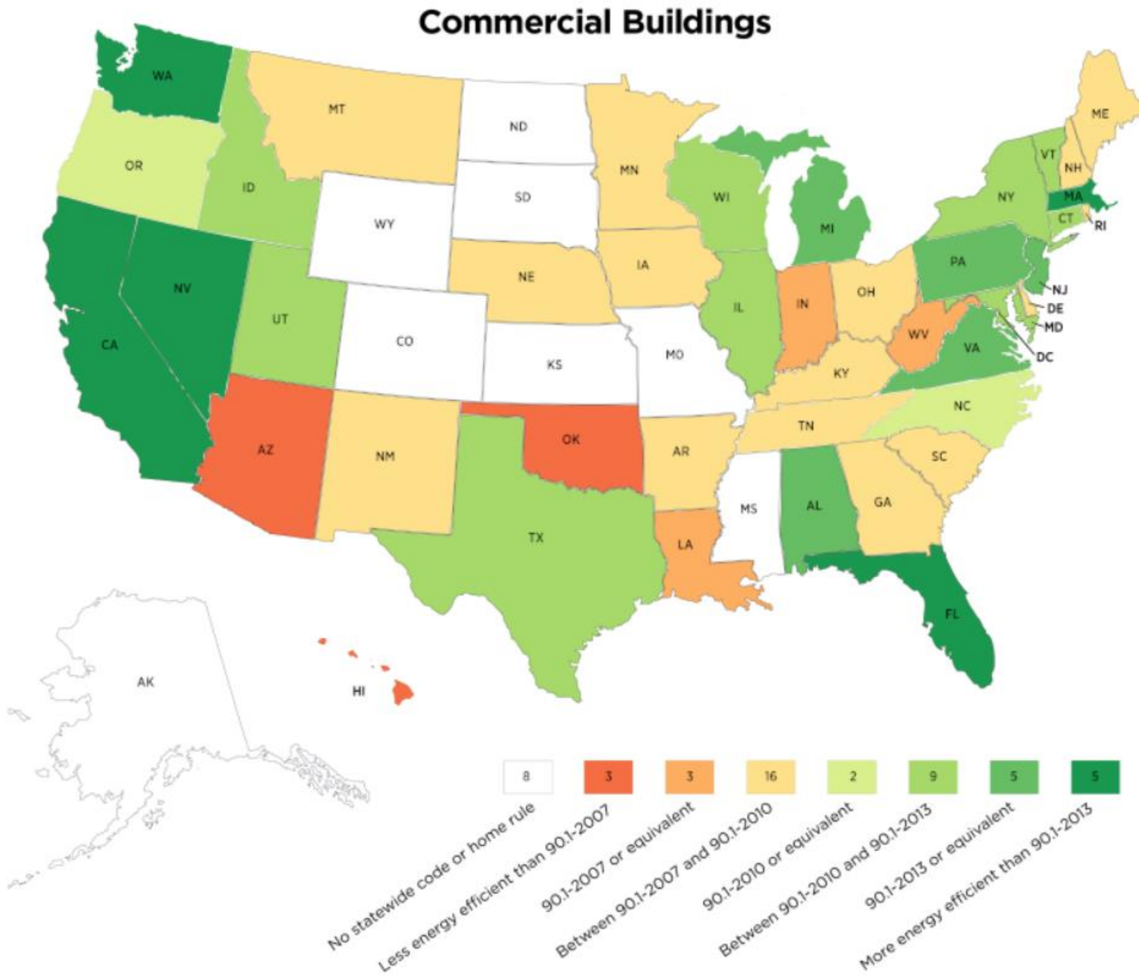

Figure 3: Current State Building Energy Code Levels (Source U.S. Department of Energy, 2018).

The data for building energy codes in states for residential buildings follows much of the same trends as seen in the commercial buildings in the figure. The data shows that while there are some states with very high levels of efficiency through building energy codes, there are also some states that have no requirements whatsoever for including efficiency into design plans. This bodes poorly for increasing levels of efficiency, as the design portion of a building where building energy codes have impact, is the most likely area for efficiency upgrades to take place. By not including any form of building energy codes, these states are effectively limiting their efficiency levels to a minimum, unless building designers decide to invest in energy efficiency even without building energy codes. While state governments create the building energy code requirements, the local jurisdictions are often the agencies that over-look enforcement. Enforcing these codes is as important as having the codes themselves, it allows the state to know that their regulations are being followed and limits the amount of building designs that don't follow the codes in place.

Having mechanisms in place to ensure that energy efficiency is appropriately considered and implemented in building design is important; but, the effectiveness of building energy codes should also be analyzed. The goals of these regulations are not just to increase energy efficiency in buildings, but to use the efficiency to increase social welfare by promoting positive net present value projects. The potential benefits of these building energy codes are huge; a McKinsey study found that with efficiency upgrades through building energy codes of $520 billion, the U.S. could save $1.2 trillion by 2020 (Galbraith, 2009). While these savings are large, the many problems of market failures discussed earlier can be seen in this study. The initial investment in this case is so large it is almost unreasonable to think that it could be attainable, as many building designers may not be fully aware of the potential of savings through energy efficiency and only follow the minimum standards required by the state. There is also a problem in assuming that building energy codes will be completely followed. A study done about the compliance of building energy codes found that there were many issues keeping enforcement agencies from ensuring there was full compliance (BCAP, 2008). These issues included basic ideas like lack of manpower, time and training; but, there were other issues that are not as easily fixed. Energy codes are not considered to be a life or health safety code which causes energy efficiency to have lower odds of being looked at entirely by inspectors as they instead choose to focus on health and safety codes. These ideas are emphasized in another McKinsey study that estimated compliance of energy building codes to be 40-60% (Doris, et al. 2009). This discussion shows the potential benefits of building energy codes, but also the problems that these policies have. Compliance is not fully achieved, and the amount of buildings that actually follow the codes cannot even be estimated completely accurately.

Building energy codes are meant to reduce energy use in the specific state or local area where the codes are designed. Compliance and manpower issues that are found across the country do not necessarily measure if the codes themselves were effective, rather these issues show that the infrastructure may not allow the codes to reduce energy use to their full potential effects. While looking at certain areas and the effects of their individual codes, there is always the potential that better areas of enforcement would have allowed for further improved effects. One study in Florida shows the energy use effects in the three years prior and following a major shift in energy code standards in 2002. These changes were done to bring the city of Gainesville in Florida up to the standards found in the IECC. The effects after three years were shown to be a 4% decrease in electricity and a 6% decrease in natural gas (Jacobsen and Kotchen, 2013). These results seem to show the effectiveness in a change of building energy codes in bringing reductions in energy use. A later study that looked at data from the same energy code shift but looked to see if the initial energy reductions continued past the three year timeframe of study. It was found that the decrease in electricity use that was found earlier disappeared after the initial study was done, but the decrease in natural gas remained (Kotchen, 2016). These results suggest that studies done immediately after an energy code shift could over-estimate the true energy reductions seen throughout the lifetime of the energy codes. While the reductions in energy usage may not have been as much as initially thought, the forecasted energy usage was expected to go down 2% from this code updates, and in the end they were near 2.9%. This shows that in this case the energy efficiency gained from more stringent building energy codes were about the same as what was predicted. This could be an appealing result, if energy code predictions can be relatively accurate it means that policies can be more focused and based on what will likely happen from building energy code changes. On the other side, a 2% reduction in energy use for what were relatively major energy code shifts in a town is not a massive amount, and as can see from the difference in results from two studies, this number may not even be completely accurate.

An important issue that arises is even if energy use is found to be reduced after upgrades in building energy codes, how much of this reduction can truly be put on the energy code themselves. A study done in California, a state that is widely known for their lower energy consumption that many areas of the United States, was done to determine if this was due to the energy efficiency regulations that were put in place during the 1970's in the state. Results found that much of the reduced energy consumption was in sectors that were not targeted by the regulation changes and the changes in residential building electricity consumption compared to the rest of the country were over 60% based on demographic changes in California (Levinson, 2013). The findings also suggested that much of the energy consumption reductions that were thought to be based from energy code shifts could be related to other actions such as the idea that new buildings are naturally equipped with more efficient technology as it is created over the years. This is important in relation to all studies that look at the changes in energy consumption with energy code changes, as the effects of new technology that are not affected by these shifting regulations must be included in the analysis. The ideas from this study cast a pessimistic light on the effectiveness of building energy codes, but the major aspect that is being shown is not that energy codes are ineffective so much as that they are very difficult to categorize and analyze with other compounding factors impacting energy use. Building energy codes are some of the most basic and essential efficiency regulations that the country uses and while specific effects from certain energy codes can be difficult to pinpoint, with effective compliance from all buildings to new energy codes, energy reduction through efficiency regulations can be seen.

3.2: Energy Efficient Technologies

Another sector of policy that is available for increasing energy efficiency is ideas revolving around consumer information. The basic idea is that if consumers are aware of the benefits that can be gained through energy efficient investments, they will then actually do the investment (assuming none of the market failures are present). One of the major federal programs that is currently running is endorsements of ENERGY STAR. This program provides an unbiased validation of appliances showing that they are highly energy efficient as compared to other similar appliances. ENERGY STAR Portfolio Manager can be used to measure energy waste in buildings, resulting in ENERGY STAR certification for those buildings that perform better more efficiently than at least 75% of similar buildings across the nation (energystar.gov). ENERGY STAR was started in 1992 from the EPA and has grown over the years to the point where it covers nearly all aspects of the building industry currently. Another program similar to this is EnergyGuide, which focuses on providing consumers information on the energy consumption of appliances. These include appliances ranging from dishwashers and televisions, all the way to air conditioning units and furnaces or heat pumps. EnergyGuide labels are yellow and show a wide range of information, most importantly being the average expected yearly energy cost of running the appliance and comparing it to other similar appliances. EnergyGuide requires “All major home appliances [to] meet the Appliance Standards Program set by the US Department of Energy (DOE)” (energystar.gov). The EnergyGuide label is federally required for almost all appliances and focuses on providing information about energy use of the specific project, ENERGY STAR certified products in contrast are highly efficient and go beyond the limits of efficiency required by the government. ENERY STAR products are all required to have the EnergyGuide label to inform consumers and allow for educated purchases.

The ideals of programs such as ENERGY STAR inherently assume that these higher efficiency standards are desirable because they reduce energy use and carbon emissions. A study done looking at the first 90 buildings that were ENERGY STAR certified found that these buildings had a 44% lower than market average site energy intensity (Hicks and Neida, 2000). This resulted in the average cost of energy in these buildings to be 30% lower than the market average. These figures show that even the initial years of the ENERGY Star program led to successful attempts at lowering energy efficiency. An important aspect of the potential for growth from these initial results is that ENERGY STAR products used to often be fairly more expensive than their counterparts. As ENERGY STAR has grown and people begin to understand the effectiveness of energy efficiency, there have been an increasing amount of ENERGY STAR certified projects, which has also caused the average price of energy efficient appliances compared to their counterparts to drop in many cases. Another study looking at the overall impact on ENERGY STAR programs found that after seven years of its beginning, ENERGY STAR certified products had a combined energy bill savings of $10 billion (Brown, et al., 2002). These programs are clearly successful in their goal of reducing energy use and saving money on energy bills. With the stringent requirements for a product to be certified as an ENERGY STAR product, it is certain to be highly efficient and in most cases provide for energy bill savings. However, an EPA study found that only 45% of U.S. households had purchased an ENERGY STAR product in the past year (U.S. Environmental Protection Agency, 2015). There are very few circumstances in which it would not be efficient to buy an ENERGY STAR appliance over other non-efficient brands, as they are confirmed to be efficient and will almost always lead to energy savings; as long as there are programs in place to ensure the funding of initial investment. This idea shows how important it is to not only inform the public about the benefits of energy efficiency through labeling, but also actively encouraging it.

Voluntary programs such as ENERGY STAR and other energy efficiency labeling mechanisms, provide incentives indirectly that encourage efficiency that exceeds federal standards, as opposed to the direct incentives from many other policy methods (Lee and Yik, 2004). The direct standards such as building energy codes set a solid guideline that all buildings in the area have to follow. Voluntary labeling programs encourage consumers to go further than this by providing them with information of emissions and cost of energy that can be reduced by buying these efficient appliances. Often times even this information is not enough to encourage a large proportion of the population to invest in energy efficiency. This problem can be fixed by federal action, such as the requirement that all federal agencies purchase ENERGY STAR certified products. To encourage a wider range of building designers and home owners to invest in efficient technologies, the major strategy is in the form of monetary incentives. There two major forms of giving monetary incentives towards energy efficiency are allowing for no interest loans and providing rebates for energy efficiency purchases. Loans allow for those without the initial capital for a more expensive efficient technology to invest and the lack of interest ensures that if the technology was efficient enough to save them money, they will have the ability to pay it back. Rebates allow for those who already have enough capital to make the initial investment to earn some money back by confirming their purchase of the efficient technology that has a rebate attached. The calculations for if a loan is profitable can often be fairly simple, all a consumer has to do is calculate the payback period by looking at the average life expectancy of the technology they are purchasing, see what the yearly energy cost savings of the technology are, and calculate how many years it will take for the energy cost savings to payback the cost of getting the efficient technology. If there is a point within the technologies life expectancy in which it will profitable, the loan is desirable. There can be difficulties when including the idea of discounting, but the fact that these loans will usually have zero interest makes discounting effects more minimal and is what encourages the purchase of these technologies.

These monetary incentives provide additional reasons on top of the base energy savings provided by energy efficient purchases; but even these may not be enough. Judging the effectiveness if monetary incentives may show that even more incentives must be put into place to encourage improvements in efficiency. In a study determining the effectiveness of the ENERGY STAR rebate program, data from 2001-2006 was taken to see if it was cost effective for an energy utility to provide rebates for ENERGY STAR certified products (Datta and Gulati, 2014). This data focuses on major appliances with ENERGY STAR certification, such as: clothes washer which have gone from 10% certification in 2001 to 38% in 2006. The rebates for these appliances were given by the utilities in the Northwest Energy Efficiency Alliance. The study found that a $1 increase in the rebate coincided with a 0.4% increase in the market share for certified clothes washers. The average rebate was around $15, so this increase actually reflects a 6% increase in the market for certified clothes washers. The significance of this study was that the cost of electricity saved from the rebates led to the rebates being significantly effective for utilities to lower their electricity demands. This would allow the utility to lower annual energy costs and even lower max capacity once enough efficient technologies are put into place. A similar study looking at ENERGY STAR certified appliances found that rebate policies increases the sales of these certified products by 3.3-6.6% (Fillippini and Datta, 2015). The results of these studies show that rebates for these products were effective in increasing the market share of ENERGY STAR products, but the numbers show that there are still significant portions of U.S. households that are not investing in ENERGY STAR products. In looking to improve rebate structure, the effects of the products themselves can be looked at. A national contingent choice survey found that individuals were willing to pay over $200 more for an ENERGY STAR certified refrigerator and that these figures decreased with age and were lower for women than men (Ward, et al., 2011). If individual consumers are willing to pay over $200 more for a certified product, this could mean that rebates for values less than $200 could not be effective in promoting more energy efficiency purchases as they may not even exceed a consumer's initial willingness to pay. By understanding consumer preferences, rebates can be structured in a way so as to encourage consumers to make efficient investments by offering amounts close to their willingness to pay.

The results of these discussions show that while monetary incentives have been somewhat effective in encouraging ENERGY STAR certified purchases. It is reported that about 75% of households say that ENERGY STAR certification is influential in their purchasing decisions (energystar.gov). Ideally every household would recognize this certification and use it to base decisions on. The difficulties of what the amount of a rebate should be are shown in that different demographic groups may have different willingness to pay for energy efficiency. When this is true, it would seem that to be most efficient rebates would have to be customized towards the individual consumer, which is impossible to achieve on a large scale. By simply existing, ENERGY STAR products make consumers more aware of energy efficiency, and as labeling of products has become more common, it is easier to understand what can be gained by energy efficiency investments. The small increase in market shares through rebates while significant, is still not enough to make these products as widely purchased as desired. If widespread consumer information and easy access to capital are not enough, the question arises just what is required to allow for full and widespread energy efficient technology.

Policies that promote energy efficiency are almost never the only policy implemented. Energy building codes, product labeling, incentives for efficient technologies, and consumer information such as product labeling will often be working together. There are also many forms of these policies that allows for flexibility and innovation towards future policy decisions. New energy efficiency building codes can be undertaken by government agencies or leading industries to promote public leadership programs. By following stricter energy codes, these leaders can encourage other buildings to follow suit and invest in similar energy codes. Minimum energy performance standards are regulations on the maximum amount of energy that can be used for a specific appliance for a designated task. This is a specific standard that is akin to building energy codes and can be implemented in combination with other codes. These are some examples of how ideas brought up through energy codes and consumer information of efficiency can be used in various ways. In a review of energy efficiency standards in place throughout the country, it was found that standards for energy efficiency and building energy codes were cost-effective means of reducing energy use by themselves, but when combined and put into place with certification or labeling (such as ENERGY STAR and Energyguide), they are increasingly cost-effective (Boza-Kiss, et al., 2013). This reinforces the idea that energy efficiency policies often work in tandem. Individuals will be more likely to comply readily to building codes if they are aware of the positive impacts of energy efficiency through labeling and certification. As more sophisticated labeling is released, the effects of the previous labeling will still remain as consumer information. The same concept can be used for energy building codes as they slowly become more efficient, this allows for efficiency policies to grow on top of one another and work together. The United States still has implemented these various policies and energy efficiency levels have increased over the years; but, there is still a question of have the policies been as effective as possible and are there other policies to be considered.

4.0: Energy Efficiency Policies in China

Looking at energy use from other major economic powerhouse countries, like China, can potentially show other approaches towards energy efficiency, in the context of their own unique economy. Economic development in China over the last 30 years has continued to increase and with it comes new energy demands. In the late 1900's to the early 2000's, China was able to effectively use energy efficiency measures to reduce consumption, but through recent years the demand for energy has increased once more.

China's early success in harnessing energy efficiency in the 1980's through the early 2000 was due to a variety of policies, many of which are similar to policies in place in the United States. These policies include: monitoring of industrial building energy use and the use of energy quotas, low interest loans for efficiency investments, consumer information, and demonstration projects (Zhou, et al., 2010). While the basic idea around many of these policies can be similar to their counterparts in the United States, there can be differences in how they are implemented. In these years the Chinese government had much control and influence over industries, which allowed them to more aggressively monitor energy quotas. Through monitoring of multiple sectors across the country, "when enterprises exceeded consumption limits, the government cut off energy supply" (Lin and Jiang, 2005). These would allow a much stricter control of energy use than the United States could accomplish with the standards they set through ideas like the building energy codes. While not used often, China's use of strict quotas along with their effective energy efficiency loan policies and energy conservation centers that provided information and technical aid for efficiency, allowed for the successful decline of energy use. The causes for the recent lack of success in energy efficiency through the massive increase in energy demand in the country could be attributed to many reasons. The move towards a more market based economy like the United States could have reduced the effectiveness of programs that were uniquely Chinese. The use of quotas are not in effect to the same extent they were in the 1980's and the government does not have the same authority in this regard. This timeframe of China shows how effective large investment in energy efficiency can be and how it can die down if you do not consistently maintain and increase the policies that you are putting in place.

Seeing the reduction in effectiveness of their current policies, the Chinese government has put into place new Five Year plans that put a renewed vigor into energy efficiency. Their policies for building energy efficiency have grown over time from standards for residential buildings, to include hotels, then to account for buildings in either side of the weather spectrum, into the Building Energy Conservation Regulation Ordinance Bill that began discussions around 2007 (Zhoe, et al., 2010). This bill is the major effect on buildings in China currently and includes regulations for data about building energy consumption and retrofits that will save energy. Although it was found in the Zhou study that the implementation of the bill was only met by 38% of newly constructed buildings. This shows that China also suffers from compliance issues that mirror problems found in the implementation of the building energy codes in the United States. New standards on energy use of buildings are in conjunction with new building labeling systems that shows average energy consumption and use in the building. To promote new energy efficiency the Chinese government plans to alter the current social welfare system into a market system, while continuing policies to develop highly efficient heating systems. Heating payments from the government will now be subsidies given to residents to pay for heat based on metered consumption, this will encourage consumer awareness and allow for a market of retrofits to improve building efficiency (Lang, 2004). These policies for buildings are just part of the larger energy efficiency policy programs that China has begun over the last 10 years to attempt to once again effectively promote energy efficiency and reduce energy use.

5.0: Conclusion

Energy efficiency is often viewed as the most effective approach towards reducing the growing need for energy. It does not require the reduction in use of services that is seen in conservation and it will almost always serve to complete its goal of reducing energy use. The only time energy efficiency policies would not be efficient is when they are not cost effective and the savings from reduced use will not payback the cost of investment. The main problem in determining energy efficiency polices then, is doing analysis of what polices are successful, to what extent are they cost effective, and what barriers are there to limit implementation. Since energy use in buildings makes up a large proportion of total consumption in developed countries, there is a focus on policies in this sector.

Consumer information is one of the most successful policy objectives that has taken place. In energy efficiency the obvious case of consumer information is product labeling. As labeling and other forms of information such as availability of energy assessments becomes more prevalent, the consumer knowledge base will grow. Different information programs can serve to add onto previous programs and consumers can then use all if the information gained to make more informed decisions. Information and incentives often times serve separate purposes, so focusing on only one will often hinder the growth of efficiency (Stern, 1999). Just like how different information policies can work together, information and other policies can work together to combine their effects on the consumer. Of the many labeling programs in the United States, Energy Guide and ENERGY STAR are the most effective because they are government programs that are credible and viable for the long term (Banerjee and Solomon, 2003). Simple seal of approval labels are also found to be more effective than labels with complex information that overwhelms the consumer (Banerjee and Solomon, 2003). Through these ideas future consumer information policies should focus on ensuring credibility of their program to increase consumer trust. By ensuring consumers are only given the most pertinent information required to make decisions, such as the average energy use of each technology and the potential energy costs as compared to other models, they will be informed enough to make a decision while not requiring them to spend time trying to decipher a jumble of text and information. By optimizing consumer information polices, the general populous will be further encouraged to invest in energy efficiency.

A major trend that showed through policies in both the U.S. and China, was the lack of compliance with minimum energy efficiency requirements through building energy codes or Federal actions. Ensuring high levels of compliance seems to be the biggest change in energy efficiency policy to see truly large effects. One way that compliance may be increased is with the continued growth and sophistication of information. By making a populous informed about the benefits of energy efficiency, officials and stakeholders important to creating building designs will understand the benefits of efficiency and become more likely to meet standards or even exceed them. Another factor towards increasing compliance is to increase enforcement of building energy codes and other energy efficiency standards. By implementing increased levels of enforcement throughout a buildings design, construction, and lifespan; designers will be more wary of being caught when they do not meet the minimum requirements. This should serve to encourage higher levels of compliance and allow a more accurate estimation of energy efficiency levels across the nation.

There are a variety of policies that can be implemented to incentivize energy efficiency besides the ones mentioned here. By understanding the benefits of energy efficiency, these policies should continue to grow and become more effective. As efficiency levels increase, energy use should continue to decline bringing all the benefits from higher energy costs savings to lower global emissions. Energy efficiency is important, and policies should be looked at and improved so as to further increase the efficiency levels throughout the nation.

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