Market and Policy Landscape for Energy Efficient Homes

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Introduction

Affordable energy efficient building techniques and technologies are available for single family homes and market surveys suggest consumer desire for energy efficient homes is prevalent, but demand remains low and potential for energy efficiency in America's housing supply remains greater than economically justified. This paper analyzes the potential for reducing residential energy consumption, barriers to increasing the market demand, and policy solutions.

Single family homes account for 17% of end use energy consumption.[1] Great strides have been made to curb the increase in carbon emissions from the energy consumed by the housing sector. There are many strategies to achieving energy efficient housing that provide a net-positive investment, meaning they save more money in long-run energy use costs than the upfront cost;[2] however, demand for energy efficient homes in the resale market remains low and the potential for energy efficiency in America's housing supply remains greater than economically justified.[3] The impetus for this analysis is to empower the market to reduce energy consumption by addressing information asymmetry of utility costs for homes on the resale market. In current US society, immediate economic benefits are a more powerful lever for change than the fear of future costs due to increased climate uncertainty, and market based solutions are more politically feasible than increasing regulations for builders, mandates for utilities, or subsidies for consumers. The shortcomings of current marketing information available for energy efficient homes in real estate transactions limit the opportunities for increased demand for energy efficient homes. The economic benefits outweigh the upfront cost, but the value of energy efficient

[1] (US Department of Energy, 2017)
[2] (Knowles III, 2008)
[3] (Residential Energy Services Network, 2017)

upgrades and their coinciding marketing certificates and ratings is disappearing upon resale.[4] This suggests that there are communication or information barriers in resale transactions. This paper analyzes the barriers to increasing the market demand for energy efficient homes and the potential policy solutions, with special attention to information disclosure policies and the idea of a nationally recognized Annual Fuel Utilization Efficiency (AFUE) labeling program for homes. I find that barriers exist to disseminating useful energy efficiency information to home buyers, hindering the market from reaching the full potential demand for energy efficiency. Informing consumers empowers the market to appropriately value energy efficiency. This idea that providing estimated operational costs to consumers mutually benefits consumer financial expenditures and simultaneously mitigates air pollution can be found in the Environmental Protection Agency's (EPA) justification for mandating fuel economy labels on new cars and light trucks and the Federal Trade Commission's (FTC) EnergyGuide for home appliances.[5,6] The EnergyGuide model is then used to form the policy recommendation to establish an improved labeling program for homes sales.

Methods & Limitations

This paper was developed through research of existing public data, literature review, and interviews with industry professionals.[7] The public data reviewed was to gather a sense of the potential for both economic and environmental benefits. The literature review was aimed at addressing the asymmetrical information that exists in real estate transactions, and what affect labeling standards can have. This study focuses mainly on single-family homes to address

[4] (Bruegge, Carrión-Flores, & Pope, 2016)
[5] (Davis & Metcalf, 2014)
[6] (US Federal Trade Commission, 2013)
[7] (National Association of REALTORS, 2017)

valuation of investment in energy efficiency for the consumer market. The consumer market is defined as home buyers and sellers, home owners making improvements, and prospective renters. About 80% of residential energy consumption is in single family homes accounting for only 63% of the total residential units.[8] Multifamily buildings are excluded because they are treated as commercial transactions, often between companies or organizations, and the transactions are infrequent and require much more costly engineering inspections that reduce the information asymmetry. The majority of multifamily buildings are also rental units with temporary leases instead of the longer term investment of purchasing. The rental market does play a role in this issue of demanding more energy efficient homes. However renters only account for 12% of single family residents.[9] The hypothesis for this project, that communication barriers exist in the market prohibiting consumer demand from reaching its full potential, came from my professional experiences as a real estate agent and later as a building science consultant for home builders. I have spent the last few years speaking with real estate professionals about energy efficient homes, "green" labels, and how to market them. Market research was limited to the Twin-Cities region of Minnesota for interviews with industry professionals and was not extensive enough to make any broad conclusions. To examine the market nationally, other survey reports for public opinion across the US were reviewed.

Opportunities in Residential Energy Efficiency

A good reason for addressing this subject is to identify ways of reaping environmental rewards where ever there is economic net benefit. Most of the cost is just that; upfront capital expenditure and perceived loss of resale value. The economic benefits need to be made clear since most

[8] (Penney, 2015)
[9] (Carliner, 2013)

energy efficiency upgrades are not as visible as many other home features. Other benefits from energy efficiency include reducing stress on the electrical grid and the environment. The opportunities herein also match those described by the EPA for fuel economy labels and efficiency standards for vehicles, with cost savings as the driver for change that mutually benefits climate change, oil dependence costs, and sustainable resource consumption.[10] In the context of homes this translates to; economic benefit to homeowners, resource efficiency and grid benefit, and climate change mitigation.

Economic Benefit to Homeowners

According to the Department of Energy in 2016 residential total end-use energy accounted for 21%[11] of total consumption in the United States, 48%[12] of which is consumed in space heating and cooling. The potential for energy savings in homes is enormous. End-use consumption is determined by using the fossil fuel equivalent of 9,510 Btu per kWh to account for the inefficiency of producing and distributing electricity, by a factor of nearly 3 since 1 kWh is equivalent to 3,412 Btu. According to a report by McKinsey and Company, the residential sector could reduce energy consumption by 28% by deploying readily available conventional energy efficiency measures, saving consumers approximately $2.2 billion annually. The U.S. Department of Energy Building America Program[13] and the U.S. Climate Change Science Program[14] both agree that residential energy use can be reduced by 70% through deep retrofit efforts and optimizing the effort in new construction; however, it should be noted that in existing homes this effort is a much bigger challenge and the deeper the retrofit effort the less cost

[10] (US Environmental Protection Agency, 2017)
[11] (US Department of Energy, 2017)
[12] (US Department of Energy Building Technologies Office, 2016)
[13] (US Department of Energy, 2008)
[14] (US Climate Change Science Program, 2006)

effective they tend to be. In new construction, 70% reduction is already achievable in large part due to the cost effectiveness of installing energy efficient materials and equipment during the initial construction. In 2012, the average household heating, cooling, appliances, electronics, and lighting costs were $1,945,[15] or 7.5%[16] of total house hold spending. Providing the necessary information to consumers can empower them to determine the economically optimal amount of investment that is appropriate. This is especially important for households with lower incomes where electricity costs can account for up to 10% of annual household income, seen in the figure above.[17]

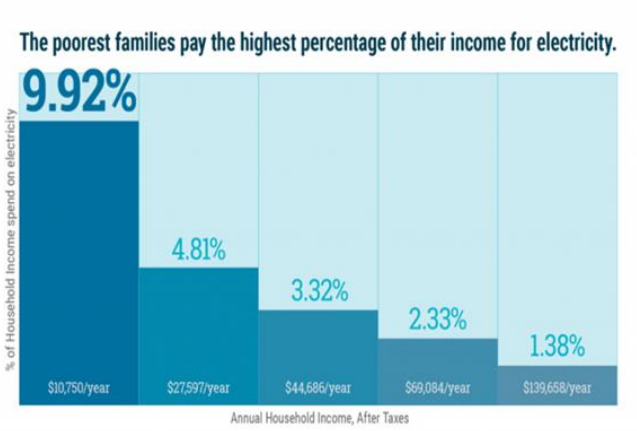

Image from: (Carliner, 2013)

Resource Efficiency and Grid Benefit

Housing stock is possibly the most prolific form of distributed infrastructure. The aggregate of reducing energy demand has added value for US energy security and grid resilience. Because the residential sector is fairly predictable and uniform about the time of day energy is used, it creates large temporal spikes in energy demand. Utility companies have to constantly calculate their power purchase planning to provide ancillary services. Meaning the amount of power generated is constantly adjusted to match the amount of electricity demanded. During these spikes they often turn on their inefficient, expensive, reserve generators; often dirty diesel engines. A more efficient housing stock can reduce the pressure and irregularities in the grid management systems. Although, this runs counter to the utility companies' desire to sell more electricity.

[15] (US Energy Information Administration, 2013)
[16] (Bruegge, Carrión-Flores, & Pope, 2016)
[17] (Bruegge, Carrión-Flores, & Pope, 2016)

Energy efficient homes also have the benefit of staying at a comfortable temperature for longer durations making them a sort of energy storage device. This benefits home owners as well as reducing stress on the grid. As new smart home technologies are introduced to the market, specifically demand response capabilities, more efficient homes will be better suited for homeowners take full advantage of the economic benefits. In 2016, US Senator Amy Klobuchar introduced S.3062, *A bill to require the Federal Trade Commission to consider including smart grid capability on EnergyGuide labels for products.*[18] This kind of disclosure requirement does not drive up manufacturing cost, but it does enable the consumer to make a more informed purchasing decision for equipment that will reduce the impact during peak demand. Even though many homes do not have smart grid connections or solar panels yet, purchasing items such as a smart grid capable water heater when the current one fails makes it possible for that consumer to take advantage of demand response programs in the future. And perhaps these disclosures get people thinking about other efficiency options that can save them money in the future.

Climate Change Mitigation and Potential Impacts

Besides the economic benefits to home owners and the operational benefits to grid operators, reducing residential energy demand is crucial for the effort to limit the effects of climate change. Energy efficiency in buildings and appliances is expected to eliminate 710 to 870 million tons of greenhouse gas emissions.[19]

Reducing emissions has benefits for more than just climate change; it also improves air quality and reduces heat island effect in urban areas. Urban heat island effect is a result of concentrated waste heat. Inefficiencies, such as excess heat leaving combustion engines and from thermal electricity production cause urban areas to experience more extreme heat waves than would

[18] (A bill to require the Federal Trade Commission to consider including smart grid capability on EnergyGuide labels for products, 2016)
[19] (Knowles III, 2008)

otherwise naturally occur. Poorly insulated urban homes with inefficient air conditioners contribute to this.

Market Signals

Reports suggest the majority of home buyers place importance on owning an energy efficient home; however, actual consumer demand has not proven this to be true just yet.[20] Homeowners do want energy efficient homes; they are excited by technology advancements, and view green labeled homes as consisting of higher quality. The National Association of Home Builders asked home buyers what they really want in a home in a 2013 survey. A prominent answer is energy efficiency. 3 of the top 7 most wanted features are Energy Star certified products: 94% of home buyers want Energy Star rated appliances, 91% want an Energy Star rating for the whole home, and 89% want Energy Star rated windows.[21] Consumer reports suggest that consumers are willing to pay up to $7,000 more on average for an energy efficient home.[22] Energy efficient homes come with spill over benefits that include more comfortable, quiet, safe, healthy, durable homes. However, these are all difficult things to experience during a one hour or less walk through during a real estate showing.

Barriers to Residential Energy Efficiency

All that potential and all those opportunities suggest that barriers exist to achieving optimum home design and construction. This paper identifies a lack of a common vocabulary and upfront cost as key barriers to reaching the potential of energy efficiency in the residential sector.

[20] (Residential Energy Services Network, 2017)
[21] (Quint, 2013)
[22] (Quint, 2013)

Lack of a Common Language

The language used in residential energy efficiency is technical and can be challenging for buyers, sellers, and even for real estate professionals to understand. Every house is different. Even large production builders who build the same model with all the same features and materials have different crews installing these materials, and each house faces the sun and wind a little differently. These differences create unique energy use profiles for each home. For homes in the extreme climate zones these differences can have a significant impact on a home's operational cost. These complexities can be difficult to translate into a measure of quality or expected cost.

Real estate agents insulate their clients from direct communication with each other for liability and commission reasons. This creates a barrier for communicating or marketing energy efficient upgrades or features because they are often hidden in walls or attics, or require technical understanding. There is a lot of technical equipment that goes into a high performance home. Most consumers have reservations about purchasing things they cannot see or touch.[23] There is also wariness among buyers to accept claims made by owners regarding the homes they are selling. On several occasions I visited open houses as an undercover customer. I found that agents in the Twin Cities area homes labeled as green rarely volunteered information other than a brief mention of the testing. When I asked about the green rating, they would highlight reduced energy bills and side benefits such as improved comfort and noise reduction, but rarely engaged further. I made phone calls to random real estate agents throughout the area to gather a sense for the existing homes market in regards to energy efficiency. In the existing homes market there is a much wider divide in the price of energy efficient homes. Agents recommended that unless a buyer is looking at the high end of the market that they look at new construction or homes that

[23] (Residential Energy Services Network, 2017)

were built in the last ten years or so. The National Association of Realtors' Multiple Listing Service database has a placeholder for green certificates, but there are 13 different certificates and only two of which use a metric that is not binary.[24] Unlike the major appliances in the home, there is no unified rating system to disclose the consumption or efficiency of a whole home.[25] The various certificate programs are also inconsistent and often do not provide understandable terms for prospective home buyers. These inconsistencies create barriers to recognizing the benefits of investing in energy efficiency.

Another barrier is the breadth of education needed about weatherization and the services available at little to no cost. Exacerbating this challenge is the limited amount of meaningful information available on a home's real-time energy use. Homeowners are often unaware of their energy consumption or how to reduce it. They may also underestimate savings from retrofits.[26] This information is increasingly being made available to residents with the intent of influencing their behavior, but would not be appropriate as a method of disclosing energy efficiency during resale because it is considered private information in most states, and would not produce a fair comparison due to differences in residents' behavior. This paper does not explore residential behavior as it pertains to in-home energy consumption, but several policies incorporate dissplaying energy consumption data as a motivational tool. Assuming rational consumer behavior, it can help make the case for displaying expected energy use data at the time of sale.

Capital Expenditure

Upfront capitol cost is perhaps the most common factor preventing the average homeowner from investing in energy efficiency. The upfront capitol cost can deter or prevent home owners from

[24] (National Association of REALTORS, 2017)
[25] (Residential Energy Services Network, 2017)
[26] (Creyts, Granade, & Ostrowski, 2010)

investing, and there is risk of not being able to recoup the investment in energy cost savings or in the resale market. A lack of cash reserves presents a serious barrier to the implementation of energy efficient upgrades in lower-income communities.[27]

The average length of homeownership is 12 to 15 years.[28,29] Not all energy efficiency improvements have payback periods that short, so the return on investment period can be longer than the average or expected length of home ownership. Saving for these projects can be challenging. Contractors installing insulation and equipment incorrectly can add to this problem. This can result in up to a 30% difference in efficiency.[30] In theory, in order for an energy efficient improvement to be financially beneficial, its resulting savings need only to be more than the difference in investment cost and the value recovered during resale. Very little is known about the cost from energy efficient upgrade that is recovered in resale. The only energy efficiency upgrade listed in Remolding Magazine's Cost vs Value Report, was window replacement, and that could still be argued to be a finish upgrade. In 2016, they added attic insulation to this list.[31] Attic insulation has been a common energy efficient upgrade because of its short payback period in energy savings, but other upgrades such as wall insulation are typically incorporated into larger home renovations projects making them more difficult to value.

Another factor that may have an impact on the length of return on investment is the cost of energy. Electricity and natural gas are relatively cheap so the impact of energy efficient investment on utility cost is greatly diminished, thus extending the payback period and reducing price elasticity. Elasticity is also reduced in this light due to the extended period of ownership.

[27] (Madrid & James, 2012)
[28] (Emrath, 2013)
[29] (Division of Consumer and Community Affairs, 2015)
[30] (Creyts, Granade, & Ostrowski, 2010)
[31] (Remodeling Magazine, 2017)

Split Incentives for Rental Properties

While only 12% of single-family homes are rented, this issue of asymmetrical information about the cost of energy for homes on the market also extends to prospective tenants. The incentives to invest in energy efficiency for rental properties are split between the tenant and property owner. Motives to invest in energy efficient improvements are reduced by; the building owners not making efficiency investments because the renters pay the energy bills or the renters are not likely to invest in property they do not own.[32] Energy costs tend to have a greater degree of financial burden on renters. The social need for reducing energy costs in rental housing is great. In addition to the split incentive to invest, renters are often disassociated with the cost when the cost is built into the rent, reducing the incentive to engage in energy efficient behavior.

Policies

Policies for energy efficiency include incorporating measures into mandatory minimum building code standards, incentives for home owners and builders, mandates for utilities, and voluntary energy efficient rating and certificate programs.

Building Codes

Regulatory policy governing residential energy efficiency in new homes is the building code. Building codes began as a safety precaution and set minimum standards for construction quality as a means of consumer protection.[33] The figure

Image from: (US Department of Energy, 2017)

[32] (Madrid & James, 2012)
[33] (Vaughan & Turner, 2013)

shows current energy code adoption by state.[34]

The first codes for buildings regarding energy use date back to 1975 when the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90 was first published to establish a unified way of measuring a home's expected energy consumption.[35] Using the ASHRAE Standard, in 2000 the International Energy Conservation Code (IECC) established a modern energy code platform that can be adopted by regulatory bodies. The IECC continues to update their model code every 3 years. There is no federal residential energy code, but most states and several cities have started to adopt them into law.[36] This way states can act as the laboratory for advancing new ideas and be a key stakeholder involved in reducing energy consumption.[37]

Energy Efficiency Resource Standards

Energy Efficiency Resource Standards (EERS) are long-term reduction targets set by states and cities for utilities or non-utility program administrators. EERS can be designed to be appropriate and optimum for any market or climate region. Targets can be for either electricity or natural gas utilities, or both, depending on the state and climate zone. EERS can be adopted

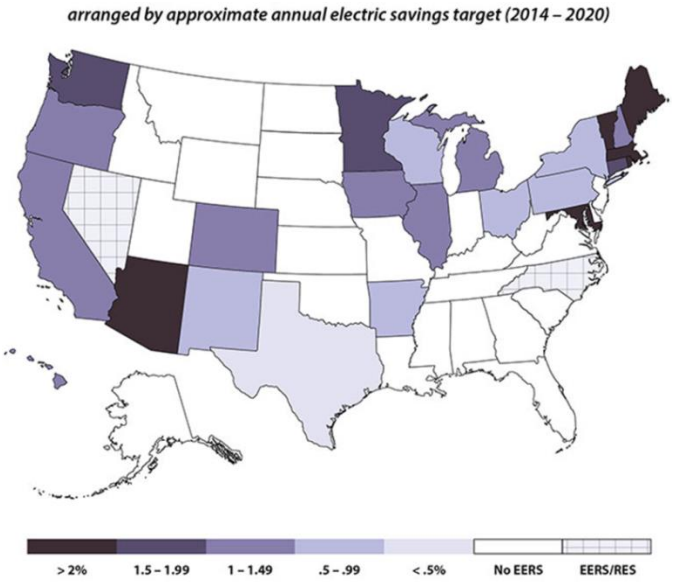

Image from: (American Council for an Energy-Efficient Economy , 2017)

[34] (US Department of Energy, 2017)
[35] (Rosenberg, Jonlin, & Nadel, 2016)
[36] (US Department of Energy, 2017)
[37] (Residential Energy Services Network, 2017)

through legislation or regulation.[38] There is a wide range of strategies including, financial incentives for builders, and weatherization and awareness campaigns for existing homes. EERS requirements often place the burden on the utility company to design the most effective programs for reducing energy demand. States with these policies can be seen in the figure above.[39] In order to measure whether or not these programs are effective, homes must be benchmarked. For existing homes some programs will prescribe a conservative estimate of the improvement, while others will conduct performance testing before and after installation. Due to the emergence of the software REM/Rate, new homes are benchmarked to the minimum requirements of the 2009 IECC.[40] Once a benchmark is established a measurement of efficiency credit for the utility can be recorded for meeting the EERS requirements. This information could also be used to create an estimate energy cost for consumers.

Providing data transparency for homeowners to be able to visualize how actions affect their utility costs can have a huge impact on reducing residential energy use. In 2016 the White House called on the utility industry to provide customers with easy and secure access to their energy consumption data in a way that would be useful. The program that was designed allows utility customers to download their detailed energy consumption data securely from their online account with the click of a universal "Green Button." Providing customers with data increases the chance they will alter their behavior and invest in improvements.[41]

Another way to encourage home owners and residential investors to make energy efficient decisions is through educational programs such as energy audits for existing homes and consultations for builders. Education programs come in all shapes and sizes. There are

[38] (American Council for an Energy-Efficient Economy , 2017)
[39] (American Council for an Energy-Efficient Economy , 2017)
[40] (Residential Energy Services Network, 2017)
[41] (US Department of Energy, 2017)

weatherization workshops, webinars, and even installation programs. Awareness and weatherization campaigns are often implemented by the utilities as part of their Energy Efficiency Resource Standards requirements, or they can also be implemented by government contract.

Some of these initiatives will include direct financial incentives. Builders can receive tax credits and rebates, but most financial incentives are directed towards helping homeowners overcome the burden of the upfront capital costs.

Ratings and Certificate Programs

Rating systems and certifications can provide a market-driven approach to circumvent or eliminate the barriers. A few agencies have created uniform and trust worthy programs that have made an impact nationally, such as; Energy Star, the HERS Index, and the Home Energy Score for whole homes, as well as EnergyGuide for appliances which this paper examines because of its application as an alternative method for the whole home labeling.

Energy Star has been a well-known and trusted energy efficiency certification label for residential appliances for decades. As of 1995 Energy Star also certifies new construction whole homes. Getting an Energy Star certificate requires builders to meet a checklist of energy efficient features and pass post construction performance testing.

Several new green certificate programs have emerged regionally throughout the country. As a side benefit, most of these new green certificates incorporate water conservation, natural landscaping, soil stewardship, low-impact building materials, and reducing material waste in addition to energy efficiency.

Since new homes now have a national benchmark model from the IECC that recognizes differences in climate, site orientation and style a more robust rating has been devised in the HERS index. The HERS index uses the 2009 IECC code to model reference homes. Software builds a simulated reference model of the home about to be built according to the minimum standards of the 2009 code and analyzes the model for average predicted energy use. The program assigns that reference model a score of 100 on the index. Homes are then inspected during construction for construction details that affect performance and measured against the reference home. New homes in states that have adopted the most progressive IECC prescriptions as their minimum code typically score around 70-80 on the HERS index. The U.S. Department of Energy has determined that a typical resale home scores 130 on the HERS Index.[42]

The Home Energy Score is designed to rate existing homes. It uses a 1 to 10 scale with 10 representing the most energy efficient homes. The Home Energy Score consists of an in-home energy audit to determine the home's energy efficiency.[43]

The Federal Trade Commission's Appliance Labeling Rule, EnergyGuide, requires energy efficiency information labels for large home appliances, certain light bulbs, plumbing products, and ceiling fans.[44] For appliances and mechanical equipment, the labels display an annual fuel use estimate translated into dollars based on a normalized energy cost. In 2012, Austin,

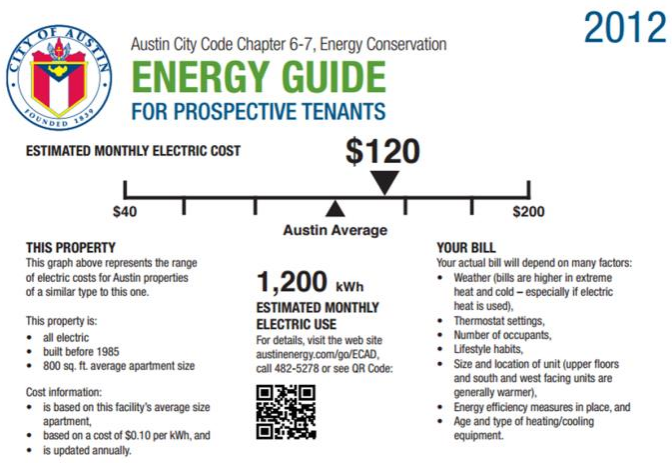

Image from: (Carliner, 2013)

[42] (Residential Energy Services Network, 2017)
[43] (US Department of Energy, 2017)
[44] (Federal Trade Commission, 2017)

Texas a pilot program of this model was tried for multifamily apartment building by simply calculating the average utility cost a building by the number of units.[45] The method for assessment here is oversimplified for a single-family application, but the marketing intentions are similar.

Energy focused financing is another way to get over the hurdle of upfront cost. All the Federal mortgage backers offer special underwriting guidelines for energy specific mortgages. The energy loan is a standardized loan product that helps a borrower qualify for a more expensive house by increasing the allowable debt to income ratio based on a reduction in expected utility expenses.[46] The expected utility expense calculation must however, be determined by one of the above mentioned rating programs. Appraisers also have tools to assist them in appropriately valuing energy efficient improvements when assessing homes.

Policy Evaluation

The evaluation criteria for these policies are measured by their effectiveness in providing economic net-benefit to residential energy consumers, energy use reduction, and political feasibility.

	Economic Benefits to Residents	Energy Use Reduction	Political Feasibility
Building Codes	Increased capital cost can hinder efforts to make new housing affordable	Avoid emitting almost a billion metric tons of CO2 compaired to old building standards by 2030	Resistance from builders and those opposed to increased regulations; and does not include existing homes
Energy Efficiency Resource Standards	Programs can be designed to prioritize for low income families	Difficult to quantify due to prescriptive programs that account for subjective behavior changes	Conflict of interest in utility managed programs: and high programming costs in public awareness campaigns
Ratings and Certificate Programs	Fail to assist prospective buyers and renters to identify expected operating costs	Fail to drive buying and renting market toward smaller more efficient homes	Provide consumer protection and information, reducing complexity without high cost

[45] (Carliner, 2013)
[46] (Residential Energy Services Network, 2017)

Building Codes

Code enforcement is extremely effective at reducing energy use in buildings. Computer modeling for energy code improvements for residential and commercial buildings are estimated to produce $126 billion in cost savings, and avoid emitting 841 million metric tons of CO_2.[47] The residential savings per new home has been 15% to 30% for residents of states with progressive energy codes.[48] Energy codes can go too far though. There are equilibriums and diminishing returns to energy efficiency. For example, adding insulation has a diminishing return on reducing heat loss.[49] Building codes can also hinder efforts to make new housing affordable. Setting regulations current with state of the art industry standards does not allow for products and methods to run their course in the field. And, of course, building codes and regulations for existing homes are not politically feasible. Regions with progressive building energy codes have created one market signal to consumers however, that newer homes are more energy efficient.

Energy Efficient Resource Standards

The decoupling of consumption and utility business models has led to creative policies from utilities striving to meet there EERS targets. It also creates new companies and jobs. Utilities often contract out the work of implementing these programs, such as in the existing home energy audit programs. Energy audit participants can save anywhere from 5% to 30% on their energy bills by making the recommended upgrades in a home energy audit.[50] This type of policy lets the utility decide the most cost effective way to reduce emissions or energy consumption in order to meet the reduction targets set out by their regulating authorities. While this type of policy is feasible it has a potential conflict of interest in the sense that utilities may not be motivated to help their customers purchase less energy.

[47] (US Department of Energy, 2016)
[48] (Residential Energy Services Network, 2017)
[49] (Mora, Tariku, & Bitsuamlak, 2012)
[50] (US Department of Energy Building Technologies Office, 2016)

Education programs are difficult to measure for effectiveness, but ultimately help home owners manage their homes' equipment and utility spending. They are also very difficult to deploy. Studies have established that "enhancing knowledge and creating supportive attitudes" about environmental benefits often has little or no impact upon behavior, but another view "suggests that behavior is strongly influenced by economic motives."[51]

Economists found that the home weatherization program was not a particularly cheap way to reduce CO2 emissions. "Although energy use - from the homes studied did go down, it came at a cost of about $329 per ton of carbon." The US federal government uses just $38 per ton to value of the social cost of carbon.[52] Financial incentives like rebates for energy efficient light bulbs and grants for home improvements tend to have low saturation and impact rates, even when they offer free products.[53] These programs are, however, a useful tool for distributing energy efficiency equitably. A low-income family can benefit greatly from reduced upfront costs for a project that is saving money on a monthly basis as well.[54] However, when retrofitting for energy efficient upgrades, treating homes as a holistic system is not usually done.[55] This can cause other issues throughout the home, and in some cases, tragic unforeseen consequences.

I spoke with mortgage professionals and real estate appraisers about financing for energy efficient loans and valuations. The common theme among loan officers was that in most cases an energy mortgage is not worth the extra time and risk for their client. The feedback from professionals was that these clients would benefit from selecting a slightly less expensive house. This is not the expected answer since most of the professionals in this industry have a

[51] (McKenzie-Mohr, 2000)
[52] (Plumer, 2015)
[53] (Hillman & Ramaswami, 2010)
[54] (Madrid & James, 2012)
[55] (Residential Energy Services Network, 2017)

commission based income. This makes me think the additional complications and risks are a deterrent for the professionals as well. In the appraisal industry the feedback from those I spoke with was that there is a learning curve to appraisers being able to recognize energy efficient upgrades. Even when they are given notice to account for certain features, there is still a large portion of the industry that does not know what to look for or how to value it. One of the mortgage professionals recommended requesting an appraiser from the Residential Professional Development Program Registry for the Valuation of Sustainable Buildings.[56] My conclusion is that buyers looking for an energy efficient home must seek out a professional who is already well versed in the topic.

Ratings and Certifications

Voluntary ratings and certifications provide a market based approach that arms consumers with information to value the energy efficient features that are not exposed in a completed home. Based on U.S. Census data, Energy Star single family homes saved home owners nearly $21 million and mitigated over 113,000 tons of $C0_2$ emissions in 2015.[57] Providing homeowners with easy access to data increases their opportunities for energy savings. Because every house is different and operates systematically, ratings and certificates provide a simple answer to the barrier created by the lack of a common language and asymmetric information.

In most articles claiming that homes with green labels sell for more they fail to mention the amount of initial investment it took to meet the green designations criteria. Depending on the location, Energy Star Homes only cost $2,000-$2,500 more and consume at least 15% less than a code-built home.[58] However, a study conducted in Florida found that the resale premium for

[56] (Appraisal Institute, 2017)
[57] (Energy Star, 2015)
[58] (Energy Star, 2015)

Energy Star homes diminishes greatly, suggesting that homeowners might have trouble effectively marketing their used green labels.[59] Some industry professionals I spoke with said Energy Star homes were gaining popularity and that it was the preferred rating among builders and home buyers before 2011, but when they moved to a more stringent requirement for Version 3 in 2012 builders sought other green certifications. In 2011, Energy Star Homes accounted for about 26% of all newly constructed homes in the United States.[60] In 2015, Energy Star Homes accounted for less than 10% of new construction.[61] In effort to streamline the process without reducing the targets in July of 2016 Energy Star revised the national program guidelines.[62] This expresses the difficult balance required to implement a successful certificate program.

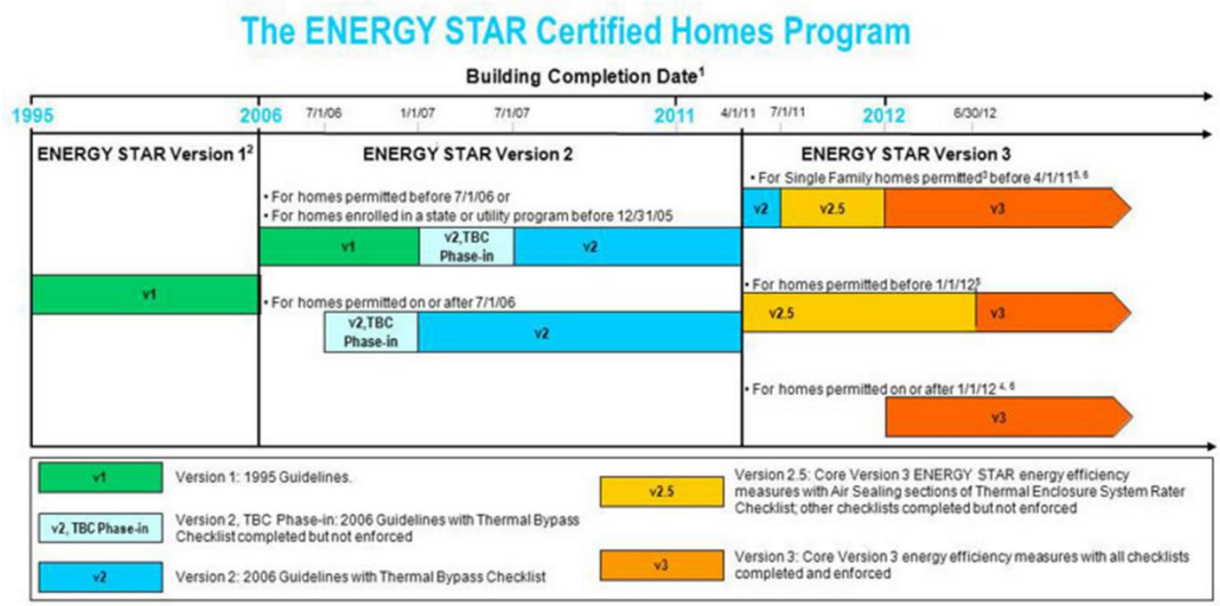

Image from: (Energy Star, 2015)

[59] (Bruegge, Carrión-Flores, & Pope, 2016)
[60] (US Energy Information Administration, 2012)
[61] (Energy Star, 2015)
[62] (Energy Star, 2015)

Rating metrics and certifications are proliferating across the US at all scales, diluting the impact and creating confusion among the programs. Most efficiency certificates fail to provide everyday consumers with detailed information to base their decisions on. Certifications are binary, ratings are confusing, and none of them account for size. Increasing new home size is the biggest problem challenging the effort to reduce American household energy use. Since 1990, homes have increased in size by 27%.[63] The easiest way to make a home more energy efficient is to make it smaller. As the volume of a home increases, so does the burden on heating and cooling equipment.

Recommendation

After considering the market barriers to appropriately valuing energy efficiency in the residential resale market, a policy recommendation can be made for improving labeling standards. A uniform expected energy cost label can create a common language, help homeowners recoup their investments, and help prospective buyers and renters identify energy efficient homes.

Current Policy

There is a wide breath and body of policies aimed at energy efficient homes, but a lack of useful information to empower the average consumer to make an educated decision. Certifications and green labels are all binary and do not account for size, so they cannot express a range of efficiency and fail to account for larger homes using more energy. The HERS index for new homes and the Home Energy Score for existing homes begin to do this, but fall short in key ways. They also do not account for size, typically the biggest contributor to energy consumption, and they are not comparable with each other, further confusing the average consumer.

[63] (US Energy Information Administration, 2012)

Proposal

The case for designing a rating program with consistent and transparent information is seen as the most important policy recommendation for enabling the resale market to appropriately value energy efficiency. This recommendation is supported by research conducted by Lucas Davis and Gilbert Metcalf at UC Berkeley and Tufts University respectively, who find that even the EnergyGuide label could benefit from additional climate region or state specific information.[64] Nikhil Nadkarni and Harvey Michaels at MIT recommend a very similar approach to applying EnergyGuide labels for homes.[65] Using the EnergyGuide platform to create an AFUE labeling standard for homes can empower the market to decide where and how much to invest in energy efficiency.

A progressive set of policies should be set in motion introducing the EnergyGuide for homes model. Making it available as a voluntary rating program to replace the HERS index and Home Energy Score programs is the first step. Starting this at the federal level will provide consistency across structure types and transboundary actors. The wide spread recognition of a national platform is needed to become a significant lever for change.

Second, a training program should be developed to train building inspectors to be able to account for building performance features. This can be done at the state level to increase short-term feasibility and flexibility among different political environments. Policies for rental markets, such as the example in Austin, and time of sale inspection requirements become a logical next step. These steps with require more political maneuvering.

[64] (Davis & Metcalf, 2014)
[65] (Nadkarni & Michaels, 2012)

Evaluation

The home evaluations must be done by a third party independent inspector or government actor to ensure data integrity and to remove the liability of false advertising from the builder. It would be ideal to have a competitive market for ratings companies, however a publicly ran business type activity framework could be useful in avoiding corruption or favoritism among rating companies. If the building code inspectors can perform sight verification of data, all new homes can easily be tested to include this labeling without much additional cost. Existing homes will require more invasive testing that may only be feasible at times of sale when inspectors are already assessing the home. Home sellers can better market their investments, and home buyers and prospective renters can make better educated decisions. Real estate professionals and property managers would have an easier time marketing efficiency and calculating mortgage related expenses. Builders and renovating companies would also benefit. Builders would be able to better market the improved energy efficiency of a new home, and renovators could see an increase in business from this competition and from the improved marketability of energy efficient upgrades.

The REM/rate software is already prepared to calculate and disseminate the necessary information, and it is already provided to utilities when they sponsor the testing through EERS programs.[66] For new construction in Minnesota this AFUE is already calculated for newly homes constructed by builders participating in the EERS program as the metric for their evaluation. This EERS program also subsidizes the cost for homeowners to get the testing done necessary to estimate this cost for resale. And in many other states that require blower door testing for building tightness, almost all the necessary information to estimate the annual utility cost is already collected. Incorporating utility bills in EnergyGuide scoring could help with accurately

[66] (NORESCO, 2017)

rating existing homes. In Austin, Texas they have already began to do this for rental properties.[67] And in Colorado they have shown that it has been politically feasible to enforce time-of-sale energy efficient upgrades onto real estate transactions.[68] These policy examples show that it is a reasonable policy goal to expect the cost of this program to be paid from the sale proceeds for field operations, and a modest Federal budget appropriation for program administration.

Conclusion

Incorporating minimum standards for energy into building codes is a good way to raise the bar for newly constructed homes, but does not address existing homes or the resale market. Weatherization and outreach programs have little effect and are not proven to be an economically efficient solution. EERS programs have a principal agent problem with utility companies' conflicting interest of making homes more efficient versus selling more energy. Current labeling options for disclosing energy efficiency value in a home fall short of informing buyers of the true operating cost of a home.

The technology and expertise is available for collecting and examining energy consumption data to better value energy efficiency. Policy makers must first issue a program for uniformly measuring and marketing energy consumption data for single family homes. Access to energy data offers an array of benefits. Home owners can use the data to identify and prioritize projects with the greatest energy efficiency potential. Utility companies can use data to optimize energy efficiency programs and better plan for future system needs. This type of information

[67] (Carliner, 2013)
[68] (Hillman & Ramaswami, 2010)

dissemination in mass promotes the advancement of more energy efficient technologies, further optimizing performance.[69]

Reducing energy consumption by improving market symmetry would further prove that it is possible to decouple economic growth from carbon emissions. Typically market based solutions are more politically feasible than regulations, mandates or subsidies. Optimizing energy efficiency is important to mitigate climate change effects and local pollutants from the burning of fossil fuels. The role information plays in shaping consumer purchase decisions can have the mutual benefits of saving money and the environment simultaneously.

The case for a nationally recognized model is so that states can easily adopt the program as they see fit, yet there will still be uniformity across climate regions. This creates stability for large builders and industry professions that cross regional boundaries, and professionals and buyers who may cross state lines. Disclosing and marketing this information enables potential renters and home buyers to make educated choices and easily incorporate energy efficiency as a factor when deciding on a home. With this tool, residents can cultivate a market that identifies and justifies the value for energy efficient homes.

[69] (Shoemaker, 2017)

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