CLIMATE CHANGE POLICY PARTNERSHIP

Residential Energy Efficiency and the American Clean Energy and Security Act HR 2454

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TOWARD A LOW-CARBON ELECTRICITY SECTOR

CCPP Technology Policy Brief Series

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Series Overview:

Toward a Low-Carbon Electricity Sector

This paper is one in a series by the CCPP at Duke University to explore the barriers facing large-scale, low-carbon electricity generation and increased efficiency in the near-term – primarily the next ten to fifteen years. Policy drivers may be necessary to provide the right price signal to develop low-carbon emission technologies, but a price signal alone may not be enough to enable broad-scale deployment.[1] Significant technical, legal, infrastructural, and social barriers prevent the implementation of the necessary technologies and efficiency improvements.

The series provides an overview of the barriers and outlines general policy options for lawmakers who wish to speed the development and/or wide-scale deployment of low-carbon energy technologies. It will include papers focusing on specific energy generation technologies, including renewable energy and energy storage, and energy efficiency, a cost-effective near-term option for displacing carbon-intensive energy generation.

Acknowledgements

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[1] Policy drivers are under consideration include a nationwide cap-and-trade system for greenhouse gas (GHG) emissions, regulation of GHGs emissions under the Clean Air Act, expanded action on the state and regional levels, or some combination thereof.

Contents

Executive Summary

The residential sector offers significant opportunities to improve energy efficiency. Approximately one-third of the occupied housing stock is at least 45 years old, and another third is between 25 and 45 years old. Homes built before the widespread adoption of building energy codes use, on average, 23% more energy per square foot than modern homes.[2] Many newer residences do not incorporate all available cost-effective energy efficiency measures or have efficient heating and cooling systems.

There are numerous market, policy, and legacy barriers to energy efficiency improvements in the residential sector. Homeowners often lack information about efficiency opportunities. Capital barriers can prevent major efficiency upgrades. In the housing market, renters and homebuyers, who pay energy costs, have different incentives than homebuilders and landlords. Most efficiency improvements incur transaction costs. Many states lack up-to-date building energy codes and noncompliance with building energy codes increases energy use. Older, more inefficient homes last for decades and improper maintenance of residential heating and cooling systems is a major problem.

In response to concerns about energy and climate change, the U.S. House of Representatives recently passed the American Clean Energy and Security Act H.R. 2454, introduced by representatives Waxman (CA) and Markey (MA). The legislation includes multiple provisions to overcome efficiency barriers and improve residential efficiency. This policy brief provides an overview of the barriers to residential energy efficiency improvements, describes how the residential energy efficiency provisions included in H.R. 2453 address these barriers, and presents options for implementing these provisions. In addition, this policy brief presents further policy options for federal policymakers who seek to improve residential efficiency. The residential efficiency provisions of the American Clean Energy and Security Act discussed in this policy brief include:

- **Building code program:** Establishes a national building energy code and sets targets to improve average new building efficiency by 30% after the bill is enacted and by 50% after 2013.
- **Building retrofit program:** Provides states, local governments, and regulated utilities funds to conduct building efficiency retrofits. The program provides direct incentives to building owners who conduct efficiency retrofits, up to 50% of the total retrofit cost.
- **Building energy performance labeling program:** Establishes a national building energy performance label for new buildings[3] to provide the residential building market information about individual building energy efficiency.

[2] Based on comparison of homes built before 1970 and homes built after 1990.
[3] The Building Energy Performance Labeling Program may also apply to buildings renovated after the bill is enacted.

- **Lighting and Appliance efficiency standards:** Strengthens and expands existing lighting and appliance efficiency standards. Establishes a reward program for retailers and manufacturers that sell and manufacture best-in-class efficient products.

Additional policy options for federal policymakers who would like to improve residential energy efficiency include:

- including existing buildings in the Building Energy Performance Labeling program
- providing incentives to states that encourage or require home energy audits at the time of sale
- conducting information campaigns to make consumers aware of the Retrofit for Energy and Environmental Performance (REEP) program and other federal energy efficiency programs
- allowing regulated utilities, local governments, and states to issue tax-exempt bonds to finance property tax– and utility bill–financed energy efficiency programs
- incorporating energy efficiency into federal foreclosure avoidance and foreclosed home resale programs
- incorporating efficiency into federal low-income housing programs

Introduction

Americans are awash in news about the benefits of energy efficiency. The recently passed American Recovery and Reinvestment Act of 2009 includes over $30 billion in tax incentives and grants for improving energy efficiency (not including transportation) (American Recovery and Reinvestment Act, 2009). Numerous studies estimate that the average life-cycle cost of electrical energy efficiency is between 3 and 6 cents per kilowatt-hour[4] (kWh)—over a third less than the average cost of residential electricity.[5] Other studies conclude that improving energy efficiency is the best near-term option to reduce greenhouse gas (GHG) emissions and increase our nation's energy security.[6] Efforts to increase federal energy efficiency efforts appear to have broad political support. The numerous arguments for improving energy efficiency and the significant government support it enjoys beg the question, *If improving energy efficiency offers so many benefits, why have homeowners and renters not done more to improve the energy efficiency of their homes and apartments?*

The answer is that homeowners and renters face numerous barriers to improving residential efficiency, including:

- A lack of information about cost-effective energy efficiency opportunities (Environmental Protection Agency, 2007)
- The high upfront cost of major efficiency improvements
- The lack of incentives for renters to make improvements to someone else's property
- The time and effort required to make many efficiency improvements that in sum can save a considerable amount of money over time
- Low awareness of the maintenance needs of heating and cooling systems (California Energy Commission, 2005)

In response to growing concerns about energy and climate change, the U.S. House of Representatives recently passed the American Clean Energy and Security Act H.R. 2454, introduced by representatives Waxman (CA) and Markey (MA). The legislation includes multiple provisions aimed at improving residential energy efficiency. This policy brief describes the residential energy provisions included in the

[4] On the basis of levelized cost of avoided electricity purchases. The EPA's *National Action Plan for Energy Efficiency* estimates that the average cost of electrical energy efficiency is 3 cents per kWh. Lazard, Ltd. estimates that electrical energy efficiency costs between 0 and 5 cents per kWh (see *Levelized Cost of Energy Analysis – Version 2.0,* June 2008). A recent study by the Center for Integrative Environmental Research at the University of Maryland, *The Role of Energy Efficiency Spending in Maryland's Implementation of the Regional Greenhouse Gas Initiative*, states that efficiency programs in neighboring states cost between 3 and 6 cents per kWh including customer costs.

[5] The EIA's *Annual Energy Review 2007* reports that the average cost of residential electricity was 11 cents per kWh in 2007.

[6] See the American Physical Society's *Energy Future: Think Efficiency*; the McKinsey Global Institute's *Wasted Energy: How the US Can Reach its Energy Productivity Potential*; and the ACEEE report *Energy Efficiency's Role in a Carbon Cap-and-Trade System: Modeling Results from the Regional Greenhouse Gas Initiative.*

Waxman-Markey bill and explains how these provisions attempt to address the barriers to residential energy efficiency. It concludes with additional policy options that federal policymakers could consider to improve residential energy efficiency.

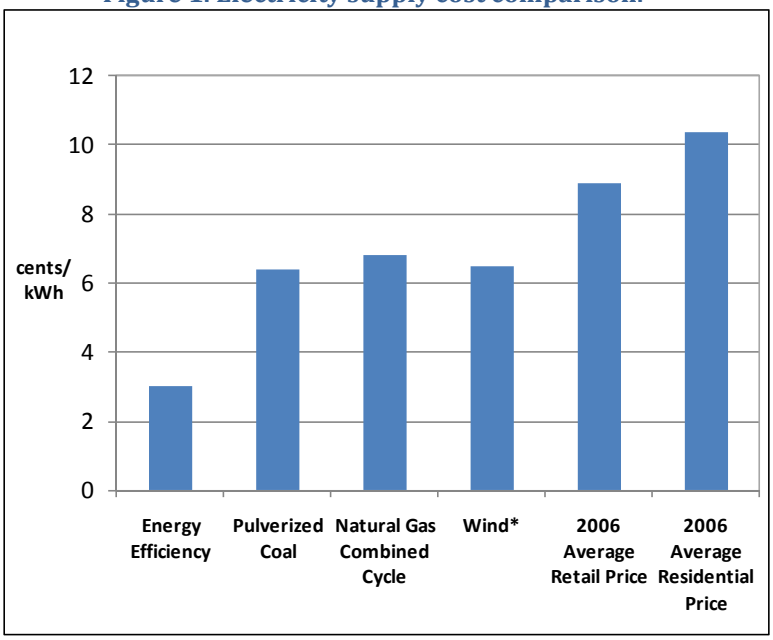
Effects of Increased Energy Efficiency

Energy efficiency reduces the amount of energy required to perform an energy service such as cooling, lighting, or refrigeration. Improved efficiency reduces the cost of the energy service and the GHG emissions[7] associated with its consumption. By reducing the amount of energy required for the service, the energy efficiency measures result in lower energy costs and lower GHG emissions.

Energy efficiency delivers multiple benefits beyond lower electricity costs and GHG emissions reduction. For example, reducing energy demand through efficiency can delay the need to invest in expensive new generation capacity (see Figure 1). Lower electricity demand reduces emissions of conventional air pollutants such as mercury, sulfur dioxide, and particulate matter from fossil fuel power plants. Improved efficiency also decreases the need for resource extraction such as coal mining and natural gas drilling. It reduces peak loads, lowering stress on the grid and reducing the incidence of blackouts (Environmental Protection Agency, 2007). Improving efficiency will lower total U.S. GHG emissions, making it easier for the economy to reduce GHG emissions and lower the market price for carbon credits under cap-and-trade legislation. In addition, lower electricity demand acts as a hedge against fossil fuel price volatility, increases energy security, and reduces the economy's vulnerability to external shocks.

[7] Unless all of the electricity consumed to provide the energy service comes from zero-GHG emission sources. In 2007, 71% of electricity available to the grid was generated using fossil fuels (*Annual Energy Outlook 2009*, EIA).

Figure 1. Electricity supply cost comparison.



*Wind cost without federal production tax credit.
Sources: DOE, *Cost and Performance Baseline for Fossil Fuel Energy Plants*; EIA, *Electric Power Annual 2006*; DOE, *Annual Report on U.S. Wind Power Installation, Costs and Performance Trends: 2007.*

Despite the benefits of higher efficiency, not all energy efficiency improvements are cost-effective. Likewise, not all appliance efficiency standards and energy conservation building codes are cost-effective or offer a reasonable payback period. And improving energy efficiency does not decrease energy consumption on a one-to-one basis, because as energy or energy services become less expensive, demand increases.[8] This phenomenon is referred to as the *take-back* or *rebound* effect.[9] Empirical studies indicate that the rebound effect varies, ranging from 0% to 50% depending on the end-use product (L. A. Greening, 2000). Please note that the rebound effect is largely due to increased consumer wealth, a positive policy outcome. The rebound effect is negated if energy prices rise as consumers increase efficiency, as is expected under climate legislation (David Hoppock, 2009). Increased federal investment in energy efficiency and more stringent appliance and building efficiency standards may make it more difficult for regulated utilities to achieve mandated efficiency goals if efficiency savings are attributed to the federal government and baseline energy demand estimates assume high penetration of efficient appliances and buildings.[10]

[8] Assuming the per-unit cost of energy stays constant or decreases.
[9] Some economists contend that the rebound effect actually increases energy use while many other economists strongly dispute this claim.
[10] Please refer to the Climate Change Policy Partnership's *Transforming Utility and Ratepayer Support for Electrical Energy Efficiency Nationwide* for more information about policies to increase utility investment in energy efficiency.

Overview of the Residential Sector

Residential energy efficiency improvements present significant long-term benefits, as residential buildings have useful lives of 60 to 100 years (Adam Jaffe, 1999) and the residential sector[11] represents 21% of total U.S. energy consumption (Energy Information Administration, 2008). The Energy Information Administration (EIA) projects that residential sector energy consumption, under business-as-usual energy policy, will grow 4%, from 21.8 quads[12] in 2007 to 22.7 quads in 2020 (Energy Information Administration, 2009).[13] As of 2005, there were over 113 million residences with approximately 180 billion gross square feet (American Physical Society, 2008). Approximately one-third of the occupied housing stock is at least 45 years old and another third is between 25 and 45 years old (Joint Center for Housing Studies of Harvard University, 2007). According to a 2005 Pew Center for Global Climate Change report, only 40% of residences are well-insulated (Marilyn A. Brown, 2005). Homes built before 1970 use on average 23% more energy per square foot than homes built after 1990 (Joint Center for Housing Studies of Harvard University, 2007).

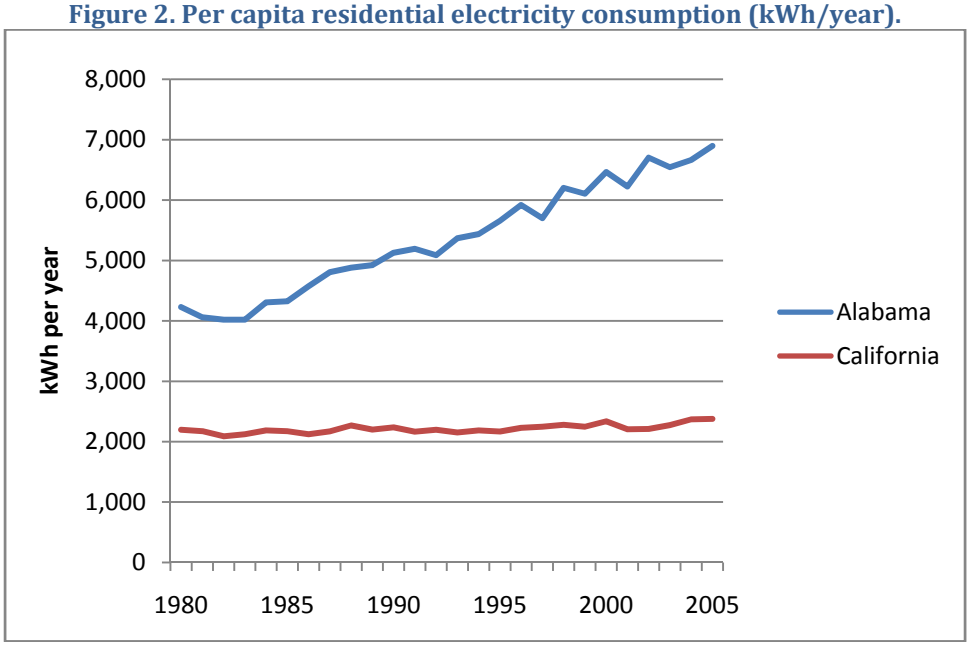
Building codes for new construction and renovations are the primary policy tool for increasing building efficiency. The cost of integrating energy efficiency measures is generally lowest in new buildings (Cavanagh, 2004).[14] Most state and local residential building energy codes are based on the consensus model International Energy Conservation Code (IECC), created by the International Code Council (ICC), a U.S.-based nongovernmental organization. The U.S. Department of Energy (DOE) assists in the ICC code-making process,[15] but there is no national model energy code for private residential buildings.[16]

State and local governments set and enforce building codes. Residential sector energy codes and policy vary significantly by state and in some cases by county or city. California has realized significant energy savings with strict energy codes and appliance efficiency standards relative to other states without statewide energy codes (Figure 2).[17] Currently, 12 states have no statewide residential building energy codes.[18]

[11] The residential sector includes all residential buildings and the energy consumed by appliances and equipment (lighting, heating, televisions, etc.) in residential buildings.
[12] One quad of energy is 10^{15} Btus.
[13] From the EIA's AEO 2009 reference scenario forecast. The AEO 2009 reference scenario assumes that there are no changes to existing (as of November 2008) state, local, and federal energy policies for the duration of the modeling period (Energy Information Administration, 2009).
[14] In some cases, it may be more cost-effective to invest in improving the efficiency of an existing inefficient building than a new building that is already relatively efficient.
[15] See http://www.energycodes.gov/) for more information.
[16] There is a national energy conservation building code for manufactured homes. The Energy Independence and Security Act of 2007 requires the DOE to establish energy efficiency standards for manufactured homes and update these standards when the ICC publishes revisions to the model IECC (Energy Independence and Security Act, 2007).
[17] California has held per capita residential electricity consumption approximately constant from 1980 – 2005 through a number of policies including building codes (American Physical Society, 2008).
[18] See http://www.energycodes.gov/implement/state_codes/index.stm for current state residential building codes.

Nationwide, enforcement of building energy codes is a major problem. Code inspections are typically paid for with building permit fees (California Public Utilties Commission, 2008). Often, these fees are insufficient to support rigorous inspections because many cities and counties do not want to impose higher building permit fees for fear of discouraging growth. A study commissioned by Southern California Edison found that noncompliance rates for California's building energy codes are 28% to 73% for the three efficiency measures[19] included in the study (M. Sami Khawaja, 2007). The same study estimates that noncompliance with California state energy codes reduces energy code savings by more than 30%.[20]

Figure 2. Per capita residential electricity consumption (kWh/year).



Data from http://apps1.eere.energy.gov/states/residential.cfm/state=CA#elec
Please note that multiple factors, including electricity prices, climate, average home size, and building energy codes affect per capita residential energy consumption. Alabama was chosen for comparison with California because it lacks statewide residential building energy codes and appliance efficiency standards (see http://www.aceee.org/energy/state/alabama/al_index.htm for more information).

[19] The three efficiency measures included in the study were hardwired lighting, window replacement, and duct improvement.

[20] The American Recovery and Reinvestment Act of 2009 requires state governors to verify in writing that the state or local governments will adopt building energy codes that meet or exceed the most recent model energy codes and develop a plan to achieve 90% energy code compliance for new and renovated buildings by 2017 in order to receive additional State Energy Program grants provided by the bill (American Recovery and Reinvestment Act, 2009).

Barriers to Improving Residential Energy Efficiency

There are numerous, well documented, barriers to improving energy efficiency in the residential sector. The following summarizes these main barriers: *market*, *policy*, and *legacy*. For more detailed discussions, please refer to *Quantifying the Effect of the Principal-Agent Problem on US Residential Energy Use* (LBNL), *Options for Energy Efficiency in Existing Buildings* (CEC), *Statewide Codes and Standards Market Adoption and Noncompliance Rates* (Quantec for Southern California Edison), *Foundations for future growth in the Remodeling Industry* (Joint Center for Housing Studies of Harvard Univ.), *National Action Plan for Energy Efficiency* (EPA), and *Towards a Climate-Friendly Built Environment* (Pew Center on Global Climate Change).

Market Barriers

Information barriers – Homebuyers, homeowners, and renters often lack information about cost-effective energy efficiency opportunities, the energy consumption of residential appliances, and the energy efficiency of individual residential units. This lack of information discourages or prevents them from making many energy efficiency improvements and prohibits a comparison of the energy costs of different residences when buying a new home or choosing an apartment.

Capital barriers – Major residential energy efficiency upgrades are often expensive and require access to capital. Homeowners must be willing to spend hundreds or thousands of dollars to pay for major efficiency upgrades or have access to loans to overcome capital barriers.

Split incentive (principal-agent) barriers – In the residential rental and new home markets, the objectives of landlords and homebuilders are generally different from those of tenants and homebuyers. Tenants and homebuyers—who pay energy costs[21]—want to minimize the energy costs of occupancy, whereas landlords and homebuilders—who generally do not pay energy costs[22]—want to minimize maintenance, appliance purchasing, and construction costs.

Transaction costs – Making energy efficiency improvements requires determining what improvements to make and the skills and knowledge required to implement them, as well as time and effort. The time, skills, and effort required to make efficiency improvements—referred to as transaction costs—create barriers to cost-effective efficiency improvements.

[21] In approximately 87% of rental units, the renter pays for electricity, but renters rarely have any influence on choice of the heating systems, air conditioning systems, windows, and insulation in the units they are renting (Scott Murtishaw, 2006). In total, 35% of residential energy consumption is affected by split incentive barriers. Ibid.
[22] Ibid.

Policy Barriers

Outdated efficiency policy – In states without up-to-date building energy codes, homebuilders are not required to implement proven, cost-effective energy efficiency measures in new and renovated residential buildings.

Code compliance – Noncompliance with existing building energy codes increases the energy consumption of new and renovated residential buildings by at least 30% (M. Sami Khawaja, 2007).

Legacy Barriers

Inefficient existing housing stock – The United States has tens of millions of older, inefficient homes and apartments that homeowners and renters will occupy for decades and possibly centuries (Joint Center for Housing Studies of Harvard University, 2007).

Building and equipment maintenance – Improper maintenance of residential buildings and residential appliances, especially heating and air conditioning systems, wastes significant amounts of energy and money. Most homeowners are unaware of the maintenance needs of heating and air conditioning systems and do not repair them until they fail (California Energy Commission, 2005).

American Clean Energy and Security Act H.R. 2454

The American Clean Energy and Security Act ("the Waxman-Markey bill") proposes a comprehensive energy and climate policy. If enacted, the draft legislation would address many of the barriers to residential energy efficiency summarized above. The following describes different energy efficiency provisions in the Waxman-Markey bill that relate to residential energy efficiency, the barriers these provisions address, additional considerations, and options for implementing these provisions. This policy brief does not discuss the manufactured homes rebate program to encourage low-income manufactured homeowners to purchase Energy Star manufactured homes (Sec. 203).

Building Energy Codes

The Waxman-Markey bill sets national building code energy efficiency targets and establishes a national energy efficiency building code for private buildings. The DOE is instructed to support updating the consensus commercial and residential model codes, set by the ICC and ASHRAE,[23] to meet the efficiency targets. The initial national average energy savings target is 30% for new buildings built in compliance with the updated code. [24] The savings target increases to 50% for new residential buildings built after January 1, 2014, and new commercial buildings built after January 1, 2015. If the DOE determines that the consensus model codes developed by the ICC or another organization meet the efficiency targets, the consensus model code becomes the national building code. [25] If the DOE finds that new model codes do not meet these energy savings targets, the DOE will create a national building code that meets the energy savings targets and achieves the maximum energy savings that are technically feasible and life-cycle cost-effective.[26]

After the DOE adopts a consensus model code as the national building code or develops its own national code, states are required to certify to the DOE that either (a) they have updated their building energy codes to meet or exceed the energy savings of the national building code or (b) that local governments representing 80% of the state's urban population[27] have updated their codes. In any jurisdiction that does not update buildings codes within 18 months, the national building code becomes the local code.

[23] The ICC and ASHRAE, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, are nonprofit professional organizations that create consensus codes and standards. Both organizations set the primary residential and commercial model energy efficiency building codes used in the United States.
[24] Energy savings are the estimated savings of a new building designed and built to meet a new code relative to a building designed and built to meet the 2006 IECC model code for residential buildings or the ASHRAE Standard 90.1-2004 model code for commercial and large multi-unit residential buildings (Sec. 201(a)(6)).
[25] DOE issues determinations on new IECC model residential codes and ASHRAE 90.1 model commercial codes based on DOE building energy modeling. The current determination process is slow because of the comment process (Majette, 2008). The Waxman-Markey bill requires DOE to establish a national building code within one year of the energy savings target date release (Sec. 201(b)(1)(A)). The DOE has 15 months to establish a national building code to meet the initial energy savings target.
[26] The DOE may modify the energy savings targets based on the maximum, cost-effective energy savings and what is technically feasible (Sec. 201(a)(3)).
[27] This provision exempts some rural areas from the national building code.

Within two years of the DOE establishing a national building code, states are also required to certify that they are achieving 90% compliance with their certified state energy codes through random sampling of new and renovated buildings or to demonstrate significant progress towards achieving compliance.[28] The DOE is instructed to provide technical and financial assistance to help states update their building codes and conduct compliance sampling. If the DOE determines that a state is not in compliance with the building codes provisions of the Waxman-Markey bill[29] and is not making progress towards achieving compliance, the state will lose some of its emissions allowances. If the state continues to fail to comply, the state will lose all of its emissions allowances for improving energy efficiency and renewable energy development (Sec. 201(e)(6)(C). States are not penalized for failing to implement other residential buildings energy efficiency programs included in the Waxman-Markey bill.

In states and local government jurisdictions that notify DOE that they intend to enforce DOE-certified state and local building codes or national building codes, penalties for violations of building energy codes (by businesses, individuals, or other entities) will be determined according to state and local laws. In areas where the state or local governments *do not* notify the DOE of its intention to enforce energy codes, the DOE will enforce the codes and determine penalties for violation of energy codes.[30]

Background information

See the second paragraph of **Overview of the residential sector** for background information about residential building energy codes.

Barriers addressed: Outdated efficiency policy; code compliance; split incentive

The building code provisions of the Waxman-Markey bill attempt to address inconsistent efficiency policy, code compliance, and the split incentive barriers. In theory, by requiring all states to adopt and enforce up-to-date building energy codes, most new and renovated residential buildings should incorporate cost-effective energy efficiency measures.

Updating state building codes and improving code compliance should help overcome the split incentive barrier for new buildings. Building codes reduce the split incentive barrier for new homes and apartments because landlords and homebuilders are required to incorporate cost-effective energy efficiency measures during construction of the building. Up-to-date building codes can also indirectly reduce information barriers because new homes and apartments in areas with up-to-date building codes tend to have similar efficiency measures whereas new homes and apartments in areas without up-to-date building codes can have large differences in efficiency.[31]

[28] States have a up to 7 years after enactment of the Waxman-Markey bill to demonstrate that they are making significant progress towards achieving compliance (Sec. 201(e)(2)(B)).

[29] The DOE can certify that a local government is in compliance and is eligible to receive allowances and other support in a noncompliant state (Sec. 201(h)(2)).

[30] The DOE does not currently enforce building codes for private buildings or have established penalties for violations of non-federal building energy codes. The Waxman-Markey bill gives the DOE three years to establish rules and penalties for enforcing national building energy codes (Sec. 201(g)).

[31] Assuming building energy codes are enforced.

Additional considerations

A primary concern is whether states will comply with the Waxman-Markey bill's building energy code requirements. The Energy Policy Act of 1992 requires the DOE to determine if new ASHRAE 90.1 model commercial building codes - the basis for many state and local governments' commercial building energy codes – offer significant energy savings. If the DOE issues a positive determination, states are required to adopt commercial building codes that meet or exceed the new ASHRAE 90.1 model code (Environmental Protection Agency, 2007).[32] Yet despite this requirement, nine states have no statewide commercial building energy code.[33] The Waxman-Markey bill appears to address this issue with significant disincentives (the loss of allowances) for noncompliance. Building the capacity to enforce a national building code in all areas of the country will require a significant effort. Further study will be required to determine if the Waxman-Markey bill will provide sufficient resources to states and local governments to enforce a national building code.

The Waxman-Markey bill requires that the DOE establish a national building code which achieves the maximum energy savings that are technically feasible and life-cycle cost-effective. Determining what is technically feasible and life-cycle cost-effective is not a simple task, however. Updates to the latest IECC model code for residential buildings (2009) were controversial (Alliance to Save Energy, 2008), and further updates to model codes or a national building code to improve efficiency may be more contentious as lower-cost, efficiency measures, or "low-hanging fruit," are exhausted.

Building Retrofit Program

The Waxman-Markey bill instructs the EPA, in consultation with the DOE, the Director of Commercial High-Performance Green Buildings, and other federal agencies, to implement a national buildings energy efficiency retrofit program known as Retrofit for Energy and Environmental Performance (REEP). The goal of the program is to facilitate the retrofitting of existing buildings to improve efficiency and other environmental attributes. State and local governments and eligible utilities will implement the program. At least 10% of REEP funding must be available on a preferential basis for public housing and assisted housing (Sec. 202(g)(3)).[34] The Waxman-Markey bill will provide funding to states for the REEP program by depositing allowances in each state's State Energy and Environment Development (SEED) accounts (Sec. 202(i)).[35] The funding can be used to:

- fund building retrofit programs;

[32] The Energy Policy Act of 1992 also requires states to consider adopting residential building codes that meet or exceed the most recent IECC code that the DOE has determined will offer significant energy savings.
[33] See the DOE's *Status of State Energy Codes* website (http://www.energycodes.gov/implement/state_codes/index.stm) for current state building energy codes.
[34] According to the EIA's 2005 Residential Energy Consumption Survey (Table HC7.3), 15% of U.S. households have income levels below the poverty line and 35% are eligible for federal assistance (Energy Information Administration, 2005).
[35] SEED accounts are accounts for the deposit and management of emissions allowances given to states for renewable energy and energy efficiency programs. See Section 131 of the Waxman-Markey bill for a complete description.

- offer credit enhancement and interest rate subsidies for energy efficiency loans;
- provide initial capital for public revolving funds that finance retrofits and are repaid through additions to participants' tax payments (tax financing) or through additional charges to participants' utility bills (on-bill financing); and
- other programs proposed by state and local agencies and approved by the DOE.

The program will provide direct support in the form of "awards" of up to 50% of the total retrofit cost to building owners who conduct energy audits and make efficiency improvements.[36] The EPA can adjust award amounts every two years to maximize cost-effective participation in the REEP program (Sec. 202(i)(3)). The awards are performance-based, meaning that participants must demonstrate the energy savings of the efficiency improvements.[37] These awards provide a financial incentive to encourage building owner participation in the REEP program.

Background information

Energy audits provide homeowners with information about a home's energy consumption and cost-effective options for improving its efficiency. Most home energy audits use energy auditing systems developed by the Residential Energy Services Network (RESNET).[38] A thorough professional home energy audit can find air and ventilation system leaks and areas of high heat flux; determine the energy consumption of major appliances; and check the condition of heating and air conditioning equipment.

Credit enhancements and interest rate subsidies for energy efficiency loans reduce the cost of borrowing to pay for efficiency retrofits. Lower energy efficiency loan interest rates decrease the payback time for efficiency retrofits. Efficiency loan programs can also reduce the cost of borrowing to pay for retrofits by providing insurance for energy efficiency loans. If government-sponsored building efficiency programs insure energy efficiency loans, lenders face reduced or eliminated risks from defaults, which lowers interest rates.

Energy efficiency mortgages are mortgages with additional capital to pay for energy efficiency retrofits, e.g., mortgages with an energy efficiency loan. The homebuyer's reduced energy bills offset the higher monthly mortgage payments, often saving the homebuyer money in net. Because the interest on a mortgage is tax-deductible, the interest on efficiency retrofits paid for with an energy efficiency mortgage is also tax-deductible. The Federal Housing Authority, Department of Veterans Affairs, Fannie Mae, and Freddie Mac each have programs to encourage use of energy efficiency mortgages, but these programs are not well-utilized (Energy Programs Consortium , 2007). The credit enhancements and

[36] Any retrofit program funded by REEP should not offer direct incentives exceeding 50% of the total retrofit cost (Sec. 202(i)(2)).

[37] For many efficiency improvements, DOE and EPA will not require participants to demonstrate energy savings. DOE will create estimates of energy savings from specific efficiency improvements that will be counted as demonstrated energy savings.

[38] See the RESNET *National Home Energy Audit Standard* website, (http://www.resnet.us/audit/default.htm#Comprehensive) for more information.

interest rate subsidies included in the Waxman-Markey bill could be used to lower interest rates on energy efficiency mortgages and encourage the use of energy efficiency mortgages.

Providing capital to help finance retrofits through public revolving funds could help fund programs that cover the initial capital costs of residential efficiency retrofits. Homeowners participating in public revolving fund retrofit programs pay for efficiency retrofits through increases in their taxes, usually property taxes, or through additional charges on their utility bills. Nonparticipants see no changes in their taxes or utility bills.

Tax-financed and utility bill–financed efficiency improvement programs generally cover all of the upfront capital costs for efficiency (Tucker, 2009). Property tax–financed and utility bill–financed retrofits allow the building owner to pass on the costs and benefits to future building owners because the financing charges stay with the building if it is sold or ownership is transferred. Most existing property tax–financed energy efficiency improvements are run by local governments. To establish a property tax–financed efficiency improvement program, local governments form special tax districts that individual property owners can join. Participating property owners then make efficiency retrofits (and distributed generation installations) with capital provided by the local government and pay for the improvements through assessments (additional charges) on their property taxes for a predetermined time.[39,40] Most local governments fund these programs by issuing bonds or loans, which are backed by liens on the participating properties.

Utility bill–financed retrofits use similar payment mechanisms. If the property changes hands, the property tax assessment or the additional charge on the utility bill stays with the property and is paid by the new owner. The savings on energy costs typically cover the assessment or additional utility charge; participants generally save money overall.[41] The program does not affect participating property owners' credit scores or debt-to-equity ratios because the bonds are backed by the property itself. States generally need to pass legislation allowing local governments to form this kind of special tax district. Colorado, California, Maryland, and Texas have passed legislation allowing special tax districts to pay for improvements to private property (WTTG FOX 5 Washington D.C., 2009) (Galbraith, 2009). Boulder County, Colorado,[40] Palm Desert, California,[42] and Berkeley, California[40] all have ongoing property tax–financed renewable energy and energy efficiency programs. The Public Service of New Hampshire,[43] the

[39] The terms of the bond or loan determine the length of the assessment. If a city sells a 20-year bond, participating property owners pay the assessment for 20 years. Programs in Berkeley (CA) and Palm Desert (CA) use 20-year assessments to repay the debt. (See Renewable Funding website below.)
[40] Property tax assessments are dependent on the cost of the property improvement.
[41] See the Renewable Funding website (http://www.renewfund.com/) and the Boulder County Climate Smart Loan Program website (http://www.bouldercounty.org/bocc/climatesmartloanprogram/) for more information.
[42] See the City of Palm Desert Energy Independence Program website (http://www.cityofpalmdesert.org/Index.aspx?page=484) for more information.
[43] See the Public Service of New Hampshire Municipal Smart Start Program website (http://www.psnh.com/Business/Efficiency/Paysave.asp) for more information.

New Hampshire Electric Co-op,[44] and the Hawaiian Electric Company[45] have utility bill–financed energy efficiency programs or pilot programs.

Barriers addressed: Capital; information; inefficient existing housing

The REEP program directly addresses capital and information barriers and creates a nationwide program to improve the efficiency of the existing housing stock. The Waxman-Markey bill allows state and local governments to offer direct awards to building owners to help pay for energy audits. Energy audits give homeowners specific information about their home's energy consumption and a list of cost-effective energy improvements. They generally include energy savings and cost estimates for each efficiency improvement (for example, new attic insulation will cost X dollars to install and save about Y kWh/year). The energy savings and cost estimates for specific efficiency improvements included in most energy audits should also reduce transaction cost barriers.

REEP program awards for energy efficiency improvements reduce the capital cost of efficiency improvements, directly lowering capital barriers. They also reduce capital barriers by supporting credit enhancements and interest rate subsidies for energy efficiency loans. Public revolving funds that pay the initial capital costs of retrofits eliminate capital barriers for participating building owners because they face no upfront cost. On the whole, the REEP program creates incentives for residential building owners to improve the efficiency of existing buildings, directly addressing the inefficient existing housing stock barrier.

Additional considerations and options for implementation

The Waxman-Markey bill directs states to use at least 5% of SEED funds for the REEP program and at least 20% of SEED funds for energy efficiency programs including REEP (Sec. 132(c)(2)). This level of dedicated funding should provide significant resources to the REEP program. Given the large stock of inefficient older buildings in the United States, REEP program participation and costs could surpass these funding levels.

As is expected with a major new program, the Waxman-Markey bill lacks detail on how the EPA will implement the REEP program. Generally, it is easiest to perform building efficiency retrofits at the time of sale because then buildings are usually free of furniture and unoccupied. REEP does not set specific policies and program procedures to encourage retrofits and energy audits at the time of sale.

Building owners' ability to participate in the REEP program and implementation of the program may vary significantly from state to state. While some state and local governments and utilities have successful efficiency programs that should be able to ramp up with additional funding, others lack the efficiency infrastructure to support large-scale building efficiency programs.

[44] See the New Hampshire Electric Co-op Smart Start website (http://www.nhec.com/business_energysolutions_smartstart.php) for more information.
[45] See the Hawaiian Electric Company SolarSaver Pilot Program website (http://www.heco.com/portal/site/heco/menuitem.508576f78baa14340b4c0610c510b1ca/?vgnextoid=9ca374c2ce6fe110VgnVCM1000005c011bacRCRD&vgnextfmt=default&cpsextcurrchannel=1) for more information.

Building Energy Performance Labeling Program

The Waxman-Markey bill requires the U.S. Environmental Protection Agency (EPA) to establish a Building Energy Performance Labeling Program for residential and commercial buildings. The program will incorporate existing building efficiency metrics and home labeling programs, including the Home Energy Rating System (HERS) and the EPA's Energy Star program for homes and buildings. The Waxman-Markey bill also directs the DOE to improve the existing Residential Energy Consumption Survey (RECS), Commercial Building Energy Consumption Survey (CBECS), and building energy databases in support of the Building Energy Performance Labeling program. The EPA will establish rules for measuring building energy performance and model energy performance labels for all major building types. Participating states should[46] make label information publicly accessible so that prospective building owners, lenders, tenants, occupants, and other relevant parties can use the information.[47] The EPA will provide states technical assistance for building labeling programs and states that pass legislation requiring building energy assessments and labeling consistent with EPA rules and guidelines will be authorized to utilize SEED allowances to fund these programs (Sec. 204(h)(4)). States that do not implement a building energy labeling program can use their SEED energy efficiency allowances for other approved energy efficiency programs (Sec. 132(c)(2)).

Prior to coming to a vote in the House of Representatives, an amendment was added to the Waxman-Markey bill that restricts the Building Energy Performance Labeling Program to construction beginning after enactment of the bill. It is unclear if the term "construction" refers only to new construction or renovations and new construction. The total building stock in the U.S. increases, on average, 1 to 2% per year (American Physical Society, 2008) and residential buildings last, on average, 60 to 100 years. This amendment excludes the majority, if not all, of the existing building stock from participation in the program.

Background information

The primary residential energy efficiency certification metric is the Home Energy Rating System (HERS) Index, developed by the Residential Energy Services Network (RESNET).[48] RESNET has a well-established training and certification program for home raters who provide professional rating to consumers. The federal government has two programs, the DOE's Builders Challenge[49] and the EPA's Energy Star Homes[50] program, that use the HERS Index to certify new homes that are 30% or 15% more efficient the

[46] The bill states "a State shall seek to ensure that label information be made accessible to the public in a manner so that owners, lenders, tenants, occupants, or other relevant parties can utilize it" (Sec. 204(h)(3)).
[47] Not all buildings required to participate in a building labeling program will automatically conduct performance labeling. Building labeling will be conducted at trigger points, such as the sale of a building or a federally subsidized energy audit.
[48] See the Residential Energy Services Network website (http://www.natresnet.org/) for more information.
[49] See the DOE's Builders Challenge website (http://www1.eere.energy.gov/buildings/challenge/index.html) for more information.
[50] See the Energy Star website (http://www.energystar.gov/index.cfm?c=new_homes.hm_index) for more information.

average new home. HERS Index labels compare the efficiency of a home to other similar homes on a zero to 100 or higher scale, with an average building equal to 100.[51]

Barriers addressed: Information; split incentive; maintenance

Building energy performance labeling directly addresses information barriers and can decrease split incentive and building and equipment maintenance barriers. Energy performance labels provide prospective homebuyers, lenders, and tenants information about the relative efficiency of individual buildings, compared to national databases, and provide estimates of energy use. This information allows prospective homebuyers and tenants to compare the estimated annual energy costs and efficiency of different residences. Energy performance labels for existing buildings could reduce the split incentive barrier by creating incentives for landlords and homebuilders to invest in energy efficiency to improve their buildings' energy performance scores.

Building performance labels could help overcome building and equipment maintenance barriers. Up-to-date information about building and equipment maintenance, especially information about heating ventilation and air conditioning (HVAC) system maintenance and recommended HVAC maintenance schedules, would encourage homeowners selling their homes and landlords to invest in building and equipment maintenance. Restricting the labeling program to new and renovated buildings significantly reduces the program's potential to overcome building and equipment maintenance barriers.

Additional considerations

The critical decisions the EPA will need to make in creating a building performance labeling program are what information to include on a label, what trigger points will require a label, and how often labels are updated. Labels have the greatest value when buildings are sold, tenants change, or at the time of other financial transactions. Ideally, a label would be updated whenever a building is sold or tenants change, but increasing the frequency of updating labels increases costs. Labels can also provide estimated energy consumptions and energy costs, as well as maintenance information for major energy-consuming equipment such as HVAC systems.

Similar to the building energy codes program, a key question is whether states will choose to implement the Building Energy Performance Labeling Program. The Waxman-Markey bill provides no disincentives for states that do not implement a building labeling program.

Lighting and Appliance Efficiency Standards

The Waxman-Markey bill strengthens efficiency standards for lighting and other residential appliances and instructs the DOE to consider the benefits of reduced CO_2 and other pollutant emissions, lower energy demand, and high-efficiency products available overseas when updating existing appliance standards or creating new ones. These and other changes effectively make it easier for the DOE to increase efficiency standards in the future.[52] More stringent lighting and appliance efficiency standards

[51] See (http://www.natresnet.org/) for a sample HERS Index label.
[52] See Section 213(d) of the Waxman-Markey bill for all amendments to the Energy Policy and Conservation Act

should decrease future residential sector energy demand because lighting and appliances represent a major portion of residential sector energy consumption (Energy Information Administration, 2009).[53] In addition to strengthening lighting and appliance efficiency standards, the Waxman-Markey bill establishes a reward program to provide incentives for retailers who sell best-in-class efficient products and manufactures that develop and produce superefficient best-in-class efficient products.[54]

Background information

Appliance efficiency standards are an established policy tool for decreasing residential sector electricity demand (American Physical Society, 2008). Multiple studies have demonstrated that existing federal appliance efficiency standards are cost-effective (Steven Nadel, 2006) (Kenneth Gillingham, 2004). Although appliance efficiency standards increase appliance costs, these increases are generally minor (Steven Nadel, 2006). The DOE currently has a backlog of products waiting to go through the efficiency standard rulemaking process.[55]

Barriers addressed: Split incentive; information

As with building codes, lighting and appliance efficiency standards reduce the split incentive barrier because landlords and homebuilders are forced to purchase and install efficient lighting and appliances.[56] Lighting and appliance standards reduce the importance of information barriers because new lighting and appliances governed by efficiency standards meet minimum efficiency requirements, reducing efficiency differences between the most and least efficient products.

Additional considerations

The Waxman-Markey bill requires the DOE to set efficiency standards to the maximum level that is technically feasible and cost-effective, taking into consideration the benefits of reducing emissions of CO_2 and other pollutants, impacts on energy prices, and efficiency gains possible with smart grid technology (Sec 213(d)). Determining the maximum technically feasible and cost-effective efficiency standards with these additional considerations may be controversial.

regarding criteria for prescribing new or revised efficiency standards.

[53] Excluding heating, air conditioning, water heating, and cooking; lighting and residential appliances represented 26% of residential sector energy consumption in 2007. Data from EIA's *Annual Energy Outlook 2009.*

[54] Best-in-class efficiency products are the top 10% most efficient models in a product class (Sec. 214(b)(1)). Superefficient best-in-class products have distinct energy efficiency attributes and performance characteristics that make them significantly better than best-in-class products (Sec. 214(e)(1)(c)).

[55] See the DOE's *Appliance and Commercial Equipment Standards* website (http://www1.eere.energy.gov/buildings/appliance_standards/schedule_setting.html) for more information.

[56] The split incentive barrier does not exist for lighting or appliances purchased by tenants and homeowners.

Additional Policy Options to Address Barriers to Residential Energy Efficiency

The following are additional policy options available to federal policymakers seeking to improve residential energy efficiency, categorized by the barrier they address.

Information Barriers

1. *Include existing buildings in the Building Energy Performance Labeling Program*

Restricting the Building Energy Performance Labeling Program to new and renovated buildings limits the information the program can provide to the housing market. Building energy performance labels provide the greatest value to the market when they provide information about significant differences in energy costs for similar buildings in a local market. (For example, available single family homes in a city.) New and renovated buildings that meet a stringent national building code will likely have similar energy performance scores, relative to existing buildings. Including new and existing in the labeling program would increase the information provided by the program and potentially help overcome split incentive and building and equipment maintenance barriers. To give states flexibility, the Waxman-Markey bill could allow states to determine which buildings are required to participate in labeling program.

2. *Provide incentives to states to require home energy audits at the time of sale*

The REEP program's goal is to facilitate efficiency retrofits of existing buildings. A critical component to any efficiency retrofit program is information about efficiency opportunities. Home energy audits provide prospective homebuyers information about a home's energy consumption and cost-effective options for improving its efficiency, overcoming information and transaction cost barriers and facilitating efficiency retrofits. A time-of-sale home energy audit would encourage a new homeowner to consider efficiency improvements. (Efficiency retrofits are often easiest during a change of ownership because the house is often unoccupied and free of furniture for a period.) State programs encouraging or requiring time-of-sale home energy audits would encourage participation in the REEP retrofit program. It is probably unrealistic to expect a homebuyer to make efficiency upgrades to a new home or home built within the past five to seven years; a federal incentive program for states that require time-of-sale audits could include exceptions for homes built within this time period.

3. *Conduct a consumer awareness campaign for the REEP program, other federal efficiency programs, and federal tax incentives to improve residential energy efficiency*

The REEP program and other federal energy efficiency programs will only be successful if many people choose to participate in these programs. Awareness of these programs and their benefits to individual homeowners, homebuyers, and tenants will be critical to their success. To increase awareness of federal efficiency programs and the real savings available from improved efficiency, the federal governments could fund media campaigns similar to other public information campaigns run by the Ad Council[57] and

[57] The Ad Council has an ongoing energy efficiency campaign sponsored by the DOE, see

other organizations. Recognizable federal officials, including elected officials, can increase awareness of the benefits of energy efficiency in public appearances at little or no cost. Many utility and local government programs work door-to-door to promote efficiency programs such as utility bill–financed efficiency retrofits, allowing a local government or utility representative to explain the benefits of participation in person (Tucker, 2009). To support these local efforts, federal efficiency funds could include money to encourage or pay for door-to-door promotion and other intensive local efforts.[58]

Capital Barriers

1. *Allow state-regulated utilities and state and local governments to issue tax-exempt bonds to finance property tax and utility bill–financed energy efficiency programs*

The Palm Desert and Berkeley property tax–financed distributed generation and energy efficiency programs are financed through local government bonds sales and loans from the local redevelopment agency. The Waxman-Markey draft would allocate federal funding to facilitate these types of programs. Another option that would allow the federal government to support property tax- and utility bill-financed efficiency programs without federal funding would be to allow state-regulated utilities and local and state governments to issue tax-exempt bonds to fund property tax- and utility bill-financed efficiency retrofit programs. Tax-exempt status for bonds used to finance such projects would lower the interest rates paid by the bonds, reducing capital costs and payback periods for participants in the program, and would likely attract additional investment. Traditionally, tax-exempt bonds have not been used to finance improvements to private property. The rationale behind allowing tax-exempt financing for renewable distributed generation and energy efficiency improvements for private property is that these improvements would reduce GHG emissions, a public benefit similar to the public benefit of reduced water pollution created by a tax-exempt-bond-financed wastewater treatment plant. Tax-exempt status for utility bill– and property tax–financed energy efficiency improvements would likely decrease federal tax revenues.

2. *Incorporate energy efficiency into federal foreclosure avoidance and foreclosed home resale programs*

Energy efficiency can reduce the cost of occupancy and help prevent foreclosure for homeowners. The Making Home Affordable[59] program helps eligible homeowners refinance to avoid foreclosure. This and other federal home loan programs could encourage the use of energy efficiency mortgages to provide capital to pay for cost-effective energy efficiency improvements and reduce overall housing costs. The American Recovery and Reinvestment Act includes $2 billion to help local communities purchase and repair foreclosed homes through the Neighborhood Stabilization Program.[60] Requiring or encouraging cost-effective energy efficiency improvements to foreclosed homes purchased under this program would lower occupancy costs for future residents and increase the value of the properties.

(http://www.adcouncil.org/default.aspx?id=19) for more information.

[58] The Waxman-Markey bill instructs the EPA to create materials for promoting the REEP program, including advertisements (Sec. 202(f)(13)).

[59] See (http://www.makinghomeaffordable.gov/) for more information.

[60] See (http://www.hud.gov/recovery/nspg.cfm) for more information.

Low-Income Housing Efficiency

1. *Incorporate energy efficiency into federal low-income housing programs*

Low-income rental units in the federal Housing Choice Vouchers Program[61] face the same split incentive barriers as other rental properties. Developers and landlords participate in federal low-income housing programs because of the financial incentives offered by the government. One way to reduce housing costs for low-income families participating in federal housing programs, like the Housing Choice Voucher Program, is to reduce their monthly energy costs through improved energy efficiency. To encourage landlords participating in the Housing Choice Vouchers Program to invest in efficiency, the Department of Housing and Urban Development (HUD) could raise the cap on rents it will subsidize for high-efficiency buildings.[62] The HUD could also require that landlords participating in the Housing Choice Vouchers Program install low-cost efficiency improvements, like high-efficiency lighting, properly sealed windows and doors, and routine maintenance of HVAC systems, as a condition of participation in the program.

[61] The Housing Choice Vouchers Program helps low income families and individuals rent privately owned homes and apartments. Housing eligible for participation in the Housing Choice Vouchers Program is often referred to as Section 8 housing.

[62] Local public housing authorities run the Housing Choice Vouchers Program and determine rent subsidy levels based on the local housing market. The HUD would instruct these agencies to increase caps on rents it will subsidize for high efficiency buildings.

Conclusion

There is enormous potential for energy efficiency improvement in the residential sector, but there are significant market, policy, and legacy barriers which must be overcome. The proposed Waxman-Markey bill includes multiple programs and allocates emissions allowance resources to address these barriers. If enacted, the Waxman-Markey bill would improve residential efficiency, but would not overcome all barriers because some barriers, such as transaction costs, are dispersed and difficult to overcome.

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