Energy Efficiency in Buildings: Critical Barriers and Congressional Policy

(name redacted)
Specialist in Energy and Infrastructure Policy

(name redacted)
Specialist in Energy Policy

(name redacted)
Senior Specialist in Science and Technology

June 24, 2009

Congressional Research Service
7-....
www.crs.gov
R40670

CRS Report for Congress
Prepared for Members and Committees of Congress

Summary

Federal policymakers are debating a range of potential initiatives to limit U.S. emissions of carbon dioxide (CO_2). The American Clean Energy and Security Act of 2009 (H.R. 2454), for example, would set a target of reducing U.S. greenhouse gas emissions, including CO_2 emissions, 17% below 2005 levels by 2020. In the electricity industry, increasing the energy efficiency of buildings is viewed by many as the measure with the greatest potential to reduce CO_2 emissions quickly and at relatively low cost. In light of the efficiency initiatives the federal government has taken since the 1970s, questions arise as to what additional policies might be considered to achieve more ambitious efficiency goals under a national policy of carbon control.

In November 2007, a congressionally-mandated advisory committee released a report examining barriers to the deployment of greenhouse gas reducing technologies and practices, including energy efficiency. The report, *Carbon Lock-In: Barriers To Deploying Climate Change Mitigation Technologies,* identified the following six "critical" barriers to end-use efficiency in buildings: industry structure, incomplete/imperfect information, high (first) costs, technical risks, market risks, and unfavorable utility fiscal policies.

Looking back on key federal efficiency statutes in the context of the *Carbon Lock-in* report, it seems that congressional policies since 1975 have been focused persistently on the critical barriers of industry structure, imperfect information, and high first costs. Congress has a history of addressing technical risk, too, by encouraging technology demonstration, although this issue appears to have been a lower priority over the last few years. In successive statutes, Congress has attempted to "push the envelope" in these four areas through ever tighter efficiency standards, new financial incentives, and other measures. Congress has a more limited history of addressing unfavorable rate policies among utilities. Until 2009, this history could be characterized as a single significant, but largely ineffective, attempt to advance efficiency-oriented utility rates under the Energy Policy Act of 1992 (P.L. 102-486). However, new rate provisions in the American Recovery and Reinvestment Act (P.L. 111-5) are another significant attempt to lower utility rate policy barriers, although it will be years before Congress can gauge their effects.

Market risks, especially energy price risks, seem to have received relatively little policy attention from Congress to date. It stands to reason that uncertainty about the future price of energy would complicate decisions about building efficiency investments, and could deter conservative building owners from considering all but the most highly cost effective improvements. As it happens, recent U.S. energy price volatility is at historic highs. Market evidence suggests that energy price uncertainties may be having a greater negative impact on the nature and timing of building efficiency investments in the private sector than is commonly understood. In the context of building energy efficiency, there may be many policy options available to reduce energy price uncertainty, but there has been relatively little identification or consideration of them in the policy community. Neither the American Clean Energy and Security Act of 2009 (H.R. 2454), now under consideration, nor any other current legislative proposals contain these kinds of provisions.

Using the "critical" barriers from the congressionally mandated *Lock-in* report as a guide, it appears that significant policy gaps remain with respect to utility rate policies and market risks. To the extent that these barriers continue to impede private investment in building efficiency, they may reduce the likelihood of achieving federal targets for carbon control associated with efficiency. Therefore, policymakers may benefit from a complete and integrated understanding of the full set of barriers to building efficiency and the range of carbon outcomes they imply.

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Introduction

Federal policymakers are debating a range of potential initiatives for reducing atmospheric carbon dioxide (CO_2) emissions from U.S. energy sources. Legislative proposals would seek to limit U.S. CO_2 emissions to specific (historical) levels through emissions caps, carbon taxes, or other regulatory mechanisms. Many of these proposals dictate or anticipate a declining long-term trajectory for annual U.S. carbon emissions. The Obama administration proposes cutting U.S. greenhouse gas emissions, including CO_2 emissions, 14% from 2005 levels by 2020.[1] The American Clean Energy and Security Act of 2009 (H.R. 2454), which is viewed as the most widely discussed such legislative proposal in Congress, would set a more aggressive goal of reducing U.S. greenhouse gas emissions 17% below 2005 levels by 2020. Other proposals to reduce U.S. carbon emissions to specific levels are found in the Cap and Dividend Act of 2009 (H.R. 1862), the Clean Environment and Stable Energy Market Act of 2009 (H.R. 1683), the America's Energy Security Trust Fund Act of 2009 (H.R. 1337), and the Safe Markets Development Act of 2009 (H.R. 1666).[2]

An overarching policy issue which arises from carbon control proposals is how the CO_2 reduction targets could be achieved. Numerous analysts have been examining this question and have identified specific measures to reach particular targets—especially in the electricity industry, which is responsible for nearly 40% of U.S. carbon emissions. In the electricity sector, these measures typically include some combination of energy efficiency, renewable energy, nuclear power, advanced fossil-fuel power generation, carbon capture and sequestration, plug-in hybrid electric vehicles, and distributed energy resources.[3] Key among these is end-use energy efficiency, which is viewed by many as the measure with the greatest potential to reduce CO_2 emissions quickly and at relatively low cost.[4] According to Secretary of Energy Steven Chu, "energy efficiency, energy conservation are where the greatest gains will be."[5] Residential and commercial buildings, especially existing stock, are considered a particularly rich target for electricity efficiency improvements, as the two sectors combined account for 40% of primary energy consumption in the United States.[6] H.R. 2454 contains key sections promoting electricity efficiency in buildings as a means of reaching the bill's carbon emissions targets.[7]

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[1] U.S. Office of Management and Budget, *Budget of the U.S. Government: Fiscal Year 2010, Budget Overview*, May 7, 2009, p. 100, http://www.whitehouse.gov/omb/assets/fy2010_new_era/A_New_Era_of_Responsibility2.pdf.

[2] For further analysis, see CRS Report R40556, *Market-Based Greenhouse Gas Control: Selected Proposals in the 111th Congress*, by (name redacted), (name redacted), and (name redacted).

[3] Barbara Tyran, Electric Power Research Institute, "The Power to Reduce CO2 Emissions: The Full Portfolio," Slide presentation, May 15, 2008, p. 7, http://www.iea.org/Textbase/work/2008/roadmap/2a_Tyran_EPRI%20Roadmaps.pdf.

[4] See, for example: Richard Cowart, "Carbon Caps and Efficiency Resources: How Climate Legislation Can Mobilize Efficiency and Lower the Cost of Greenhouse Gas Emission Reduction," 33 *Vermont Law Review* 201-223, 2008; McKinsey & Company, Inc., *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?*, December 2007.

[5] Secretary of Energy Steven Chu, Remarks before the Energy Information Administration 2009 Energy Conference: *A New Climate for Energy*, Washington, DC, April 7, 2009.

[6] U.S. Energy Information Administration, Annual Energy Outlook 2009 with Projections to 2030, DOE/EIA0383(2009), March 2009, fig. 36. Primary energy is defined as "energy in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy. For example, coal can be converted to synthetic gas, which can be converted to electricity; in this example, coal is primary energy, synthetic gas is secondary energy, and electricity is tertiary energy" (U.S. Energy Information Administration, "Energy Glossary – P," n.d., http://www.eia.doe.gov/glossary/glossary_p.htm).

[7] Title II.

But increasing the efficiency of buildings is not a new priority in the United States. Indeed, Congress has recognized the benefits of electricity efficiency in buildings, and the challenges of capturing those benefits, since the Energy Policy and Conservation Act of 1975 (P.L. 94-163). To date, federal initiatives in building energy efficiency have been somewhat effective, but not as much as they would need to be to achieve the steep CO_2 reductions anticipated under H.R. 2454. It is widely believed that much greater electricity savings are available through additional building efficiency improvements. However, analysts have identified a number of critical socio-economic and policy barriers which have historically limited the impact of federal and state building efficiency programs. This report describes those barriers, the degree to which federal law has addressed them, and their implications for meeting future U.S. carbon reduction targets.

Although this report focuses on electricity efficiency in buildings, there are other opportunities for energy efficiency related to buildings that may also offer significant opportunities for atmospheric CO_2 reductions. These include improved energy efficiency in transportation (to and from buildings), reducing direct use of fossil fuels in buildings, and reducing energy use or carbon emissions associated with building materials and construction (e.g., steel and concrete). Analysis of some of these options is provided in CRS Report R40147, *Issues in Green Building and the Federal Response: An Introduction*, by (name redacted).

Energy Efficiency and Conservation

The term "energy efficiency" can mean different things in different contexts. For the purposes of this report, "energy efficiency" means that an energy conversion device, such as a household appliance or an elevator, uses less energy while providing the same level of service for a building (e.g., cooling, lighting, motor drive). Efficiency improves when the device undergoes a technical modification, or through the use of certain design changes such as better insulation, thermal windows, improved ventilation, and solar orientation.[8] The energy-saving result of an efficiency increase is referred to as "energy conservation."

Electricity Efficiency Potential

Baseline improvements in energy efficiency occur over time as an economic response to changes in energy prices, the availability of new technology, turnover in end-use equipment, and other factors. Beyond these baseline improvements, conservation studies since the 1970s have identified substantial additional potential for energy efficiency. One analysis in 1976 stated,

> technical fixes in new buildings can save 50 percent or more in office buildings and 80 percent or more in some new houses.... [B]y 1990, improved design of new buildings and modification of old ones could save a third of our current total national energy use—and save money too.[9]

[8] Strictly speaking, "conservation" means "avoiding waste," but the term is typically used interchangeably with "efficiency" in the energy policy context, as it is in this report. "Efficiency" and "conservation" contrast with "curtailment" or "load management" which decrease output (e.g., turning down the thermostat) or services (e.g., driving less) to decrease energy use at specific times. Curtailment is often employed as an emergency measure.

[9] Amory B. Lovins, "Energy Strategy: The Road Not Taken?" *Foreign Affairs*, Vol. 55 No. 1 (October 1976).

A 1981 study by the Solar Energy Research Institute[10] likewise found that "through energy efficiency, the U.S. could achieve a full-employment economy and increase worker productivity, while reducing national energy consumption by nearly 25 percent."[11] The study further concluded that "the consumption of electricity can be reduced to a point where, on a national basis, demands through the end of the [twentieth] century can be met with generating equipment now operating or in advanced stages of construction."[12]

More recent studies continue to identify significant untapped electricity conservation potential. The "Five Lab Study" in 1997 estimated a technical electricity savings potential of approximately 23%, and a maximum "achievable" potential of 15% among residential and commercial buildings, assuming aggressive policies promoting conservation and a carbon cost of $50/metric ton (1993 dollars).[13] A 2004 meta-analysis by the American Council for an Energy-Efficient Economy of several regional studies reported a technical electricity conservation potential of 33%, and an achievable potential of 24% over a 5 to 15 year time horizon, depending upon the study.[14] The U.S. Department of State's 2006 *Climate Action Report* concludes that "by using commercially available, energy-efficient products, technologies, and best practices, many commercial buildings and homes could save up to 30 percent on energy bills."[15]

Impacts from Efficiency Initiatives

Both federal and state agencies have implemented a multitude of initiatives over the last 40 years to capture energy efficiency potential in the electricity sector. These initiatives have included appliance, equipment, and building efficiency standards; electric utility-administered conservation incentives;[16] consumer information campaigns; and other programs. Notwithstanding these efforts, the levels of incremental electricity conservation actually achieved since the 1970s have been more modest than the 25%-30% suggested in conservation potential studies. A 2004 analysis examining a comprehensive range of both federal and utility-sponsored conservation and energy efficiency programs (including federal efficiency standards) administered through 2000 concluded as follows:

> [P]rograms for which *ex post* quantitative estimates of energy savings exist are likely to have collectively saved up to 4.1 quads of electricity annually. These estimates typically reflect the cumulative effect of programs (e.g., all appliance efficiency standards, past and present)

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[10] Now the National Renewable Energy Laboratory.

[11] Solar Energy Research Institute (SERI), *A New Prosperity: Building a Sustainable Energy Future*, Brick House Publishing, Andover, MA, 1981, p. 1.

[12] Ibid, p. 2.

[13] Interlaboratory Working Group on Energy-Efficient and Low-Carbon Technologies, *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy-Efficient and Low-Carbon Technologies by 2010 and Beyond*, 1997, pp. 3.3-3.4, http://enduse.lbl.gov/projects/5lab.html. The five laboratories are Oak Ridge National Laboratory, Lawrence Berkeley National Laboratory, Pacific Northwest Laboratory, Argonne National Laboratory, and the National Renewable Energy Laboratory. $50/metric ton of carbon is equivalent to approximately $13.60/metric ton of CO_2.

[14] Steven Nadel, Anna Shipley and R. Neal Elliott, "The Technical, Economic and Achievable Potential for Energy-Efficiency in the U.S. – A Meta-Analysis of Recent Studies," *Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy-Efficient Economy, Washington, DC, 2004.

[15] U.S. Department of State, *U.S. Climate Action Report—2006*, July 2007, p. 40.

[16] Commonly referred to as "demand-side management" or "DSM" programs.

> on annual energy consumption. This total energy savings represents about 6% of annual nontransportation energy consumption.... [17]

A study of California's 2001 energy demand reduction initiative (promoted heavily as an emergency measure to avoid blackouts during the state's electricity crisis) reported 6% reduced electricity usage compared to the prior year, although only a portion of this reduction was "attributable to savings from energy efficiency or onsite generation projects ... likely to persist for many years."[18] Consistent with these studies, a 2008 analysis by EPRI projected a "realistic" U.S. end-use electricity savings potential of 7% beyond baseline levels which would occur without additional market intervention.[19] A 2007 study by the McKinsey Global Institute found a savings potential from improved efficiency of well over 20% in the residential and commercial sectors, but projected that policies in place at the time would lead to an annual capture rate of under 0.5%.[20]

Critical Barriers to Energy Efficiency

Taken together, the studies of technical conservation potential and actual conservation impacts suggest a perpetual opportunity for incremental electricity conservation on the order of 25%—more than four times the savings such programs have actually realized. Moving beyond the 5% to 7% electricity savings range, however, has been a persistent challenge to conservation proponents.

> Students of end-use markets have long been puzzled by the lack of adoption of ostensibly cost-effective energy efficiency technologies. A rich literature has developed around this question, and evidence for various barriers to adoption of efficiency technologies is widespread.[21]

Seeking the most current perspectives on these barriers, along with other constraints on CO_2 emissions reduction, Congress established an advisory committee under the Energy Policy Act of 2005 (P.L. 109-58) to "develop recommendations that would provide for the removal of domestic barriers to the commercialization and deployment of greenhouse gas intensity reducing technologies and practices."[22] The advisory committee released its report, *Carbon Lock-In: Barriers To Deploying Climate Change Mitigation Technologies* (hereinafter referred to as the *Lock-in* report) in November 2007. The report lists 10 categories of potential barriers inhibiting the deployment of a range of greenhouse gas reduction technologies, identifying those barriers

[17] Kenneth Gillingham, Richard G. Newell, and Karen Palmer, *Retrospective Examination of Demand-Side Energy Efficiency Policies*, Resources for the Future, RFF DP 04-19 REV, June 2004, revised September 2004, pp. 63-64.

[18] Charles A. Goldman, Joseph H. Eto, and Galen L. Barbose, *California Customer Load Reductions during the Electricity Crisis: Did they Help to Keep the Lights On?*, Lawrence Berkeley National Laboratory, LBNL-49733, May 2002, pp. iii, 20.

[19] Michael Howard, Senior Vice President, "Electric Power Research Institute, Energy Efficiency: How Much Can We Count On?" Presented at the Edison Foundation Conference, *Keeping the Lights On: Our National Challenge*, April 21, 2008, p. 14, http://www.edisonfoundation.net/events/2008-04-21/EPRIPresentation.pdf.

[20] Florian Bressard et al., *Curbing Global Energy Demand Growth: The Energy Productivity Opportunity*, McKinsey Global Institute, May 2007.

[21] J.G. Koomey, C.A. Webber, C.S. Atkinson, and A. Nicholls, "Addressing Energy-Related Challenges for the U.S. Buildings Sector: Results from the Clean Energy Futures Study," Energy Policy, Vol. 29, No. 14 (November 2001): 1211.

[22] §1601(g)(1)

considered "critical" or "important" for particular options. The report's findings related specifically to end-uses in buildings are summarized in **Table 1**.

Table 1. Barriers to Energy End-Use Efficiency in Buildings

Critical	Important	Other
Industry Structure	External Benefits and Costs	Infrastructure Limitations
Incomplete/Imperfect Information	Lack of Specialized Knowledge	
High (First) Costs	Policy Uncertainty	
Technical Risks		
Market Risks		
Unfavorable Fiscal Policies		

Source: Marilyn A. Brown, Jess Chandler, Melissa V. Lapsa, Benjamin K. Sovacool, *Carbon Lock-In: Barriers To Deploying Climate Change Mitigation Technologies*, Oak Ridge National Laboratory, ORNL/TM-2007/124, November 2007, Revised January 2008, pp. 101-102, 124.

While by no means an original list, **Table 1** is unusual in segregating the barriers according to general importance.[23] All 10 barriers to energy efficiency listed above likely warrant policy attention, but understanding and overcoming the six barriers considered critical may be a priority. This report adopts the critical barriers in **Table 1** as an organizing structure because the *Lock-in* report which produced them was prepared specifically at the direction of Congress and because the barriers as a whole are consistent with those identified in prior analyses. As in all such lists of barriers, their separation into distinct categories may be somewhat artificial. In reality, there may be interactions among specific categories (e.g., incomplete information and lack of specialized knowledge) which defy clear separation. Nonetheless, for purposes of policy analysis, this list of barriers can serve as a useful basis for examining related federal statutes in an organized way. The critical barriers as characterized by the *Lock-in* report, as well as similar studies, are discussed in more detail below.

Industry Structure

The *Lock-in* report identifies industry structure as the "most important" of the critical barriers to building efficiency. Industry structure in this context refers to a complex and fragmented set of decision-making relationships involving numerous stakeholders (e.g., investors, owners, occupants, builders, architects, equipment manufacturers, lenders, code setters, and realtors) whose interests in efficiency may not align.[24] A 1996 Lawrence Berkeley National Laboratory study likewise found that among "the most vexing issues for energy efficiency policies" is "the variety of institutions and firms that influence energy use."[25] A 2007 international study by the

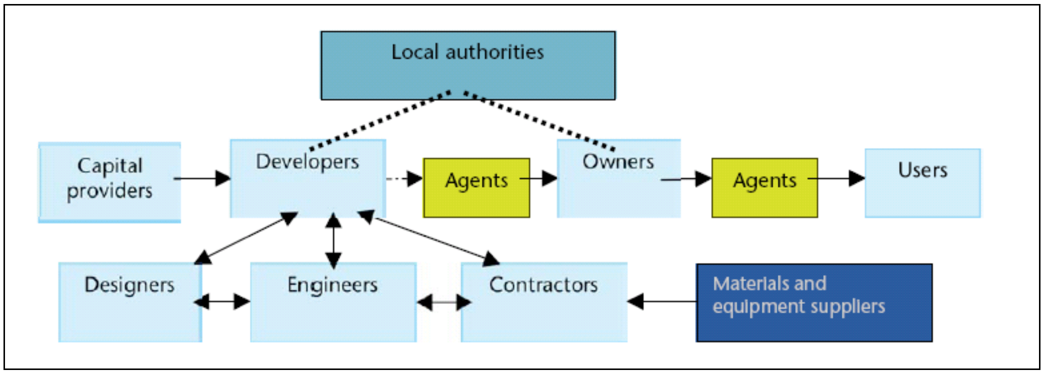
[23] See, for example, similar analysis in: National Round Table on the Environment and Sustainable Development Technology Canada, *Geared for Change: Energy Efficiency in Canada's Commercial Building Sector*, Ottawa, ON, Canada, 2009, pp. 21-30; and in: Howard Geller and Sophie Attali, "The Experience with Energy Efficiency Policies and Programmes in IEA Countries: Learning from the Critics," International Energy Agency, IEA Information Paper, August 2005, p. 23.

[24] Brown et al., 2008, p. 101.

[25] William H. Golove and Joseph H. Eto, *Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency*, LBL-38059, UC-1322, Lawrence Berkeley National Laboratory, March 1996, pp. xii-xiii.

World Business Council for Sustainable Development reached similar conclusions. The council's report graphically illustrates the complex nature of relationships among the various stakeholders affecting building efficiency decisions, as shown in **Figure 1**.

Figure 1. Complexity in the Buildings Supply Chain



Source: World Business Council for Sustainable Development, *Energy Efficiency in Buildings: Business Realities and Opportunities, Summary Report*, Geneva, August, 2007, p. 10.

One important set of difficulties arising from the industry structure in **Figure 1** are "principal-agent" problems associated with efficiency investments, wherein the parties responsible for choosing end-use equipment are not financially responsible for its energy costs. In the residential rental market, for example, landlords may choose not to install efficient appliances for their tenants—who must pay the bills to run them. Similarly home builders, in order to keep down construction costs, may choose not to use the most energy-efficient windows or insulation options—at the expense of the home's future buyer who will pay higher utility bills.[26] These and other problems associated with industry complexity and fragmentation make increasing building efficiency a challenge because it can be difficult to act upon so many decision processes comprehensively, coherently, and effectively using targeted public policy instruments.

Incomplete/Imperfect Information

The *Lock-in* report identifies incomplete and imperfect information about the cost-effectiveness and availability of efficient technologies as another critical barrier to improved building efficiency. As an earlier study stated, "Cost-effective energy efficiency measures are often not undertaken as a result of lack of information on the part of the consumer, a lack of confidence in the information, or high transaction costs for obtaining reliable information."[27] In the residential sector, the *Lock-in* report cites the lack of end-use energy consumption information in typical utility bills as obscuring the cost-effectiveness of end-use efficiency improvements. In the non-residential sector, the complexity of buildings makes it hard to determine to what extent any

[26] Scott Murtishaw and Jayant Sathaye, *Quantifying the Effect of the Principal-Agent Problem on US Residential Energy Use*, Lawrence Berkeley National Laboratory, LBNL-59773 Rev, August 12, 2006, p. 2.

[27] Ernst Worrell Lynn Price, "Barriers and Opportunities: A Review of Selected Successful Energy-Efficiency Programs," MS: 90-4000, Lawrence Berkeley National Laboratory, p. 2, http://ies.lbl.gov/iespubs/47908.pdf.

particular building is energy efficient, and consequently, what measures have what potential to improve that building's efficiency.[28]

High First Costs

The *Lock-in* report finds that "consumers are often reluctant to pay more upfront to purchase products with lower life cycle costs, especially when lenders do not credit them for lower utility bills later."[29] Consistent with this finding, a 2009 survey of commercial building professionals reported that 73% of respondents considered first cost the most significant barrier to the adoption of high-efficiency lighting systems.[30] Changes in building design, technology selection, and building controls face similar obstacles when they involve higher initial costs, even if the changes are clearly cost-effective investments over time. Some consumers, such as low-income households and small businesses, have limited access to credit, face high financing costs, and often have difficulty calculating life cycle costs to evaluate efficiency investments.[31] In a 2009 joint survey of facility managers by Johnson Controls and the International Facility Management Association, 63% of respondents cited either capital availability, payback period, or return on investment as the top barrier to achieving energy efficiency.[32]

Technical Risks

To the extent that energy efficiency measures involve changes in building technologies, the *Lock-in* report finds that insufficient validation of their performance leads to a perception of technical risk. Moreover, the cost-effectiveness of advanced technologies, in particular, can be situation-specific and hard to predict. [33] One example of the latter barrier is the adjustable speed motor drive (ASD), which has potential application in reducing energy use significantly in many motor-driven end uses, especially water pumping and building air handling systems. While ASDs have great efficiency potential, the cost to implement them may vary greatly in advanced applications. As one university extension program has concluded, the cost of a basic ASD installation may "easily" more than double when accounting for unique application requirements, special features, advanced controls, and other factors.[34] A combination of technical riskiness and cost uncertainty deters many businesses from implementing new efficiency measures in place of "tried and true" technologies.

Market Risks

The *Lock-in* report identifies market risks as uncertainties about the lifecycle costs of competing technologies, and uncertainties about the development and availability of new technology in the

[28] Brown et al., 2008, p. 101.

[29] Brown et al., 2008, p. 102.

[30] "First Cost, Client Pushback Biggest Barriers To Adoption Of High-Efficiency Lighting Systems, Say BD+C Readers," *Building Design + Construction*, March 1, 2009.

[31] Brown et al., 2008, p. 37.

[32] Johnson Controls and International Facility Management Association (IFMA), *Energy Efficiency Indicator, 2009 Findings*, May 6, 2009, p. 15, http://johnsoncontrols.mediaroom.com/file.php/3719/JCI+EEI_2009_findings.pdf.

[33] Brown et al., 2008, p. 102.

[34] Washington State University, Cooperative Extension, *Energy Efficiency Fact Sheet: Adjustable Speed Motor Drives*, 2003, p. 2, http://www.energy.wsu.edu/documents/engineering/motors/motordrvs.pdf.

marketplace, among other considerations. [35] In the case of building efficiency, acceptance of efficient technologies is also hindered specifically by energy price uncertainties and concerns related to irreversible investments.[36] The former has been a particular challenge due to recent volatility in U.S. natural gas and coal prices, for example, which are principal fuels for electricity generation. Regarding irreversible investments, building owners may be reluctant to make long-term commitments to new technologies during a period of rapid technical change. This is analogous to waiting an extra two years to replace an office computer system with the expectation that microprocessor performance will greatly improve in the meantime.

Unfavorable Fiscal Policies

The fiscal impediments to energy efficiency identified by the *Lock-in* report primarily are rooted in the rate structures of electric utilities. The report cites the lack of cost-recovery mechanisms for utility efficiency investments, utility revenue erosion from efficiency improvements, and lack of de-coupling of utility profits from sales as "critical" disincentives to building efficiency. [37] The rates an electric utility charges its electricity customers typically tie a utility's recovery of fixed costs to its sales of electricity.

> This system of price cap regulation discourages even the most economical [efficiency] investments if they are likely to reduce throughput. As sales go down, the utility's shareholders or customer-owners lose dollars with every unsold kilowatt-hour. To actively encourage or promote demand- or supply-side resources installed on the customer side of the meter ... would undermine the institution's financial health.[38]

Since electric utilities are thought to have great influence on the electricity use and the investment behavior of their customers, such financial disincentives for utilities are seen as broadly hampering, or at least not facilitating, activities to improve building end-use efficiency.

Critical Efficiency Barriers and Federal Policy

Given the set of critical barriers identified in the *Lock-in* report—prepared at the behest of Congress—it seems logical to review federal building efficiency policies in the context of these barriers. In particular, a review of the *Lock-in* analysis invites the question: How have federal statutes on building efficiency addressed the critical barriers in the *Lock-in* report? To explore this question, CRS has categorized building efficiency provisions in key federal statutes according to the six critical barriers discussed above. In performing this analysis, we reviewed the original statutory language and, in some cases, associated committee reports to determine the legislative intent of statutory provisions that were relevant to energy efficiency in buildings. Based upon this review, we judged which provisions appeared to address at least some part of the critical *Lock-in* barriers as described in the report. Statutory provisions clearly addressing more than one barrier category were identified with the multiple barriers.

[35] Brown et al., 2008, p. 24.

[36] Brown et al., 2008, p. 102.

[37] Brown et al., 2008, p. 102.

[38] Sheryl Carter, "Breaking the Consumption Habit: Ratemaking for Efficient Resource Decisions," *The Electricity Journal*, December 2007, p. 67.

Table 2 summarizes the exercise, identifying with an "X" in the appropriate columns, whether the key federal statutes contain provisions aligned with critical efficiency barriers. Note that such categorization can be subjective, and some provisions address more than one barrier, so the inclusion of certain provisions in one category versus another could be debated. Note also that provisions for largely unrestricted grants to state-run building efficiency programs could not be specifically categorized and, therefore, were excluded from the analysis.[39] Despite these caveats, **Table 2** offers a number of key insights about the trajectory of congressional policy promoting energy-efficient buildings over the last 35 years, as discussed below. A detailed version of this table, listing specific sections from each statute that are relevant to this analysis, is provided in the Appendix (**Table A-1**).

Table 2. Building Efficiency Provisions in Key Federal Statutes

	CRITICAL BARRIERS					
KEY STATUTES	**Industry Structure**	**Incomplete/ Imperfect Information**	**High (First) Costs**	**Technical Risks**	**Market Risks**	**Unfavorable Fiscal Policies**
P.L. 94-163	X	X	X			
P.L. 95-618			X			
P.L. 95-619	X	X	X	X		
P.L. 96-294	X	X	X			
P.L. 100-12	X					
P.L. 102-486	X	X	X	X		X
P.L. 109-58	X	X	X	X		X
P.L. 110-140	X	X	X	X		X
P.L. 110-343			X			
P.L. 111-5	X	X	X			X

Source: CRS analysis

Historical Focus of Buildings Efficiency Policy

As **Table 2** shows, Congress has a substantial and sustained history of policy intervention for three of the critical barriers in the *Lock-in* report. Beginning with the Energy Policy and Conservation Act of 1975 (P.L. 94-163) Congress has enacted policies addressing efficiency barriers due to industry structure, imperfect information, and high first costs. In the case of industry structure, these initiatives have focused largely on promulgating ever-stricter equipment efficiency standards and building codes, promoting state efforts to improve building efficiency, and mandating efficient practices for federal buildings. In the case of imperfect information, federal initiatives have promoted studies of conservation potential in buildings, energy audits, public education, and labeling programs. In the third case, grants, tax credits, and loan programs have been offered to help offset first cost barriers for efficiency measures, especially in the low-income residential sector.

[39] See, for example: P.L. 109-58 § 123 "State Energy Programs."

Congress began addressing the technical risk barrier somewhat later than the first three barriers. Although some technology demonstration measures were enacted under the National Energy Conservation Policy Act of 1978 (P.L. 95-619), Congress pursued technical risk policies more vigorously in the Energy Policy Act of 1992 (P.L. 102-486) and subsequent statutes. For all of these critical barriers, one can debate the nature, breadth, and significance of the policy intervention—but it is clear that Congress has had ongoing concern about the issues and has periodically revisited them in response to changing building sector conditions.

In contrast to the building efficiency barriers above, Congress does not have a history of sustained statutory initiatives addressing either unfavorable fiscal policies or market risk. The Energy Policy Act of 1992 included important provisions related to the role of electric utilities in promoting end-use efficiency, but the effects of those provisions were ultimately limited. Additional statutes related to fiscal policies are discussed later in the report. Congress appears to have taken little, if any, action to address market risks as defined in the *Lock-in* study. If one accepts that overcoming fiscal policies and market risk is critical to improving U.S. building efficiency, congressional treatment of these two barriers warrants further examination.

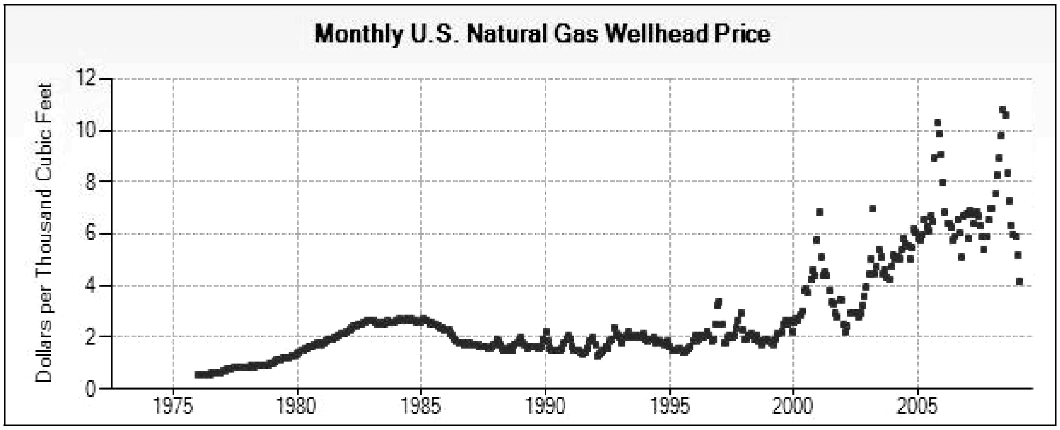
Federal Policy Towards Efficiency Market Risks

As noted above, the *Lock-in* report identifies energy price uncertainties and concerns about irreversible investments as key barriers to building efficiency. Energy price uncertainty is probably the greater barrier, because it drives the cost-effectiveness of efficiency measures both from an individual end-user's perspective and from a broader social perspective.

It stands to reason that uncertainty about the future price of energy would complicate decisions about building efficiency investments, and could deter conservative building owners from considering all but the most highly cost effective improvements. As it happens, recent U.S. energy price volatility is at historic highs. The price of natural gas illustrates this point. Natural gas is a key fuel for electric power generation, especially during peak hours, so natural gas price in some regions can be a significant determinant of electricity prices. As **Figure 2** shows, natural gas price volatility this decade has been staggering. According to the Energy Information Administration, "[a]s a result of wide swings, the range in average monthly wellhead prices for [2008] was the widest in history."[40]

[40] Energy Information Administration, *Natural Gas Year-In-Review 2008*, Online report, April 23, 2009, http://www.eia.doe.gov/pub/oil_gas/natural_gas/feature_articles/2009/ngyir2008/ngyir2008.html.

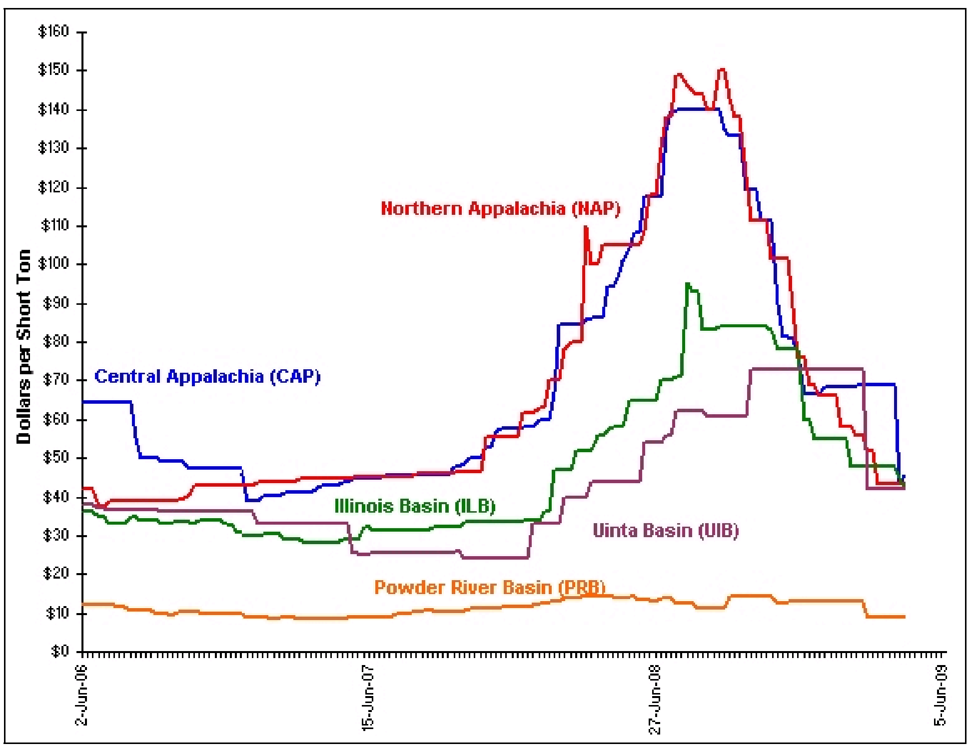
Figure 2. Recent Volatility in U.S. Natural Gas Prices



Source: Energy Information Administration, "U.S. Natural Gas Wellhead Price," Internet database, April 29, 2009, http://tonto.eia.doe.gov/dnav/ng/hist/n9190us3M.htm.

Coal prices have also become extremely volatile in most U.S. coal-producing regions, as shown in **Figure 3**. Coal-fired generation accounts for approximately 50% of electricity produced in the United States, so coal prices are a key driver of U.S. electricity prices.

Figure 3. Historical Average Weekly Coal Commodity Spot Prices



Source: U.S. Energy Information Administration, "Coal New and Markets," Internet page, June 1, 2009, http://www.eia.doe.gov/cneaf/coal/page/coalnews/coalmar.html.

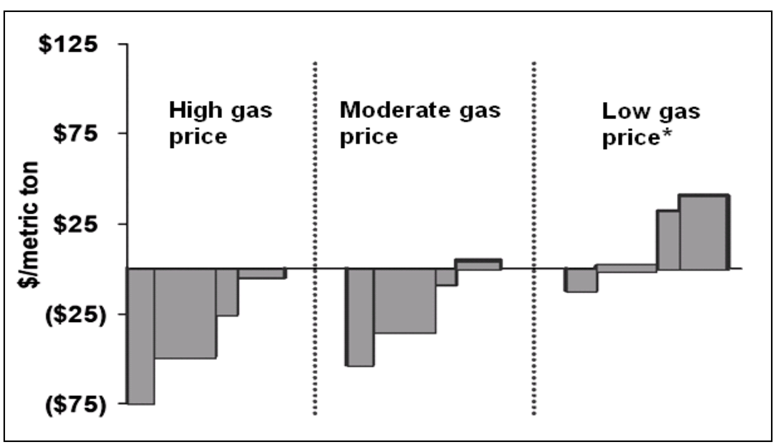
Notes: Coal prices shown are for a relatively high heat content coal selected in each region, for delivery in the quarter following the current quarter.

Relatively limited volatility of energy prices through the late 1990s may partly explain the lack of congressional attention to this issue in its historical efficiency statutes—energy price uncertainty may have only emerged as a critical efficiency barrier this decade. In the current energy market, however, where prices for some energy commodities can change by a factor of two or three in a matter of months, consumers face difficulties evaluating the lifecycle costs and cost-effectiveness of energy efficiency investments. In the short run, retail electricity prices—which generally are regulated—may partly insulate end-users from volatility in wholesale prices for generation fuel. But over the long run, electricity rates must ultimately reconcile with generation fuel costs, so the trajectory of those future costs is still a key concern for efficiency measure cost-effectiveness, even at the end-use level. An increase in natural gas-fired generation in response to future carbon costs may make volatility in natural gas prices, specifically, an even greater influence on retail electricity costs.

From a social perspective, other energy market factors may exacerbate energy price uncertainty and its implications for the cost-effectiveness of building efficiency. Slowing growth of electricity demand, such as during the current economic downturn, may lower electricity prices by changing the supply-demand balance, and may also change which generation units supply the marginal demand for power. Uncertain energy prices and electricity load growth, taken in combination, can have great implications for the cost effectiveness of building efficiency measures. An analysis by Exelon Corporation demonstrates the potential effect of these factors, estimating the utility's cost of avoided carbon emissions (an alternative measure of cost-effectiveness) by increasing end-use energy efficiency among its customers (**Figure 4**). The "blocks" in the figure represent distinct categories of efficiency investment. As **Figure 4** shows, whereas energy efficiency more than pays for itself under high natural gas prices as experienced in July 2008, most efficiency measures cost in excess of $25 per metric ton of avoided CO_2 under a scenario with low natural gas prices and low electric load growth.

Figure 4. Energy Efficiency Cost Effectiveness Scenarios

Electric Utility Perspective



Sources: Adapted from John W. Rowe, Chief Executive Officer, Exelon Corp., "Energy in a Carbon Constrained World," Presentation to the Energy Information Administration 2009 Energy Conference: A New Climate For Energy, Washington, DC, April 7, 2009; Paul Elsberg, Senior Communications Specialist, Exelon Corp, Personal communication, May 29, 2009.

*Low gas price is a function, in part, of low load growth.

The costs of any future restrictions on atmospheric CO_2 emissions also exacerbate energy price uncertainty if those costs are not clearly established in advance. A carbon tax, or cap-and-trade allowance program, ultimately should encourage efficiency investments by raising their cost-effectiveness relative to energy supply options that continue emitting CO_2. Uncertainty about the carbon costs, however, simply adds another degree of variability to future energy prices, and, in this respect, may make it harder for building owners to make efficiency commitments. Carbon policies complicate efficiency investment calculations and may encourage delay in implementing cost-effective efficiency measures to see how energy prices will trend when carbon costs and market responses are factored in. As one Johnson Controls executive reportedly has stated, following the company's joint survey with the International Facility Management Association,

> We see a wide distribution of views about what will happen to energy prices—ranging from a 100 percent increase to a 60 percent decrease.... This uncertainty appears to be another reason business leaders are holding back on [energy efficiency] investments.[41]

Market evidence, therefore, suggests that energy price uncertainties may be having a greater negative impact on the nature and timing of building efficiency investments in the private sector than is commonly understood.

Policy Considerations for Energy Price Uncertainty

Energy price uncertainty presents a challenge to government policymakers because it is usually driven by global, competitive market forces beyond the reach of policy instruments available to any single national authority. As unanticipated volatility in U.S. gasoline prices demonstrated last year, Congress may have few options to moderate energy commodity price swings driven by global supply and demand—even when there may be a compelling national interest to do so.

Notwithstanding the competitive drivers of energy commodity prices, Congress has, in some cases, considered or enacted policies to shield energy producers or consumers from energy price swings to ensure the economic viability of their investments. For example, in the 110th Congress, provisions in the proposed Coal Liquid Fuel Act would have provided federal price guarantees for coal liquefaction projects "resolving uncertainties in the long-term outlook for oil prices that ... inhibited the flow of private capital into coal-to-liquids facilities."[42] The Alaska Natural Gas Pipeline Act of 2004 provides an $18 billion loan guarantee for the pipeline developers, offsetting the risk of a potential drop in delivered natural gas prices and an associated loss of natural gas revenues.[43] The Energy Security Act of 1980 offered federal loan guarantees and price guarantees to encourage investment in synthetic fuels and biomass energy infrastructure (which may not have been economical based solely on the market price of produced energy).[44] Although such price risk policies are intended to promote increased investment in specific categories of energy supply, similar price risk justifications could apply equally to end-use efficiency investments.

[41] Clay Nesler, Vice President, Global Energy & Sustainability, Johnson Controls, Inc. as quoted in: "New Research From Johnson Controls Indicates Energy Efficiency Is Still Important to Business Leaders, but Investment Lags," *PR Newswire*, May 6, 2009.

[42] U.S. Representative Rick Boucher, Statement before the House Energy and Commerce Committee, Energy and Air Quality Subcommittee, *Legislative Hearing on Discussion Drafts concerning Energy Efficiency, Smart Electricity Grid, Energy Policy Act of 2005 Title XVII Loan Guarantees, and Standby Loans for Coal-to-Liquids Projects*, 110th Cong., 1st sess., May 24, 2007; H.R. 2208 §(2)(2)(A)(ii).

[43] P.L. 108-324, Div. C § 116.

[44] P.L. 96-294 §§ 133, 134, 214, 215.

One particular complication of energy price uncertainty for energy efficiency initiatives is its implications for the level of government incentives offered to encourage building efficiency investments. Be they tax breaks, cash rebates, low interest loans, or other financial mechanisms, government incentives for building energy efficiency measures must be established based upon assumptions about financial performance. If cost-effectiveness estimates are highly variable due to energy price volatility, financial incentive programs may end up paying more than they need to, or may not pay enough, to achieve a given energy savings outcome. Facing rapidly changing energy prices, administrative delays or statutory time lags in establishing (or revising) the levels of efficiency incentives may result in additional economic inefficiency.

Although global energy markets are not subject to direct control by U.S. agencies, some drivers of electricity prices, specifically, may be more in Congress's sphere of influence. For example, the costs imposed by carbon control, corporate taxes, and other federal requirements are largely established by Congress. In these cases, even where markets may also play a role (e.g., sulfur dioxide allowance trading), Congress may establish rules and limits to provide greater cost certainty and, in this way, reduce the investment risk premium associated with cost uncertainty. In the context of building energy efficiency, there may be many policy options available to reduce electricity price uncertainty, but there has been relatively little identification or consideration of them in the policy community. Neither the American Clean Energy and Security Act of 2009 (H.R. 2454), now under consideration, nor any other current legislative proposals contain these kinds of provisions.[45] Accordingly, Congress may ultimately move to develop additional information and perspective on the role of market risks on building efficiency investment and their implications for achieving national building efficiency goals.

Utility Fiscal (Rate) Policy Issues

The *Lock-in* report identifies utility cost-recovery, revenue erosion, and the coupling of utility profits to sales as key fiscal policy disincentives to building efficiency. Some stakeholders maintain that, until utility profits are decoupled from the amount of electricity they sell (through alternative rate structures), utilities will be, at best, only reluctant partners in government efforts to reduce building electricity consumption.

Addressing utility rate issues has been a challenge for the federal government as retail rate design for electric utilities historically has been under exclusive state or local authority. Nonetheless, as **Table 2** shows, starting with the Energy Policy Act of 1992 (P.L. 102-486), Congress has enacted rate-related provisions intended to alleviate utility rate policy challenges.[46] Among other provisions, P.L. 102-486 required that state utility regulators consider setting the rates for electric utilities so that outlays for energy conservation and energy efficiency resources, accounting for lost revenues, would be at least as profitable as those for new energy supply infrastructure (§111(a)(8)). These "revenue neutral" rate provisions targeted fiscal policy barriers to utility-run efficiency programs like those cited in the *Lock-in* analysis. The Energy Policy Act of 2005 (P.L. 109-58) mandated a study of state policies promoting utility energy efficiency programs, taking into consideration rate issues and other fiscal disincentives (§139). The resulting report, released

[45] The American Clean Energy and Security Act of 2009 (H.R. 2454) was introduced on May 15, 2009 by Representatives Henry A. Waxman and Edward J. Markey. The bill was reported by the House Energy and Commerce Committee on May 21, 2009.

[46] State utility commissions regulate the rates of investor-owned utilities. The rates of public power entities, such as municipal utilities and rural electric cooperatives, are set by the entity governing board, such as a city council.

by the Department of Energy in March 2007, recommended that state regulators consider a range of policies to remove rate disincentives to utility-run end-use efficiency programs.[47] The Energy Independence and Security Act of 2007 (P.L. 110-140) expanded the provisions in P.L. 102-486 by mandating that state utility regulators consider "rate design modifications to promote energy efficiency investments" (§532(a)).

Although Congress first enacted rate barrier provisions in P.L. 102-486, these and subsequent statutes have had only a limited impact on current utility rate structures. Adoption of revenue neutral rates and other rate policies under P.L. 102-486 and P.L. 110-140 has been voluntary—and most state utility commissions have not embraced them. Some states that initially adopted these policies in the 1990s have subsequently moved away from them due to perceived incompatibility with utility deregulation (concurrently promoted by Congress) and rapidly evolving energy markets.[48] Opponents of new rate structures, in particular, have argued that they depart too much from traditional regulation, they shift sales risks from utilities to customers, they are complicated by other regulatory initiatives to promote end-use efficiency, or that they change rate designs for all customers for the benefit of a few, among other reasons.[49] It is beyond the scope of this report to examine the merits of these arguments individually. Building efficiency advocates and federal policymakers have offered a number of counterarguments.[50] The key point is that state and local regulators have limited the implementation of rate policy measures in P.L. 102-486 and other, similar, rate initiatives. As of March 2009, for example, only 13 states had approved, or planned to approve, either fully decoupled rates or decoupled rate pilots.[51]

The American Recovery and Reinvestment Act (P.L. 111-5) signed by President Obama on February 17, 2009, includes new provisions to address utility rate policy issues. The act authorizes additional state energy program grants only to states whose governors

> seek to implement ... a general policy that ensures that utility financial incentives are aligned with helping their customers use energy more efficiently and that provide timely cost recovery and a timely earnings opportunity for utilities associated with cost-effective measurable and verifiable efficiency savings, in a way that sustains or enhances utility customers' incentives to use energy more efficiently. (Div. A, Title III, § 410(a)(1))

While its language is broad, the potential impact of this provision is debatable, in part because it appears to stop short of being mandatory. Furthermore, because state utility commissions are largely independent of governor's offices, they may not be legally bound to adopt a governor's regulatory policy.[52] According to the accompanying House committee report, therefore, this

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[47] U.S. Department of Energy, *State and Regional Policies that Promote Energy Efficiency Programs Carried Out by Electric and Gas Utilities*, March 2007, pp. iv-v.

[48] Jonathan Lesser, "Déjà Vu All Over Again: The Grass Was Not Greener Under Utility Regulation," *Electricity Journal*, Vol. 20 No. 10, December 2007, p. 36.

[49] David E. Dismukes, Louisiana State University, *Regulatory Issues for Consumer Advocates in Rate Design, Incentives & Energy Efficiency*, Presentation at the National Association of State Utility Consumer Advocates (NASUCA) Mid-Year Meeting, June 11, 2007, p. 6, http://www.enrg.lsu.edu/presentations/2007.

[50] See, for example, Marty Kushler, Dan York and Patti Witte, Aligning Utility Interests with Energy Efficiency Objectives: A Review of Recent Efforts at Decoupling and Performance Initiatives, American Council for an Energy-Efficient Economy, October 2006, http://www.aceee.org/pubs/u061.htm.

[51] Edison Foundation, "Status of Revenue Decoupling for Electric Utilities by State: March 2009," Washington, DC, March 5, 2009, http://www.edisonfoundation.net/IEE/issueBriefs/Elec_Decoupling_Map0309.pdf.

[52] U.S. Congress, House Committee on Energy and Commerce, *Energy and Commerce Recovery and Reinvestment Act*, 111th Cong., 2nd sess., January 26, 2009, 111-7, p. 78.

provision is designed only to "nudge" states "toward adopting policies that would remove disincentives that utilities have to invest in energy efficiency."[53] However, the language seems to suggest that a state utility commission will have to, at least, consider changes in its ratemaking practices to align utility incentives with end-use energy efficiency.[54] Moreover, many stakeholders interpret the provision as encompassing utility rate decoupling, among other rate options, which may lead more states to consider (or reconsider) decoupling policies, specifically, in the interest of securing federal stimulus funds.

Policy Considerations for Utility Rate Barriers

It remains to be seen to what extent P.L. 111-5 will ultimately result in more efficiency-oriented rate structures among U.S. utilities, and, consequently, more efficient buildings among their customers. Establishing new utility rates is typically a multi-year regulatory process, especially if those rates involve a significant departure from traditional practice. Moreover, because decoupling is controversial, some governors may choose to forgo federal energy grant funds and not abide by the act's utility rate measures. Legal challenges by opponents of alternatives rates, especially decoupled rates, may also ensue. Even in states where decoupled rates are ultimately adopted, their effects on building efficiency may vary. The National Association of Regulatory Utility Commissioners (NARUC), which opposes federal decoupling policies, has stated, "[w]hether decoupling will in itself result in increased efficiency is still the subject of debate."[55]

Given the recent passage of the utility rates provisions in P.L. 111-5, and reviewing the history of the earlier efficiency-oriented rate provisions in prior statutes, Congress may choose to see how effective its latest policies turn out to be before considering additional actions on utility rates. H.R. 2454 contains no utility rate decoupling provisions. Nonetheless, according to press reports, some stakeholders are proposing mandatory rate decoupling statutes in the current session of Congress, potentially tied to a new federal cap and trade program for CO_2 emissions.[56] Whether such a policy would ultimately achieve greater building efficiency than that in P.L. 111-5 is unclear, although a proposal of this type would suggest that at least some analysts believe Congress's most recent utility rate policy may not go far enough in reducing utility rate barriers. In any case, because of the time required to consider, enact, and implement new utility rate policies among the states, and the time required for utilities to implement additional efficiency activities under those rates, utility rate policies will likely remain a significant obstacle to building efficiency programs well into the next decade.

Discussion

To date, the impact of federal efficiency initiatives in terms of energy savings has been well below its technical potential—but not for lack of attention from legislators. Congress has had an interest in improving the energy efficiency of buildings in the United States for over three

[53] Ibid.

[54] Kenneth Rose, "Addendum to the EISA PURPA Standards Manual," American Public Power Assoc., March 17, 2009, p. 4, http://www.appanet.org/files/PDFs/ARRAcorrectiontoPURPAandnote.pdf.

[55] National Association of Regulatory Utility Commissioners, *Decoupling For Electric & Gas Utilities: Frequently Asked Questions (FAQ)*, 2007, p. 5.

[56] "Energy, State Groups Fear 'Decoupling' Revival Push In House, Senate," *Energy Washington Week*, April 29, 2009.

decades. Recent concerns about the contribution of power plant fuel combustion to atmospheric CO_2, and therefore to global warming, have lent a new urgency to building efficiency considerations.

Looking back on federal efficiency statutes in the context of the *Lock-in* report, it appears that congressional policies since 1975 have been focused persistently on the critical barriers of industry structure, imperfect information, and high first costs. Congress has a history of addressing technical risk, too, by encouraging technology demonstration, although this issue appears to have been a lower priority over the last few years—perhaps due to the imperative of accelerating the implementation of well-demonstrated efficiency measures. In successive statutes, Congress has attempted to "push the envelope" in these areas through ever tighter efficiency standards, new financial incentives, and other measures. For these barriers, policy debates revolve more around the aggressiveness of federal actions and the details of programs rather than whether Congress should intervene.

Congress also has a history of addressing unfavorable fiscal policies among utilities. Until 2009, this history could be characterized as a single significant, but largely ineffective, attempt to advance efficiency-oriented utility rates under P.L. 102-486. Rate provisions in P.L. 111-5, however, are another significant attempt to lower rate barriers, although it will be at least a few years before Congress will be able to gauge whether this statute will be more successful than the one passed in 1992. So, in this case as well, Congress has long recognized the significance of the rate barrier to building efficiency. It seems simply to have been harder to develop and enact consensus policies to address it. That utility rate reform has been complicated should come as no surprise due to the regulatory primacy of the states on utility retail rate matters and the often controversial economic implications of decoupled rates.[57]

Congressional treatment of market risks seems to differ from its treatment of the other critical barriers. Market risks, especially energy price risks, seem to have received relatively little policy attention from Congress to date. One might argue that first cost incentives, like efficient equipment rebates, implicitly address energy price volatility by making up for the risk premium that volatility imposes on the financing of efficiency investments. But Congress does not appear to have incorporated this perspective in its statutory provisions, so even though market risks and incentive levels could be linked in this way, important questions remain about the nature of this linkage and its importance in end-user investment decisions. Given the importance commercial building owners and operators seem to place on this issue, Congress may consider a more direct examination of market risk issues in the context of building efficiency investment and the policy options available in response. What these policy options may be is an open question, as few analysts have devoted significant attention to the issue. Statutes promoting an Alaska natural gas pipeline or synthetic fuel plants offer possible examples of energy market risk mitigation policies, but there may be other, potentially more appropriate ones.

Some analysts suggest that policies establishing federal energy efficiency resource standards, which would require utilities to achieve specified levels of energy efficiency in their service territories, could be an effective means of promoting efficiency investments in the face of the barriers discussed in this report. The Save American Energy Act (H.R. 889) and the American Clean Energy and Security Act of 2009 (H.R. 2454 § 101) are prominent examples of such

[57] See, for example: U.S. Representative Joe Barton, "American Recovery and Reinvestment Act of 2009 (H.R. 1)," Floor debate, *Congressional Record*, vol. 155, part 16 (January 27, 2009), pp. H576-H577.,

legislation currently under debate. In setting efficiency performance targets for utilities, however, such policies may not necessarily target specific efficiency barriers as identified in the *Lock-in* report. Utilities bearing more responsibility for efficiency improvements among their customers might, therefore, face the same barriers that the federal government does now, with no new mechanisms to overcome them. The utilities could choose to seek new rate structures to promote efficiency, but such actions would require the consent of state regulators, already required to consider such rates as a condition of receiving federal energy grants under P.L. 111-5. So it is unclear if, and how, federal energy efficiency resource standards would do more to overcome the *Lock-in* barriers than existing congressional initiatives.

Implications for U.S. Carbon Goals

The discussion above offers some perspective, albeit only qualitative, on the implications of congressional building efficiency policies for meeting U.S. carbon reduction targets. Carbon control studies that project electricity efficiency savings on the order of 5% to 10% over a 20-year time frame appear consistent with U.S. conservation program experience, and may be aided by any future costs of CO_2 emissions if they are reflected in electricity prices. Achieving efficiency improvements substantially above these levels, however, will likely require aggressive and effective policies to overcome *all* critical barriers to investment in building efficiency. Using the "critical" barriers from the congressionally mandated *Lock-in* report as a guide, it appears that significant policy gaps remain with respect to utility fiscal policies and market risks. To the extent that these barriers continue to impede private investment in building efficiency measures, they may reduce the likelihood of achieving federal targets for carbon control associated with efficiency. Therefore, policymakers may benefit from a complete and integrated understanding of the full set of barriers to building efficiency and the range of carbon outcomes they imply.

Appendix.

See **Table A-1** on the following page.

Table A-1.Building Efficiency Provisions in Key Federal Statutes

BARRIERS	P.L. 94-163 (EPCA, 1975)	P.L. 95-618 (Energy Tax Act of 1978)	P.L. 95-619 (NECPA, 1978)	P.L. 96-294 (Energy Security Act of 1980)	P.L. 100-12 (NAECA, 1987)	P.L. 102-486 (EPAct 1992)	P.L. 109-58 (EPAct 2005)	P.L. 110-140 (EISA, 2007)	P.L. 110-343 (EIEA, 2008)	P.L. 111-5 (ARRA, 2009)
Industry Structure	325, 330-336, 339, 361-366, *381-382*, 394, 400D		210-223, 252-253, 301-312, 421-427, *501, 541-544, 547-551*, 621-623	Title V, Subtitles B-D	1-11	101, 104, 122-124, 127-128, *152, 154, 156, 161, 163, 166-168*,	*102, 104, 105, 109, 111*, 135, 136, 139, 141, 152-154, 506	301-325, 413, 421, 431-441, 481, 494, 503, 504, *522-528*		410(a)(2-3)
Incomplete/ Imperfect Information	321-324, 326-339, 391-393, 400A-400C		210-225, 301-312, *541-544, 547-551*	Title V, Subtitles F, H		102, 121, 125-126, 143, *157-160, 163-165*, 171-173, 1602	*101, 103*, 131-134, 137, 138, 140, 1251, 1252, 1802, 1806, *1829*	423, 1203		Div. A, Title VIII
High (First) Costs	395-400, 400E-400J	Title I	217, 225, 241-251, 254, 301-312, *545*	Title V, Subtitles A, E		105-106, 141-142, *153, 155, 162*,	*105*, 122, 124-126, 128, 151, 1331-1335	411, 471, 493, 495, 511-518, 541-548, 1201, 1202, 1204-1206, 1306	Div. B	Div. A, Titles *III,*IV, *V,*VII, XII; 1121
Technical Risks			*521-524*			103, 2101-2102, 2104-2105	*107*, 127, 140, 911-925, 1701-1704	422, 491-493, 495, 1203, 1301-1305, 1307		
Market Risks										
Unfavorable Fiscal Policies						111, 113-114, 3015	139	532		410(a)(1)

Notes: Provisions in italics apply to federal buildings only. Provisions authorizing general efficiency grants to state or tribal government agencies are not specifically directed toward any barrier categories, so they are excluded from the table. The number of provisions in any specific box in the table should not be interpreted as a measure of relative significance or anticipated policy impact.

Author Contact Information

(name redacted)
Specialist in Energy and Infrastructure Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Specialist in Energy Policy
[redacted]@crs.loc.gov, 7-....

(name redacted)
Senior Specialist in Science and Technology
[redacted]@crs.loc.gov, 7-....