An Economic Perspective on Building Labeling Policies

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Executive Summary

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On-going concerns about climate change and other environmental impacts of energy use continue to drive many policy initiatives at the state and local levels. As policy makers increasingly pursue broad-based approaches that target all individual energy uses, building energy use has received increased attention. One relatively new approach goes by many names, including energy labeling, energy scoring, and energy benchmarking. Despite the many names, the underlying principle is the same: building energy efficiency performance is measured and reported with the goal of changing decisions about energy use and investments in energy efficiency. The information developed would be provided to potential buyers and renters, similar to energy efficiency labels used for consumer products, such as motor vehicles and appliances.

In recent years, several U.S. cities and states have adopted (or plan to adopt) mandatory energy labeling requirements, mostly directed at commercial, mixed-use, and multi-family properties. Mandatory programs in Australia and Europe have been operating for longer periods. Voluntary labeling programs, such as Energy Star and Leadership in Energy and Environmental Design ("LEED") in the United States, have been developed to supplement the existing ways that property owners can communicate information about building energy use to potential tenants and buyers.

Economic Rationales for Mandatory Building Energy Labeling

There is suspicion and some evidence that building energy use and related investment decisions are adversely affected by various market and behavioral failures. These failures reduce economic efficiency if they prevent property owners from adopting cost-effective energy efficiency improvements – that is, energy efficiency improvements that generate energy cost savings greater than investment costs – or lead to "excess" (economically inefficient) energy use. For example, potential failures may arise if owners cannot credibly convey information about the savings in future energy use from energy efficiency

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investments to potential owners or tenants, or if landlords have diminished incentives to invest in greater energy efficiency because tenants reap the energy savings. The desire to address these market failures has been an important rationale for many energy efficiency policies, although empirical understanding of the magnitude of their impact on actual energy efficiency investment and energy use is still somewhat limited.

Existing markets have developed mechanisms to collect and communicate information relevant to building energy performance that, to some degree, address these market and behavioral failures, including: utility bills; property inspections by potential buyers, renters, or home inspectors; voluntary energy labeling; and building audits, potentially subsidized through energy utility programs. Evidence suggests that these mechanisms affect market outcomes by providing information about energy performance to buyers and sellers, thereby allowing owners to recover a portion of the cost of energy efficiency improvements through higher rents or higher sale prices.

Potential and Actual Performance of Mandatory Building Energy Labeling

In principle, a building labeling mandate could serve the same purpose as these existing market mechanisms if required labeling further addresses (beyond these existing market mechanisms) some of the market and behavioral failures that may limit investment in energy efficiency. For example, energy labeling may increase attention to energy performance and thus could conceivably lead property owners to act on opportunities to invest in cost-effective energy efficiency. Labeling may also improve building owners' ability to credibly convey information about energy performance to potential buyers, thus increasing their ability to recover the costs of investments in energy efficiency through higher sale prices or rents.

However, to increase property-owners' investment in cost-effective energy efficiency, building labeling largely relies on indirect mechanisms in which the additional information provided by building labels changes energy efficiency investment decisions, although building label information may be most salient in unrelated real estate market transactions. Reliance on these indirect mechanisms increases uncertainty about program effectiveness and makes actual program performance largely an empirical question. While building energy labeling is often proposed as a natural extension of energy labels for consumer products, such as air conditioners, refrigerators, and motor vehicles, practical differences between these types of labeling illustrate many potential limitations to the effectiveness of building labeling at achieving intended changes in behavior:

- Building labeling does not distinguish between occupant energy use patterns and a building's inherent energy efficiency, unless special measures are taken to control for occupant energy use.
- Building labeling typically provides no information directly relevant to financial outcomes, but instead introduces information on performance *relative* to other properties. By highlighting relative performance, rather than underlying economic costs, behavioral biases may drive investment and energy use decisions arising from building labeling.
- Product labels provide information on energy performance in the showroom when product purchase decisions are being made. Thus, if labels affect product choices, they will have long-lived consequences for energy efficiency, and potentially change the overall efficiency of the equipment stock. By contrast, if building labeling affects property purchase and rental decisions, there will be no immediate impact on the energy efficiency of the building stock; labels may alter

the choice among properties, but does not affect the energy efficiency of the overall building stock because it does not directly affect energy use and investment decisions.

- Because each building is unique, development of accurate building label information requires very careful property-specific assessments, which are costly to create and verify. By contrast, for consumer products, energy performance only needs to be measured once for each product, which can also increase confidence in the reliability of measurements.

Despite the growing adoption of building energy labeling, there is very limited evidence on the actual performance of such labeling at changing energy use and investment. This is due in part to the relatively recent adoption of these programs. However, the one empirical study we are aware of that measures program performance (in Denmark) finds that labeling has no effect on energy use. Other qualitative assessments of European programs using survey methods suggest similar conclusions about their effectiveness. Research on United States programs has not addressed questions related to program performance. Thus, there is currently no real evidence that these mandatory programs lead to any changes whatsoever in energy use.

Empirical evidence suggests that building energy labeling may have an influence on property prices and rents, although the impact of any additional information provided by building labels is difficult to measure, separate from the many other factors that influence real estate transactions, including the traditional approaches to communicating information on building energy performance (for example, utility bills and pre-sale building inspections). Some studies report that the market premium given to properties with energy labels can exceed the value of likely future energy savings. There are a number of potential explanations for such differences, including unobserved property characteristics, buyer or renter preferences for "greener" properties, and consumer behavioral biases for having a higher "position" relative to others on energy performance (that is, "cache" for higher energy scores and "stigma" for lower scores).

Benefits and Costs of Building Energy Labeling

The potential benefits arising from any building labeling policy include cost savings generated by partially or fully addressing market or behavioral failures that (a) prevent implementation of cost-effective energy efficiency measures and/or (b) encourage excess (economically inefficient) energy use. Reducing energy use can result in environmental benefits, such as reductions in greenhouse gas ("GHG") emissions, and air and water pollution. The key costs of building labeling programs are the costs for each building to comply with the program and the cost of program administration. Compliance costs include the cost of measuring energy performance, and reporting, verifying, and periodically updating building label measurements.

From an economic perspective, mandatory building energy labeling should only be pursued if the program generates positive social net benefits – that is, if the sum of all benefits exceeds the sum of all program costs. The idea is simple, but as is often the case, precise estimates of some of these benefits and costs are challenging to develop. This is particularly the case because of the limited information available about the actual performance of building labeling programs.

The benefits and costs will likely both rise with increasing program "stringency" (although not necessarily in proportionate amounts). Relatively simple "energy intensity" scores may be relatively low cost, but are likely to create only limited benefits. Measures to increase potential benefits also lead to correspondingly larger costs: more accurate scores require more thorough, costly assessments; score verification to increase accuracy and deter manipulation requires hiring engineering contractors; and audits to identify cost-effective energy efficiency require hiring third-party auditors.

New programs should only be pursued if they provide positive net benefits incremental to existing programs and market mechanisms. For building energy labeling programs, it is important to recognize the many market mechanisms that already exist and provide information on energy use and investment. These include voluntary programs that have evolved in response to perceived information gaps on energy performance. A mandatory program would, in effect, pre-empt such voluntary initiatives. To the extent that voluntary programs achieve broad participation, at least by those properties with high energy performance, the goals of mandatory labels may already be partially achieved, since those who do not participate in the voluntary program effectively signal to the market their lower energy efficiency performance. Interactions with other policies also need to be considered. In particular, imposing additional requirements on sources already covered by quantity-based policies, such as cap-and-trade for greenhouse gases, may only shift emissions to other sources, thus failing to lead to any incremental emission reductions, while potentially raising costs.

Building energy labeling will have other economic impacts. Building labels likely result in one-time transfers of financial values between property owners, as owners with "greener" properties see appreciation in their asset values, while owners with "less-green" properties see depreciation of their asset values. These transfers could have significant city-wide and/or neighborhood effects, or even effects on different building sectors.

Our assessment of mandatory building labeling policies has identified limitations to these policies that merit full and careful consideration before proceeding with new programs. While benefits are conceivable, there is limited evidence that these programs will result in meaningful changes in energy use, let alone energy savings that offset the program's economic costs. With building energy labeling requirements just now coming into effect in a number of cities and states, experience from these programs may provide valuable insights into whether these types of requirements are an effective approach to addressing market and behavioral failures that can limit cost-effective energy efficiency investments and energy use decisions.

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I. INTRODUCTION

On-going concerns about climate change and other environmental impacts of energy use continue to drive many policy initiatives at the state and local levels. As policy makers increasingly pursue a broad-based approach that targets all individual energy uses, building energy use has received increased attention. One relatively new approach goes by many names, including energy labeling, energy scoring and energy benchmarking. Despite the varied names, the underlying principle is the same: building energy efficiency performance is measured and reported. The information developed is provided to potential buyers and renters, similar to energy efficiency labels used for consumer products, such as cars and appliances, with the goal of changing decisions about energy use and investments in energy efficiency.

In recent years, several U.S. cities and states have adopted mandatory energy labeling requirements, mostly directed at commercial property. Mandatory programs outside the Unites States (in Australia and Europe, for example) have been operating for longer periods. Within the Unites States., voluntary labeling programs, such as Energy Star and Leadership in Energy and Environmental Design ("LEED"), have been developed to provide property owners with a supplement to existing means of communicating information about energy use, such as utility bills and building inspections.

Policies targeting building energy use can increase economic efficiency if they bring about investments in *cost-effective energy efficiency* that would not happen without the policy. Cost-effective energy efficiency is the adoption of an energy efficiency technology that results in energy cost savings (including external social costs) that exceed the costs of deploying the new technology. For buildings, common technologies include ceiling and wall insulation, double-paned windows, efficient heating and ventilation systems, efficient appliances and equipment, weatherization, and programmable thermostats. The hope of building labeling programs is that they may increase investment in cost-effective energy efficiency or lead to other economically-efficient reductions in energy use through expanding available information about building energy performance.

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In this study, we provide an economic perspective on building energy labeling programs. We first provide background on potential policy rationales for intervening in property owners' energy management decisions and the types of energy efficiency programs that have been adopted targeting building energy use. Next, we describe different types of building labeling policies, describe the mechanisms by which they might increase investment in cost-effective energy efficiency, and summarize the empirical evidence on the effectiveness of these programs at reducing energy use and increasing investment in energy efficiency. Finally, we consider the benefits, costs, and other economic consequences of building energy labeling programs. In so doing, we focus on determining whether building labeling programs are *efficient* – that is, whether their net social benefits are positive and exceed those of alternative policies.

II. MARKET FAILURES AND GOVERNMENT INTERVENTIONS IN BUILDING ENERGY USE AND EFFICIENCY

Before embarking on an assessment of building labeling policies, it is important to understand potential policy rationales for intervening in real estate markets and building management decisions. To provide this background, we first discuss the various market and behavioral failures that potentially affect building energy use and investment. Following this, we discuss the types of policies that have been undertaken by local, state, and national governments motivated, in part, to address these market failures.

A. The "Energy Paradox" and Rationales for Policies Directed at Building Energy Use and Investment

Perhaps the central issue in the policy and economics of energy efficiency is the *apparent* failure of households and businesses to adopt cost-effective energy efficient technologies – that is, technologies that produce energy cost savings that exceed the cost of technology adoption. Referred to as the "energy paradox" or "energy efficiency gap," this apparent phenomenon has been the basis for much of the policy directed toward increasing energy efficiency, including the building labeling programs that are the subject of this paper.[3] Many factors may be responsible for the "energy paradox," including: *market failures* that prevent markets on their own from achieving an efficient allocation of resources; *behavioral failures* that may lead people's actual decisions and choices to differ systematically from economically "rational" decisions; and *market barriers* that are impediments to the adoption of new technologies or investment in energy efficiency that reflect real underlying economic costs.[4]

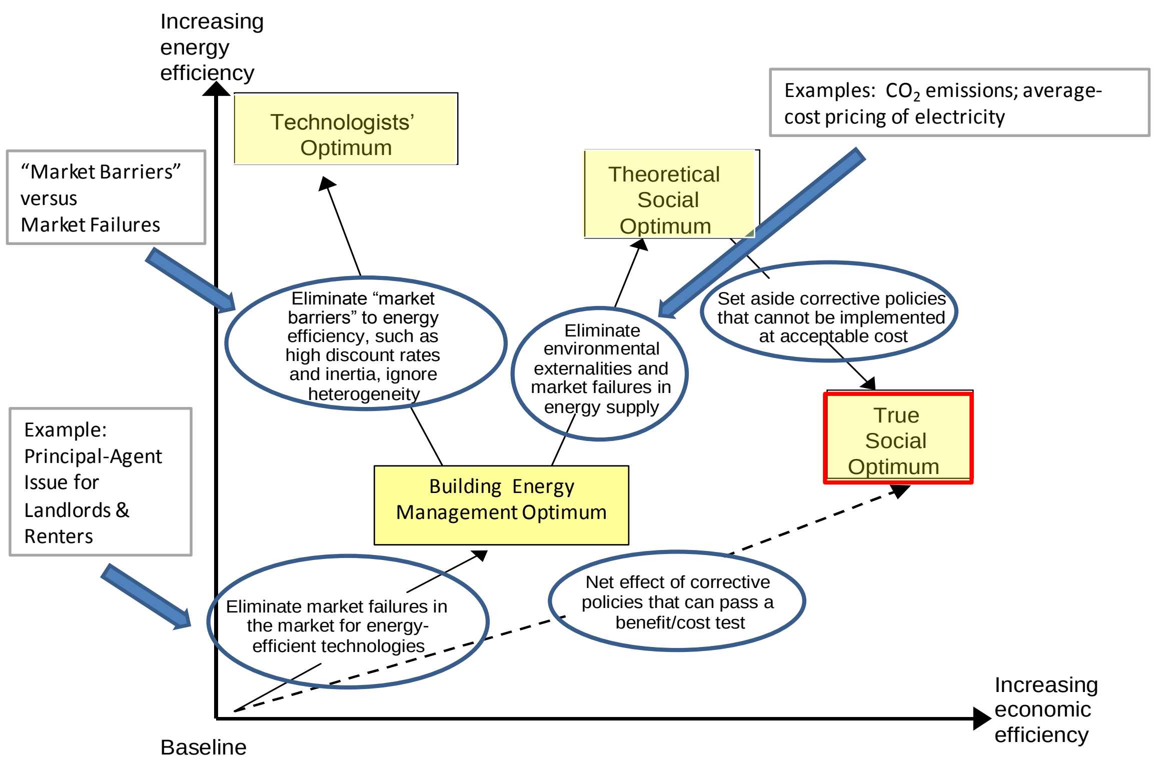
From an economic perspective, policies that address market and behavioral failures offer the opportunity to improve the allocation of resources and thereby increase economic efficiency. One type of market and behavioral failure, particularly relevant to building energy use, involves those that directly

[3] Jaffe, Adam and Robert N. Stavins, "The energy efficiency gap: What does it mean," *Energy Policy* (1994) 22:804-810; Jaffe, Adam, Richard Newell and Robert N. Stavins, "The Economics of Energy Efficiency", in *Encyclopedia of Energy,* ed. C. Cleveland, Amsterdam: Elsevier, pp. 79-90.

[4] Some define market barriers as any factor that creates a disincentive to adoption of a new technology, including market failures.

affect *how* decisions about adopting energy-efficient technologies are made and whether cost-effective energy efficiency is adopted. Because they are most relevant to the potential benefits from building labeling, we discuss these failures in greater detail in Section II.B. Well-designed policies that address these market and behavioral failure can increase the adoption of cost-effective energy efficiency. As shown in Figure 1, when this occurs, this increases both economic efficiency (horizontal axis) and energy efficiency (vertical axis), moving the state of the world from the status quo "Baseline" to the "Building Energy Management Optimum."

Figure 1: Economic Framework for Examining Energy Efficiency Policies



Note: This framework was originally developed in Jaffe and Stavins (1994).

Now, consider policies aimed at reducing or eliminating not just market failures but also market barriers. Examples of market barriers are low energy prices, fluctuating energy prices, high technology costs, lower technology quality or reliability, search costs, and uncertainty regarding future savings of technology performance.[5] Unlike market failures, market barriers do not result in the inefficient

[5] The apparent energy paradox may also arise due to measurement issues, such as hidden costs that are not fully accounted for (for example, search costs), and differences between real-world energy savings and those assumed by

allocation of resources. Consequently, policies aimed at eliminating such market barriers can lead to increasing energy efficiency but may also result in decreased economic efficiency. This is because they typically encourage the adoption of technologies whose costs exceed their benefits. These policies may achieve the "Technologists Optimum" – a high level of energy efficiency – but reduce society's overall well-being.

Energy policies often appear designed to achieve this "Technologists Optimum" rather than an economic optimum. For example, a long-term regulatory goal being pursued in many states is "zero net energy use" in buildings.[6] Although definitions vary, zero net energy use buildings are those with on-site renewable energy generation equal to actual energy use. While zero net energy use may be a helpful aspirational goal to motivate research and development into advanced technologies, it fails as a regulatory goal to reflect any balancing of the benefits of achieving zero net energy use with the costs, and consequently may result in very costly efforts being undertaken to reduce relatively little energy use.

In addition to market failures and barriers affecting investments in energy efficiency, there are also other market failures that affect energy use. Energy use may generate negative environmental externalities, including local and regional emissions (such as NO_X, SO_2, PM), global emissions (e.g., greenhouse gases ("GHGs") such as CO_2), water quality problems (from fuel and mining waste contamination), and impacts on aquatic species (from cooling water systems). When households and businesses fail to account for these impacts in their energy use decisions, their decisions will not reflect the true social costs of energy use, thus leading them to use inefficiently large amounts of energy. In addition, energy may be under-priced for other reasons, which could also lead consumers to use excess energy. This can occur when electric and gas utilities set their rates based on average rather than marginal costs or when governments subsidize energy costs. As shown in Figure 1, policies that build upon the "Building Energy Management Optimum" by eliminating these market failures can further increase economic and energy efficiency, moving the state of the world to the "Theoretical Social Optimum."

Finally, note that, while it would be desirable to design good policies to mitigate all market failures, even the best policies available to address a market failure may not create sufficient benefits to offset the cost of implementing the policy. Given this reality, the best alternative may be not to implement such a policy. While this will reduce energy efficiency because a certain degree of inefficiency in energy use and investment will not be addressed, it will increase economic efficiency by avoiding well-intentioned policies whose implementation costs exceed the theoretical net benefits of the policy. This results in the "True Social Optimum" in Figure 1.

For the remainder of this paper, we focus on the impediments to achieving the "Building Energy Management Optimum" in Figure 1, since building energy labeling policies potentially address these

the analyst. Gillingham, Kenneth, Richard Newell and Karen Palmer, "Energy Efficiency Economics and Policy," NBER Working Paper, No 15031, June 2009.

[6] Massachusetts Department of Energy Resources, "An MPG Rating for Commercial Buildings: Establishing a Building Energy Asset Labeling Program in Massachusetts," December 2010; California Public Utilities Commission, "The California Efficiency Strategic Plan," September 2008.

market failures, but surely will not be the most effective policy for addressing other market failures, such as those related to GHG emissions or energy pricing.

B. Market and Behavioral Failures Affecting Building Energy Use and Investment Decisions

Several market and behavioral failures potentially affect building energy use and investment. Box 1 illustrates these failures and market barriers through an example of a specific energy efficiency investment decision that might be faced by a building owner. Below, we focus on two types of problems that energy labeling programs potentially aim to address: information problems and behavioral failures.[7]

Information problems

When market participants fail to have accurate information about a product's attributes, they can make decisions that do not account for the true costs and benefits of alternative choices. Two types of information problems are of particular concern.[8]

The *principal-agent problem* arises when one party makes decisions with financial implications for another party. Several types of principal-agent problems potentially affect investment in building energy efficiency. First, building owners may not make investments in energy efficiency if they lease to tenants that pay their own utility bills, since the tenant will keep the cost savings; likewise, renters may not make such investments, because there is a high likelihood they will move out and lose out on future energy savings. While this problem could be solved by having building owners pay utility bills, such an arrangement creates another principle-agent problem: renters have no incentives to use energy carefully, because they do not pay any of the costs of energy use. Principal-agent problems may also arise in building construction. If builders have difficulty conveying information to prospective buyers about energy efficiency investments, they may opt not to make cost-effective investments, which can have long-run implications for energy use when these decisions are made in the construction of new buildings.

[7] Investment in building energy efficiency is also potentially affected by credit constraints, although building labels do little to address this type of market failure. A credit constraint arises when a property owner (or renter) under-invests in energy efficiency measures because of insufficient funds and inability to borrow such funds. When a limit on access to funds prevents a household or business from undertaking cost-effective energy efficiency investments, the property owner misses out on the opportunity to make economically efficient investments. Over time, energy service performance contracts have emerged as a market response that provides a means of addressing credit constraints in some circumstances. For companies or homes with credit limits, an energy service company finances energy saving investments, and shares in the resulting energy savings over time. Despite these developments, credit constraints may still limit investment in energy efficiency. Building labeling has no obvious impact on this potential problem.

[8] A third problem is related to the *"public good" aspect of information*: once created, information can be used by many people at little or no additional cost. Because it may be hard to limit access to information, the incentive for any individual to develop information is reduced. Consequently, general information about energy efficiency may be underprovided. However, this public good attribute does not diminish the incentive for any individual market participant, such as a building owner, to supply information about their own product (or building), since this information can distinguish their products from competitors' offerings. Building labeling has no obvious impact on this potential problem.

These principal-agent problems are exacerbated by *asymmetric information*, which arises when one party to a transaction has more information than others. With asymmetric information, buyers may be skeptical of seller claims regarding building energy performance, due to incentives and opportunity to misrepresent this potential. If true, property owners may have difficulty credibly conveying information about a building's energy efficiency to prospective buyers or renters, thus limiting their ability to earn a return on investments in energy efficiency. Consequently, they may opt not to act on cost-effective energy efficiency opportunities.

These information problems have long been identified as a potential contributor to underinvestment in energy efficiency. The scope of decisions potentially affected by the principal-agent problem may be quite large – for example, one analysis finds that principal-agent problems potentially affect 25 percent of refrigerator energy use, 66 percent of water heating use, 48 percent of space heating use, and 2 percent of lighting use.[9] However, there is an incomplete understanding of the magnitude of these impacts.[10] Despite the broad scope of activities potentially affected by this problem, one analysis suggests a relatively modest impact – on the order of 1 percent of aggregate residential energy use. [11]

Moreover, there is substantial evidence that property prices and rents reflect to some degree information about properties' energy efficiency. This type of information about a property's energy performance can be provided through many channels, including utility bills, inspection by the potential buyer or professional home inspectors. Research has shown that there is a relationship between fuel expenditures and sale prices, suggesting that some information about energy costs and building energy performance is conveyed to potential buyers and renters and influences market prices.[12]

[9] Murtishaw, Scott and Jayant Sathaye, "Quantifying the Effect of the Principal-Agent Problem on US Residential Energy Use," Ernest Orlando Lawrence Berkeley National Laboratory, LBNL-59773, August 12, 2006.

[10] For example, Davis (2012) found that the less efficient appliances in rental properties increased energy use by 0.5 percent, and Gillingham, Harding, and Rapson (2012), who found that owner-occupied houses in California were 12 to 20 percent more likely to have insulation than rental properties. Davis, Lucas W., "Evaluating the Slow Adoption of Energy Efficient Investments: Are Renters Less Likely to Have Energy Efficient Appliances?", Chapter 19 in *The Design and Implementation of US Climate Policy*, Don Fullerton and Catherine Wolfram, Eds., 2012, pp. 301-316; Gillingham, Kenneth, Matthew Harding, and David Rapson, "Split incentives in Residential Energy Consumption," *The Energy Journal* 33(2), 2012, pp. 37-62.

[11] Allcott, Hunt and Michael Greenstone, "Is There an Energy Efficiency Gap," *Journal of Economic Perspectives* 21(1), Winter 2012, pp. 3-28.

[12] For example, Dinan and Miranowski (1989) found that home price increased by $11.63 for every $1 decrease in annual fuel expenditure. Similarly, Johnson and Kaserman (1983) found that home price rose by $20.73 for every $1 decrease in annual utility bills. Laquartra et al. (2002) provide a survey of relevant literature. Other analyses of the effect of energy labels on property prices and rents have also found that properties with energy-efficient technologies (e.g., double paned windows, wall insulation, and ceiling insulation) tend to receive higher prices and rents. Dinan, T. M. and J. A. Miranowski, "Estimating the Implicit Price of Energy Efficiency Improvements in the Residential Housing Market: A Hedonic Approach," *Journal of Urban Economics* 25(1), 1989, pp. 52-67; Johnson, Ruth C. and David L. Kaserman, "Housing Market Capitalization of Energy-Saving Durable Good Investments," *Economic Inquiry* 21(3), July 1983, pp. 374-386; Laquartra, Joseph et al., "Housing Market Capitalization of Energy Efficiency Revisited," *ACEEE Summer Study of Energy Efficiency in Buildings, Teaming for Efficiency, Proceedings* 8, 2002. See also Brounen, Dirk and Nils Kok, "On the Economics of Energy Labels in the Housing Market," *Journal of Environmental Economics and Management* 62(2), September 2011, pp. 166-179; and Jaffe,

Behavioral failures

Behavioral failures arise due to systematic biases in people's actual decisions and choices, as compared to the model of perfectly rational behavior. Economists' understanding of these behavioral failures has evolved significantly in recent years, with important insights being drawn from both psychology and sociology.

Many behavioral failures potentially influence energy use and energy efficiency investments, including status quo bias (the tendency to prefer the current state of affairs and thus avoid changes), bounded rationality (which suggests cognitive limitations to solving more complex problems), heuristic decision making (when individuals use simple rules to solve complex problems) and inattention (when individuals fail to fully consider some aspects of a problem unless they are highlighted).[13] Two examples are particularly relevant to building labels. Inattention suggests that decision-making may disproportionately reflect factors made salient when decisions are being made.[14] In this regard, building labels may highlight energy performance when individuals make purchase or rental choices; however, because this information is considered at the time of purchase or rental does not mean that it is salient at a later point in time when decisions are being made about energy efficiency investments or energy use.

Another example is the way in which people are influenced by social norms and biases toward where they rank *relative* to others, rather than their well-being independent of others. Several studies have found that energy conservation increases when people receive messages that their energy use is greater than that of their neighbors.[15] Such normative signals can also result in a "boomerang" effect in which individuals with above average scores actually increase their energy use.[16] This research suggests that building labeling based on *relative* scores could lead people with low scores to take action simply to get "above average" even if the costs exceed any societal benefits. Labels designed with this objective in mind have a different purpose than those designed to provide information to improve decision-making, and they take advantage of aspects of human behavior with known, and potentially problematic, welfare consequences.[17]

Adam B. and Robert N. Stavins, "Dynamic Incentives of Environmental Regulation: The Effects of Alternative Policy Instruments on Technology Diffusion," *Journal of Environmental Economics and Management* 29, 1995, pp. S43-S63.

[13] Shogren, Jason F. and Laura O. Taylor, "On Behavioral-Environmental Economics," *Review of Environmental Economics and Policy*, 2008, pp. 1-20; Allcott and Greenstone (2012).

[14] For example, Chetty, Looney and Kroft (2009) find that including taxes in the sticker prices tends to decrease purchases compared to calculating them at the register. Chetty, Raj, Adam Looney, and Kory Kroft, "Salience and Taxation: Theory and Evidence," *The American Economic Review* 99(4), 2009, pp. 1145-1177.

[15] Allcott, Hunt, "Social Norms and Energy Conservation," *Journal of Public Economics* 95, 2011, pp. 1082-1095; Schultz, P. Wesley et al., "The Constructive, Destructive, and Reconstructive Power of Social Norms," *Psychological Science* 18(5), 2007, pp. 429-434..

[16] Schultz et al., 2007.

[17] In effect, labels could be aimed at turning home energy use and investment into "positional" goods, in which well-being depends on *relative* position. While this may have short-term benefits if this good is underprovided, in general, positional goods tend to lead too many resources being expended producing the positional good – that is, an

Some of these systematic biases can potentially lead to inefficient outcomes. Because of difficulties identifying the underlying source of the "energy efficiency paradox," it may be tempting to ascribe its source to behavioral failures. However, the impact of such behavioral factors compared to other unobserved costs (such as contractor and equipment search costs, differences between actual and theorized performance, installation complications) can be difficult to distinguish. Moreover, the net effect of behavioral failures on energy use and investment is not clear; behavioral failures could lead consumers to use too much or too little energy, or lead them to under- or over-invest in energy efficiency.[18] Economists' understanding of how these behavioral failures potentially affect energy use and investment is still evolving.

While behavioral failures may affect individual consumer decisions, firms that are subject to competitive market forces are much less likely to suffer from these problems.[19] Firms that do not take advantage of cost-effective investments in energy efficiency will be less efficient than other firms in their industry, making them less able to compete. This competitive dynamic creates strong incentives for firms to use energy efficiently and undertake all cost-effective energy efficiency investments.

Along with creating potentially inefficient market outcomes, these behavioral failures can have significant implications for the effectiveness of policies aimed at mitigating market failures. Behavioral economics has illustrated that *how* options are presented and framed can have a substantial influence on subsequent choices. A study of different incentives to purchase hybrid electric vehicles found that their effectiveness depends on how these incentives are "delivered" to consumers (e.g., income tax credits, sales tax waivers, high occupancy vehicle access).[20] This research points to the difficulties often faced in designing policies that can effectively address market and behavioral failures.

"arms race" on energy efficiency. Frank, Robert H., "Positional Externalities Cause Large and Small Preventable Losses," *American Economic Review* 95(2): 137-141, 2005.

[18] Gillingham, Newell, and Palmer (2009).

[19] Shogren and Taylor (2008); Gillingham, Newell and Palmer (2009).

[20] Gallagher, Kelly Sims and Eric Muehlegger, "Giving Green to Get Green? Incentives and Consumer Adoption of Hybrid Vehicle Technology," *Journal of Environmental Economics and Management* 61(1), 2011, pp. 1-15.

Box 1: Illustration of Market Failures, Behavioral Failures and Market Barriers

Various types of possible impediments to cost-effective investments in energy efficiency can be illustrated with variations of a simple example. Suppose that a building owner/landlord has the opportunity to make a $10,000 one-time investment in some energy efficiency project (for example, an upgrade in wall and roof insulation) that is expected to lead to energy savings with a present value of $13,000. Basic economics – and common sense – suggest that the owner/landlord should make this investment. Why might he not do so? The table below describes several possible reasons. For example, because the energy savings may accrue not to the landlord but instead to the tenant, the party who actually pays the energy bills, the landlord may choose not to make the investment. This is the principal-agent problem. Or, because performing an audit, finding a qualified contractor and attending to other administrative requirements may cost more than the expected net savings of $3,000, the landlord may likewise choose not to make the investment. This is an example of a market barrier.

Reasons Why an Owner/Landlord May Choose Not to Make an Investment in Energy Efficiency that is Expected to Save Money

Market Failures	Principal-Agent (Landlord-Tenant) Problem	If property owner makes the investment, the tenant, who pays the energy bills, receives the cost savings.
	Asymmetric Information	Property owner is unable to credibly convey the information about the lower energy cost to prospective tenants and thus is unable to recoup his full investment through higher rent.
	Credit Constraints	Property owner does not have access to sufficient funds to pay the upfront costs of the investment.
Market Barriers	Search Costs	Property owner incurs "search" costs to perform an audit and find a quality contractor that exceed cost savings.
	Uncertainty	Future cost savings are uncertain, creating the risk that the long-term savings will be less than the investment costs.
Behavioral Failures	Inattention	Property owner focuses on other salient features when making renovations (e.g., comfort, amenities, cost).
	Status Quo Bias	Property owner defers decisions unless faced with large benefits or factors that force decisions (e.g., deadlines).

C. Options to Address Building Energy Use and Investment Market Failures

Given concerns about the environmental impacts of energy use and the “energy efficiency paradox,” many policies have been designed to achieve reductions in building energy use. Table 1 provides a sampling of the types of building energy policies that have been undertaken, including specific examples of public and private programs. The policies identified fall into three general categories: standards, financial incentives, and information and education programs. In some cases, these programs target specific market failures. For example, several public-private partnership programs provide building owners with access to technical expertise that may be underprovided by private markets because there are spillovers from such information sharing that are hard for the private sector to fully capture. In other cases, policies simply aim to encourage greater energy efficiency under the assumption that there is underinvestment. For example, governments and energy utilities provide financial support for investments in energy efficiency through low- or no-interest loans, rebates or tax credits. These subsidies generally do not target any individual market failure.

The programs identified in Table 1 illustrate the wide range of measures that target building energy efficiency. These programs target residential, small commercial and large commercial buildings to varying degrees, along with general education programs for the building sector.

Table 1. Examples of Current United States Energy Efficiency Policies Targeting Commercial and Residential Buildings

Policy Type	Program	Purpose	Example	Description
Standards	Consumer Durable Goods (Appliances) Energy Efficiency	Uniform standards on a national scale: Establish consistency and certainty for manufacturers and consumers	National Appliance Energy Conservation Act of 1987	Established national standards for 12 appliances, including refrigerators, ovens, and air conditioners; includes periodic updates and addition of new appliances.
			Energy Policy Act of 1992	Established national standards for lighting, motors, and commercial HVAC; includes periodic updates.
	Building Codes	Promote long term efficiency of building design	American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standards	Includes standards for building envelopes, lighting, and HVAC systems. Vary by state in scope and stringency.
Financial Incentives	Utility Demand Side Management	Energy conservation: Target overall reduction in demand through efficiency measures	Free Energy Audits	Qualified technicians evaluate building performance and recommend cost-effective improvements.
			Rebates and/or Interest Free Loans	Provide funding to implement cost-effective improvements identified during home energy audits.
	State and Federal Tax Credits and Deductions	Energy conservation: Incentivize consumer purchases of more efficient products	American Recovery and Reinvestment Act (ARRA)	Energy Tax Credit for energy efficiency (30% of cost, up to $1,500), alternative energy (30% of cost for geothermal, wind, solar), and plug-in electric vehicle credits (up to $7,500). See http://energy.gov/savings_for a complete list of credits by state.
	Voluntary Weatherization Assistance	Improve building performance and promote cost-effective measures for low-income households	U.S. Department of Energy (DOE) Weatherization Assistance Program (WAP)	Federal Funding provided to state and local agencies for home audits and improvements. DOE reports 6.4 million participating homes since 1976, with an annual energy bill reduction of $47.
			Low-Income Home Energy Assistance Program (LIHEAP)	State funding provided by U.S. Department of Health and Human Services.

Policy Type	Program	Purpose	Example	Description
Information and Education Programs	Information	Educate building owners and occupants: Public-private partnerships to match end-users with technical knowledge	U.S. DOE Energy Efficient Building Programs, Industrial Assessment Centers, and Plant-wide Assessment	Provide technical assistance and audits to homeowners, commercial building owners, and industry participants to improve energy efficiency.
			Partnership for Advanced Technology in Housing (PATH)	Joint program between residential home builder stakeholders, financial companies, and US Department of Housing and Urban Development.
	Product Labeling: Mandatory and Voluntary	Energy use disclosure: Provide positive marketing and create more informed consumers	Mandatory: EnergyGuide	Federal Program that requires annual energy consumption estimates and operation costs for a variety of appliances; provides comparison to other products in class.
			Voluntary: U.S. Environmental Protection Agency Energy Star	Labels provided to top-in-class for energy efficiency; covers a broad range of consumer goods, commercial buildings, and residential homes (including improvements). U.S. EPA estimates reductions of 5,400 $MMTCO_2eq$ and savings of $314b from 1993-2010.
	Building Labeling: Mandatory and Voluntary	Energy use disclosure: provide positive marketing and create more informed consumers	Mandatory: Residential and Commercial Building Labeling	See Table 4 for detailed summary.
			Voluntary: Leadership in Energy and Environmental Design (LEED)	Recognizes high performance buildings, with energy efficiency as one of several considerations. USGBC reports over 50,000 participating projects comprising 8.9 billion square feet.
	Voluntary Disclosure	Goodwill publicity: Transparent goals and recognition of improvement	1605b Reports to the U.S. Energy Information Administration	Voluntary reports of GHG emissions by corporations and other entities.
			U.S. DOE Climate Challenge Program	U.S. DOE and electric utility partnership with established tracking and commitments.

Note: Table based on Gillingham et al. (2004) and Doris et al. (2009).

III. ASSESSMENT OF MANDATORY BUILDING LABELING PROGRAMS

The goal of building labeling programs is to encourage owners and occupants to make investments in energy efficiency and/or to use less energy in their day-to-day activity. Building labeling programs are intended to achieve such changes through several possible mechanisms:

1. By providing information about building energy performance, programs may focus individuals' attention on their energy use, which may not otherwise have been a high priority. In theory, people may respond to this information by reducing their energy use.
2. Building labeling programs may provide a way for owners to convey the value of any investments in energy efficiency to potential buyers or renters. In theory, if buyers or renters can observe a building's energy performance, they will be willing to pay more to buy or rent properties that have lower operating costs. This would increase the incentive to building owners to make investments in energy efficiency.
3. Building labeling programs might help owners to identify cost-effective investment opportunities and/or specific actions to reduce energy use.

These mechanisms may encourage greater investment in cost-effective energy efficiency to the extent that they partially or fully address the information or behavioral problems that may limit such investment. Building labeling programs do not directly address other market failures, such as environmental externalities (for example, GHG emissions). While energy efficiency programs may reduce GHG emissions, they will not do so cost-effectively compared with other policy mechanisms, such as market-based approaches.

In this section, we describe key elements in the design of building labeling programs. We then summarize U.S. and non-U.S. labeling programs, and finish with a summary of these programs' performance.

A. Design and Impact of Building Labeling Policies

Building labeling programs can have substantially different designs. A key distinction is between mandatory and voluntary policies. Under a mandatory policy, all regulated properties must comply with the labeling program's requirements. Thus, there is a new regulatory requirement. By contrast, voluntary programs provide owners with the option to participate. These programs, such as the U.S. Environmental Protection Agency's ("EPA's") Energy Star program and the LEED programs, typically provide some recognition or accreditation for buildings that verify that they meet pre-determined energy (and potentially environmental) standards. Voluntary programs are, in some sense, an additional market response to a potential lack of information on energy performance that complements other available means, such as sharing utility bills and building inspections. Under voluntary programs, only those property owners that see value in providing the additional label information will participate.

Our discussion largely focuses on mandatory programs. The design of mandatory programs inescapably involves tradeoffs between the quality, accuracy, and utility of the information that the program provides, on the one hand, and the cost of the program, on the other hand. A program can be designed to be less costly, but it may be less accurate or informative as a result. Similarly, a program can be designed to be more accurate and more useful to market participants, but doing so may raise its costs. Table 2 below summarizes the primary building labeling program designs.

Table 2. Types of Building Labeling Programs, Characteristics, and Requirements

Type of Program	Main Characteristics and Requirements
Energy Intensity Scores	• Reflects building attributes and occupant use • Absolute or relative score • Usually no information relevant to financial implications, including cost-effective energy efficiency actions • Lower cost • Typically not tailored to unique building attributes • Can be voluntary or mandatory • Risk of manipulation without (potentially costly) verification
Energy Integrity Scores	• Reflects only building attributes • Absolute or relative score • More complexity to isolate building from occupant effects • Usually no information relevant to financial implications, including cost-effective energy efficiency actions • May not be tailored to unique building attributes • Can be voluntary or mandatory • Risk of manipulation without (potentially costly) verification
Audits	• Detailed on-site review of property • Usually tailored to unique building attributes • Can be used to complement an energy intensity or energy integrity score • Provides specific suggestions to help identify cost-effective energy efficiency • Can be voluntary or mandatory • Higher cost
Mandated Audit Actions	• Requires property owners to implement audit action items • Greater aggregate investment in energy efficiency • Higher costs • Likely to lead to investments whose costs exceed benefits, leading to inefficient outcomes

Energy Intensity Scores

An energy intensity score aims to capture a building's overall energy performance given its size and the nature of the activities occurring in it. The score reflects both building characteristics and occupants' habits and behavior. In its basic form, the score is based on a formula that reflects building characteristics such as the size, the type of operations taking place within it, and the number of employees using it. Based on their score, buildings may be categorized into an even simpler "grade" (for example, "A" to "F").

Energy intensity scores typically reflect performance relative to other buildings with similar characteristics.[21] In this regard, building energy labels differ from energy labeling for consumer products, which provide consumers with an estimate of annual energy expenditures (with appliance labels) or miles per gallon (with car labels).

Relative to other types of policies, the potential benefits of energy intensity scores include their relatively low cost. A basic approach is to have building owners gather basic information about building characteristics and energy use and enter this information into a software program. More costly procedures would involve on-site inspection by trained engineers and/or verification of data collected by building owners or managers.

The drawbacks of this type of metric are driven largely by its relative simplicity:

1. Use of simplified tools for measuring energy intensity may lead to unreliable metrics. For example, automated software tools may encourage a one-size-fits-all approach that does not account for site-specific circumstances.[22]
2. Energy intensity scores do not distinguish between the behavior of the current occupants and the efficiency of the building's structure, systems, and equipment. Thus, a particular building's energy intensity score may not be a particularly accurate reflection of the building's current or potential energy performance.
3. While an energy index can provide some measures of a building's energy performance, it provides little or no information on financial implications, including information to help inform decisions about how to improve energy use or investment in energy efficiency.
4. Energy intensity scores calculated through automated software are also prone to manipulation, unless the information that owners submit is audited or verified, requirements that would raise costs.
5. Relying on relative performance raises several issues. First, while household or business concerned with relative position may induce investments in energy efficiency by those that are "below average," this tendency will not necessarily lead to cost-effective energy efficiency based on accurate information about energy costs. Second, in a program that uses

[21] For example, each building's score may be scaled so it is analogous to a percentile score on a standardized test, with a score of 50 being average.

[22] For example, a particular building owner/landlord may not be able to influence the energy use of a tenant during the duration of that tenant's lease.

relative scores, the average or median score may shift over time. Consequently, the information conveyed by building scores may depend on the date the score was calculated.[23] This may require more frequent updating of energy performance scores, which would raise costs.

In addition, note that, although building energy labeling is often proposed as a natural extension of energy labels for consumer products, such as air conditioners, refrigerators, and motor vehicles, these labeling programs differ in important ways:

1. Energy labels for products convey *financial information* about costs savings (or, information that is easily converted into financial information, such as fuel efficiency labels provided for motor vehicles). By comparison, building labels typically do not provide such financial information, but instead provide information on a building's efficiency *relative* to other buildings.
2. Energy labels for products potentially *affect decisions at the point of purchase* when consumers are making the choice among products with differing energy efficiency. By contrast, for buildings, property purchase and rental decisions often do not occur at the same time as decisions about energy efficiency investments. Consequently, energy labels may not be salient at the time when property owners are considering investments in energy efficiency, particularly to the extent that programs are designed to influence purchase and sale decisions, rather than energy efficiency investment and use decisions.
3. Information for energy labels need only be developed once for each unique consumer product. By contrast, for buildings, information for energy labels needs to be developed for each and every individual building, not just each type of building, requiring additional measurement costs. Substantial heterogeneity in buildings increases this challenge.
4. Product labeling is based on verifiable standards, which improves their credibility. For buildings, however, measurement standardization is more difficult to verify, which reduces the credibility of the information.[24]

[23] Eichholtz, Kok, and Quigley (2010b) find that the effect of Energy Star ratings diminishes as time elapses since the certification. One interpretation of this is that, because building performance is gradually improving over time, Energy Star certification (indicating that a building's energy efficiency is within the top quartile) becomes less meaningful since a property that was in the top quartile in past years may no longer be so highly rated. Eichholtz, Piet, Nils Kok, and John M. Quigley, "Sustainability and the Dynamics of Green Building," April 2010.

[24] Tigchelaar, Casper, Julia Backhaus, and Marjolein de Best-Waldhober, "Consumer Response to Energy Labels in Buildings," Intelligent Energy Europe, September 2011; Backhaus, Julia, Casper Tigchelaar, and Marjolein de Best-Waldhober, "Key Findings & Policy Recommendations to Improve Effectiveness of Energy Performance Certificates & the Energy Performance of Buildings Directive," Intelligent Energy Europe, September 2011; Lainé, Liz, "Room for Improvement: The Impact of EPCs on Consumer Decision-Making," Consumer Focus, February 2011; Amecke, Hermann, "The Effectiveness of Energy Performance Certificates – Evidence from Germany," Climate Policy Initiative Report, August 26, 2011.

Energy Integrity Scores

Energy integrity scores are intended to be a refinement of energy intensity scores, by better reflecting the inherent performance of a building's structure, systems, and equipment independent of the influence of occupants' energy use habits and activities. Measuring energy integrity is more costly due to the effort required to isolate the building's inherent energy performance independent of its current occupants' energy use. Controlling for occupant behavior may require additional measurement and analysis, although tools such as thermal imaging may potentially lower these costs. The advantage of an energy integrity score is that it provides a more accurate measure of the building's performance, separate from its occupants. It may be more informative to new buyers or renters, whose habits may differ from those of current occupants.

Audits

An energy audit identifies specific cost-effective actions that can be taken to improve a building's energy efficiency, considering both up-front financial costs of these investments and anticipated annual energy cost savings. Building owners and managers may voluntarily undertake energy audits as an element of their energy management of their facilities. Residences may also voluntarily undertake energy audits, and such audits are often subsidized through utility funded programs.

Audits therefore differ from energy intensity and energy integrity scores because they can provide tailored information and recommendations about cost-effective investments in energy efficiency. Because audits provide information on such investments, rather than relative performance, an audit may be required in addition to energy scores.

The primary drawback of an audit program is its cost. Audits typically require detailed assessments based on on-site visits by approved third parties with sufficient training and expertise. Performing a detailed on-site building assessment requires that the auditor visit the building, collect information, and analyze the building's structure, systems, and equipment (such as its insulation, heating and cooling systems, and windows), and prepare a detailed report.[25] A recent survey of energy auditors found that the average fee for a basic residential home audit was about $350 per audit, while another study found average costs of $492 per audit (with about 70 percent of audits costing between $300 and $700).[26] Commercial audits are significantly more expensive.[27] From an economic perspective, it is important to compare this cost (together with other costs) to the value of benefits to determine whether audits are beneficial on net. Furthermore, while required audits likely lead to some incremental cost-

[25] For example, *see* Pacific Northwest National Laboratory, "A Guide to Energy Audits," U.S. Department of Energy, Building Technologies Program, PNNL-20956, September 2011.

[26] Palmer, Karen L. et al., "Assessing the Energy-Efficiency Gap: Results from a Survey of Home Energy Auditors," *Resources for the Future Discussion Paper No. 11-42*, October 4, 2011; *Residential Energy Services Network, Inc*., "National Average Cost of Home Energy Ratings," Feb 27, 2009.

[27] A California study found that commercial property audits could range from $0.12 to $0.50 per square foot in 1997 dollars. With inflation, this suggests that the audit for a 50,000 square foot commercial building could be as high as $35,000. California Energy Commission, "How to Hire an Energy Auditor to Identify Energy Efficiency Projects," P400-00-001c, January 2000.

effective investments in energy efficiency, they may also result in many audits that result in no action taken because property owners perform the audit only because of the requirement, not because they are interested in investing in their properties.

Mandated Audit Actions

While mandatory building labeling requires that building owners develop (and supply) certain information on their buildings, property owners retain discretion over which investments and actions they undertake. However, policymakers might be tempted to impose requirements that building owners implement actions identified as cost-effective in energy audits. Likewise, policymakers might require that poorly performing buildings decrease their energy use.

While we do not assess the many issues related to the adoption of these types of mandatory requirements, there are several factors suggesting potential economic inefficiencies from these approaches. In particular, while, in theory, audits identify only cost-effective energy efficiency investments, there are many reasons to believe that auditor estimates may not fully account for the many factors that determine whether energy-saving investments are cost-effective. If true, some building owners would inevitably be required to make investments that would make them (and society as a whole) worse off. Such required investments would also result in net social costs, since the requirements would lead to actions that produce benefits through energy savings (and potentially reduction in environmental impacts) that are less than the costs of these investments. Requirements that poorly performing buildings decrease energy use could result in similar problems. Simply because a building's energy efficiency performance is low relative to comparable buildings does not mean that investments to improve energy efficiency will be cost-effective.

Other Design Choices

In addition to choosing a basic type of building labeling program, policymakers must make other choices that have implications for program cost and effectiveness. Table 3 summarizes key questions they face and some of the implications of those questions for the cost and effectiveness of the program.

One important question is what types of buildings the labeling program covers. Owners of these different types of buildings make decisions in different ways and are likely to be affected by market and behavioral failures to varying degrees. For example, the owner of a large commercial property (e.g., a downtown office building), whose principal concern is earning profit from his or her property, is more likely to have the both the incentive and the resources to identify and implement cost-saving investments in energy efficiency, even in the absence of a building labeling program. Thus, a building labeling program may impose costs on these owners for little incremental benefit, unless they somehow address principal-agent problems that may affect a property owner's ability to recover the costs of these investments.[28]

[28] These costs can include costs to (1) collect and manage information using different measuring tools or software tools, (2) implement additional administration tasks to ensure compliance, and (3) hire outside engineers to verify results.

Table 3. Other Choices in Designing a Building Labeling Program

Key Design Question	Implications for Program Costs and Effectiveness
What types of buildings are affected? ➢ **Building type (commercial, residential, industrial, mixed)** ➢ **Building size** ➢ **Building age**	• Properties vary in the potential market and behavioral failures they face • Older buildings may have the potential for substantial improvements but are heterogeneous and may be difficult to score accurately • Aggregate program costs increase as more buildings are subject to the program
How often must owners comply?	• More frequent measurement improves the quality of information, but also increases costs to regulated entities and to the government
To whom is the information disclosed?	• Wider disclosure may raise program visibility, but may also raise costs, depending on requirements
When is the information disclosed?	• The cost of disclosure requirements will depend, in part, on how information is disclosed (e.g., through a public registry, or through individual communication by market participants) • The timing of disclosure requirements affects when market participants receive information, and the extent to which it potentially affects investment, purchase, and/or rental decisions
Is the program voluntary or mandatory?	• Voluntary participation in building labeling programs will lower aggregate costs, while potentially reducing overall impacts (if any) on energy use

B. Building Labeling Policies in Practice

Several U.S. cities, U.S. states, and countries outside the United States have implemented mandatory building labeling programs in recent years. Across the United States, six cities (Austin, New York, Philadelphia, San Francisco, Seattle, and Washington, D.C.) and two states (California and Washington) have enacted mandatory building labeling for selected buildings in their jurisdictions. These programs have all been enacted recently and many have yet to take effect. Austin's initiative was the first major U.S. program, with certain residential buildings subject to the city's program since June 1, 2009. In many of the cities, program requirements will not be fully phased in until 2013 or 2014. Table 4 below summarizes these programs.

The common focus of all of the programs is medium and large commercial buildings, with requirements only affecting buildings above certain size thresholds. All city programs, except San Francisco's, apply to large apartment or mixed-use buildings, and several apply to public buildings as well.

Most programs require that covered buildings/owners "benchmark" their energy intensity using the Energy Star Portfolio Manager ("ESPM") tool. The ESPM is used in the U.S. EPA's voluntary Energy Star program, which allows high-performing buildings to receive an Energy Star label if their energy use intensity is in the top 25 percent of buildings in their building classification.[29] According to the Energy Star program, ESPM "is an interactive energy management tool that allows you to track and assess energy and water consumption across your entire portfolio of buildings in a secure online environment."[30] Owners must gather and submit information to Energy Star on their buildings' basic characteristics, including the ways in which space is used, and the buildings' monthly energy use. EPSM provides a score between 1 and 100, which reflects a building's energy efficiency relative to similar buildings in the same geographic region. A score of 50 indicates average performance; higher scores indicate better performance. While the ESPM was developed for EPA's voluntary program, it has been widely adopted as a tool in individual city and state programs. Another voluntary program is the LEED program. Administered by the U.S. Green Building Council, a non-profit organization that promotes green building design, this program also provides firms with the opportunity to have their building be LEED-certified if they meet certain energy and environmental standards.[31]

Of the mandatory programs, several impose requirements beyond benchmarking through ESPM. Austin requires that owners of residential buildings at least 10 years old have their residences audited by a certified auditor prior to sale.[32] The audit covers home features such as attic insulation, duct systems, heating and cooling equipment, and window insulation. Austin also requires that high energy use multi-family buildings (defined as those with energy use more than 50 percent above average multi-family building energy use) must reduce their energy use by 20 percent within 18 months. New York also requires buildings covered by the requirements to undertake audits at least every 10 years.[33] San Francisco requires energy audits every five years for buildings at least five years old and 10,000 square feet in size, but does not mandate improvements or disclosures.

Some city programs report (or plan to report) buildings' ESPM scores publicly, including making data available through online databases. Others plan to limit disclosure of ESPM scores to those

[29] Energy performance must be verified by a licensed professional. "Energy Star Overview," available online at www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager#rate.

[30] "Energy Star Portfolio Manager Quick Reference Guide," available online at http://www.energystar.gov/ia/business/downloads/PM_QuickRefGuide.pdf?fc6d-46e6.

[31] http://new.usgbc.org/home.

[32] Audits are not needed if one has been done in the previous 10 years, or if the home has made investments in energy efficiency through one of the local utility's programs.

[33] These requirements were included in the city's Greener, Greater Building Plan, which also tightens requirements on the need to bring buildings up to code during renovations, and requires all buildings to update lighting systems and install sub-metering for individual tenants.

participating in market transactions, such as buyers and seller in property sales, and current and prospective tenants. Thus, the mechanism used to communicate ESPM scores differs across programs. In general, mandated building audits would not be publicly disclosed.

The two state-level programs in the United States, in California and Washington, are almost identical, because Washington modeled its program after California's. Both states require certain commercial and public buildings to benchmark their energy use through ESPM and to disclose that information prior to completing certain types of transactions (purchase, leases, or loans). Both also require utility companies to track and upload energy consumption information to ESPM, or at least use a compatible format. Thus, although these programs do not require measurement and reporting at regular intervals, there is constant tracking of energy usage for the building owner's reference.

The European Union and Australia have implemented building labeling programs that resemble the programs in the United States. In 2002, the EU began to require its member countries to develop an energy label, called the Energy Performance Certificate ("EPC"), which residential and commercial properties were required to obtain and disclose when properties are constructed, sold, or rented.[34] The program resembles in many ways U.S. programs that rely on ESPM scores, although there is variation in implementation across countries. Australia's program, the Energy Efficiency Rating ("EER") program, is similar. For buildings in the Australian Capital Territory, where the program applies, building design features are fed into a software program, which gives the building a score measured in stars. Scores are required to be disclosed in sale or rental advertisements and are included in sales contracts.[35] The EER is essentially an energy integrity score, because the score depends only on building features.

To date, no U.S. programs rely on energy integrity scores. However, some jurisdictions are considering the use of such metrics. For example, Massachusetts has considered mandating energy labeling based on an energy integrity metric as part of compliance with the Massachusetts Global Warming Solutions Act.[36]

[34] "Energy Efficiency: Energy Performance of Buildings," available online at http://europa.eu/legislation_summaries/other/l27042_en.htm.

[35] See Australian Government, Department of the Environment, Water, Heritage and the Arts, "Energy Efficiency Rating and House Price in the Act," 2008, available online at: www.nathers.gov.au/about/publications/pubs/eer-house-price-act.pdf.

[36] Massachusetts Department of Energy Resources (2010).

Table 4
Summary of Building Labeling Programs in the United States

Location	Program Name	Types of Buildings Covered	Effective Dates	Program Requirements	Disclosure Requirements
Austin, TX	Energy Conservation Audit and Disclosure (ECAD) Ordinance	• Commercial buildings 10,000 sf and larger • Residential and Mulitfamily buildings 10 years or older (Condominums must comply with either Residential or Multifamily requirements depending on the number of units)	• June 1, 2009: Residential buildings • June 1, 2011: Multifamily buildings For Commercial Buildings: • June 1, 2012: > 75,000 sf • June 1, 2013: 30,000 - 74,999 sf • June 1, 2014: 10,000 - 29,999 sf	• Residential/Multifamily: Mandatory audit and disclosure to pontential buyer/tenant for houses/buildings over 10 years old (some other exemptions) • Commercial: Mandatory annual Energy Star benchmarking	• Required disclosure to prospective buyer of single-family homes and commercial properties • Required disclosure to current and prospective tenants of multi-family buildings • All audits or benchmark results submitted to the program director within 30 days • No explicit rules for broader public disclosure
New York, NY	Greener Greater Buildings Plan (GGBP)	• Public buildings over 10,000 sf • Private buildings (Commercial and mixed-use, and Residential) buildings over 50,000 sf • Condominiums over 100,000 sf	• May 1, 2010: Public Buildings • May 1, 2011: Private buildings (ie. Commercial, mixed-use, residential, and condominiums)	• Mandatory annual Energy Star benchmarking, including water consumption • Mandatory audits every 10 years	• Public buildings: Disclosed online by September 1, 2011 • Private buildings whose main use is non-residential: Disclosed online by September 1, 2012 • Private buildings whose main use is residential: Disclosed online by September 1, 2013 • The first year of benchmarking information is not disclosed
Philadelphia, PA	Bill No. 120428-A; Energy Conservation	• All commercial buildings over 50,000 sf • All multi-use buildings with at least 50,000 sf of commercial use	• June 1, 2013	• Mandatory annual Energy Star benchmarking, including water consumption (only commercial uses in multi-use buildings are measured)	• Benchmarking information to be disclosed publicly online, although no date has been specified • Benchmarking report provided to potential lessees or buyers upon request
San Francisco, CA	Existing Commercial Buildings Energy Performance Ordinance	• Non-residential buildings over 10,000 sf	• October 1, 2011: > 50,000 sf • April 1, 2012: 25,000 - 49,999 sf • April 1, 2013: 10,000 - 25,000 sf	• Mandatory annual Energy Star benchmarking for buildings more than 2 years old • Mandatory Energy Audits every 5 years for buildings more than 5 years old	• Benchmarking information is made publicly available online with a one year lag • Building owner must disclose benchmarking summary to current tenants • Audits are not disclosed and are for the building owners' use only

Table 4 (continued)
Summary of Building Labeling Programs in the United States

Location	Program Name	Types of Buildings Covered	Effective Dates	Program Requirements	Disclosure Requirements
Seattle, WA	Seattle Benchmarking and Reporting	• Non-residential buildings over 20,000 sf • Multifamily buildings over 20,000 sf	• April 1, 2012: Non-residential buildings 50,000 sf or larger • October 1, 2012: Multifamily buildings > 50,000 sf • April 1, 2013: Non-residential and multifamily buildings 20,000-49,999 sf	• Mandatory annual Energy Star benchmarking	• Data will not be reported publicly, but can be obtained through the state's Public Recornds Act • Building owners must disclose information to prospective tenants, buyers, or lenders upon request
Washington, D.C.	District Energy Benchmarking	• Public buildings over 10,000 sf • Private buildings (Commercial and Multifamily) over 50,000 sf	• 2009: Public buildings For Private Buildings: • April 1, 2013: > 100,000 sf • April 1, 2014: 50,000 - 99,999 sf	• Mandatory annual Energy Star benchmarking, including water consumption	• Information will be made available online for each building following the second annual benchmarking submission • Initial reports for buildings larger than 200,000 sf will include data for 2010-2012, and reports for buildings 150,000 to 199,999 sf will include data for 2011-2012
State of California	Bill No. 1103	• All non-residential buildings over 5,000 sq feet • All public buildings	• Public buildings since 2004 Non-residential: • July 1, 2013: > 50,000 sf • January 1, 2014: 10,000 - 49,999 sf • July 1, 2014: 5,000 - 9,999 sf	• Non-residential buildings: Mandatory annual Energy Star benchmarking • Energy efficiency tracking of public buildings (Under Executive order S-20-04)	• Non-residential buildings required to disclose benchmarking information to all potential lessees, buyers, and financers
State of Washington	Senate Bill No. 5854	• Non-residential buildings over 10,000 sq feet • Public buildings over 10,000 sq feet	• January 1, 2010: Public buildings (owned or leased by the State) > 10,000 sf Non-residential: • January 1, 2011: > 50,000 sf • July 1, 2012: 10,000 - 49,999 sf	• Mandatory benchmarking and disclosure for non-residential buildings and public buildings • Non-residential buildings: Mandatory benchmarking for the purpose of disclosing prior to a transaction (sale, lease, load/financing)	• Non-residential buildings required to disclose benchmarking information before a transaction, lease, or loan • Public buildings must publicly disclose their benchmarking data online

C. Impact of Building Labeling Policies

While building labels are intended to improve energy use and investment decisions, it is an empirical question whether they have this effect in practice. Analysis of the impact of voluntary and mandatory building programs throughout the world provides some insight into the impact of building labeling on energy use and investment.

For building label policies to generate economic benefits, they need to foster changes in occupant energy use or energy efficiency investment decisions. Evidence on the impact of these programs on energy use is very limited. The only study we are aware of that directly addresses this question is a study of the EPC program in Denmark, which found that the introduction of EPCs did not lead to any change in residential energy use.[37] Other qualitative assessments of the EPC program suggest similar conclusions about the program's effectiveness.[38] There have been even fewer assessments of the impact of U.S. building labeling programs on energy use. In part, this may be the result of the relatively recent adoption of mandatory policies. In Austin, Texas, one of the first U.S. programs, only 11 percent of residential households acted on any of the measures identified in required home energy audits.[39]

Because of the scarcity of research on the impact of building energy labels on energy use, we consider more indirect measures. In particular, existing studies have examined the link between building energy labels and property values and rents. While such a link does not mean that labels affect energy use and investment, without this link, there is little reason to think that energy label scores influence owner energy efficiency decisions.

Many studies have examined the relationship between property values, as reflected in transaction prices or rental rates, and building labels. In general, these studies find that buildings with higher label scores are associated with higher property values and rents. For mandatory programs, properties with higher ratings tend to have higher market prices or rents than properties with lower ratings. Likewise, properties certified to meet a voluntary energy efficiency standard (e.g., Energy Star) or "green" standard with an energy element (e.g., LEED) tend to have higher values or rents than properties without such certification. Table 5 summarizes some of these results, which include studies of both residential and commercial properties.

[37] Kjærbye, Vibeke Hansen, "Does Energy Labelling on Residential Housing Cause Energy Savings?", AKF Working Paper, 2008.

[38] These assessments tend to reach the conclusion that the EPC to date has had limited impact on energy use. For example, one analysis of the EPC concluded that "the EPC currently hardly plays a role in people's decision-making." Tigchelaar, Backhaus, and de Best-Waldhober (2011). These analyses tend to draw these conclusions based on interviews that largely focus on the impact of EPC's on home purchase and rental decisions, however, not decisions related to energy use and investment. See also Backhaus, Tigchelaar, and de Best-Waldhober (2011); Lainé (2011); and Amecke (2011).

[39] Novak, Shonda, "Impact of home energy audit rule less than expected," *The Austin American-Statesman*, July 16, 2010.

Table 5: Summary of Empirical Analyses of the Relationship Between Building Energy Labels and Property Values and Rents

Study	Regulation	Label	Results
Residential Properties			
Brounen and Kok (2010)	Mandatory (with partial compliance)	EPC (Denmark)	"Green" EPC label is associated with a 3.7% higher sale price ("Green" defined as scoring A, B or C on A to G scale)
Austria Department of Environment (2008)	Mandatory	EER (Australia)	Each half-star on an Energy Efficiency Rating (EER) is associated with higher home price of 1.23% (2005) and 1.91% (2006) (EER range is 1 to 6 stars)
Aroul and Hansz (nd)	Mandatory & Voluntary	Green building	Homes built to a mandatory "green" standard are associated with a 2% higher sale price
Commercial Properties			
Eichholtz, Kok and Quigley (2010a)	Voluntary	Energy Star & LEED	Energy Star rating is associated with: ▪ 10% higher rent ▪ 16% to 19% higher sale price
Eichholtz, Kok and Quigley (2010b)	Voluntary	Energy Star & LEED	Energy Star rating is associated with: ▪ 2 % higher rent (or 7% based on occupancy-adjusted rent) ▪ 13% higher sale price
Fuerst and McAllister (2011)	Voluntary	Energy Star & LEED	Energy Star rating is associated with: ▪ 4% higher rent ▪ 26% to 27% higher sale price
Kok and Jennen (2011)	Mandatory	EPC (Netherlands)	▪ Each point on Energy Index is associated with 4.7% higher rent (index ranges from 0.49 to 3.05) ▪ "Green" EPC Score is associated with 6.5% - 7.5% higher rent ("Green" defined as scoring A, B or C on A to G scale) ▪ Only 1 ot 7 EPC scores ("C" category) has statistically significant relationship with rent
Wiley, Benefield and Johnson (2010)	Voluntary	Energy Star & LEED	Energy Star rating is associated with 7% to 9% higher rent
Pivo and Fisher (2010)	Voluntary	Energy Star	Energy Star rating is associated with: ▪ 3% higher rent (based on operating income as measure of rent) ▪ 9% higher sale price (based on assessed market value as measure of price)

Notes:

Impacts reflect estimates from model specifications reported in each paper. Empirical models differ in terms of exogenous controls and model structure.

EPC - Reflects "energy index" based on modeled primary energy consumption under average conditions.

EER - Energy Efficiency Rating, reflecting the thermal performance of the building shell.

Before considering the possible implications of these studies, it is important to recognize their limitations. One key limitation is that, in general, these studies only demonstrate that higher label scores are *correlated* with property values and rents. *Correlation does not mean causality*. Thus, the studies do not indicate that the introduction of the label program led to the observed differences in property values and rents.[40]

Another limitation is that these studies do not indicate whether voluntary and mandatory programs result in qualitatively different impacts. From an economic perspective reflecting only differences in energy costs, the impact of a high energy performance score should be the same regardless of whether this score is part of a mandatory program, in which many properties receive low scores, or part of a voluntary program, in which owners of low-performing buildings simply do not pursue voluntary certification. Because a building's relative position on an energy score ranking could affect consumer preferences in "non-rational" ways, however, it is possible that the mandatory and voluntary programs could have different consequences for property valuations. Current research does not shed much light on this question.

Two other limitations are that these studies do not rule out the possibilities that (a) the information provided by building labels is already available in the market and (b) the value of label information to the market, if any, may reflect factors other than future energy savings. We discuss these possibilities below.

Do building labels provide additional information not already available to the market?

Empirical research shows that the market, to some degree, captures buildings' energy performance without building energy labels.[41] Consequently, for building energy labels to influence energy use and investment decisions, they must provide *additional* information about the property not already available in the market to potential buyers or renters.

Note that the basic empirical results reported in Table 5 showing a correlation between building label scores and property values and rents do not indicate whether labels provide additional information to the market. Consider a world in which the market already fully captures information on building energy performance and labels simply measure this performance. Then one would expect empirical results to find a correlation between building labels property values although the labels provide no new information on energy performance. In other words, the causality may run from energy efficiency to both labels and property values, providing a spurious correlation between labeling and property values.

Several studies shed some light on this issue. Two recent studies show that households with more energy efficient technologies have higher values and rents, independent of any effect from building

[40] Throughout our discussion, we are careful to distinguish correlations and associations between variables from causality, i.e. one variable directly influencing another variable.

[41] For example, see Nevin, Rick and Gregory Watson, "Evidence of Rational Market Valuations for Home Energy Efficiency," *The Appraisal Journal*, October 1998, pp. 401-409. Laquartra et al. (2002) provide a survey of relevant literature.

energy labels.[42] In one of these studies, the effect of the building label diminishes by over 60 percent after accounting for certain household energy-efficiency characteristics.[43] This result suggests some overlap between building label information and other information available to the market. Thus, the effect reported in Table 5 likely overstates the impact of labeling. Another study of Energy Star rated buildings found an association between transaction prices and building energy costs.[44] Thus, consistent with the earlier research, these results suggest that specific information about a property's energy use affects property values.[45] Thus, the amount of additional information provided by building labels is unclear.

Do building labels reflect values other than future energy savings?

From an economic perspective, building energy labels may help occupants make more economically efficient decisions about energy use. However, several empirical findings suggest that energy labels are communicating something beyond information on energy performance relevant to energy expenditures.

In an analysis of the impact of EPC labels on home prices in Holland, the effect of a higher label score is the same whether or not the analysis controls for home characteristics reflecting greater energy efficiency.[46] For example, the price of an "A" rated home is 10 percent greater than a "D" rated home, all things equal, regardless of whether the presence of central heating, insulation and exterior maintenance is accounted for in the analysis. If energy labels were communicating additional information about energy performance, then one would expect the magnitude of this effect to decline when these other measures of home energy performance were added. The fact that the effect of the EPC score remains unchanged suggests that it may be measuring characteristics other than energy performance.

Results of several studies suggest that the effect of energy labels on property values or rents exceeds the present value of future energy costs savings. A study of residential buildings in Denmark found that the premium in house sale prices from EPC labels far exceeded the underlying differences in energy expenditures.[47] Similarly, a study of U.S. commercial properties found that the estimated price

[42] Brounen and Kok (2011) account for central heating, insulation, and exterior maintenance. The Australian Department of the Environment, Water, Heritage and the Art (2008) accounts for: largest window facing north, chimney, double glazed windows, wall/ceiling vents, utility door, wall insulation, and ceiling insulation.

[43] In a study of mandatory energy labeling in Australia, residential home price was 2.5 percent higher for each additional star in a 1 to 5 star rating system, but only 0.9 percent when five household energy attributes were added to the regression. Australian Government, Department of the Environment, Water, Heritage and the Arts, "Energy Efficiency Rating and House Price in the Act," 2008.

[44] Eichholtz, Kok and Quigley (2010b) found that one dollar savings in energy costs was associated with a 4.9 percent higher transaction price. This relationship suggests that future energy savings are capitalized in the property transaction prices, with consumers discounting future energy savings at an 8 percent discount rate.

[45] It is also possible that building energy labels increase awareness of or attention to building's attributes relevant to energy performance.

[46] Brounen and Kok (2011).

[47] Brounen and Kok (2011), p. 16. For example, the premium for a property with the highest rating compared to the lowest rating is about €34,400 at the mean transaction price. By contrast, the difference in average monthly energy

premium for buildings with a voluntary energy label exceeded the underlying difference in energy savings.[48]

While these results suggest that energy labels are reflecting "something else," it is not clear what this something else is. There are several possibilities, all with different implications for energy efficiency:

1. *Indirect measure of other non-energy and non-environmental attributes.* Building energy label scores may act as an indirect signal for other features related to building quality. For example, "high quality" office buildings with many amenities may also tend to have high building energy label scores.[49] In some cases, these attributes may have direct financial consequences.[50] For these buildings, the labels may serve merely as signals of overall quality and not necessarily about energy use in particular.

2. *Environmental preferences of property owners or renters.* As compared to financial values, building owners or renters may have personal preferences for more energy-efficient or "greener" properties, which result in a premium for the most energy-efficient properties independent of the cost savings that arise from their levels of energy efficiency.[51]

bills between such properties is €126. The present value of this difference in energy bill is far less than this price premium – for example, even using a *zero* percent discount rate, the present value of these savings over 15 years is about €22,700, which is less than two-thirds of corresponding price premium at the mean. At a 3% discount rate, the savings are about €16,800, which is less than half of the price premium.

[48] Eichholtz, Kok and Quigley (2010a) find that buildings with Energy Star certification had a market premium of 16 percent or 19 percent (depending on empirical specification) relative to properties without this label. They also analyze the relationship between this market premium and the underlying Energy Star score, which ranges from 0 to 100. They find that among properties with Energy Star certification, a 10 percent increase in energy use is associated with a 0.6 percent to 1.4 percent increase in transaction price, suggesting that the 16 percent market premium reflects factors unrelated to Energy Star scores. Eichholtz, Piet, Nils Kok, and John M. Quigley, "Doing Well by Doing Good? Green Office Buildings," *American Economic Review* 100, December 2010, pp. 2492-2509.

[49] If the building label is positively correlated with aspects of the building observed by market participants but unobserved by the researcher, then the "excess" returns could reflect these unobserved attributes. To see this, consider a world in which "high quality" office buildings with many amenities also tend to have high building energy label scores. If the analyst cannot observe these "high quality" office features, then the energy label score may act as a proxy for these other building attributes, along with reflecting the office's energy performance. In this case, if the analyst observes that buildings with higher energy scores seem to have higher values, she will not be able to determine whether this is the result of energy performance, unobserved building features, or some combination of the two. Unfortunately, it is difficult to determine whether this problem is materially affecting existing research. While many studies include factors reflecting various building amenities, in general they do not provide information on quality.

[50] Energy labels may be reflecting other "green" building attributes that provide financial returns. For example, green buildings may use less water, thus lowering water utility bills. In other cases, financial benefits may be more indirect. Among the claimed benefits of "greener" buildings are increased worker productivity, reduced absenteeism, and greater building occupant comfort. "Green" buildings may also support "corporate social responsibility" objectives that potentially provide a range of benefits.

[51] This raises the question of whether labels affect decisions by highlighting attributes important to consumers, or whether labels highlight less-important attributes, thus giving them disproportionate prominence in decision-making.

3. *Behavioral biases.* A higher score on a building label could lead buyers or renters to change their valuations simply by virtue of a building's *relative* score to the extent that there is a behavioral preference for a higher position over a lower position. Such preferences could impart some prestige value for higher energy scores or negative stigma for lower scores.

D. Net Benefits of Building Labeling Policies

From an economic perspective, the decision to adopt a regulatory policy should depend on several key questions. First, does the policy create positive net social benefits? That is, do the benefits created by the policy exceed its costs? Second, does the preferred policy (or package of policies) provide greater net benefits than alternatives? Third, what are the policy's distributional and other economic impacts? Focusing on building labeling programs, we address the first two questions in this section and return to the third question in Section E.

To generate positive net benefits, a policy must create aggregate benefits that exceed the policy's aggregate costs. The key potential benefit arising from any building labeling policy is cost savings generated by partially or fully addressing market or behavioral failures that (a) prevent implementation of cost-effective energy efficiency measures and/or (b) encourage excess energy use, given the value provided by energy use to individuals and businesses. If a building labeling program succeeds in encouraging property owners to make cost-effective investments in energy efficiency and/or to use less energy, this would generate such savings. Other key potential benefits are environmental, such as reductions in GHG emissions and water pollution that result from lower energy use.

The key costs of building labeling programs are the costs for each building to comply with the program and the cost of program administration. Compliance costs will include the cost of measuring energy performance, and reporting, verifying, and periodically updating building label measurements. As discussed earlier, the stringency of these requirements could vary widely, with costs rising with: more complex/involved energy performance measurement; more stringent verification standards, such as the requirement that independent engineers verify measurements; and more frequent updating. Compliance costs could also include more diffuse costs. For example, requirements that realtors provide energy label information could lead to additional administrative costs (faced by realtors).

A building labeling program will generate positive net benefits if the sum of all benefits of the program exceeds the sum of all costs of the program. The idea is simple, but as is often the case, precise estimates of all of these benefits and costs are challenging to make.

Part of what makes these calculations challenging is uncertainty about how effective building labeling programs will be in practice. As discussed in Section III.C., experience with existing building label programs suggests that there is substantial uncertainty about whether and to what extent building labels actually lead to changes in energy use and investment. Building labels may lead to differentiation in property values and rents by energy efficiency performance. While these changes have distributional consequences, which we discuss further below, they do not directly result in any economic benefit.

That is, are labels an effort to inform decisions or to shift decisions toward choices that reflect certain (pre-chosen) values?

Unless these changes in valuation actually lead to more economically efficient energy use or investment, there are no economic efficiencies gained by introducing building labels.

The potential benefits from labeling depend greatly on program specifics. As discussed earlier, there is little direct evidence that building labels actually lead to meaningful changes in energy use or investment. Despite this uncertainty, one could expect that certain program differences would lead to lesser or greater changes in behavior and decisions.[52]

In addition to uncertainty about the level of energy savings (if any) achieved, there is uncertainty about whether any actions taken as a result of programs are cost-effective. In particular, given evidence that variation in market prices from energy labels potentially "overvalue" actual savings (and the fact that many energy labels do not convey information relevant to financial calculations), there is some uncertainty about whether changes in energy use or investment are economically efficient. In the end, determining the net benefits of a particular building labeling program is difficult. One must consider whether the program causes changes in behavior that would not have happened without the program and whether those changes create benefits that exceed the cost of making them. Programs that encourage or mandate investments to reduce energy use without regard to the costs of those investments will be unlikely to have positive net benefits. Similarly, programs that impose substantial costs on regulated owners without clear evidence that those programs will change owners' behavior will be unlikely to have positive net benefits.

Interactions between policies can also affect the level of benefits achieved by building labels. In particular, policies that overlap with quantity-based policies, such as cap-and-trade, may lead to no additional environmental benefits.[53] Because cap-and-trade limits total emissions, any policy that seeks to achieve additional emission reductions by targeting particular sources already covered by cap-and-trade will only shift emissions among sources covered by the cap, rather than reducing aggregate emissions. For states already covered by GHG cap-and-trade systems, such as California and states under the Regional Greenhouse Gas Initiative, any reductions achieved by building labeling would be offset (in full or in part) by increases from other sources covered by the emissions cap.

Even if a building labeling program creates positive net benefits, it is important to consider alternative approaches to achieving the same goal. If multiple alternative policies likely create positive net benefits, then benefits will be greatest by choosing wisely amongst these alternatives. We do not fully assess alternatives to mandatory building labeling, but offer several relevant observations about alternatives.

[52] As discussed in Section III.C, research suggests that differences in valuations associated with energy labels exceed the value of all future energy cost savings, although this research does not clearly indicate whether any "excess value" results from non-energy services, underlying environmental value, or behavioral factors. To the extent that changes in energy use and investment were motivated by any economically inefficient decisions, these would result in costs, not benefits.

[53] Schatzki, Todd and Robert N. Stavins, "Implications for Policy Interactions for California's Climate Policy," August 27, 2012; Goulder, Lawrence and Robert Stavins, "Interactions Between State and Federal Climate Change Policies," The Design and Implementation of U.S. Climate Policy, eds. Don Fullerton and Catherine Wolfram. Cambridge: National Bureau of Economic Research, 2012.

One important alternative is to continue to rely on existing market mechanisms for providing information on energy use and investment. These mechanisms include:

1. Review of electric, gas and oil bills, as provided by building owners when making purchase or rental decisions;
2. Property inspection by potential buyers and professional home inspectors when making property purchase decisions; and
3. Voluntary building labels (Energy Star, LEED, etc.) or audits, potentially subsidized through electric and gas utility programs, to identify cost-effective energy efficiency investments.

As discussed earlier, voluntary programs are in some sense a market response to an information gap on energy performance. The incremental benefits provided by a mandatory program will depend, in part, on the scope of voluntary programs that they effectively pre-empt. To the extent that voluntary programs achieve broad participation, at least by those properties with high energy performance, the goals of mandatory labels may already be partially achieved, since those who do not participate in the voluntary program effectively signal to the market their poorer energy performance.

Similarly, mandatory audit programs have the effect of pre-empting existing utility programs that subsidize energy audits. While subsidies typically result in over-supply of the subsidized good (in this case, energy audits), a mandatory program actually results in even greater excess supply, since it requires that all market participants purchase the subsidized good.[54]

E. Economic and Distributional Impacts of Building Labeling Policies

Along with considering a policy's benefits and costs, it is important to consider other economic consequences. An important concern is the set of distributional consequences that may arise if the policy has disproportionate impacts on particular segments of society.

The distributional consequences of building labels are potentially complex. In principle, mandatory building labeling will have immediate distributional consequences, as owners with "greener" properties (as measured by the energy scoring metrics) see appreciation in their asset values, while owners with other, less green properties see depreciation of their asset values. Consequently, there could be a one-time transfer of asset values among property owners depending on energy performance, as measured by the indices.

These distributional consequences could raise wider concerns. For example, if "less-green" buildings tend to be lower-valued properties owned by lower-income households, then building labels would have a disproportionate negative impact on lower-income households. Another concern could be adverse effects across entire neighborhoods (including potential "stigmatizing") or business sectors. If "less-green" properties tend to be geographically concentrated (for example, in older neighborhoods), labeling will lower property values across entire neighborhoods. On the other hand, reductions in prices or rents for lower-value properties could provide more opportunities for lower-income households or

[54] Of course, subsidized energy audits may nonetheless be an economically efficient policy if they effectively address market and behavioral failures, including those identified in this paper.

small businesses to buy or rent homes. Likewise, individual building sectors may tend to be particularly high- or low-scoring, which could have financial consequences for these sectors. The likelihood that such distributional impacts would occur depends on these relationships.

Along with transfers of asset values across property owners, there is also the possibility that building labeling could lead to an aggregate appreciation or depreciation of a city's building stock. This type of city-wide (or state-wide) aggregate effect could occur if potential buyers and renters have particularly negative responses to building labels. For example, because the impact of labeling on consumer preferences may depend on their score relative to the measurement scale, a particular scale that appears to give many properties low scores could, in aggregate, depreciate property values. For example, if the average Energy Star ESPM score for properties in a city is below 50, then reporting of ESPM scores could depreciate property values in aggregate.[55]

Another distributional issue relates to who will bear the costs of collecting, verifying and communicating information about energy efficiency. Under current market practices, property owners have the opportunity to provide such information to consumers. Mandatory building labeling effectively requires that building owners carry out such activities.[56] For smaller building owners, these costs are not immaterial if regulations require that third-party verifiers or auditors be employed; by contrast, less stringent requirements impose lesser cost impacts.

IV. CONCLUSION: LESSONS FOR FUTURE STATE OR CITY LABELING PROGRAMS

A number of states and cities have been turning to a wide range of policies and regulations to address many goals related to energy and the environment. While the potential for market and behavioral failures affecting energy performance suggests that certain policies targeting energy use may be justified from an economic standpoint, this does not mean that it is sensible to pursue any and all policies. Designing policies that effectively address these market and behavioral failures without imposing excess costs is challenging.

Our assessment of mandatory building labeling policies has identified many limitations to these policies that merit full consideration before proceeding with new programs. With building energy labeling requirements just now coming into effect in a number of cities and states, experience from these programs may provide valuable insights in the future into whether these types of requirements are an effective approach to addressing market and behavioral failures that can limit cost-effective energy efficiency investments.

[55] Of course, the reverse is also true; a score in which every property appears "above average" could lead to property value appreciation across the city.

[56] Depending on the magnitude of these costs, they could encourage renting over owning, or encourage aggregation of properties by owners that can take advantage of economies of scale in building management, including management of local regulatory requirements.

V. BIBLIOGRAPHY

Allcott, Hunt and Michael Greenstone, "Is There an Energy Efficiency Gap," *Journal of Economic Perspectives* 21(1), Winter 2012, pp. 3-28.

Allcott, Hunt, "Social Norms and Energy Conservation," *Journal of Public Economics* 95, 2011, pp. 1082-1095.

Amecke, Hermann, "The Effectiveness of Energy Performance Certificates – Evidence from Germany," Climate Policy Initiative Report, August 26, 2011.

Aroul, Ramya and J. Andrew Hansz, "The Value of "Green": Evidence from the First Mandatory Residential Green Building Program," Journal of Real Estate Research, forthcoming.

Australian Government, Department of the Environment, Water, Heritage and the Arts, "Energy Efficiency Rating and House Price in the Act," 2008, available online at http://www.nathers.gov.au/about/publications/pubs/eer-house-price-act.pdf.

Backhaus, Julia, Casper Tigchelaar, and Marjolein de Best-Waldhober, "Key Findings & Policy Recommendations to Improve Effectiveness of Energy Performance Certificates & the Energy Performance of Buildings Directive," Intelligent Energy Europe, September 2011.

Brounen, Dirk and Nils Kok, "On the Economics of Energy Labels in the Housing Market," *Journal of Environmental Economics and Management* 62(2), September 2011, pp. 166-179.

California Energy Commission, "How to Hire an Energy Auditor to Identify Energy Efficiency Projects," P400-00-001c, January 2000.

California Public Utilities Commission, "The California Efficiency Strategic Plan," September 2008.

Chetty, Raj, Adam Looney, and Kory Kroft, "Salience and Taxation: Theory and Evidence," *The American Economic Review* 99(4), 2009, pp. 1145-1177.

Davis, Lucas W., "Evaluating the Slow Adoption of Energy Efficient Investments: Are Renters Less Likely to Have Energy Efficient Appliances?", Chapter 19 in *The Design and Implementation of US Climate Policy*, Don Fullerton and Catherine Wolfram, Eds., 2012, pp. 301-316.

Dinan, T. M. and J. A. Miranowski, "Estimating the Implicit Price of Energy Efficiency Improvements in the Residential Housing Market: A Hedonic Approach," *Journal of Urban Economics* 25(1), 1989, pp. 52-67.

Eichholtz, Piet, Nils Kok, and John M. Quigley, "Doing Well by Doing Good? Green Office Buildings," *American Economic Review* 100, December 2010, pp. 2492-2509.

Eichholtz, Piet, Nils Kok, and John M. Quigley, "Sustainability and the Dynamics of Green Building," April 2010.

"Energy Efficiency: Energy Performance of Buildings," available online at http://europa.eu/legislation_summaries/other/l27042_en.htm.

"Energy Star Overview," available online at www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager#rate.

"Energy Star Portfolio Manager Quick Reference Guide," available online at http://www.energystar.gov/ia/business/downloads/PM_QuickRefGuide.pdf?fc6d-46e6.

Frank, Robert H., "Positional Externalities Cause Large and Small Preventable Losses," *American Economic Review* 95(2): 137-141, 2005.

Fuerst, Franz and Patrick McAllister, "Green Noise and Green Value? Measuring the Effects of Environmental Certification on Office Values," Real Estate Economics 39(1): 45-69 (2011).

Fuller, Merrian, et al., "Driving Demand for Home Energy Improvements," Environmental Technologies Division, Lawrence Berkeley National Laboratory, LBNL-3960E, September 2010.

Gallagher, Kelly Sims and Eric Muehlegger, "Giving Green to Get Green? Incentives and Consumer Adoption of Hybrid Vehicle Technology," *Journal of Environmental Economics and Management* 61(1), 2011, pp. 1-15.

Gillingham, Kenneth, Matthew Harding, and David Rapson, "Split incentives in Residential Energy Consumption," *The Energy Journal* 33(2), 2012, pp. 37-62.

Gillingham, Kenneth, Richard Newell and Karen Palmer, "Energy Efficiency Economics and Policy," NBER Working Paper, No 15031, June 2009.

Jaffe, Adam and Robert N. Stavins, "The energy efficiency gap: What does it mean," *Energy Policy* (1994) 22:804-810.

Jaffe, Adam B. and Robert N. Stavins, "Dynamic Incentives of Environmental Regulation: The Effects of Alternative Policy Instruments on Technology Diffusion," *Journal of Environmental Economics and Management* 29, 1995, pp. S43-S63.

Jaffe, Adam, Richard Newell and Robert N. Stavins, "The Economics of Energy Efficiency", in *Encyclopedia of Energy*, ed. C. Cleveland, Amsterdam: Elsevier, pp. 79-90.

Johnson, Ruth C. and David L. Kaserman, "Housing Market Capitalization of Energy-Saving Durable Good Investments," *Economic Inquiry* 21(3), July 1983, pp. 374-386.

Kjærbye, Vibeke Hansen, "Does Energy Labeling on Residential Housing Cause Energy Savings?", AKF Working Paper, 2008.

Kok, Nils and Marteen Jennen, "The Value of Energy Labels in the European Office Market," May 2011.

Lainé, Liz, "Room for Improvement: The Impact of EPCs on Consumer Decision-Making," Consumer Focus, February 2011.

Laquartra, Joseph et al., "Housing Market Capitalization of Energy Efficiency Revisited," ACEEE Summer Study of Energy Efficiency in Buildings, Teaming for Efficiency, Proceedings 8, 2002.

Massachusetts Department of Energy Resources, "An MPG Rating for Commercial Buildings: Establishing a Building Energy Asset Labeling Program in Massachusetts," December 2010.

Murtishaw, Scott and Jayant Sathaye, "Quantifying the Effect of the Principal-Agent Problem on US Residential Energy Use," Ernest Orlando Lawrence Berkeley National Laboratory, LBNL-59773, August 12, 2006.

Nevin, Rick and Gregory Watson, “Evidence of Rational Market Valuations for Home Energy Efficiency,” *The Appraisal Journal*, October 1998, pp. 401-409.

Novak, Shonda, “Impact of home energy audit rule less than expected,” *The Austin American-Statesman*, July 16, 2010.

Pacific Northwest National Laboratory, “A Guide to Energy Audits,” U.S. Department of Energy, Building Technologies Program, PNNL-20956, September 2011.

Palmer, Karen L. et al., “Assessing the Energy-Efficiency Gap: Results from a Survey of Home Energy Auditors,” *Resources for the Future Discussion Paper No. 11-42*, October 4, 2011.

Pivo, Gary and Jeffrey D. Fisher, "Income, Value, and Returns in Socially Responsible Office Properties," The Journal of Real Estate Research 32(3): 243-270 (2010).

Residential Energy Services Network, Inc., “National Average Cost of Home Energy Ratings,” Feb 27, 2009.

Schatzki, Todd and Robert N. Stavins, “Implications of Policy Interactions for California’s Climate Policy,” August 27, 2012.

Schultz , P. Wesley et al., “The Constructive, Destructive, and Reconstructive Power of Social Norms,” *Psychological Science* 18(5), 2007, pp. 429-434.

Shogren, Jason F. and Laura O. Taylor, “On Behavioral-Environmental Economics,” *Review of Environmental Economics and Policy*, 2008, pp. 1-20.

Tigchelaar, Casper, Julia Backhaus, and Marjolein de Best-Waldhober, “Consumer Response to Energy Labels in Buildings,” Intelligent Energy Europe, September 2011.

“US Green Building Council,” available online at http://new.usgbc.org/home.

Wiley, Jonathan, Justin Benefield, Ken Johnson, "Green Design and the Market for Commercial Office Space," Journal of Real Estate Finance Economics 41: 228-243 (July 2008).