Energy Efficiency Labeling for Real Estate:
A Literature Review Addressing Four Policy-Relevant Issues

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Executive Summary

There is increasing interest in developing information about a building's energy efficiency and making that information available to the participants in real estate transactions involving the building. The rationale is generally the same for both residential and commercial properties: information suggesting that a building is energy-efficient will indicate to prospective purchasers that the property will have lower operating costs and perhaps other amenities, and purchasers will be willing to pay a higher price in recognition of these benefits. The owner/potential seller of a building will thus recognize a dual value in making investments to improve the energy efficiency of his building: not only will the owner get the benefits of the reduced operating costs and other potential amenity values during the time while he remains the owner, but the owner will also gain a higher selling price when he sells into a market that recognizes the capitalized value of the ongoing stream of these reduced operating costs and amenities. The purchaser of the building, if the label includes information such as an energy audit indicating what can be done cost-effectively to increase the building's energy efficiency, will also have a helpful road map suggesting high-payoff investments that he may wish to make in his new purchase. Labeling or somehow otherwise making apparent to the market the energy efficiency of buildings will thus encourage energy conserving investments in buildings, which in turn will save money, reduce emissions of greenhouse gasses and other pollutants, and contribute toward energy independence for the U.S.

The following are a few among the many recent developments involving energy efficiency labeling for buildings:

- A growing number of homebuilding companies have committed to estimating the expected energy performance of their new homes using the Home Energy Rating System (HERS) and then marketing the homes using this rating. More than one million new homes have been rated using HERS since 1995.

- Since June of 2009, Austin, TX has required homes more than 10 years old to undergo an energy audit before they are sold, with the audit results to be provided to prospective purchasers. Other jurisdictions have considered or are considering a variety of similar audit and/or upgrade requirements applicable at time of sale or lease.

- The U.S. Department of Energy (DOE) has developed a Home Energy Score for rating the energy efficiency of an existing home in comparison to its peers, and is implementing a program to make the scoring system available throughout the U.S. A certified "Assessor" working through one of more than 25 DOE "Partners" (utilities, State and local governments and non-profits, now covering much of the country) will evaluate and score a home when the homeowner requests an assessment, providing the homeowner with both the comparative score and a report indicating cost-effective measures the homeowner might undertake to improve his home's score. More than 16,000 homes have been scored as of January, 2015.

- In the U.S., mandatory energy rating and disclosure requirements are more common for commercial buildings than for residential buildings. The States of California and

Washington, Montgomery County (MD) and the cities of Boston, Chicago, New York, Minneapolis, Philadelphia, San Francisco, Seattle and Washington, D.C., have adopted mandatory energy scoring, benchmarking or labeling requirements for various sorts and sizes of commercial buildings. Most of these programs require use of the U.S. Environmental Protection Agency's (EPA's) Energy Star Portfolio Manager software and the Energy Star rating scale. Many other jurisdictions are considering similar requirements.

- LEED certification for a building addresses energy efficiency as well as other green or sustainable attributes.[1] More than 8 billion square feet of commercial and institutional properties are now participating in the LEED rating systems, and more than 83,000 homes have been certified or registered under LEED. LEED credentials are regarded as very helpful to selling or leasing these properties.

- The European Union (EU) and Australia have adopted policies requiring disclosure of energy efficiency information at the point of sale for both residential and commercial properties. While progress in implementing these programs has been uneven, the Netherlands, Denmark, Great Britain, Germany and two Australian States or Territories now have at least several years of experience with very large mandatory labeling and disclosure programs. In the European Union, Australia, and several smaller countries, energy labeling and disclosure for buildings has been adopted as a key policy measure toward achieving international commitments for greenhouse gas emissions reductions.

This paper examines several policy issues associated with this growing trend toward energy efficiency labeling of residential and commercial properties. We pose four sets of questions regarding energy labeling, and review all the available, relevant literature from the U.S., Europe and Australia to answer the questions. In general, there has been more experience with energy labeling of residential properties and more studies reviewing this experience in Europe and Australia than in the U.S., while the opposite is true regarding energy labeling for commercial properties. The four sets of questions and our conclusions on each are as follows.

1. <u>Impact of energy efficiency labeling on the market value of labeled properties</u>

Is a property's market value affected by making information available on the property's energy efficiency? Does disclosure of energy efficiency information affect variables in addition to property values that are also important in real estate markets, such as length of time on the market or vacancy rate for properties to be leased? What studies or other evidence exists on these questions?

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[1] LEED and several other varieties of "green" certification for residential or commercial properties are not, strictly speaking, energy labels. On average, roughly half of the scoring points that buildings typically attain in order to qualify for LEED certification derives from features of the buildings relating to energy efficiency. The remainder of what qualifies most buildings includes water efficiency, use of sustainable building materials, indoor environmental quality, and more. Energy efficiency is very important, but not all that is needed in order to qualify a building for LEED certification. We nevertheless include LEED and similar green certifications in this paper in examining the market response to energy labels. We believe that the market responds similarly in most respects to green certifications as it responds to energy labels, and research relating to green certifications is thus often relevant to energy labels also. We will note when we believe there are significant differences between the market responses to energy labels and to green certifications.

Energy labels or scores for properties have consistently been found to generate a significant market response. Relative to unlabeled but otherwise comparable properties:

- Energy-efficient properties that receive a favorable label or better score receive a premium in the market;

- Energy-inefficient properties that receive an unfavorable label or lower score get discounted in the market.

There are a few areas around the world where energy labeling programs have existed for sufficient time and sufficient data has been generated to allow researchers to investigate the impact of a property's energy efficiency and its corresponding label or score on the property's value. Researchers in these studies use statistical techniques to estimate the separate impacts of various key factors -- the property's location, size, age, quality, amenities, etc., as well as the property's energy label or score -- on a property's market value. Good quality statistical studies in California, three U.S. cities, the Netherlands, Australia, Great Britain and Japan have found that a favorable label for a highly energy-efficient home increases the home's market value by roughly 2 - 9 % relative to an otherwise comparable home of average energy efficiency. Three methodologically weaker studies in the U.S. found a labeling premium for energy-efficient homes ranging from 2 - 30%, while another methodologically questionable U.S. study found that labeled properties were discounted by 2.5%.

Findings have been roughly similar in the larger number of good statistical studies investigating the impact of energy efficiency and energy labels on the market value of commercial properties, mostly office buildings. Each of the six good quality studies in the U.S. finds a significant average market premium for green-certified or favorably energy-labeled office buildings (LEED or Energy Star) relative to otherwise comparable non-labeled office buildings, in the form of higher rents, lower vacancy rates, higher sales prices, and/or higher effective rents. The magnitude of these premiums for favorably energy-labeled office buildings appears to have declined with the recession and the weakening market for office space, but these premiums still remained significant through the end of 2009, when the best of the relevant studies closed. As an average over the period from 2004 through 2009, most of the studies found that the average rent per square foot in Energy Star-rated office building ranged from about 1% to 4% higher than that for a comparable non-rated building. The premium in terms of effective rent for an Energy Star-rated building was even higher than this because the Energy Star buildings had generally higher occupancy rates. In terms of sales prices per square foot, Energy Star-rated office buildings showed average sales prices roughly 8% to 16% higher than those for comparable non-rated buildings. The studies found that the rental and sales premiums for LEED office buildings typically exceeded those for Energy Star-rated buildings.

Several studies of energy labels for office buildings in Great Britain, the Netherlands and Australia provide evidence that energy-efficient, labeled properties accrue market premiums in rent, sales price and overall value similar to those demonstrated in the U.S.

In sum, there are many studies providing very strong evidence that both residential and commercial office space markets in the U.S. and elsewhere give a significant premium to buildings that have labels suggesting relatively high energy efficiency. The increase in a property's market value associated with a favorable energy score or label can be substantial; sometimes exceeding a 10% premium.

2. <u>Impact of energy labeling and disclosure programs in encouraging energy-saving investments</u>

How well have energy labeling and disclosure programs worked? Have labeling and disclosure encouraged property owners to make investments in energy efficiency in anticipation of realizing a higher market price when the property is sold? And, perhaps additionally, have the energy audit reports or other materials accompanying many energy labels encouraged the new purchasers of a property to make investments in energy efficiency that they otherwise might not have made?

In our view, the record here is disappointing. Energy labeling and disclosure programs have not elicited the improvements in energy efficiency that the proponents of these programs have hoped for.

We have reviewed numerous studies that have evaluated the impact of energy labeling programs on the use of energy in buildings or on the rate at which building owners have implemented energy-saving investments. Most of these studies evaluate experience in Europe and Australia, since labeling and disclosure programs have been more prevalent and have been operated for much longer in these other parts of the world than in the U.S. Most notably, the European Union has conducted a large, three-year evaluation of progress as its 28 member nations have developed and implemented energy labeling and disclosure programs as the EU requires.

Government programs that have required or encouraged property owners to obtain energy scores/labels have obtained disappointing results in the degree to which these programs induce property owners to undertake additional energy-conserving investments. While the market value of homes or office buildings does appear to respond as expected to energy labels, the owners of labeled properties have changed their behavior very little to take advantage of the seemingly attractive financial returns from undertaking additional energy efficiency upgrades. In general:

- Homeowners don't appear to significantly increase their energy-conserving investments in order to generate a better score/label and resulting higher sales price when they eventually sell;

- Recent homebuyers don't appear to implement to any significant degree the energy-conserving investments that have been suggested to them in connection with the scores/labels for their newly purchased homes. (Most programs involving scores/labels at time of transfer include for the purchaser a list of recommended energy efficiency upgrades that is tailored specifically for that particular home.) This is true even though many of the suggested upgrades would pay for themselves very quickly in the form of reduced energy costs.

A large study in Denmark that tracked energy usage in nearly 4,000 homes for four years following their sale found no statistically significant reduction in energy use for labeled homes relative to unlabeled homes. The author concluded that "We do not find significant energy savings due to the Danish Energy Labeling Scheme." (Kjaerbye, 2008)

In 2002, the European Union adopted the Energy Performance of Buildings Directive, which, among other things, requires member nations to implement energy labeling programs for most residential and commercial buildings upon construction, sale or rental. The required label, or Energy Performance Certificate (EPC), is to display the energy performance of the building and to compare it against the performance of other buildings of the same sort. In 2011, the EU completed a three-year review of the effectiveness of member countries' EPC programs. The review, known as the IDEAL-EPBD project, was explicitly aimed at understanding the apparent lack of success that EPCs have had in motivating homeowners to improve the energy efficiency of their dwellings:

> "In countries where the directive has been implemented for a while, the energy label hardly seems to motivate people to improve the energy performance of their dwelling. At the same time, however, improving the dwelling based on the label and the advice given can save the new owner large amounts of money in the long term. The IDEAL-EPBD project was investigating why the response of households towards the energy label is limited so far:
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> - What are the reasons behind whether or not homeowners take the energy label into account?
> - What are the reasons behind whether or not homeowners take the additional proposed measures?" (Intelligent Energy Europe, 2012)

The final report from this performance review of European energy labels concluded:

> "More than one hundred in-depth interviews and a large-scale survey among more than 3000 homeowners revealed how little impact the Energy Performance Certificate (EPC) currently has on home owners' decision-making. … Many reasons for this lack of impact have been identified, for example lack of availability, lack of awareness, and lack of understanding. One approach to tackle these issues is, of course, to increase the visibility and availability of the EPC. However, this does not mean that people will pay more attention to it, take it more into consideration and that it therefore will have more impact. For this to happen, the EPC needs to provide the kind of information that is most meaningful and relevant to people. …
>
> The current impact of EPCs during home purchasing is low, but it can be increased by making the EPC better available and providing more useful and meaningful information…
>
> The current impact of EPCs during home improvements is low, but it can be increased by making the EPC better available and providing improved and trustworthy information. Survey and interview findings show that the EPC plays only a minor – if any – role in homeowners' decision-making regarding home improvements. The most important factors influencing people's considerations are the age and condition of their dwelling, comfort and financial issues." (ECN, 2011)

Similar conclusions have been reached in Australia regarding the low impact of energy labels in encouraging homeowners to implement energy conserving investments.

One study of the impact of municipal energy benchmarking and disclosure requirements for commercial buildings in four large U.S. cities found a small (2%, but statistically significant) reduction in utility costs some 1 - 3 years following implementation of the requirements. The authors attribute this reduction to the heightened attention that commercial building owners gave to energy costs following benchmarking. We speculate that this reduction in utility costs likely occurred as a result of relatively quick and easy behavior changes (e.g., moderating thermostat settings) that owners may have implemented following scrutiny of their utility bills. We expect that any reductions stemming from new investments in energy efficiency, if they occur, will take longer to emerge.

In sum, energy labeling and disclosure programs as they have been designed and implemented thus far have obtained disappointing results by prompting little in the way of additional energy conserving activities from homeowners. These disappointing results are similar to what has typically been obtained from other sorts of programs aiming to encourage homeowners to reduce their energy use, including subsidies, cost-sharing, loans, technical assistance, free audits, behavior-based strategies (e.g., social marketing, goal setting, smart meters, benchmarking, rewards), and more. (Although behavior-based strategies appear to be showing better results recently.) It appears exceptionally difficult by any means to motivate homeowners to significantly change their energy-using behaviors or to accelerate their investments in energy efficiency upgrades. Owners of commercial buildings may perhaps be somewhat more likely than home owners to implement energy efficiency measures in order to capture some of the increased market values (e.g., rents, property values) that result.

3. <u>Could an energy label serve to reduce a property's market value?</u>

Could an energy label have a negative rather than a positive effect on a property's market value? Nearly all of the studies from around the world that we have reviewed suggest that a label or certificate indicating that a home or office building is energy-efficient will increase the labeled property's market value. Could the inverse be true also -- will a label indicating that a property is energy-inefficient serve to decrease the property's market value?

Certainly. Just as information suggesting some desirable quality of a property is likely to increase the property's market value, information suggesting some undesirable aspect of the property will tend to decrease the property's value. For example, there are many studies documenting a loss in market value -- sometimes substantial -- for properties with perceived environmental faults. In the body of this report we provide examples of studies quantifying the loss in value that properties suffer from a variety of environmental problems, including air and water pollution, proximity to hazardous waste sites, lead paint, mold, radon, and more. In a parallel manner, any information suggesting that a property is energy-inefficient, whether that information comes in the form of an energy label or in some other manner, will also tend to decrease the property's market value.

Many of the energy labels or certifications or ratings that we discuss in this paper provide only positive or favorable information about the energy efficiency of a property. Many programs identify and then label, rate or certify only particularly energy-efficient buildings or, more broadly, particularly "green" buildings: Energy Star, LEED, Green Building Standard, Earth

Advantage, Built Green, EarthCraft House, BREEAM (U.K.), Green Globes (Canada, U.S.), Green Star (Australia), EnerGuide (Canada), Green Mark (Singapore) and more. These labels are conferred only on exemplary buildings. They are "unidirectional" in the sense that they convey only good, favorable information about a labeled building. These labels are intended to draw attention to and validate positive features of a building and, as such, they can only increase the market value of a building that has been awarded the label. Virtually all of the studies that we have reviewed confirm that these unidirectional labels do in fact serve to increase the market value of the select buildings that receive these labels.

Other sorts of energy labels or certifications or ratings, however, may be "bi-directional" in the sense that they can provide either positive or negative (or neutral) information about a labeled building. A label can be bi-directional only if both energy-efficient and energy-inefficient buildings are labeled -- the energy-efficient buildings will receive favorable labels or ratings and their market values will presumably increase, while the energy-inefficient buildings will receive unfavorable labels or ratings and their market values will presumably decrease. In practice, a label can function in a bi-directional manner only if inefficient as well as efficient buildings are *required* to be labeled. If labeling is optional, only the owners of energy-efficient buildings will seek to have their buildings labeled. Owners of inefficient buildings will not choose to have them labeled since doing so will reveal the buildings' inefficiency and reduce their value. To answer the primary question we posed in this section, then, an energy label can have a negative effect on the value of a property only when all buildings of some sort (e.g., all single-family homes, all office buildings, all large apartment buildings, all new homes, etc.) are required to be labeled -- such a label will function in a bi-directional manner and energy-inefficient properties will lose value while energy-efficient properties will gain value.

The two perhaps most widely used bi-directional energy labels are:

- The European Community's Energy Performance Certificate (EPC), which for most EU countries is formatted as a letter grade for the building ranging from A (shown in green, highly energy-efficient) through D (shown in yellow, roughly average energy efficiency) down to G (shown in red, very poor energy efficiency). Most EU countries' EPCs also include an energy efficiency score for the building ranging from 0 (highly energy-inefficient) to 100 (highly efficient) as well as the letter grade.

- The Energy Efficiency Rating (EER) in Australia. This rating is denominated in stars, with a highly inefficient building receiving zero stars, the very most efficient buildings (net zero energy consumption) receiving ten stars, and most buildings with intermediate efficiency receiving between one and four stars. Several different software packages have been approved for use in Australia to assess the energy efficiency of a building and determine the number of stars at which it should be rated.

Four studies have quantified the substantial loss in value that energy-inefficient properties have incurred under these bi-directional label programs:

- Brounen and Kok (2010) studied the impact of the Netherlands' EPC on the values of nearly 32,000 homes sold during 2008 and 2009. They found that the label decreased the value of the most energy-inefficient homes (label category G) by an average of 4.8%

relative to otherwise comparable homes in the middle efficiency category (label category D). In equivalent U.S. dollars, the average loss in market value for these highly inefficient homes was $14,000 to $17,300. Other inefficient homes (label categories F and E) also lost value relative to otherwise comparable middle-efficiency homes, but by lesser amounts.

- Kok and Jennen (2011) similarly studied more than 1,000 leasing transactions in EPC-labeled office buildings in the Netherlands between 2006 and 2010. They found that buildings with “non-green” labels (categories D, E, F and G) rented for 6.5% less per square meter than offices with “green” labels (categories A, B and C). In equivalent U.S. dollars, the average rent for “non-green” labeled offices was $1.40 per square foot less than that for otherwise comparable (in terms of location, age, quality, amenities, and all other attributes except for energy efficiency) “green” labeled offices.

- The Australian government (DEWHA, 2008) studied the impact of mandatory energy labeling on the value of more than 5,000 homes sold in Australia’s Capital Territory (Canberra and suburbs) during 2005 and 2006. They found that homes with the lowest energy efficiency rating (zero stars) sold for an average of 6.36% less than otherwise comparable homes with median energy efficiency (2 star rating). In equivalent U.S. dollars, the loss in market value for these highly inefficient homes was $24,000 to $32,000.

- Fuerst, et al (2013) evaluated the impact of the letter grade assigned as a part of Great Britain’s EPC on sales prices for homes in England and Wales from 1995 through 2011. The researchers’ database included more than 320,000 homes that had been sold at least twice during this period, representing approximately a 10% random sample of such homes in England and Wales. They concluded that a G label reduced a home’s value by an average of 7.6% relative to an otherwise comparable but D-rated home, while an F label reduced this value by 1.6%. Relative to an estimated average home price of about £180,000 for a British home with average energy efficiency, the 7.6% loss incurred by an inefficient home that receives a G label would amount to roughly $20,000 to $28,000 at the home prices and exchange rates prevailing during much of that period. This amount would again represent a substantial loss in value due to the mandatory labeling program for owners of inefficient homes.

These studies demonstrate that the market substantially devalues energy-inefficient homes or office buildings that are labeled in a manner that indicates their inefficiency.

In the U.S., in contrast to Europe and Australia, there is no bi-directional energy label that has been very widely used, either for commercial or for residential buildings.

This situation may be changing for commercial buildings in the U.S., however. Several State and local governments (the States of California and Washington, Montgomery County (MD) and the cities of Boston, Chicago, New York, Minneapolis, Philadelphia, San Francisco, Seattle and Washington, DC.) have recently begun to require owners of some types of commercial buildings to develop energy efficiency ratings for these buildings and to disclose the ratings in various ways. In these several jurisdictions, all buildings of the specified types, whether energy-efficient or energy-inefficient, must be labeled, typically based on USEPA/DOE Energy Star calculation software. In these instances, after the market begins to recognize the publicly disclosed rating that a building receives, the label may begin to function in a bi-directional manner, probably increasing the value of energy-efficient buildings and reducing the value of energy-inefficient buildings. However, there have not yet been any studies evaluating the market impacts from labeling in the jurisdictions with programs such as these that could be considered bi-directional label programs.

In most instances throughout the country neither the State nor local government has mandatory energy rating and disclosure requirements for commercial buildings. Owners of relatively inefficient commercial buildings choose not to seek any of the nationally available voluntary labels. Energy Star, LEED and other energy certifications available for commercial buildings in the U.S. serve almost always as unidirectional, positive labels. There is no record yet of commercial buildings in the U.S. losing value because of energy labeling -- nor should there be any such record with labeling in nearly all jurisdictions being voluntary until recently.

The situation is similar with respect to labeling for residential buildings. Only a very few U.S. jurisdictions require owners of larger multifamily residential buildings to calculate and disclose energy efficiency ratings, typically using Energy Star software. In the great majority of jurisdictions, the owner of a multifamily residential building can choose whether he wishes to seek an energy certification or not. Certification is also optional for single family homes in virtually all jurisdictions in the U.S.

There are, however, several recent developments that could perhaps lead eventually to the widespread use of bi-directional energy labels for residential properties in the U.S.:

- Austin, Texas requires older homes to undergo an energy audit prior to sale, with the results of the audit required to be provided to potential purchasers. The audit information and report presumably serves as a sort of bi-directional label -- homes with high energy efficiency, low projected energy costs and energy audits that find relatively little that should be done will presumably gain value in the market, while inefficient homes with a lengthy list of suggested audit upgrades will presumably lose value. A few other communities are considering similar requirements as Austin's.

- Many builders have begun to label all their new homes so as to indicate to a prospective purchaser how much the owner of the new home will likely spend for energy costs and how these costs might compare against energy costs for other comparably sized new homes. These labels for new homes are likened to the familiar fuel economy labels for new vehicles. Some builders have presumably chosen to use this sort of energy label because they believe it will increase the value of their labeled homes; they intend the label as unidirectional and positive. It is easy to envision, however, how this sort of label could be used in a bi-directional manner -- for example, if more jurisdictions were to require that a label be developed and displayed for *all* new homes (Santa Fe, NM already does), or for *all* new and existing homes upon listing for sale. In either of these cases, the mandatory nature of the label would result in a bi-directional impact as energy-efficient homes that are labeled would gain in value while energy-inefficient homes that are labeled would lose value.

- The Department of Energy (DOE) has developed a Home Energy Score (HES) and label that can be used to rate and label homes ranging anywhere from highly inefficient to highly efficient. DOE hopes that State and local governments will adopt HES as a basis for either voluntary or mandatory labeling and disclosure programs for new and existing homes. The HES could serve as a bi-directional label in any jurisdiction that adopts it on a mandatory basis.

Since no mandatory, bi-directional energy labeling programs have yet been adopted and then assessed in the U.S., there is no evidence in U.S. residential markets of an energy label causing a decline in the value of some sorts of homes. The evidence from several studies in foreign countries, however, is clear: homes and commercial properties that are relatively energy-inefficient will suffer a decline in value if they are labeled in a manner that makes their energy-inefficiency apparent to the market.

We are concerned about this negative impact that a mandatory and thus bi-directional labeling program would likely have on the value of relatively energy-inefficient labeled buildings. Lower income neighborhoods or cities with a preponderance of older, non-renovated, and thus energy-inefficient homes could see a substantial community-wide decline in property values if a mandatory, bi-directional energy labeling program were implemented. Commercial buildings in older, non-renovated business areas could suffer similarly.

4. <u>Stigma associated with a negative energy label</u>

Could a property receiving an unfavorable energy-efficiency rating be stigmatized, and suffer a loss in market value that substantially exceeds the capitalized cost of the additional energy the inefficient property is likely to use?

Yes. Many studies indicate clearly that a favorable or positive energy label or rating (i.e., representing the property as energy-efficient) will, on average, increase the property's market value. The opposite clearly appears to be true also: an unfavorable or negative energy label, signifying that the property is energy-inefficient, will on average decrease the property's value.

Does the gain or loss in market value from a positive or negative energy label accurately reflect the objective information on the property's likely future energy use that underlies the label? Does the gain in market value for a favorably labeled home match the value of the underlying future stream of energy cost savings that the favorably labeled home is likely to accrue relative to a home of average efficiency? Does the loss in market value for an unfavorably labeled office building roughly match the cost of the additional energy that the owners and tenants of this building are likely to use in the future? Is there any sort of systematic difference between the market's response to an energy label and the value of the energy cost differentials underlying the label?

We are going to use the terms "cachet" and "stigma" to represent the portion of any market response to an energy label that exceeds the value of the underlying future energy cost differentials signaled by the label. We say that an energy label involves some amount of positive "cachet" when the gain in market value that an energy-efficient property receives after being given a favorable label exceeds the capitalized value of the energy cost savings the efficient property will accrue relative to an otherwise comparable unlabeled property of average efficiency. The same energy label might also create some amount of negative "stigma" for a different set of properties -- for energy-inefficient properties when the loss in market value resulting from a negative/unfavorable energy rating exceeds the capitalized value of the additional energy costs that an inefficient property will accrue relative to a comparable unlabeled property of average efficiency. Cachet and stigma are two sides of the same coin: an energy label may create cachet for some properties and stigma for others whenever the market interprets a bi-directional energy label as signifying something additional about a labeled property beyond whether the property's future energy costs will be low or high.

Several studies evaluating the market response to particular energy labels provide sufficient information for us to determine whether cachet and stigma occur for these labels. The following table shows the results of five analyses in which the market response to an energy label is compared against the value of the energy cost differentials underlying the label. The conclusion is the same for each of the studies: cachet and stigma do in fact occur since the market response to each label (the second column) exceeds the value of the energy cost differentials underlying the label (the third column). And, a further, perhaps more surprising, conclusion is that the magnitude of the cachet and stigma response to each label (with the exception of one of the Netherlands scenarios) is so large as to exceed the objective value of the energy costs or savings signified by the label. Most of the market response to each of these energy labels consists of cachet and stigma; only a minority of the market response to the label consists of an economically rational valuation of the energy cost differentials signaled by the label.

Five Analyses Evaluating Impacts of Energy Labels	Value of the Label as Established in the Market (A)	Capitalized Value of Difference in Energy Costs (B)	% of Market Impact that is Due to Cachet and Stigma (A-B)/(A)
1. Gain or loss of 1 Star in energy rating (EER) for a median Australian home	±12,822 to 19,808 AUD	±4,193 AUD	67 to 79%
2. Netherlands: A-labeled (very efficient) home relative to G-labeled (very inefficient) home F-labeled (inefficient) home relative to G-labeled (very inefficient) home	+ €34,378 + €5,768	+ €14,190 + €3,548	59% 38%
3. Green-labeled (LEED, Energy Star, Green Point) homes in California	+8.7%, or $34,800 relative to average home price of $400,000	≤ $14,400	≥ 58%
4. Energy Star and 2 local certifications for single-family homes in Austin (TX), Portland (OR) and Research Triangle (NC)	Varies with the certification, city and home vintage. One example: Energy Star in Austin for older homes was worth +5.8% ($14,504) or $2,387/yr	Varies. For the Austin example, $323 to $697/yr	66 - 97%. For the Austin example: 71 to 86%
5. Energy Star office building in U.S. compared w/non-certified and less efficient but otherwise comparable office building	8 to 26% higher value for Energy Star bldg. Best estimate: 14% premium in value, roughly $37.50/sq ft	+$5.90 to $9.10/sq ft	76 to 84%

One might view this large cachet and stigma effect as suggesting that the market typically over-reacts to these energy labels, making more of the label than what the label objectively means in terms of a property's energy costs. Alternatively, one could view this as evidence that the market ascribes substantial value to some attributes of a property other than energy costs that may also be suggested by the energy label. Perhaps the market interprets a favorable energy label as suggesting that the labeled home will be comfortable as well as energy efficient, with no drafts and an even distribution of heat. Or perhaps the market interprets a favorable label and expected low energy consumption as indicating that a home has been well maintained and that future repair and maintenance expenditures for all purposes are likely to be low for the home. Or perhaps a prospective purchaser of a home with a favorable energy label recognizes that the label means the home causes relatively few greenhouse gasses to be emitted, and the prospective purchaser assigns some value to minimizing his carbon footprint and is willing to pay an increased price for the home in recognition of this. In sum, we don't know exactly why large amounts of cachet and stigma appear to be generated by energy labels, and whether the substantial market reaction to energy labels represents an overreaction or instead is justified in some objective sense. This is a topic worthy of further research.

The existence of substantial cachet or stigma associated with an energy score or label has both benefits and costs. To the extent that cachet or stigma increase the market value impact of an energy score/label, the desired incentive effect of the score or label in encouraging energy-conserving investments is increased. (Although, in answer to the second question posed in this paper, this incentive effect appears in practice often to be insufficient to prompt significant investments by the property owner in energy efficiency.) On the other hand, a large stigma impact for energy-inefficient properties receiving a poor score/label will increase the painful loss in property values that will ensue if labeling occurs in poorer communities that have older, non-renovated housing.

The potential stigma impact of an unfavorable energy score or label seems perhaps similar to "environmental stigma" issues that have been widely studied in the real estate valuation literature. Such environmental contamination problems as proximity to hazardous waste sites, radon, lead paint, asbestos, and air and water pollution have been found to reduce property values both as a result of explicit quantifiable impacts (e.g., expected costs to remediate the problem, quantified and monetized values of the health risks likely to result from the problem) and due to an additional, unexplained "stigma."

The design and appearance of an energy score or label likely have much to do with whether the score/label generates substantial cachet and stigma beyond the impact reflecting the property's underlying energy costs. Many energy score/label systems that are in current usage appear as if they provide some sort of comprehensive judgment on the overall quality of a property; suggesting something about the general desirability of the property in addition to providing information about the property's energy efficiency. In our opinion, several of the most widely used energy labels have design attributes that seem likely to generate substantial cachet and stigma:

- In most of the European Union building label schemes, energy-efficient properties receive ratings that are shown in green color with letter grades A, B or C, while inefficient properties get labeled in red color with letter grades E, F, or G. The green/red color scheme perhaps suggests to some potential purchasers either to go or to stop when considering purchasing the labeled property, while the green labels additionally suggest that energy-efficient properties may be ecologically desirable in general ("green"). The letter grades suggest school report cards -- presumably no one would like to be given a grade of E or F when buying a house, and labeling a home in this manner likely causes a further decline in its value.

- In Australia, energy-efficient properties can get labeled with five to ten stars, while particularly inefficient properties will be labeled with zero or one star. This star-denominated labeling system may suggest in the mind of a prospective purchaser a variety of other instances in which getting zero stars is bad and getting many stars is good: in rating movies, in rating hotels, in rating public restrooms, in rewarding good behavior and scoring homework in elementary school.

- In the U.S., the LEED system aims to provide recognition (certified, silver, gold, platinum) for properties that are exceptional across multiple dimensions of sustainability, with energy efficiency being only one dimension. The scoring system underlying the gradations of LEED recognition is obscure and few individuals who might consider purchasing or renting in a LEED building are likely to understand exactly what a LEED certification means. Most individuals, we expect, would interpret a LEED certification as meaning simply that the LEED building is ecologically superior but would have difficulty in citing the more specific attributes, including energy efficiency, that are promised by the label.

The label design for DOE's Home Energy Score (HES) labeling system, in contrast, seems relatively straightforward in providing information about likely energy usage and costs in the labeled home without suggesting anything additional that is positive or negative about the home. In this respect, the HES label seems parallel to the miles per gallon fuel efficiency stickers applied to new vehicles and to the EnergyGuide stickers for new appliances. None of these labels should generate much in the way of cachet and stigma, we expect.

We believe there are several reasons why jurisdictions considering a mandatory energy label and disclosure requirement for residential or commercial properties might wish to design the label so as to minimize cachet and stigma:

- Cachet and stigma cause the market impact of a label to exceed the value of the energy cost differential underlying the label. Those who are designing an energy labeling program should be concerned about both the effectiveness and the accuracy of the label. The intended purpose of an energy label is to make the energy consumption characteristics of a property apparent to the market and to encourage building owners and purchasers to make cost-effective energy conservation investments. The more effective the label is in generating a market response -- an increase or decrease in the value of the labeled property -- the greater will be the incentive for energy-conserving investments. However, an energy label that is effective in generating higher market values and higher purchase prices for positively labeled properties will eventually lose this effectiveness and come to be viewed as inaccurate and deceptive by the market unless favorably labeled properties do in fact provide the energy cost savings that are implied by their labels. Cachet and stigma cause the market impact of a label to diverge from and exceed the value of the underlying energy cost savings or penalties. If the cachet and stigma impacts created by a label are substantial this divergence will be large, leading inevitably to a growing sense that the label has been deceptive.

- The research we have reviewed indicates that "bi-directional" energy labels are likely to increase the market value of positively labeled, energy-efficient properties, and to decrease the market value of negatively labeled, energy-inefficient properties. We are concerned about the loss in market value that properties receiving an unfavorable or negative rating on an energy label will incur. If the loss in market value includes not only some reflection of the property's higher future energy costs, but also an additional large penalty due to an intangible "stigma" associated with the negative label, the decline in market value could be substantial and problematic. Entire neighborhoods or commercial sections of cities that have concentrations of older, non-renovated and perhaps poorly maintained buildings, which are generally energy-inefficient and which receive predominantly negative energy labels, could be stigmatized and suffer large declines in real estate market values. Declining real estate values, as we know from the past several years of experience in much of the U.S., can cause a variety of social and economic problems. We are concerned about this “downside” from mandatory energy labels. The magnitude of the downside could be greatly increased if a negative or unfavorable label causes a substantial stigma impact in addition to reflecting the discounted present value of the future stream of higher energy costs in an energy-inefficient building.

Introduction

There is increasing interest in developing information about a building's energy efficiency and making that information available to the participants in real estate transactions involving the building. The rationale is generally the same for both residential and commercial properties: information suggesting that a building is energy-efficient will indicate to prospective purchasers that the property will have lower operating costs and perhaps other amenities, and purchasers will be willing to pay a higher price in recognition of these benefits. The owner/potential seller of a building will thus recognize a dual value in making investments to improve the energy efficiency of his building: not only will the owner get the benefits of the reduced operating costs and other potential amenity values during the time while he remains the owner, but the owner will also gain a higher selling price when he sells into a market that recognizes the capitalized value of the ongoing stream of these reduced operating costs and amenities. The purchaser of the building, if the label includes information such as an energy audit indicating what can be done cost-effectively to increase the building's energy efficiency, will also have a helpful road map suggesting high-payoff investments that he may wish to make in his new purchase. Labeling or somehow otherwise making apparent to the market the energy efficiency of buildings will thus encourage energy conserving investments in buildings, which in turn will save money, reduce emissions of greenhouse gasses and other pollutants, and contribute toward energy independence for the U.S.

The following are a few among the many recent developments involving energy efficiency labeling for buildings:

- A growing number of homebuilding companies have committed to estimating the expected energy performance of their new homes using the Home Energy Rating System (HERS) and then marketing the homes using this rating. More than one million new homes have been rated using HERS since 1995.

- Since June of 2009, Austin, TX has required homes more than 10 years old to undergo an energy audit before they are sold, with the audit results to be provided to prospective purchasers. Other jurisdictions have considered or are considering a variety of similar audit and/or upgrade requirements applicable at time of sale or lease. However, the largest such jurisdiction, the Province of Ontario, Canada, passed a Green Energy Act in 2009 with audit and disclosure requirements for homeowners, but with the recession and budget concerns the regulations needed to implement the program have not been written and the program appears now to be abandoned.

- The U.S. Department of Energy (DOE) has developed a Home Energy Score for rating the energy efficiency of an existing home in comparison to its peers, and is implementing a program to make the scoring system available throughout the U.S. A certified "Assessor" working through one of more than 25 DOE "Partners" (utilities, State and local governments and non-profits, now covering much of the country) will evaluate and score a home when the homeowner requests an assessment, providing the homeowner with both the comparative score and a report indicating cost-effective measures the homeowner might undertake to improve his home's score. More than 16,000 homes have been scored as of January, 2015.

- In the U.S., mandatory energy rating and disclosure requirements are more common for commercial buildings than for residential buildings. The States of California and Washington, Montgomery County (MD) and the cities of Boston, Chicago, New York, Minneapolis, Philadelphia, San Francisco, Seattle and Washington, D.C., have adopted mandatory energy scoring, benchmarking or labeling requirements for various sorts and sizes of commercial buildings. Most of these programs require use of the U.S. Environmental Protection Agency's (EPA's) Energy Star Portfolio Manager software and the Energy Star rating scale. Many other jurisdictions are considering similar requirements.

- LEED certification for a building addresses energy efficiency as well as other green or sustainable attributes.[2] More than 8 billion square feet of commercial and institutional properties are now participating in the LEED rating systems, and more than 83,000 homes have been certified or registered under LEED. LEED credentials are regarded as very helpful to selling or leasing these properties.

- The European Union (EU) and Australia have adopted policies requiring disclosure of energy efficiency information at the point of sale for both residential and commercial properties. While progress in implementing these programs has been uneven, the Netherlands, Denmark, Great Britain, Germany and two Australian States or Territories now have at least several years of experience with very large mandatory labeling and disclosure programs. In the European Union, Australia, and several smaller countries, energy labeling and disclosure for buildings has been adopted as a key policy measure toward achieving international commitments for greenhouse gas emissions reductions.

This paper examines several policy issues associated with this growing trend toward energy efficiency labeling of residential and commercial properties. We pose four sets of questions regarding energy labeling, and review the available, relevant literature from the U.S., Europe, Australia and the remainder of the world to answer the questions. In general, there has been more experience with energy labeling of residential properties and more studies reviewing this experience in Europe and Australia than in the U.S., while the opposite is true regarding energy labeling for commercial properties. The remainder of this paper consists in our answers to the four questions.

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[2] LEED and several other varieties of "green" certification for residential or commercial properties are not, strictly speaking, energy labels. On average, roughly half of the scoring points that buildings typically attain in order to qualify for LEED certification derives from features of the buildings relating to energy efficiency. The remainder of what qualifies most buildings includes water efficiency, use of sustainable building materials, indoor environmental quality, and more. Energy efficiency is very important, but not all that is needed in order to qualify a building for LEED certification. We nevertheless include LEED and similar green certifications in this paper in examining the market response to energy labels. We believe that the market responds similarly in most respects to green certifications as it responds to energy labels, and research relating to green certifications is thus often relevant to energy labels also. We will note when we believe there are significant differences between the market responses to energy labels and to green certifications.

1. Impact of Energy Efficiency Labeling on the Market Value of Labeled Properties

Is a property's market value affected by making information available on the property's energy efficiency? Does disclosure of energy efficiency information affect variables in addition to property values that are also important in real estate markets, such as length of time on the market or vacancy rate for properties to be leased? What studies or other evidence exists on these questions?

There are more studies assessing the impacts of energy labeling on commercial real estate markets than on residential markets. This is likely for two reasons. First, at least in the U.S., a much larger fraction of commercial buildings has been energy-labeled or certified in some manner (e.g., LEED, Energy Star) than has been the case for single-family homes. There is more experience on the commercial side to be analyzed. Second, in order to analyze the impact of labeling on the market value of properties, information on whether a property has been labeled/certified or not must somehow be connected to information on the sales price for that property. For commercial properties this connection has existed since at least 2005 -- information on whether a building is labeled or certified and information on sales and rental prices are included in a national database maintained and made available for analysis by the CoStar Group. For single family homes, though, until recently very few of the local multiple listing service (MLS) compilations have include information on whether a home has received a label or certification.[3]

We will summarize and review the available studies investigating the impact of energy labeling on the market value of residential and commercial properties. We will discuss residential properties first, and will discuss studies conducted in U.S. markets and then studies in other countries.

Studies on impact of energy labeling for residential properties

Home sales in California

Kok and Kahn (2012) analyzed all 1.6 million single-family homes sold in CA between 2007 and 2012 to estimate the impact of green labeling on the sales price of otherwise similar homes. 4,321 of the homes sold during this period were green labeled, only about 0.3% of the total. There were three sorts of green-labeled homes: LEED, Energy Star, and Green Point The researchers found that green-labeled homes received a market premium averaging 9% relative to otherwise similar but not green-labeled homes (average premium of $34,800 relative to an average market price for an unlabeled home of about $400,000).

[3] The MLS for the Portland, OR and Seattle, WA areas represent early exceptions. Several green groups persuaded the relevant MLS organizations for these metropolitan areas to modify their databases beginning in 2007 to include green certification/labeling information for properties and to track the sales of certified homes. Supported by NAR's "The Green MLS Tool Kit" program, over the next several years additional regional and local MLS organizations (e.g.., Atlanta, Chicago, Colorado, Traverse City MI) began including green features in their property listings. The data needed to investigate the market impact of energy or green certifications for single-family homes is rapidly becoming available for much of the U.S.

The researchers performed their analysis using a technique known as hedonic regression analysis.[4] They "explained" a home's sales price as a function of numerous attributes of the home, including its size, age, number of bedrooms and bathrooms and various amenities as well as whether the home was green-labeled or not. Dummy variables were included in the regression to capture the impacts also of location and time on home sales prices. The researchers' methodology was excellent.

Kok and Kahn arrived at several interesting findings in addition to the substantial premium accorded to a green label. They found that the sale price premium associated with a green label varies considerably from region to region in California, and is highest in the areas with hotter climates. It is plausible that residents in these areas value green labels more due to the increased cost of keeping a home cool. They also found that the price premium associated with a green label is positively correlated to the environmental ideology of the area, as measured by the rate of registration of hybrid vehicles. They believe this correlation suggests that some homeowners may attribute value to intangible qualities associated with owning a green home, such as pride or perceived status. Note that two of the three green labels analyzed in this study, LEED and Green Point, require a home to have significant additional desirable qualities beyond energy efficiency to qualify, but the researchers surprisingly found the market premium to be larger for Energy Star labeled homes than for these other two seemingly broader labels.

Home sales in three U.S. Cities

Walls, et al (2013) conducted a rather similar hedonic regression analysis study investigating the impact of green/energy labels on the sales prices for single family homes in Austin, Texas, Portland, Oregon, and the Research Triangle area of North Carolina. These three areas are among the first in the U.S. in which realtors participating in the local multiple listing services (MLS) agreed to report green certifications for listed properties, thus generating information that researchers could analyze subsequently to compare the sales prices and characteristics of green-labeled homes against those for homes that were not green-labeled. The green labels in these three cities that Walls, et al, investigated included:

- In the Research Triangle Area, Energy Star certification.[5,6]

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[4] Several of the leading researchers investigating the impact of energy efficiency labeling describe hedonic analysis as follows:

> "The underlying premise of hedonic analysis is that the utility obtained from the numerous attributes of a multi-faceted "economic good" are reflected in the price paid. In the case of housing, occupiers receive utility from each of the attributes that a dwelling might offer such as location, number of bedrooms, age or energy efficiency. Dwelling prices are hedonic in that they represent a payment for this 'bundle' of attributes. The number of hedonic attributes could, theoretically at least, be large in number but usually a small number of characteristics tend to be the key price determinants. When examining the impact that [energy] ratings might have on prices, it is essential that other price determinants, particularly the key ones, are identified and controlled for." (Fuerst, et al., 2013)

[5] From 1995 when the U.S. Environmental Protection Agency (EPA) and the Department of Energy (DOE) initiated the Energy Star program for homes, through mid-2006, in order to earn Energy Star certification a new home needed to be at least 30% more energy-efficient than a standard reflecting typical good practice for new homes in 1992.

- In Austin, either Energy Star certification or recognition by the Austin Energy Green Building (AEGB) program. AEGB assigns new homes between one and five stars based on the home's energy efficiency, water efficiency, site characteristics, construction materials and other factors. The researchers counted a home as having a green label via the AEGB if it received three or more stars, which can be awarded only if the new home is more energy efficient than is required by the city's relatively strict building code. About 2/3 of the "green-labeled" homes sold in Austin during the study period were Energy Star certified and the remaining 1/3 had received three or more AEGB stars.

- In Portland, either Energy Star certification or a certification by the Earth Advantage Institute, which conducts a green certification program for new homes in the Pacific Northwest. Like the AEGB program and unlike Energy Star, Earth Advantage certification requires both above-average energy efficiency and a variety of other non-energy conditions. 56% of the "green-labeled" homes sold in Portland during the study period were Earth Advantage-certified and the remaining 44% had received Energy Star certification.

The researchers developed hedonic regression equations estimating the impact of numerous home characteristics, including green certifications, on sales prices for these homes for transactions occurring during the period from first inclusion of green label information in each city's MLS (start of 2007 in Portland, start of 2008 in Austin, and late 2009 in Research Triangle) through the end of 2011. Walls, et al, performed their analysis in a manner so as to estimate the impacts of green certification on home prices for each of the different: i) cities; ii) types of certification; and iii) years in which the homes were constructed.

With regard to Energy Star certification, the authors found that:

- In Austin and the Research Triangle area, Energy Star-certified homes built between 1995 and 2006 had higher sales prices than otherwise comparable homes built during those same years, with this premium being approximately 5% in Austin and 18% in Research Triangle. However, for homes built after 2006 in these two cities, Energy Star had essentially no significant effect on sales prices.

The qualification requirements for Energy Star certification have been upgraded twice since then: from mid-2006 through 2011, a new home needed to be at least 15% more efficient than a 2004 good practice standard, and since 2012 a new home needed to be at least 15% more efficient than a more stringent 2009 good practice standard.

[6] Until version 3.0 of the program became effective in 2012, Energy Star certification was available only for new homes and not for existing homes. Energy Star certification requires inspection of many physical components of a home which are typically accessible and visible only when the home is being constructed (i.e., new homes) or during near-total replacement or reconstruction projects on existing homes (e.g., reconstructions). Very few homeowners have sought or received Energy Star certification subsequent to their home's construction. As such, the Energy Star label or certification, if it does in fact serve to increase the market value of a labeled/certified home, provides a pre-construction incentive to a homebuilder to design and build an energy-efficient home and realize an increased selling price, but the program is not designed to provide a parallel incentive to the owner of an existing home to undertake post-construction improvements that will improve the home's energy efficiency and perhaps increase the price that the owner of an existing home will receive when he eventually sells.

- In Portland, Energy Star certification had no significant effect on sales prices for any vintage of home.

The authors suggest that

> "This difference in effects for Energy Star certification by house vintage may reflect the fact that newer noncertified homes are becoming more energy efficient. As a result, Energy Star certification tends to provide less benefit for newer homes in terms of absolute savings. In Portland, where building codes were more stringent, even in the 1995–2006 time period, this same effect holds: the benefits of Energy Star certification are smaller because more stringent building codes reduce the absolute financial benefit of Energy Star certification." (Walls, et al, 2013, page 16)

We are somewhat skeptical about the authors' suggestion that the apparent shrinking value of the Energy Star certification over time is due to the declining magnitude of the energy cost savings that can be expected for a certified home over a noncertified home.[7]

[7] We observe that this suggestion appears consistent with a general concern that the Energy Star program has faced in certifying as energy efficient a wide range of appliances, computers, printers, lighting and other products in addition to buildings. For each of these products, the Energy Star program has chosen some product-specific baseline level of energy consumption and then specified a minimum level of performance better than this baseline that a manufacturer must exceed if he wishes to obtain Energy Star certification for his particular model of the product. As time passes after an Energy Star standard has been specified, though, the typical performance of non-certified models of the product improves and approaches the level of the standard. The increment of performance implied by the Energy Star certification -- the distance between the certification standard and the performance of non-certified models -- shrinks over time, and the implied value of the Energy Star certification thus declines. The Energy Star program has defended against this shrinking value by occasionally increasing the baseline level of performance that manufacturers must exceed in order to gain certification, but the program has then been accused of "moving the goalposts in the middle of the game." A manufacturer needs some constancy during the entire product life cycle (design, manufacture, marketing and then servicing the product when it is in use) in the level of performance that his product is expected to achieve, and altering the target mid-course is problematic. In practice, the Energy Star program has attempted to strike some balance between tightening the standard periodically in order to maintain the value of the certification, but leaving the standard unchanged for sufficiently long to provide some certainty for manufacturers.

Although we recognize this as an issue for all Energy Star programs, we are somewhat skeptical of Walls, et al's supposition that the apparent lower premium accorded to the Energy Star certification among post-2006 vintage homes relative to pre-2007 homes is due primarily to the shrinking incremental energy cost savings associated with the certification. In the authors' supposition, this shrinking premium is apparently due to the Energy Star efficiency standard remaining fixed over time while the energy efficiency of non-certified homes has increased over time. However, over the period between 2005 and 2012, the energy efficiency required of a new home in order to qualify for Energy Star certification has been ratcheted up three times. It is thus not clear that the increment over typical energy efficiency that has been required for a home to qualify for certification has been declining over this period. We suspect, if the value of the Energy Star certification has in fact declined over time as the authors find, that the primary reason may lie not in the declining value of the energy savings implied by the certification, but instead in a declining value of the "cachet" (intangibles other than energy cost savings) associated with the label. (See the final section of this paper for a discussion of the two elements accounting for the value that the market accords to an energy label: i) the capitalized value of the energy cost savings or penalty associated with the label; and also ii) the value of the intangible "cachet" (positive) or "stigma" (negative) associated with the label.) Both Walls, et al's study and studies by several other groups of researchers that we discuss in the final section of this paper find that "cachet" and "stigma" account for a large portion of the value that markets assign to energy labels. We suspect, if the value of the Energy Star certification has in fact declined post-2006, that the primary reason lies in the shrinking "cachet", portion of the certification's value, perhaps somehow associated with the recession and general decline in home values post-2006. Perhaps with the recession and decline in home values, potential homebuyers are much less

In contrast to the mixed findings regarding the market premium accorded to an Energy Star certification, the authors found that the local certifications in Austin and Portland -- each of which addresses several additional desirable characteristics of a home beyond energy efficiency -- have a larger impact on prices:

- In Austin, a home with an AEGB rating has a sales price that is approximately 10 - 26% (depending on vintage) higher than a similar home without such a rating.

- In Portland, a home with an Earth Advantage certification sells for between 4 and 10 % (depending on vintage) more than an otherwise similar non-certified home.

Walls, et al, explain this more consistent and generally higher value of the two local certifications relative to the value of the Energy Star certifications as follows:

> "The green certification schemes in Austin and Portland are clearly capturing something other than energy savings. … a home meeting either the Earth Advantage or AEGB certification standards is meeting a large number of requirements related to water efficiency, types of materials used in construction, landscaping, and a host of other specifications. These could account for the large premiums associated with sale (and resale) of these homes. According to the certification agencies themselves and local builders in Austin and Portland, there is a strong sense that the [two local] certifications are more a symbol of overall home quality than any single green feature of the homes, including energy efficiency." (Walls, et al, 2013, page 23)

In their study, Walls, et al (2013) provide two further analyses or observations that we believe to be important:

- The authors perform an extensive analysis in which they compare the value of the energy cost savings implied by a certification (i.e., the capitalized value of the stream of energy costs expected in a certified home compared relative to the value of the stream expected in an otherwise comparable but noncertified home) against the estimated market value of the certification. They find in all cases -- for each city, for each certification, and for each vintage home -- that the value of the certification substantially outweighs the value of the underlying energy cost savings expected with the certification. We discuss this finding further in the final section of this paper.

- The authors find that there are significant differences in the regression equations that they estimate explaining home prices in the three cities, including differences in the estimated value of the certifications across the cities and differences in other coefficient estimates. They observe that "This calls into question results from hedonic studies that pool observations across a wide geographic area and provides support for our approach of studying markets independently. " We agree that there are likely local and regional differences in how home sales prices respond to certifications and other home characteristics, but an analysis of data that are pooled across localities can nevertheless be

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willing than they were pre-recession to ascribe value to those elements of a green certification that don't clearly result in savings in the cost of operating and maintaining a home (i.e., "cachet" rather than energy cost savings).

very useful to inform consideration of any labeling measures that might be contemplated at a regional or national level. In our view, instead of questioning whether a hedonic study should be performed with data pooled across a wide geographic area, it might be more appropriate to consider how locational effects can be controlled for appropriately in such a study.

We want to add one final observation about the Walls, et al, study. The researchers investigated the value of energy labels by investigating nearly exclusively homes that were newly constructed and sold by builders, developers or other marketers to the first households that were going to live in these homes. The vast majority of Energy Star, AEGB and Earth Advantage certifications have been for newly built homes. Only a very few of the sales of certified homes in the authors' databases represent sales of existing homes from one household to another. The few homeowner-to-homeowner sales of certified properties in the authors' databases involve either the sale of one of the rare homes that had somehow obtained one of these certifications as an existing home, or the resale of a home that had been certified and sold for the first time as a new home but which was now appearing in the database when it is sold for a second or subsequent time. We suspect that the market value of an energy label in a home sale from builder/developer to a home's first resident owner may be rather different from the market value of the same label in the sale of an existing home from the current homeowner to the next homeowner. At a minimum, the manner in which the certified home is marketed to prospective purchasers will be rather different in an instance when a new home is being marketed by its builder/developer in contrast to the situation when an existing home is being sold by the homeowner. And, we would expect that any increment in market value associated with a certification would have an incentive effect in encouraging a builder/developer to construct an energy-efficient home that would be different again from the incentive effect the same certification might have in encouraging a homeowner to invest in energy efficiency upgrades for the home he is going to live in and then perhaps sell. We caution that the findings regarding energy certifications in the Walls, et al, study should be viewed as applying only for *new* homes.[8] To investigate the impact of energy labeling or certification on the sales prices instead for *existing* homes and on the incentives that labeling may provide for upgrading existing homes, one would need to review the experience with energy labeling in Europe, Australia or other countries where, unlike in the U.S., there is extensive experience with energy labeling of existing homes. The same is true, but to a lesser and declining degree, for energy labeling of commercial properties. Energy labeling for existing, as opposed to new, commercial properties in the U.S. has been increasing rapidly in recent years, and there is now some experience regarding the impact of energy labels on the values of existing commercial properties in the U.S. that can be evaluated.

<u>Earth Advantage studies in Pacific Northwest</u>

Earth Advantage, an organization in Portland, Oregon that works with the building industry to implement sustainable building practices, has studied the market impact in the U.S. Pacific Northwest of green certification for homes (Griffin, et al., 2009). "Green-certified" homes in

[8] From data provided in the Walls, et al, (2013) paper, we estimate that 3,151 of the 3,379 certified home sales in the authors' databases involve new homes (more than 93%). In contrast, among the 167,986 sales of non-certified homes that are used in the statistical comparison, only 23,135 (less than 14%) involve new homes. We wonder if the findings the authors obtained might be different if they were to limit the study exclusively to sales of new homes, comparing the 3,151 certified new home sales against the 23,135 non-certified new home sales.

this study include any that have received Energy Star, LEED, Earth Advantage or Built Green certifications, the latter three of which address additional green characteristics of homes beyond energy efficiency. A residential appraiser matched individual green-certified new homes against comparable non-certified counterparts (new or existing), and the researchers then compared sales information for each green-certified home against sales information for several matched homes that were not certified but otherwise similar to the green home. In the Portland metropolitan area through 2008, 92 new homes with a green certification sold for 3-5% more and 18 days faster than comparable non-certified homes. In Seattle, 62 green-certified new homes sold for 9.6% more, but several days (40%) slower.

In our view, there are significant methodological problems in this study in defining the comparable homes that are contrasted with the green-certified homes, and we believe that the market value premium for certified homes may be less than Earth Advantage has estimated.[9]

In another analysis, Earth Advantage compared the sales price of certified homes against non-certified homes in the Portland metropolitan area for each year from 2007 through 2010 (Earth Advantage, 2011). Across these years, green-certified new homes accounted for 14 - 20 % of all new home sales, and the average green-certified new home received a price premium ranging from 12- 21% relative to the average non-certified new home. Among existing homes in 2010, the only year for which existing home figures have been reported, the average certified existing home received a price premium of 30% over the average non-certified existing home. In contrast to the first Earth Advantage study, though, in this study no effort was made to match each green-certified home that was sold against one or more comparable non-certified homes that were sold. Instead, the entire pool of green-certified homes that were sold was compared *en masse* against the entire pool of non-certified homes that were sold. In our view, the large price premiums observed in this study should not be interpreted as reflecting an increment in market value due to green certification alone, since there appear to be substantial differences in location, size, recency, etc. on average between certified and non-certified houses that undoubtedly also contribute to the higher average market value for the green-certified homes. In our view, neither of the Earth Advantage studies employed a methodology such as hedonic regression analysis that

[9] The authors applied a number of criteria in choosing the several comparable homes for which sales price was to be compared against the sales price for a green-certified home. One criterion was that the "comparable" homes should be approximately the same size as the green home, but "approximately the same size" was defined as within a range from 15% smaller to 5% larger. Another criterion was that the comparable homes should be "approximately the same value" as the green home, defined as having a final sales price within a range from 20% below to 10% above that of the subject home. Both of these criteria ranges are not symmetric around zero, meaning that the homes chosen as comparable are, on average, 1) probably slightly smaller in size; and 2) probably sold at slightly lower market price. The second of these criteria for comparability is particularly problematic. In limiting the set of homes chosen as comparables only to homes that sold for prices near that of the subject green-certified home, Earth Advantage has limited the range of conclusions that the study could draw regarding the market impact of green certification. If the "comparable" homes that are chosen for each green home can lie within a price range only from 20% less expensive to 10% more expensive than the green home, the study could not conclude anything other than that green-certified homes on average sell at a price ranging from 10% less to 20% more than comparable non-certified homes. And, screening for comparable homes using a price range from 20% less to 10% more is asymmetric -- it is easier for a home selling for less than the subject home to qualify as a "comparable" than it is for a home selling for more than the subject home to qualify as comparable. Using sales price as a criterion for judging comparability likely substantially affects the average sales price observed among the homes that are selected as comparable. The criteria applied in defining comparability are not neutral: they tend to generate a study outcome in the direction that Earth Advantage found -- comparable homes sell, on average, for less than certified homes.

could appropriately estimate the separate impacts of certification and each of the other factors that affect a home's selling price.

Green homes in Atlanta compared against non-green homes

Matthews and Cahill (2011) compared the sales prices of certified green new homes in the Atlanta metropolitan area against prices for conventional new construction. Sales data for approximately 1,400 new single family homes sold in 2009 were analyzed. Matthews and Cahill found that certified green new homes sold faster than conventional new homes (average 108 days on the market vs. 139 days) and for closer to the original list price (sales price for certified green homes was 94.5% of list price vs. 90.9% for conventional new homes). Data for the first three quarters of 2010 showed generally the same pattern, though with some quarter-by-quarter variation.

Although the authors did not report this, their data for the full year of 2009 also showed that certified green new homes sold for an average price *less* than the average for conventional new homes; $389,950 vs. $399,900, about 2.5% less. This surprising finding illustrates a pitfall of studies like Matthews and Cahill (2011) and Earth Advantage (2011) that simply compare average market data for labeled or certified homes against corresponding average market data for non-labeled or non-certified homes. The problem with this study approach is that the two groups of homes being compared -- labeled or certified homes compared against non-labeled or non-certified -- likely differ on average in significant ways in addition to being labeled/certified or not. The average market performance observed for one group of homes over the other reflects not only the influence on the market of the energy labels or certificate, but also the influence of other important variables such as location, size, age, amenities, etc. that may differ between the two groups. Without using some statistical technique (e.g., hedonic regression or carefully matched controls) that can isolate the effect of labeling/certification alone, a simple comparison of market data for labeled and non-labeled homes is of limited utility in evaluating the impact of labeling.

Impact of green features on value of new homes in Texas

Aroul and Hansz (2012) studied the impact of green features in new homes on selling prices for these homes in two fast-growing communities in Texas. The researchers studied home sales from the beginning of 2002 through July, 2009, in the nearby cities of Frisco and McKinney. Frisco initiated in 2001 what the authors claim to be the first mandatory green building program for new homes in the country, and strengthened the green building requirements in 2007. McKinney had no green mandate for new home construction, but some builders built to green standards voluntarily. Using a hedonic regression approach that controlled for the effects of the home's location, size, age, number of bedrooms and bathrooms and various amenities, the researchers compared the sales prices for green homes against those for non-green homes across the nearly 15,000 homes sold in these two cities. Green homes were found to sell for a premium of 2.1% relative to non-green homes during the period from 2002 through July, 2007, and for a slightly larger premium of 2.4% during the final two years from August, 2007 through July, 2009 after Frisco's green requirements were strengthened.

This study, in contrast to others reviewed in this section of this paper, did not investigate whether there was a market premium for green homes that was attributable to an explicit green label or certification. In this study, instead, homes were defined as "green" if they either: 1) Were built pursuant to the green building requirements in Frisco, which the researchers termed as "mandatory" green homes; or 2) Included any of various key words in the home sales listings that the researchers interpreted as signifying green building -- the researchers termed these homes as "voluntary" green homes. The key words that the researchers interpreted as denoting a home built voluntarily to green standards included such terms as LEED, EnergyStar, Greenbuilt, HERS, etc. (thus including as green all the homes that actually were green-labeled or certified), but also such terms as "drought tolerant landscaping", "low flow fixtures", "solar", "mechanical fresh air", etc.. The great majority of the green homes in the researchers' regression analysis were "mandatory" green homes rather than "voluntary" because the great majority of homes sold in Frisco during the study period had been platted and constructed after the city's green building requirements had been adopted. Nevertheless, the two-part operational definition of "green home" that the researchers applied in this study makes us uncertain about how to interpret their results:

- The researchers would likely have found a price premium of more than 2.1 - 2.4% if all the potential purchasers of homes in these two cities had known that those in Frisco were in fact green. Some potential purchasers were likely unaware of the Frisco green building ordinance (e.g., those moving into this fast-growing area from elsewhere) and were perhaps unaware of some of these homes' green features, and these individuals might have been willing to pay more for these homes -- resulting in a higher observed premium -- had they known that these homes met some explicit green standards.

- On the other hand, many of the researchers' "voluntary" green homes were considered to be green because of features not involving energy efficiency (e.g., water conserving fixtures and xeriscaping), and at least some of the market premium that the researchers estimated for these "voluntary" green homes was probably attributable to characteristics of the homes other than energy efficiency.

<u>Home sales in the Netherlands</u>

Brounen and Kok (2010) analyzed empirical data from home sales in the Netherlands from January 2008, when a national energy performance certificate (EPC) program began, through October 2009. The Netherlands requires the owner of any dwelling constructed before 2000 and that is not a registered historic structure to obtain an EPC before selling or leasing the building. To obtain the EPC, the owner must contract with a licensed professional to conduct an energy performance audit and then must provide a certificate indicating the audit results to any prospective buyer or tenant. The certificates range from A, signifying a building with exceptionally high energy efficiency, to G, signaling poor energy efficiency. Homes rated A, B, or C are considered "green" and are given a green label; homes rated D are considered intermediate; and homes rated E, F, or G are considered energy-inefficient and are given a red label.

The authors used hedonic regression analysis and concluded that, on average, homes with green labels sold or rented for a 3.7 % price premium over otherwise comparable D- rated homes. The average price premiums found for each certificate grade were ordered consistently across the seven letter grades: for example, homes with an A-rating (best energy performance), had a 10.1% price premium over comparable D-rated homes, while G-rated homes (worst energy performance) sold at a discount of 4.8% relative to comparable D-rated homes. Homes with less positive ratings than A sold for smaller premiums, while homes with less negative ratings than G sold at smaller discounts.

Impact of energy labeling on the value of homes in Australia

In 2004, the Australian government committed in principle that all commercial and residential building owners should be required to disclose the building's energy performance prior to sale or lease. The first Australian jurisdiction to adopt such a program had been the Australian Capital Territory (ACT), consisting of the capital city of Canberra and surroundings. In 1999, the ACT implemented a program requiring the owner of any residential building offered for sale to obtain an energy efficiency rating (EER) and to include the EER in any advertisement for sale of the building. Based on national software that had been developed several years previously, the EER rates a home's thermal performance in a range from zero stars (worst) to six stars (best) in half-star increments. The full EER certificate also includes recommendations on improving the building's energy efficiency, and the full certificate must be provided to the home's purchaser before the transaction is completed. An EER is to be developed by a certified appraiser. The EER is not a complete indicator of a home's energy efficiency. It reflects only the thermal performance of the building envelope, and it thus does not consider some elements that are important to a home's energy use such as the nature and efficiency of the heating and cooling systems, lighting, appliances, etc. Several years after the program was implemented for home sales, it was extended also to home rentals. In addition, the range of scores was extended up to ten stars, with the higher ratings being reserved for particularly energy-efficient new homes.

Researchers with Australia's Federal Department of Environment, Water, Heritage and the Arts (DEWHA) used hedonic regression analysis to analyze the impact of various factors, including the home's energy efficiency rating, on the prices of houses sold in the ACT during 2005 and 2006 (DEWHA, 2008). The researchers found that the EER was highly statistically significant in explaining home values. Other things being equal, the 2,385 homes sold in 2005 gained an average of 1.23% in market value for each half star in energy rating. In 2006, 2,719 homes gained an average of 1.9% for each half star. At the median home sale price of 365,000 AUD in 2005 in the ACT, for example, increasing the EER by one star would be associated with an average price increase of about 11,000 AUD. The study methodology appears quite good, using a reasonably complete and appropriate set of explanatory variables, including variables relating to home and lot size, structural characteristics, location, neighborhood attractiveness and prestige, price inflation over time, and energy efficiency characteristics.

Impact of Great Britain's Energy Performance Certificate Rating on Home Sales Prices

Similar to the Brounen and Kok (2010) study in the Netherlands, Fuerst, et al (2013) evaluated the impact of the letter grade assigned as a part of Great Britain's Energy Performance Certificate (EPC) on sales prices for homes in England and Wales from 1995 through 2011. Like most of the other EU member countries' EPCs, the British EPC assigns the rated property one of seven letter grades, ranging from A, most energy efficient, to D, neutral, to G, least energy efficient. The authors' database included more than 320,000 homes that had been sold at least twice during this period, representing approximately a 10% random sample of such homes in England and Wales. The focus on homes that had sold at least twice during this period is a unique feature of this study, allowing investigation of the impact of the label on price appreciation over time as well as the impact of the label on price. The authors also investigated the potentially different impacts of energy labels and other variables on the prices of homes of differing varieties: detached, semi-detached ("duplex" or "twin", side-by side), terraced (row houses, with more than two homes in the row) and apartments.

The authors performed hedonic regression analyses to evaluate the impact of the energy rating on price and on price appreciation. They included a typical list of variables in addition to the EPC rating in statistically "explaining" home prices and price appreciation. They obtained the following results:

Estimated Impact of British EPC Rating on Home Prices (per square meter), From Fuerst, et al, 2013

Energy Rating (A best, G worst)	Estimated Price Impact				
	All Homes	Detached	Semi-Detached (duplex/twin)	Terraced (row houses)	Apartments
A and B	+ 13.8%*	+ 2.1%	+ 10.1%*	+ 18.2%*	+ 11.6%*
C	+ 9.9%*	+ 1.3%	+ 7.7%*	+ 15.5%*	+ 10.4%*
D	+ 7.6%*	+ 1.3%	+ 6.8%*	+ 13.5%*	+ 9.3%*
E	+ 6.6%*	+ 0.3%	+ 5.1%*	+ 11.4%*	+ 8.0%*
F	+ 6.0%*	- 0.0%	+ 4.0%*	+ 8.2%*	+ 5.6%
G (basis for comparison)	---	---	---	---	---

* Statistically significant

The energy efficiency rating was found to significantly affect home prices for the full sample of all homes, with a 13.8% price increment for homes rated as most energy-efficient (A and B) relative to otherwise similar homes with the lowest energy rating (G). The price increment was found to increase monotonically with the level of the rating, and the estimated increment for each energy rating was found statistically to be significantly different from zero.

The authors obtained similar findings for each of the different categories of homes with the exception, perhaps surprisingly, of detached homes, for which the authors found much lower and not statistically significant estimated price increments for the better energy ratings.

The authors obtained quite different results when they investigated the impact of the energy rating on the average annual rate at which prices appreciated for the different categories of homes:

Estimated Impact of British EPC Rating on Home Price Appreciation (per square meter), From Fuerst, et al, 2013

Energy Rating (A best, G worst)	Estimated Impact on Price Appreciation				
	All Homes	Detached	Semi-Detached (duplex/twin)	Terraced (row houses)	Apartments
A (few)	- 3.4%	+ 2.7%	- 5.3%	--- (none)	+ 5.7%
B	- 3.3%	+ 10.1%*	- 1.1%	+ 0.6%	- 1.1%
C	+ 2.4%*	+ 5.8%*	+ 2.6%*	+ 1.1%	+ 0.8%
D	+ 1.1%*	+ 3.7%*	+ 1.2%	+ 0.6%	- 0.7%
E	- 0.7%	+ 0.9%	- 1.3%	- 0.9%	- 0.6%
F	- 1.8%*	- 0.6%	- 2.4%*	- 2.0%*	- 0.3%
G (basis for comparison)	---	---	---	---	---

* Statistically significant

The authors had no prior expectations about the relationship they might find between a home's energy rating and its price appreciation:

> It is possible that price premiums associated with superior energy performance have been factored into initial prices and that there is no 'growth premium'. On the other hand, it is possible that the increasing salience of energy and environmental issues in the last decade has meant that price effects have produced positive effects on price appreciation. In other words, the effects of superior energy performance on initial prices may be positive and, due to subsequent greater demand for energy efficient dwellings, the effects on price appreciation may also be positive. (Fuerst, et al, 2013, page 24)

The authors found in their study no coherent relationship between a home's energy rating and its price appreciation, with the exception of a generally positive relationship for detached homes specifically. For the other categories of homes and for all homes in total, the authors found conflicting patterns where better energy ratings sometimes appeared to lead to higher price appreciation and sometimes to lower or even negative price appreciation, with few of the estimates being sufficiently certain as to be statistically distinguishable from zero. For detached homes, though, the authors found generally that higher energy ratings led to higher price appreciation, with the relationship being near monotonic, and with several of the estimates being statistically significant.[10]

The authors thus apparently found strong evidence for all sorts of British homes other than detached homes that a higher EPC energy rating gave the home a substantial one-time increase in

[10] For detached homes only, the researchers obtained regression results that were consistent with the proposition that better-rated homes have accrued greater price appreciation than otherwise similar but poorer-rated homes. Of the six price appreciation coefficients estimated by the researchers for detached homes, five increase monotonically with the rating (all but for A-rated homes, which apparently have appreciated at a lesser rate than B-, C-, or D-rated homes. This could perhaps be an anomalous finding that results from the very few A-rated homes in the sample that had been sold twice during the study period.) Of the six price appreciation coefficients estimated by the researchers for detached homes, five show a positive value as expected given this proposition -- all but for F-rated homes, which apparently have appreciated at a lower rate than G-rated homes. Three of the estimated coefficients, those for D-, C- and B-rated homes, have the expected sign, increase monotonically, and are statistically significant.

market value, but no widening in that increment over time. For detached homes they found the opposite -- a high EPC rating gave a detached home no initial boost in value, but over time the highly-rated detached home increases significantly in value relative to lower-rated detached homes -- and presumably thus some years after receiving the EPC rating, the higher-rated detached home will eventually show a significant market premium over lower-rated detached homes, just as other categories of homes were found to do.

We believe this study is strong methodologically and provides important findings. The authors provide a good discussion of the theory underlying hedonic regression analysis as a way to investigate the market impacts of energy ratings, and they address several notable methodological and data issues. The authors observed in their data sample that:

- A home's age and its EPC rating are negatively correlated. Older homes tend to have lower EPC ratings. 92% of the homes built during the period 2007 - 2011 received EPC ratings of A, B, or C (energy efficient), but only 10% of the homes build before 1949 received these high ratings.

- Newer homes, on average, have lower prices than older homes. This is not because the market generally accords higher prices to older homes than to newer ones (the impact of age on price is, in fact, the opposite), but instead largely because of the changing composition of the British housing stock over time. Homebuilding in Britain in recent decades has focused on smaller, lower-priced apartments. It is the preponderance of larger, detached and higher value homes among the older housing stock in Britain that makes older homes, on average, worth more than newer homes.

- Were it not for the hedonic regression methodology, which aims to disentangle the independent impacts of EPC rating, age, size, location and type of home on prices, one might conclude from the two preceding observations that a high EPC rating reduces the sales price for a home. Newer homes have higher average EPC ratings and lower prices, while older homes have lower average EPC ratings and higher prices. It is only after including a relatively complete set of explanatory variables in the regression equations and performing separate regressions for each category of homes that the researchers can more accurately estimate the independent effect of any single variable, such as the EPC rating, on home prices. Performing separate regressions for each category of homes is particularly important, something that has not been done by most other researchers. For example, apartments on average are the newest (causing higher values), the smallest (causing lower values), and the most energy efficient (causing higher values) of the various home types studied, and they compose widely varying fractions of the housing stock in the different geographic zones that the authors include in the regressions as a series of locational dummy variables. Had the authors performed regressions only for the entire data set including all home types instead of also performing separate regressions for each category of homes (including regressions specifically for apartments), the authors would have been unable to estimate the separate impacts of each of the explanatory variables as well as allow for the possibility that these impact coefficients might vary with the type of home being considered.[11]

- The authors note that they do not have data that they can use in their analysis on a home's condition, on whether or not it has been renovated, and on whether or not it has various desirable modern features. The *age* variable in the authors' regressions thus likely represents *condition* to some degree, since newer homes are typically in better condition than older homes. The relationship between age and condition, though, is complicated by renovations -- an old home may be in very good condition if it has recently been renovated -- and the absence of any variable to represent renovation thus makes *age* an inaccurate indication of *condition*. *Age* may also relate negatively to a home's market value since young age will typically correlate negatively with whether a home has modern/and generally desirable features that are not otherwise reflected in the regression equations, such as modern style, fixtures, décor, and floorplan, etc. In the researchers' view, *age* in their regression equations thus reflects a complex and likely inaccurate aggregated measure of several attributes of a home to which the market assigns positive or negative values. The estimated coefficient for the *age* variable is thus difficult to interpret, and the estimated regression equations explaining home values are much less accurate than they might be if a full set of explanatory variables could be included, including condition, renovations, modern features, and perhaps more.

- With *age* also strongly negatively correlated with a home's EPC rating, it is likely that the estimated coefficients for each of *age* and *EPC rating* will reflect some of the impact that is due to the other of these two variables; an issue known in econometrics as multicollinearity. The coefficients estimated for each of these two variables are unstable and the standard deviations of these two coefficient estimates are higher than they would be if only one of these variables were included in the regression equation. The coefficients estimated for each of these two variables would likely change erratically in response to small changes in the hypothesized model or the dataset on which the regression is run. This problem is exacerbated by the uncertainty in understanding exactly what the *age* variable signifies in the absence of accurate information with which to reflect the impact on prices of condition, renovations, modern features, etc. Given this issue, in our view it is quite surprising that so many of the coefficients on *EPC rating* that the researchers estimated in their various regressions are statistically significant. In our view, the high statistical significance that the researchers found for these coefficient estimates is evidence for the strength of the underlying relationships being investigated --

[11] Another commendable element of these researchers' methodology for this study was their decision to express the dependent variable in their regressions as the price per square meter for the home rather than as the price alone. Other researchers in other studies have used less appropriate procedures to reflect the impact of size on home values. Some studies have omitted a size variable altogether (thus inappropriately reflecting the impact of size in the estimated coefficients for included variables that are highly correlated with size, such as perhaps age), while others have used variables that reflect size much less well than *square meters*, such as *number of rooms*, or *number of bedrooms*. Fuerst, et al (2013) reflect the impact of size by use both *price per square meter* as the dependent variable, and *number of bedrooms* as an independent variable, reasoning perhaps that additional square footage in the form of more and smaller bedrooms contributes less to a home's value than does additional square footage in other uses -- perhaps a larger kitchen or family room or study. Indeed, the authors find that the coefficients estimated for *number of bedrooms* are consistently negative and highly statistically significant in their various regressions explaining the price per square meter for homes.

a high EPC rating does in fact independently increase the value of a home relative to the value of a lower-rated but otherwise identical home.

The researchers performed further investigations in an attempt to better understand their findings to the effect that 1) a higher EPC rating significantly increased sales prices for all categories of homes other than detached homes, while 2) a higher EPC rating had no significant impact on price appreciation for any category of homes other than detached homes.

- With regard to the first of these findings, they split the sample of nearly 79,000 detached homes into subsamples of 15,300 detached homes in rural areas and 63,400 detached homes in more densely populated areas. They then performed separate regression analyses for the two subsamples of detached homes. The researchers found that the detached homes in more densely populated areas yielded regression results quite similar to those for semi-detached homes and generally similar to those for other categories of homes -- a higher EPC rating consistently and statistically significantly increased the value of these homes. For the subsample of detached homes in rural areas, though, the estimated regressions were weak, explaining a lower percentage of the variance in prices than for any of the other regressions the researchers had estimated. They concluded, in essence, that detached homes in rural areas in Britain are a highly diverse collection of dwellings for which it is difficult to explain market value with the limited set of explanatory variables for which data were available to the researchers. Rural detached homes include, for example, some where much of the property's sales price consists of the value of land (e.g., many country estates), and others where the sales price represents largely the value of the dwelling alone. With the dependent variable in the regressions being the property's sales price divided by the square meters of dwelling (information on the property's land area was not easily available to the researchers), the inclusion of properties with large land holdings in the data set of properties being analyzed creates large random error terms. Similarly, the researchers were unable to reflect in their regressions the impact on sales prices of other qualities that can quite be important and are often found among detached homes in rural areas -- historic qualities, charm (e.g., thatched roofs, gardens, landscaping), notable provenance, etc. These several variables omitted from the regressions are much more common and important for detached homes in rural areas than for other categories of homes.

- With regard to the finding that a high EPC rating appeared to increase price appreciation for detached homes but not for other categories of homes, the researchers observed generally that newer homes, particularly apartments, have seemingly been overbuilt in Britain in recent decades, and recent price appreciation for them has been significantly lower than for older homes. A home's age is negatively correlated with its price appreciation over the period of the study. The authors do not discuss why a higher EPC rating appears to result in higher price appreciation particularly for detached homes and not for other categories of homes, but we speculate along the following lines. Detached homes, on average, are significantly older than the other categories of homes studied. Most of the EPC ratings that have been assigned in Britain and thus most of those that are included in the researchers' database have been awarded during the most recent years of the study period. The most likely and perhaps the only way in which an older detached home can have a high EPC rating at the close of the study period is for the home to have been renovated in a manner that makes it relatively energy efficient, and any such energy-efficient renovations are quite likely to have occurred in recent years, not long ago. A significant fraction of the detached homes with higher EPC ratings that are in the researchers' "at-least-twice-transacted-during-the-study-period" sample that is investigated in their price appreciation analysis may thus have been renovated and may have obtained their high EPC ratings between the first and the final transactions considered in the appreciation analysis. The high rate of price appreciation that the researchers found for highly rated detached homes may thus be due to a renovation that occurred between the first and subsequent sales transactions that are included in the study database for many of the detached homes. Perhaps homes in the researchers' "at-least-twice-transacted" dataset that have high energy ratings and that are in categories other than detached have been renovated between transactions much less frequently than detached homes have been, and thus other categories of homes do not show the same apparent (but misleading) rate of price appreciation with a high energy label as do detached homes.

In sum, the Fuerst, et al (2013) study of British home values provides strong evidence that a higher energy efficiency rating will significantly increase a home's value relative to an otherwise similar home with a lower energy efficiency rating. This study is careful and methodologically better than most other studies on the impact of energy labels. The authors investigate several more detailed issues involving how an energy rating may affect a home's market value -- does the effect differ for different sorts of homes (e.g., detached homes, row houses, apartments, etc.) and does a positive energy efficiency rating have continuing effect in terms of price appreciation over time as well as a one-time effect on a home's value?

Impact of a green label on condominium prices in Tokyo

Fuerst and Shimizu (2014) performed a hedonic regression analysis in order to estimate the impact of a green label on the prices for new condomiums in metropolitan Tokyo. Since 2002, the developer of any planned new condominium building exceeding a specified size in metropolitan Tokyo has been required to file an environmental plan, and since 2005 the plan has been required to include quantitative information on several environmental attributes including two that relate to energy efficiency: i) the quality of the building's insulation and its projected heat loss; and ii) the nature of various energy-saving systems in the building. These several attributes are evaluated and assigned one to three stars, with three stars assigned to the best performing buildings. The researchers reviewed the available information for all new condominium buildings constructed in metropolitan Tokyo since 2005, and assigned the building a green rating if it received two or more stars for either of the two energy efficiency-related environmental attributes.

After controlling via hedonic regression for numerous other variables potentially affecting asking and selling prices for these condominiums, the researchers found that, other things being equal, a green labeled condominium had an initial asking price 6% higher than an unlabeled but otherwise similar condominium. The premium in the eventual sales price for a green labeled condominium was smaller at 1.6%. The average reduction between asking and selling price for a green labeled condominium was 4.4%, whereas the average reduction for an unlabeled condominium was lower at 3.5%. The developers of green-labeled condominiums evidently sought a higher price premium relative to non-labeled condominiums than they were ultimately able to get. All of these price differences between labeled and unlabeled condominiums were statistically significant.

Impact of Finland's Energy Performance Certificate rating on sales prices for apartments

Similar to other studies of European Union (EU) nation's housing markets, Fuerst and Oikarinen (2014) evaluated the impact of the letter grade assigned as a part of Finland's Energy Performance Certificate (EPC) on sales prices for apartments in Helskinki from 2007 through 2012. Again as for most of the other EU member countries' EPCs, the Finnish EPC assigns the rated property one of seven letter grades, ranging from A, most energy efficient, to D, neutral, to G, least energy efficient. The authors conducted a hedonic regression analysis, explaining the apartments' sales prices as a function of the EPC rating and other variables. The authors portrayed this study as the first evaluating the impact of an energy label in a country with a cold winter. They obtained the following results:

Estimated Impact of Finnish EPC on Helsinki Apartment Prices (per square meter), From Fuerst and Oikarinen (2014)

Energy Rating (A best, G worst)	Estimated Price Impact
A and B	+ 8.1%*
C	+ 2.6%
D (used for comparison to others)	---
E	- 2.0%*
F	- 1.1%
G	+ 0.3%

* Statistically significant

The authors found, other things being equal, that the most energy-efficient apartments (rated A or B) "sell at a notable premium, but the pricing effect between the other ratings is small". The authors also apparently found that the energy rating had no impact on the time that apartments remained on the market after listing and before sale, which they referred to as "liquidity". In comparison with the findings of most other studies in other countries that have estimated the market premium for green labeled or energy-efficient homes, this study in Finland found a smaller spread in value from the highest rated homes to the lowest rated homes (i.e., 7.8% premium in Finland for highest rating relative to lowest, in comparison to 8.7% in California, 14.9% in Netherlands, 13.8% in Great Britain, 12 - 19% in Australia, and 1.6% in Japan). The authors' supposition that the "cold winter" in Finland might cause a particularly large premium for highly energy efficient homes does not seem to have been borne out. This study has not yet been published and the only readily available information about it is in the form of a short conference presentation. We believe this study provides some interesting findings (see the last section of this paper for more), and we look forward to seeing a version that provides a fuller description of the study methodology and results.

Summary of findings on market value of energy labels for homes

In the following table, we summarize the results as reported above from the better-quality studies that have investigated the impact of energy labeling on the value of homes.

Study Findings Regarding Market Premiums for Energy-Labeled Homes

Study	Estimated Avg. Impact on Price	Further Detail
1. Kok and Kahn (2012), California	Energy Star, LEED, Green Point: + 8.7% vs. unlabeled homes	Avg. sales price $434,800 for green-labeled vs. $400,000 for otherwise comparable but unlabeled homes
2. Walls, et al (2013), Austin TX, Portland OR, Research Triangle NC	Magnitude of estimated impacts differs across cities and over time, but the broader labels that address more than energy efficiency always generate a significant premium, while the narrower Energy Star certification often does	The price premium for Energy Star certification was found generally to decline over time: in two cities the premium was 6 - 18% for homes built pre-2007 but insignificant thereafter, in one city no significant premium was found for new homes of any vintage
3. Brounen and Kok (2010), Netherlands	Homes with green labels sold or rented for 3.7% more than homes with neutral labels	Homes rated in the highest of the 7 label categories received 14.9% avg. premium over comparable homes rated in the lowest category
4. DEWHA (2008), Australia	An increase of 1 star in the 6-star energy rating system increased price by 2.5% in 2005, 3.8% in 2006	Relative to the average home sales price in 2005 of 365,000 AUD, a one-star increase in rating is worth 9,000 - 14,000 AUD . Increase from 1 star to 6 might be worth 12 - 19%
5. Fuerst, et al (2013), Great Britain	Increase from lowest of the 7 Energy Performance Certificate ratings to the highest adds 13.8% to the value of an otherwise comparable home	Findings very similar to those in Netherlands study, above. Higher efficiency rating appears to cause one-time increase in value relative to lower rating, but not a continuing higher rate of price appreciation over time.
6. Fuerst and Shimizu (2014), Tokyo	Asking price for green labeled new condominiums was 6.0% higher than for unlabeled. Ultimate selling price was only 1.6% higher.	Developers of green labeled condominiums sought a higher price premium relative to unlabeled condominiums than they were able to get.

Each of the six better-quality studies found a statistically significant average market premium for green-certified or energy-labeled homes. The two U.S. studies and the Tokyo study essentially address new homes only. The European and Australian studies address a representative mix of existing and new homes. The studies provide substantial evidence that housing markets give a significant premium to homes that have labels suggesting relatively high energy efficiency.

Studies on impact of energy labeling for commercial properties

Miller, Spivey and Florance: Does Green Pay Off?

Miller, Spivey and Florance (2008) conducted one of the first studies investigating whether energy labeling or certification affects the values realized in leasing or sale of commercial office buildings. The researchers analyzed the CoStar Group's commercial property database, which includes information on the great majority of office buildings in the U.S. available for lease or sale as well as other properties. The database includes extensive information about each listed building, including location, physical characteristics (age, size, height, Class, amenities, condition, etc.), market information (sales prices, asking rental rates, vacancy rates, nature of leases, etc.), and whether the building is LEED-certified and/or Energy Star-rated. As of early 2008, there were more than 900 Energy Star-rated office buildings and 580 LEED-certified buildings in the database. The researchers drew a sample of office buildings from the database for analysis, consisting of all office buildings available for lease or sale that met five criteria: Class A; 200,000 square feet or more; 5 stories or more; built since 1970; multi-tenanted. The resulting sample included nearly 3,000 office buildings, of which 643 were Energy Star-rated and an unspecified but "much smaller" number were LEED-certified. The researchers made a number of straightforward comparisons between these green buildings and the non-green office properties in this sample. Comparisons were made between these two groups of buildings at the end of every three months from the third quarter of 2004 through the first quarter of 2008, thus providing a picture of trends over this 3 ½ year period of time. The comparisons showed:

- Occupancy rates for Energy-Star office buildings exceeded those for non-green buildings by a fairly consistent 1 - 3 ½ percentage points;

- Direct rental rates per square foot for Energy-Star office buildings exceeded those for non-green buildings by anywhere from nothing to $2.50, with this spread at its widest as the office rental market worsened after late 2006;

- Building sales prices per square foot for Energy-Star buildings relative to non-Energy-Star were about 8% higher in 2005, 30% higher in 2006, 15% higher in 2007, and 24% higher in the first quarter of 2008;

- Comparisons between LEED-certified buildings and non-LEED-certified buildings were much more variable over time, likely because of the smaller number of LEED properties in the sample. Occupancy rates for LEED properties ranged from almost 1 % below those for non-LEED properties to 4 ½ percentage points higher. Direct rental rates for LEED properties ranged from about $6 to $18 per square foot higher than for non-LEED properties.

We view these comparisons as not very helpful in identifying the impact of green certification on rental or sales prices for office buildings. The difference in average market value between green and non-green buildings reflects the influence of numerous variables in addition to whether the buildings are green-certified or not. The green buildings in the authors' sample are likely, on average, newer, better located, having more amenities, and generally of higher quality than the non-green buildings against which they are compared. The market premium that the authors observe for green-certified office buildings over non-certified buildings probably reflects both the impact of certification and the higher average quality and better locations on average of the green buildings. The potential impact of certification alone cannot be estimated without applying some sort of statistical procedure to control for the impact of these other important causes of differing average market values between certified and non-certified buildings.

Miller: Does Green Still Pay Off?

Miller (2010) updated his 2008 study on whether office buildings exhibit a green premium ("Does Green Pay Off?") to address more recent developments between the fourth quarter of 2007 and the second quarter of 2010 ("Does Green Still Pay Off?"). Again, Miller compared average rental rates, vacancy rates, sales prices and cap rates for LEED-certified and Energy Star Class A office buildings against corresponding values for non-green-certified Class A office buildings. Miller noted that during this more recent period covered by his newer article a large proportion of office buildings with LEED certification were new -- planned in 2004-2006 but delivered since late 2007 and hitting the market during the real estate recession. In effect, the great majority of the green office buildings that Miller studied in his earlier article were planned and delivered during a very good market for office space, whereas much of Miller's more recent sample is offices that were planned during a good market but delivered into a bad one.

Miller found that during the period between the fourth quarter of 2007 and the second quarter of 2010:

- Average rent per square foot for Class A LEED-certified offices was consistently about $4/square foot (about 11 – 14%) higher than for non-certified Class A offices. For Energy Star offices, however, the premium over non-green offices observed during his previous study had disappeared, and Energy Star and non-green offices had virtually identical average rents.

- The vacancy rate for Class A LEED-certified offices grew from about 2 percentage points worse/higher (about 14% worse/higher) to about 5 percentage points worse (about 30% worse) than the vacancy rate for non-certified Class A offices. For Energy Star offices, the vacancy rate was consistently 2 ½ to 3 ½ percentage points lower/better than that for non-certified Class A offices.

Miller noted that the rental premium for LEED-certified offices more than makes up for their higher vacancy rate relative to non-green offices. And, for Energy Star offices, their lower vacancy rate relative to non-green offices provides them with a slight advantage in terms of total revenues per square foot despite their equivalent rental rates.

Miller also suggested that the additional figures he presented comparing sales prices and cap rates for green vs. non-green buildings reflect very little data (few sales). Thus, we do not summarize his data on sales prices and cap rates.

We are concerned, with respect to Miller's more recent study as well as his previous one, that the simple comparisons between average figures for green Class A office space and non-green Class A office space do not involve sufficient controls in order to isolate the market impact of green certification alone. We believe that developers have aimed to achieve green certification more commonly in higher average rent office markets than in lower average rent office markets – and thus that green office buildings comprise a higher fraction of total Class A office space in higher rent markets than the fraction they comprise in lower rent markets. By comparing Class A green office buildings against Class A non-green office buildings without implementing statistical controls, Miller in large measure is simply comparing the (higher average rent) markets in which green-certified buildings are more common against the (lower average rent) markets in which green-certified buildings are less common. The differences he finds in rental and vacancy rates for green vs. non-green offices reflect to a large degree the differences in rental and vacancy rates between the higher rent markets in which green buildings are more common and the lower rent markets in which green buildings are less common. Indeed, Miller provides two tables listing the top ten "greenest" and top ten "brownest" States based on the proportion of green office buildings relative to the total stock of buildings in the market. It is clear that the States having the highest fractions of green office buildings include many high-rent metropolitan markets (e.g., DC; OR – Portland; WA – Seattle; CO – Denver; MA – Boston; IL – Chicago; CA – San Francisco, Los Angeles). In contrast, the top ten "brownest" States in which a very small fraction of the office space is green appear to include no large, high-rent metropolitan markets (e.g., OK, LA, WV, SD, MS, ND, AL, KY, IN, NE).

Absent some appropriate procedure for controlling for the differing office space markets in which buildings are located, we do not believe that Miller's articles have reliably isolated the impact of green certification on office rental or vacancy rates.

In one version of the Miller papers (Miller, Spivey and Florance, draft dated July 8, 2008, available at: http://www.costar.com/josre/pdfs/CoStar-JOSRE-Green-Study.pdf), the authors did attempt to estimate the impact of green certification on office property sales price while controlling via hedonic regression for some of the other influences on value (age of building, location in CBD or not, location in one of five high-value markets or not, year of sale). They estimated that LEED certification confers a premium of nearly 10% in market value, while Energy Star certification results in a price gain of 5.8%. This version of their paper, however, does not include a description of the methodology and subsample of the CoStar data that was used, provides little documentation on how the statistical controls were implemented, and does not indicate whether the premiums found for green certification are statistically significant. It also does not appear to us that this approach controlled sufficiently well for the impact of location on commercial properties' values.

Pivo and Fisher: Returns in Socially Responsible Office Properties

Pivo and Fisher (2010) examined data from the National Council of Real Estate Investment Fiduciaries on investment performance for nearly 1,200 office properties. They compared the financial performance of Energy Star-rated buildings against that of non-labeled but otherwise similar buildings selected as controls. They found that buildings with the Energy Star label had significantly stronger financial performance than comparable non-labeled buildings. On a per square foot basis, Energy Star buildings had 12.9 percent lower utility costs, 5.2 percent higher rents, 1.3 percent higher occupancy rates, and ultimately, 2.7 percent higher net operating income per square foot and 8.5 percent higher market values. The authors speculated that the 2.7% premium in net operating income would be insufficient to provide an 8.5% premium in market value, and hence cap rates for Energy Star properties must be lower. Indeed, the authors found that investors valued Energy Star properties using a cap rate 52 basis points lower than that for otherwise comparable non-Energy Star properties.

While these results are interesting, the study sample size is smaller than several other similar studies, its controls for location and building quality are not as strong as in other studies (e.g., there was no information on the building's class), and building values were given as assessed values rather than market transaction prices.

Eichholtz, Kok and Quigley: Doing Well by Doing Good? Green Office Buildings

Eichholtz, Kok and Quigley (2009) investigated whether there was any premium for green commercial office buildings that were sold or rented in the U.S. from 2004 through 2007. They used statistical controls that Miller had not employed. The rental sample covered 694 green office buildings in the CoStar database as of end of 2007 and 7,488 non-green control buildings, and the sales sample included 199 buildings sold during 2004 – 2007 (199 green sales, 1,617 control building sales). A control group was created for each green building rented or sold consisting of all other office buildings of roughly similar sort located within ¼ mile of the subject building. The researchers used hedonic regression to estimate the rental or sales premium for green-labeled office buildings (about 75% Energy Star, about 25% LEED) relative to the non-green buildings after controlling for differences involving building quality (e.g., Class A vs. B vs. C), size, age, on-site amenities, location, and more.

The results suggest that commercial building with an Energy-Star certification rented for about three percent more per square foot than an otherwise identical building without this certification. The difference in effective rent (reflecting also the higher occupancy rate associated with Energy Star certification) is estimated to be higher at about six percent. The increment to the selling price may be as much as 16 percent. The estimated premiums for LEED certification were somewhat higher than for Energy Star (e.g., 5.2% premium in rent/square foot relative to 3.3% for Energy Star), but the estimated premiums for LEED were not statistically significant (perhaps because of the substantially smaller number of LEED certified buildings in the sample than of Energy Star buildings).[12]

The researchers further analyzed the set of Energy Star-certified buildings in their sample. For many of these buildings they obtained detailed estimates of annual energy costs, and they then studied how rental and sales prices related to these costs. They concluded:

> "Our analysis establishes that variations in the premium for green office buildings are systematically related to their energy-saving characteristics. For example, an increase of ten percent in the site energy utilization efficiency of a green building is associated with a two percent increase in selling price - over and above the 16 percent premium for a labeled building. Further calculations suggest that a one dollar saving in energy costs from increased thermal efficiency yields roughly eighteen dollars in the increased valuation of an Energy-Star certified building. This suggests that the increment to rent or value attributable to its certification as "green" reflects more than an intangible labeling effect."

We believe these findings are particularly interesting, but we have a somewhat different perspective on them. The authors emphasize that the purchaser of an Energy Star building will pay even more than the 16% "green premium" if the building is particularly energy-efficient relative to other Energy Star-certified buildings. The study results indicate, however, that the

[12] However, when analyzing "effective rent" for LEED-certified buildings relative to effective rent for non-certified control buildings, the authors did find a statistically significant premium of about 9%.

opposite is true also -- that on average a purchaser will pay *less* than the 16% green premium if the Energy Star-certified building in question is energy-*inefficient* relative to other Energy Star-certified buildings. We ask how inefficient an Energy Star building would need to be in order for the full 16% green premium to be outweighed and for the building to warrant a price no higher than that for a comparable non-certified building. The answer given the regression equation the researchers have estimated for Energy Star buildings (i.e., constant elasticity functional form with a coefficient estimate indicating that a 10% change in energy efficiency results in a 2% change in sales value) is that a particular Energy Star building would need to use 80% more energy per square foot than the average Energy Star building in order for the researchers' estimated 16% green sales premium to be entirely dissipated. Miller, Spivey and Florance (2008) report for 2006 and 2007 (much of the period covered by the Eichholtz, Kok and Quigley sales analysis) that Energy Star-rated buildings had average energy costs of about $1.27 per square foot in contrast to average energy costs roughly 50 cents/sq ft higher ($1.81 per square foot) for non-certified buildings. The specifications for Energy Star certification are written so as to qualify only the most energy-efficient 25% of all buildings; it is thus doubtful that even the worst Energy Star-certified building would consume as much energy per square foot as the average non-certified building. Assuming as a worst case that the most inefficient Energy Star office building included in the researchers' sample from the CoStar database had energy costs as high as the non-green office building average of $1.81 per square foot, this hypothetical worst case Energy Star office building would consume 43% more energy than the $1.27 average for all Energy Star-certified office buildings. Applying the researchers' estimated coefficient to this hypothetical worst-performing Energy Star building, this building's 43% increase in energy usage relative to the Energy Star average would give it a price decrement of 8.6% relative to the average Energy Star building.[13] This 8.6% price decrement for a highly energy-inefficient Energy Star building is not nearly enough to outweigh the researchers' estimated 16% price premium that results on average from an Energy Star certification.

The researchers conclude that the green increment associated with the Energy Star certification "reflects more than an intangible labeling effect". We agree, but would prefer to view the researchers' results in a different way. Instead of regarding the green increment associated with Energy Star certification as *variable* with the certified building's energy efficiency, we would suggest viewing the purchase price for an Energy Star building relative to a non-certified building as consisting of some variable increment reflecting the greater energy efficiency of the subject building plus a *constant* increment reflecting some intangible effect of the Energy Star label. It appears that the value of the intangible labeling effect must be positive, since the variable increment associated with the Energy Star building's energy efficiency appears unlikely ever to be large enough to comprise all of the 16% average total premium for an Energy Star building over a non-certified building. We wish the researchers had pursued further the questions of how large is the value of the intangible labeling effect, and how information about the energy efficiency of the Energy Star buildings might have been communicated among buyers and sellers independent of, or in addition to, the Energy Star label.

[13] Applying the researchers' estimated coefficient for Energy Star office buildings -- a 10% increase in such a building's energy usage relative to the average Energy Star building would result in a 2% decrease in the building's average selling price -- the hypothetical worst-case Energy Star building's 43% increase in energy usage would result in an 8.6% decrease in the building's selling price relative to the average Energy Star building.

Digressing a bit, we note that there is a substantial literature pre-dating the extensive use of energy-labeling or green-labeling demonstrating that information on the energy efficiency or energy costs of a property is somehow communicated and then effectively reflected in real estate market values. See Nevin and Watson (1998), for example, for a review of seven studies each of which found "higher home values associated with energy efficiency." Three of the studies that quantified this relationship, as well as Nevin and Watson's own analysis, showed "an incremental home value of $10 to around $25 for every $1 reduction in annual fuel bills."

Eichholtz, Kok and Quigley's (2009) analysis of the CoStar database of commercial office buildings raises another point that is relevant to other studies assessing the magnitude of any market premium associated with green-labeled or certified buildings. In comparing the nearly 700 green-labeled/certified buildings against more than 7,000 nearby non-labeled/non-certified buildings ("controls") in the rental sample, the researchers found the following sorts of quality differences between the certified and the non-certified buildings:

- 79% of the certified buildings were Class A office space (having, by definition, "rents above average for the area"), 19% were Class B, and only 1% were Class C (having "rents below the average for the area"). In contrast only 35% of the non-certified buildings were Class A, 49% were Class B, and 16% were Class C.

- The certified buildings were much newer than the non-certified buildings (7% of certified buildings were more than 40 years old, in contrast to 47% of the non-certified buildings).

- 72% of the certified buildings had on-site amenities (e.g., retail shops, food court, fitness center, restaurant, etc.) in contrast to 49% of the non-certified buildings.

In short, the certified buildings were, on average, much higher quality than the non-certified buildings. It should come as no surprise then that the average rent in the certified buildings was substantially higher than in the non-certified buildings ($26.83/sq ft vs. $23.51/sq ft) and the average sales price was substantially higher also ($289/sq ft vs. $249/sq ft). Even the average occupancy rate was higher for the certified buildings than for the non-certified buildings (89% vs. 81%), leading to an effective rent that was much higher in the certified buildings relative to the non-certified buildings. To fairly assess the market premium attributable specifically to labeling or certification, the researchers needed to control properly for any important differences in quality between the certified and non-certified buildings that were not encompassed by the label. The Energy Star label, for example, is intended to signal to potential renters or purchasers of a building something about the energy costs inherent in using the building, but it is not intended to suggest anything about whether the building is Class A, B or C, or about whether the building has various amenities, etc.. If the researchers were simply to compare the rents or sales prices of labeled/certified buildings against those for non-labeled/certified buildings, the simple comparison would show the combined impact of both the label/certification and the other unrelated quality differences between the two groups of buildings. In order to estimate the impact of labeling/certification alone, the researchers needed to use some sort of statistical technique to "pull out" of the observed market premium the impact of the quality differences that are unrelated to the label. Eichholtz, Kok and Quigley did so by using hedonic regression techniques; other researchers have addressed this issue by using matched control groups, and still other techniques are possible. An important topic that we address in this paper as we review various researchers' efforts to estimate the impact of labeling or certification is whether and how well each study has used statistical techniques such as these to separate the impact of labeling/certification on market values from the impact of other factors on market values.

Wiley, Benefield and Johnson: Green Design and the Market for Commercial Office Space

Wiley, Benefield and Johnson (2010) performed a similar study using the CoStar database to estimate the impact of green certification on rental rates, occupancy rates and sale prices for Class A office buildings throughout the U.S. The authors used a hedonic regression approach involving somewhat fewer variables describing the quantity and characteristics of the buildings than in the Eichholtz, Kok and Quigley study. The authors' rental analysis included office properties in 46 metropolitan markets and the sales analysis covered 24 metropolitan markets. They found that LEED-certified buildings rented for 15 – 18% more and Energy Star buildings rented for 7 – 9% more than comparable non-certified buildings. In terms of sales prices, LEED-certified buildings sold at an average premium of $130/sq ft (30 - 50% more) relative to the price of non-certified buildings, and Energy Star buildings sold at an average premium of $30/sq ft (8 - 15% more) relative to non-certified buildings.

Both Wiley, Benefield and Johnson (WBJ) and Eichholtz, Kok and Quigley (2009) (EKQ) thus found that green certification increases market values for commercial office buildings during the period from 2004 through 2008. LEED certification appeared to increase market value more than Energy Star certification:

- Rental rates: LEED certification adds 5% (EKQ, but not statistically significant) or 15-18% (WBJ). Energy Star certification adds less: 3% (EKQ) or 7-9% (WBJ).

- Sales prices: LEED certification adds 30 - 50% (WBJ), while EKQ could not analyze the increment with LEED certification because of the small number of LEED property sales in their database. Energy Star certification adds 8 - 15% (WBJ) or 16% (EKQ).

Some subsequent researchers have questioned the manner in which Wiley, Benefield and Johnson controlled for a building's location in attempting to isolate the impact of green certification on rental rates and sales prices. Wiley, Benefield and Johnson did so by including in their regression analysis a large number of non-certified office buildings that are located within the same metropolitan area as each included green-certified building. Within each metropolitan area, though, the authors did not make any more precise effort to identify locationally equivalent non-green office buildings that could serve as controls for the certified green buildings in the study. The authors might have done better by choosing as controls all non-green buildings that were geographically very close to the green buildings (e.g., within ¼ mile of the green building, as in the Eichholtz, Kok and Quigley study), or by hand-picking a set of locationally equivalent non-green control buildings for each of the green buildings (choosing "matching" controls, as done by Griffin, et al., 2009). Subsequent researchers believe that Wiley, Benefield and Johnson's overly broad definition of "locationally equivalent" in choosing buildings to serve as controls in their study likely led them to overestimate the market premiums associated with green certification:

> "In essence, they identify rental and sale premia for certified buildings relative to noncertified buildings *in the same metropolitan area*. However, if certified buildings tend to be more likely to be in better quality locations within a metropolitan area, observed premia may include a location as well as a certification premium." (Fuerst and McAllister, 2011)

Fuerst and McAlister, 2009: Effect of Eco-Labeling on Office Occupancy Rates

Fuerst and McAlister used the CoStar database and hedonic regression techniques to investigate the impact of green certification (LEED or Energy Star) on occupancy rates for office buildings in 81 metropolitan areas throughout the U.S. They found that occupancy rates for LEED-certified buildings averaged 8% higher than for non-certified buildings and occupancy rates for Energy Star rated buildings averaged 3% higher than for non-certified buildings. These increases in occupancy rates for green-certified office buildings were estimated after correcting for differences in quality, location, etc. between the green-certified and non-certified buildings.

Fuerst and McAlister obtained these results by analyzing data on occupancy rate and potential explanatory variables (e.g., age, size, height and class of building, asking rent, type of lease, geographic location, etc.) for 292 LEED-certified, 1,291 Energy Star and approximately 10,000 non-certified control buildings. For each green-certified building in the study, the control buildings included all non-certified office buildings with appropriate data available located within the same office space submarket as the green-certified building (643 submarkets, as classified by Co Star). At an average of approximately3 8 submarkets per metropolitan area, this approach to identifying locationally equivalent office buildings to serve as controls in the analysis is much preferable to that employed by Wiley, Benefield and Johnson, who, in effect, assumed all office buildings within an entire metropolitan area as locationally equivalent.

Fuerst and McAllister do not report the time period that their analysis covers, but we presume given the typical time lag between the origin of the data underlying a study and publication of the study that most or all of the researchers' data derives from before 2008. In a study that we reviewed earlier in this paper, Miller (2010) indicates that the premiums accorded to green-certified office buildings (higher rents and/or higher occupancy rates) were substantially lower after 2007 than before 2008. We suspect that Fuerst and McAlister might find a smaller advantage in occupancy rates for green-certified office buildings relative to non-certified buildings if they were to repeat their study using more current data.

Fuerst and McAlister, 2011: Green Noise or Green Value?

Fuerst and McAllister performed a similar hedonic regression study using the CoStar database, this time investigating how the rental rates and sales prices for green-certified office buildings compared with those for non-certified office buildings. The rental analysis addressed 197 LEED-certified properties, 834 Energy Star-rated properties, and about 10,000 non-certified office buildings that served as controls and were located in the same metropolitan submarkets as the green properties. The sales analysis involved 127 LEED-certified buildings, 559 Energy Star-rated properties, and more than 5,000 non-certified buildings that had been sold and which served as controls. The rental analysis was conducted using information from the 4^{th} quarter of

2008, thus reflecting conditions during the recession. The sales analysis used data on sales from 1999 through 2008. The authors found the following:

- Rental rates. LEED-certified buildings rented for an average of 5% more per square foot than did non-certified buildings, after correcting for building quality, location, etc. There was weak evidence that the level of LEED certification (certified, silver, gold, or platinum) made a difference in the amount of the estimated green premium, though this was uncertain because of the very small number of platinum LEED-certified buildings. Energy Star-rated buildings rented for an average of 4% more per square foot relative to non-certified buildings.

- Sales prices. LEED- certified buildings sold for an average of 25% more per square foot than did non-certified buildings. Energy Star-rated buildings sold for an average of 26% more per square foot relative to non-certified buildings.

We have more confidence in these estimates developed by Fuerst and McAlister (2011) than we have in the estimates developed by the other researchers that we have discussed thus far. Fuerst and McAlister analyzed a larger number of green-certified properties, their analysis spans both pre-recession and recession years, their approach in controlling for the impact of location is better than most others, they apply a correction in their rental analysis to recognize the differing impacts of net vs. gross leases, and they use a broad and sensible set of explanatory variables in their hedonic regressions.

Eichholtz, Kok, and Quigley, 2010: Sustainability and the Dynamics of Green Building

Eichholtz, Kok, and Quigley expanded on their earlier study in which they estimated the impact of green certification on rental rates and sales values for office buildings. In their earlier study the researchers analyzed the CoStar database as of September, 2007 for their study of rental rates, and analyzed sales reported in the database between 2004 and late 2007. In both the rental and the sales analyses the researchers thus assessed the impact of green certification at times when the market for commercial office space was relatively strong. In the new study, the researchers performed two additional analyses using data from CoStar as of October, 2009, thus adding coverage of a period during which the market for office space weakened substantially. In the two new analyses, the authors:

1. Updated the earlier rental and sales analyses by looking in October, 2009, at how conditions had changed for the set of 694 green-certified office buildings that had been analyzed as of September, 2007 in the earlier study; and

2. Conducted new rental and sales analyses, parallel to what they had done in the earlier analyses as of September, 2007, for the much larger set of 2,687 green-certified office buildings that could be found in the CoStar database as of October, 2009.[14]

[14] By using the CoStar database as of October, 2009 for the new study, the researchers not only extended the analysis into a period when the office space market was weak rather than strong, but they also sharply increased the number of green-certified buildings that were examined and from which conclusions could be drawn. As of September, 2007, there were 694 green-certified buildings in the CoStar database with sufficient information available to be included in the earlier study. As of October, 2009, the number of green-certified buildings in the

In the new study, Eichholtz, Kok, and Quigley used a methodology nearly identical to their earlier study: hedonic regression analysis with a rich set of variables used to explain a building's rental rate and sales price. A control group was created for each green building in the analysis consisting of all other non-green office buildings of roughly similar sort located within ¼ mile of the subject building. For each green-certified building in the rental or sales analysis, there were an average of approximately twelve non-green buildings found in the CoStar database within a ¼ mile radius that were included in the analysis as controls.

The following table summarizes the researchers' findings when they looked again in October, 2009 at the same set of green-certified office buildings that they had analyzed as of September, 2007:

Estimated Change Over Time in Average Rental Rates for 694 Green-Certified Office Buildings Relative to Rents for 8,182 Non-Green Control Buildings

	Nominal Rent: Green vs. Non-Green	Effective Rent*: Green vs. Non-Green
As of September, 2007	4.1% higher	7.5% higher
As of October, 2009	1.2% higher	2.4% higher

* Effective rent = Nominal rent adjusted for vacancy rate

In October, 2009, these green-certified office buildings continued to show (after adjusting for differences in building age, quality, location, etc.) a higher average rent than comparable non-green-certified office buildings, but the magnitude of this premium appeared to have shrunk as the recession proceeded. The authors attribute the shrinking premiums to both: i) the general decline in rents with the recession (between 2007 and 2009 the authors estimate that average nominal rents for all commercial office space declined 5.4% and average effective rents declined by 7.5%); and ii) the increased competition that green-certified buildings faced from each other in 2009 after the large increase in their supply during the previous two years.[15] In their ultimate conclusion, the authors chose to emphasize the fact that these green-certified buildings continued to maintain a premium over comparable non-green-certified buildings instead of focusing on the shrinking magnitude of this premium:

> "Surprisingly, we find that the large increases in the supply of green buildings during 2007-2009, and the recent downturns in property markets, have *not* significantly affected the returns to green buildings relative to those of comparable high quality property investments; the economic premium for certified office space has decreased slightly, but

U.S. had grown dramatically, with nearly four times as many such buildings existing and suitable for inclusion in the researchers' new analysis. The much larger number of buildings included in the new analysis greatly increases the statistical power of the researchers' regression analyses.

[15] In a sophisticated analysis, the authors found that that the average premium for green buildings declined substantially between 2007 and 2009 for those 2007 green buildings that faced new competition during this period from additional new green buildings within a ¼ mile radius. The green building premium declined much less between 2007 and 2009 for those 2007 green buildings that did not face any new competition from new green buildings in their immediate vicinities.

rents and asset values are still higher than those of comparable properties." (Eichholtz, Kok, and Quigley, 2010, page 1)

We suggest an additional possible reason for this shrinking premium over time, particularly for the Energy Star-rated buildings within the researchers' 2007 sample (of the 694 green-certified buildings in the 2007 sample, about ¾ were Energy Star-rated and about ¼ were LEED-certified). Only the most energy-efficient 25% of all buildings at any point in time are eligible for an Energy Star rating. As the energy efficiency of the nation's entire stock of buildings improves over time, the level of performance required to qualify for an Energy Star rating increases also. An Energy Star rating obtained by a building several years ago when the standard was lower is thus not as meaningful as a rating obtained more recently when the standard is higher. If the market perceives this as a declining value of a building's Energy Star rating with the passage of time, the average premium that any particular set of Energy Star-rated buildings will exhibit relative to non-rated buildings will decline over time. In fact, the researchers estimate in one of their regressions that the average rental rate premium for an Energy Star-rated building relative to a non-rated building declines by about 0.4% for each year since the Energy Star building obtained its rating (statistically significant at the 95% level). Likewise, the researchers estimate that the average premium in effective rent for an Energy Star-rated building relative to a non-rated building declines by about 1.1% for each year since the Energy Star building obtained its rating (statistically significant at the 99% level).

The authors also performed an analysis as of October, 2009 that compared the rental rates and sales prices for all the green-certified buildings existing in the CoStar database as of this time against comparable non-green-certified buildings. This 2009 set of green-certified buildings was nearly three times as large as the sample obtained for the September, 2007 analysis, reflecting the rapid growth in green certification occurring across the nation during this period. The rental analysis as of October, 2009 included nearly 2,000 green-certified buildings (LEED and Energy Star) and more than 18,000 non-green buildings within ¼ mile of the green buildings that served as controls. The sales analysis as of October, 2009 included 744 green-certified office buildings that were sold between 2004 and 2009 and more than 5,000 non-green office buildings that were sold during the same period and that served as controls in the sales analysis study. These figures make Eichholtz, Kok, and Quigley (2010) by far the largest of all the hedonic regression analyses investigating whether green certification increases the market value of commercial office buildings. The researchers obtained the following results:

Rental Rates in October, 2009, for 1,943 Green-Certified Office Buildings Relative to Rental Rates for More Than 18,000 Comparable Non-Green Office Buildings

Nominal Rent (per sq ft)			Effective Rent (per sq ft)		
All Green Bldgs	LEED	Energy Star	All Green Bldgs	LEED	Energy Star
1.8% higher	5.8% higher	0.5% higher	4.7% higher	5.9% higher	4.3% higher

Relative to non-green office buildings of comparable quality and location, green-certified office buildings in late 2009 were estimated to have higher average nominal rents and occupancy rates, leading to a 4.7% premium in effective rents. LEED-certified green buildings exhibited higher average rent premiums than did Energy Star-rated green buildings.

Sales Prices for 744 Green-Certified Office Buildings Sold From 2004 - 2009 Relative to Sales Prices for About 5,000 Comparable Non-Green Office Buildings Sold in Same Period

Sales Price (per sq ft)		
All Green Bldgs	LEED	Energy Star
13.3% higher	11.1% higher	14.0% higher

Green buildings also showed higher average sales prices over the period from 2004 - 2009 than did comparable non-green office buildings. Energy Star-rated buildings apparently showed somewhat higher sales premiums than did LEED-certified green buildings, but the researchers did not present this comparison and we have calculated the estimated premium for Energy Star-rated offices with some degree of uncertainty.[16]

Reichardt, et al, 2012: Sustainable Building Certification and the Rent Premium: A Panel Data Approach

The authors studied rental and vacancy rates from the beginning of 2000 through the end of 2009 for a large set of green-labeled office buildings in the ten largest metropolitan office space markets in the U.S. The study was aimed largely at investigating the dynamics of green labeling impacts over time. The study investigated the premia for Energy Star and LEED labeled office buildings relative to comparable non-labeled buildings, how these premia may have changed over time, and whether these premia were different for buildings that received their green labels at different times.

The study database included 1,584 Energy Star-labeled buildings, 337 LEED-certified buildings, and more than 5,000 non-labeled buildings in the same markets that served as controls. This metropolitan market-wide approach for identification of controls is like that in Wiley, Benefield

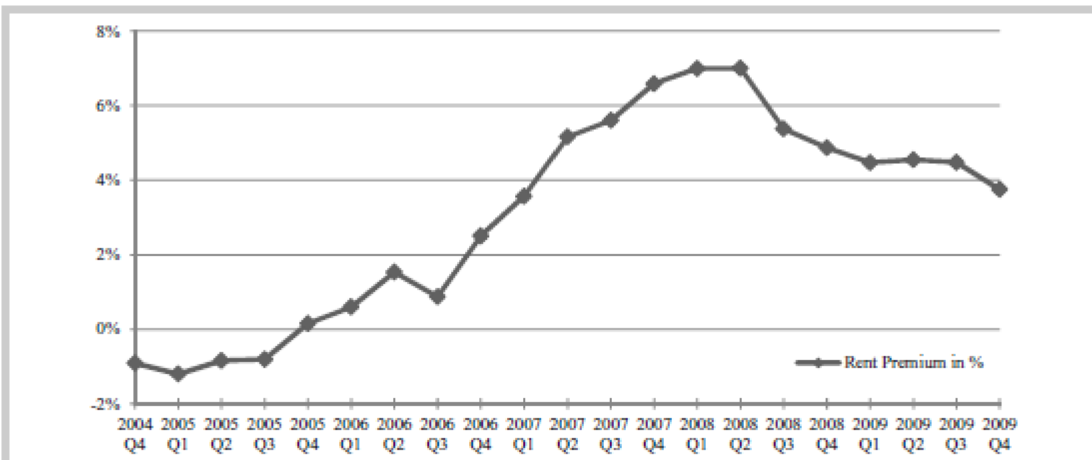
[16] In their log-linear regression estimating the average sales price premium for LEED and Energy Star buildings separately, Eichholtz, Kok and Quigley (2010) included both a 0/1 dummy variable for Energy Star certification and another variable "Label Vintage" that represented the number of years previous to 2009 when the building's Energy Star rating was conferred. We are unable to evaluate what the combination of the coefficient estimates for these two Energy Star variables means regarding the average premium for Energy Star certification over the researchers' sample of office building sales, particularly so because the average sales price for buildings during the researchers' sample period increased sharply from 2004 through 2007, then declined sharply thereafter through 2009.

We estimated the average Energy Star sales premium of 14.0% as shown in the table above as follows. The researchers present other regression estimates to the effect that: 1) The average sales price premium over the entire sample due to any form of green certification (LEED or Energy Star) is 13.3%; and 2) The average sales price premium due to LEED certification specifically is 11.1%. We assumed that approximately ¾ of the green building sales in the researchers' data sample were Energy Star-rated properties and approximately ¼ were LEED-certified buildings. (The researchers do not provide this breakdown in their paper, but this ¾-to-¼ split represents the approximate share of Energy Star vs. LEED in the nation's total square footage of office space as of early 2007, approximately at the midpoint of the researchers' 2004 - 2009 period of analysis.) We calculated then that if the weighted average sales price premium from any form of green certification was 13.3% and 25% of the green certifications comprising the total were LEED with an average price premium of 11.1%, then the 75% of the green certifications that were Energy Star must have had an average price premium of 14.0%. (1/4 x 11.1) + (3/4 x 14.0) = 13.3.

and Johnson (2010); we believe it is less reliable than the tighter approach to identification of controls as buildings within ¼ mile of the subject building (as in Eichholtz, Kok, and Quigley, 2010), or as buildings within the same metropolitan area sub-market (as in Fuerst and McAlister, 2011).

The authors found as an average across all green-labeled office buildings and all years that Energy-Star and LEED buildings received rental rates 2.5% and 2.9% higher, respectively, than unlabeled buildings. Energy-Star buildings had an average occupancy rate 4.5% higher than unlabeled controls, while LEED buildings had an average occupancy rate slightly lower than, though not statistically significantly different from, unlabeled controls. The authors found that the average premium in rental rates for Energy Star buildings changed substantially over time, rising from nothing for the relatively few Energy Star buildings early in the decade to a peak of 7% in early 2008, and then declining rapidly with the softening office space market to 3.7% at the end of 2009.

Estimated Rental Premiums for Energy Star Office Space from 2004 Through 2009



<u>Summary of findings on market value of energy labels for office buildings in the U.S.</u>

In the following table, we summarize the results as reported above from the better-quality studies that have investigated the impact of energy labeling on the value of commercial office buildings in the U.S.

Each of the six better-quality studies finds a significant average market premium for green-certified or energy-labeled office buildings (LEED or Energy Star) relative to otherwise comparable non-labeled office buildings, in the form of higher rents, lower vacancy rates, higher sales prices, and/or higher effective rents. The magnitude of these premiums for energy-labeled office buildings appears to have declined with the recession and the weakening market for office space, but these premiums still remained significant in late 2009, when the most recent of the relevant studies closed. Throughout the period from 2004 through 2009, an Energy Star-rated office building appeared to have an average rent per square foot ranging from about 1% to 5% higher than that for a comparable non-rated building. The premium in terms of effective rent for the Energy Star-rated building was higher than this because the Energy Star buildings had generally higher occupancy rates. In terms of sales prices per square foot, an Energy Star-rated office building showed average sales prices roughly 10% to 16% higher than those for comparable non-rated buildings.

The studies provide strong evidence that the commercial office space market in the U.S. gives a significant premium to buildings that have labels suggesting relatively high energy efficiency.

Study Findings Regarding U.S. Market Premiums for Energy-Labeled Office Buildings

Study	Estimated Avg. Impact on Rent	Estimated Avg. Impact on Sales Price	Other Findings and Comments
1. Eichholtz, Kok and Quigley (2009)	Energy Star: + 3.3% LEED: + 5.2% (not stat. signif.)	Energy Star: + 16%	Effective Rent: Energy Star: + 6.0% LEED: + 5.2%
2. Wiley, Benefield and Johnson (2010)	Energy Star: + 7 to 9% LEED: + 15 to 18%	Energy Star: + 8 to 15% LEED: + 30 to 50%	Less desirable approach used in this analysis to control for impact of a building's location on its market value
3. Fuerst and McAlister (2009)			Occupancy Rate: Energy Star: + 3% LEED: + 8%
4. Fuerst and McAlister (2011)	Energy Star: + 4% LEED: + 5%	Energy Star: + 26% LEED: + 25%	In contrast to studies #1,2,3, this study includes data during the recession as well as pre-recession. Rental sample was taken in 4th quarter 2008, sales sample includes 1999 - 2008.
5. Eichholtz, Kok and Quigley (2010)	All: + 1.8% Energy Star: + 0.5% LEED: + 5.8%	All: + 13.3% Energy Star: + 14.0% LEED: + 11.1%	Effective Rent: All: +4.7% Energy Star: + 4.3% LEED: + 5.9% Largest database and longest time period covered among all the analyses. Rental sample was taken in October, 2009. Sales sample includes 2004 - 2009. Premiums for labeled buildings fell by more than 50% between September, 2007 and October, 2009.

6. Reichardt, et al (2012)	Energy Star: + 2.5% LEED: + 2.9%		Occupancy Rate: Energy Star: + 4.5% LEED: - 1.7% (not stat. signif.) The avg. premium in rental rates for Energy Star buildings rose from nothing for the relatively few Energy Star buildings early in the decade to a peak of 7% in early 2008, and then declined rapidly with the softening office space market to 3.7% at the end of 2009 Large database and coverage from 2004 through 2009, but less desirable approach for identifying controls.

Studies estimating the market value of energy-labeling for commercial properties outside the U.S.

We will quickly summarize the findings from several studies of energy-labeling for commercial properties in non-U.S. markets.

Kok and Jennen (2011) used hedonic regression analysis to compare the rental rates across more than 1,000 leasing transactions between 2006 and 2010 in office buildings in the Netherlands that had been labeled with the European Union's Energy Performance Certificate (EPC). An EPC in the Netherlands includes a letter rating ranging from A, signifying a building with exceptional energy efficiency, to G, signaling poor energy efficiency. Buildings rated A, B, or C are considered "green" and receive an EPC that is, in fact, green in color; buildings rated D are considered intermediate (yellow label), and buildings rated E, F, or G are considered energy-inefficient and are given a red label. Kok and Jennen found, after controlling for an office building's location, size, quality, and nearby amenities, that buildings with non-green labels (D or lower) had average rents per square meter that were 6.5% below those for buildings with green labels (A, B, or C).

In looking beyond the strong relationship found in comparing the entire group of highly-rated buildings against the entire group of lower-rated buildings, however, the authors did not find a smooth relationship between the specific rating of the building's EPC and rental rates. Among the seven levels of EPC ratings, C-rated office buildings had the highest average rents (not A-rated buildings), E-rated buildings had rents lower than either F- or G-rated buildings, and G-rated buildings had higher average rents than did D-rated buildings. The authors provided possible explanations for some of these apparent anomalies, including small sample sizes at the extremes of the EPC scale, and perhaps additional variables affecting rental rates that were not included in the regressions. Nevertheless, the erratically ordered values found for the different EPC label levels suggest some uncertainty about the researchers' overall findings.

Kok and Jennen (2011) also made the interesting observation -- contrasting with the findings in two U.S. office market studies (Eichholtz, Kok, and Quigley, 2010; and Reichardt, et al, 2012) -- that the rental premium for green office space narrowed during the recession through early 2009, but then started widening rapidly from mid-2009 through the end of 2010 when the Dutch study concluded. The two U.S. studies that have analyzed the change over time in the premium for green office space found that the green premium in the U.S. narrowed substantially during the recession and continued to do so through the end of the studies in late 2009 or early 2010. If the U.S. studies had continued beyond this period, would they also, like the Dutch study, have found that the narrowing green premium would reverse and then begin to widen?

In a conference presentation and unpublished working paper, Chegut, Eichholtz and Kok (2010) investigated the premiums for BREEAM-certified green office buildings in Great Britain.[17] Rental rates for BREEAM-certified offices averaged 16 - 20% higher than for comparable non-certified properties. Two of three regression specifications found no sales price premiums for green-certified office buildings. Little documentation is available on the researchers' analytical

[17] BREEAM is an abbreviation for BRE (Building Research Establishment) Environmental Assessment Method. It is a methodology and certification that addresses the sustainability of non-domestic buildings, rather like LEED in the U.S. and Green Star in Australia. It addresses several aspects of sustainability in addition to energy efficiency.

methods, there are likely small sample problems in the sales analysis, and the researchers' limited set of control variables in the regressions has been questioned.

In a preliminary analysis of the impact of the EPC rating on the rental and capital values of nearly 700 U.K. commercial buildings (retail, office, industrial) Fuerst and McAllister (2011a) find some evidence that A-rated (most-efficient) buildings showed some increase in market value, yield and rent over less highly rated buildings, but no further evidence of any systematic variation in any sorts of values across lesser-rated (B through G) buildings. They concluded that "more data [is] needed" and that:

> "… energy labelling is not yet having the effects on Market Values and Market Rents that would be expected if high EPC ratings were associated with substantial cost savings that are fully reflected in capital values and/or were readily available and taken into account by prospective tenants and buyers."

Fuerst and Wyatt (2012) have apparently found that BREAMM-credited office buildings in the U.K. (BREAMM in the U.K., is rather similar to LEED in the U.S.) receive a price premium over comparable non-BREAMM offices, but the full details of their study are not available.

The real estate data firm IPD, Ltd. (Investment Property Databank) maintains an index of Australian property values and publishes reports that evaluate the financial returns from different types and levels of green-certified office buildings against those for non-certified offices:[18]

- Green Star-certified office buildings had average 2-year returns ending March, 2011 of 7.4%/yr compared with 4.0%/yr for non-certified buildings. Among the Green Star-certified offices, those with four stars had average returns of 10.8%/yr while those with five stars had average returns of 5.0%/yr (lower!).

- Prime office buildings with a NABERS rating[19] had average 3-year returns ending March, 2011 of 2.1%/yr compared with 1.6%/yr for non-rated buildings. Among the NABERS-rated offices, those with 0 to 3.5 stars had average returns of 2.0%/yr while those with four or five stars had average returns of 2.3%/yr.

These comparisons reflect simple averages comparing the returns from a large number of certified or rated office buildings against those for a similarly large group of non-certified or non-rated buildings. Without a careful statistical procedure to control for various differences between the two groups of buildings (e.g., differences in terms of average location, age, building quality, amenities, etc.), however, the increased financial returns that IPD found for certified or rated buildings reflects not a distinct premium for green buildings but instead some combination of a potential premium for green buildings and the unknown impact of the various other factors

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[18] Available at: http://www.prpaustralia.com.au/contentUploaded/ResearchReports/25_10_2011%20-%20Transitional%20Period%20of%20Commercial%20Building%20Disclosure%20Ending%20Soon.pdf

[19] NABERS ratings in Australia reflect only the energy efficiency of the building, in contrast to the broader set of sustainability issues considered in Green Star certification. NABERS is similar to Energy Star in the U.S., while Green Star is similar to LEED. In general in Australia, Green Star is primarily focused on new buildings and NABERS more broadly used for existing buildings.

differentiating one group from the other. This lack of adequate statistical controls is an issue that we cited also for several studies attempting to investigate the green premium in the U.S. (e.g., Miller, Spivey and Florance, 2008; Miller, 2010; Earth Advantage, 2011).

Newell, MacFarlane and Kok (2011) conducted another recent study estimating the impact of green certification for office buildings in two Australian markets: Sydney and Canberra. Rental rates, vacancy rates and various measures of financial returns were analyzed for 206 green office buildings and 106 non-green buildings selected as controls to match the green buildings in several broad submarkets. In contrast to the IPD Australian studies referenced above, hedonic regression was used to estimate the impact of green certification separately from the impact of most other factors potentially causing differences between the green and non-green samples. However, relative to the better studies of U.S. office markets, the sample size is small, the approach used to control for building location is not very precise, and no information is presented on the level of statistical confidence in the results. The researchers concluded:

- NABERS-rated office buildings showed a premium in overall value (considering rental rates, vacancies, rent incentives and operating costs) relative to comparable non-rated buildings. The average premiums varied with the number of NABERS stars the building received. Office buildings with a 5-star rating showed a 9% premium in value and those with 3 to 4 ½ stars had 2 to 3% premium. Office buildings with a NABERS rating at less than 3 stars showed a minimal premium in value over comparable non-rated buildings. In some of the market areas analyzed (Sydney CBD and Canberra), buildings with these lower NABERS ratings were estimated to lose value as a result of having been rated.

- It appears that higher average gross rents per square meter contribute roughly half or less of this premium from certification. Also important are: lower operating costs, lower rent incentives (i.e., fewer months of “free rent”), and lower vacancy rates in NABERS-rated office buildings.

- Green Star-rated buildings showed a 12% premium in overall value relative to comparable non-green office buildings, a substantially higher premium than even the highest-rated NABERS properties. Many fewer office buildings that had received Green Star ratings were included in the data sample, and it is not clear whether these findings are statistically significant or not.

In sum, several studies of energy labels for office buildings in Great Britain, the Netherlands and Australia provide evidence that energy-efficient properties will gain market premiums in rent, sales price and overall value similar to those demonstrated in the U.S.

2. Impact of Labeling and Disclosure in Encouraging Energy-Saving Investments

How well have energy labeling and disclosure programs worked? Have labeling and disclosure requirements and programs encouraged property owners to make investments in energy efficiency in anticipation of realizing a higher market price when the property is sold? And, perhaps additionally, have the energy audit reports or other materials accompanying many energy labels encouraged the new purchasers of a property to make investments in energy efficiency that they otherwise might not have made?

In our view, the record here is disappointing. Energy labeling or disclosure programs have not elicited the improvements in energy efficiency that the proponents of these programs have hoped for. In the following pages we review various studies that have evaluated the impact of energy labeling programs on the use of energy in buildings or on the rate at which building owners have implemented energy-saving investments. Nearly all of these studies evaluate experience in Europe and Australia, since energy labeling and disclosure programs have been much more prevalent and have been operated for much longer in these other parts of the world than in the U.S.

We also focus in this review of the impact of labeling and disclosure programs largely on owner-occupied homes, in contrast to rental properties, both residential and commercial. Energy labeling and disclosure programs might be expected to have lesser impacts for rental properties than for owner-occupied properties, since rental properties often represent "split incentive" situations. For example, in circumstances when the renter pays his own energy bills the building owner has little economic incentive to pay for capital improvements to the structure that can reduce the tenant's energy usage and costs; and conversely in circumstances when the building owner pays the building's energy bills the renter has little incentive to modify his energy-using behaviors in ways that can reduce the owner's utility costs. In this sense, owner-occupied buildings (mostly homes), where split incentives do not exist, provide a better opportunity for economic incentive approaches such as labeling and disclosure to encourage energy-conserving investments than do rental properties.

Results of energy labeling and disclosure programs in the U.S.

<u>Mandatory energy audit prior to sale for older homes in Austin, Texas</u>

Effective June 1, 2009, the city of Austin, TX, mandated an energy audit prior to sale of most homes more than 10 years old, with the results of the audit being provided to the prospective purchaser. The only assessment of this program of which we are aware examined the first eleven months after full implementation and concluded "impact of home energy audit rule less than expected: number of upgrades far below city goal; fears about effect on sales appear overblown." (this and subsequent quotations about the Austin, TX, program are from Novak, 2010). More than 9,500 homes in the City were sold during this period and 4,862 had audits conducted.

> "In 96 percent of the … audits conducted, the energy auditors recommended at least one improvement. However, only 520 homebuyers or sellers followed through on any of the

> recommendations. This is far short of the City Council's first-year goal of 25 percent of all homes sold getting energy upgrades."

Only about half of the homes sold had audits conducted (the program includes a variety of exemptions from the audit-prior-to-sale requirement), and among the homes audited, only 11% had an improvement made consistent with one or more of the audit recommendations. Slightly more than half of the improvements that were made were accomplished by purchasers after the home was sold, and slightly less than half were made by sellers prior to sale.

One commenter on the Austin program said that the audits (typically costing $200 - $300 each) are a burden for lower-income home sellers who "count every penny"; and that "the audits largely duplicated the job done by licensed home inspectors and don't materially add to the stock of more energy-efficient housing in Austin because acting on the recommendations is voluntary".

On the other hand, several real estate agents said generally that the Austin ordinance has not stalled home sales or weakened sellers' negotiating power. One agent said that "The audit has never crushed any deals for any of my buyers or sellers."

This early assessment of Austin's mandatory audit requirement is the only report of which we are aware that evaluates the effectiveness of an energy labeling and disclosure program for homes in the U.S. Later in this section of the report we will discuss several evaluations of the effectiveness of the many more energy labeling and disclosure programs for homes that have been implemented in Europe and Australia.

<u>Benchmarking and disclosure requirements for commercial buildings in the U.S. -- Palmer and Walls, 2014</u>

Palmer and Walls (2014) recently assessed several issues relating to the growing number of municipal programs requiring benchmarking and disclosure of energy efficiency information for commercial buildings (e.g., in Austin, Boston, Chicago, Minneapolis, New York, Philadelphia, Seattle, Washington, D.C.). These programs generally require the owners of larger commercial buildings, and occasionally larger multi-family residential buildings, to report their buildings' energy use to the government, benchmark it against energy use by other comparable buildings, and often then to disclose this information to the public and/or tenants and/or parties to real estate transactions involving the buildings. Palmer and Walls indicate that the motivation for these benchmarking and disclosure requirements is the

> "… existence of the so-called 'energy efficiency gap,' or 'energy paradox,' the observation that consumers and firms fail to make investments that appear to more than pay for themselves in the stream of energy savings they yield."

The "energy paradox" generally parallels the conclusion that we reach in this section of our report -- that it appears surprisingly difficult to induce property owners to make energy conserving investments, even when such investments appear to offer attractive economic returns to the property owners. Palmer and Walls cite four reasons why the energy paradox[20] exists for commercial buildings:

1. "*Missing or imperfect information*. Buildings are inherently a bundled good consisting of many attributes, some of which are more readily observable than others. In a commercial building, energy efficiency is a function of how a building is constructed, including difficult to observe features like the amount of insulation in the walls and the performance of boilers and chillers and air handling systems and elevators. Energy use typically represents one-third of building operating costs so building owners who care about the profitability of their investments would be well served by making cost-effective investments that could reduce energy costs. However, because of the multi-year paybacks associated with most of these investments and uncertainty about the energy savings they will yield, building owners may often not have enough information to make these risky investments. Compounding the problem is the difficulty owners face in conveying energy efficiency information to potential future buyers."

2. "The *principal-agent problem*, also known in this context as the landlord-tenant problem, occurs when one party makes an investment and another party reaps the benefits or pays the costs that result from that investment. A manifestation of the landlord-tenant problem is when a landlord pays for the key energy investments, such as insulation and equipment, but the tenant pays the energy bills. The landlord has little incentive to invest in efficiency improvements because he does not directly reap the benefit, nor can he typically recoup the cost through higher rents because he cannot credibly convey the building's energy efficiency properties to prospective tenants."

3. *"Credit market failures*. Most building owners, especially owners of large commercial buildings in urban areas, will need to finance any investments they make in energy improvements and retrofits. Upgrading lighting and replacing heating, cooling, and ventilation systems can cost tens of thousands, or even hundreds of thousands of dollars. … For commercial property owners who are mainly in the real estate business, commercial mortgage underwriting practices present a hurdle. … energy costs are essentially a "wash" in the net operating income calculations that lenders make and use for mortgage approval: they are a component of operating costs but are assumed, in most cases, to be offset by tenant lease payments. Lenders evaluate overall risks rather than energy risks, typically setting maximum loan-to-value ratios and minimum debt service coverage ratios.

[20] There is extensive literature documenting the existence of an "energy paradox" or "energy efficiency gap" in areas ranging from buildings to automobiles and appliances. Energy consumers seem to underinvest in what would appear to be financially attractive opportunities to increase energy efficiency, where private returns substantially exceed private costs. With respect particularly to energy use in buildings, the underinvestment in energy efficiency by property owners has proven difficult to ameliorate. Governments and utilities have commonly obtained low participation and disappointing results with incentive programs aimed at inducing homeowners to upgrade their HVAC systems and controls and to improve the building envelope. In recent years, governments and utilities in the U.S. have made substantial efforts to improve what have historically been only marginally successful programs in this area. The following are several references on these topics: the energy paradox, disappointing results from past programs, reasons why the energy paradox exists and why it is difficult to address, and possible new policy directions for encouraging more homeowner investments in energy efficiency. Jaffee and Stavins (1994), Abrahamsee et al (2005), Russell (2006), Fuller (2009), Fuller et al (2010), Aufhammer and Sanstad (2011) (pages 18 - 29), Neme et al (2011), Palmer et al (2011), Stavins (2013), and Gillingham and Palmer (2014)

Even though buildings with lower energy costs may be lower risk for default on a loan, it is not common practice for this to be reflected in these ratios."

4. "*Rational inattention*. A … potential problem recently discussed in the literature is inattentiveness to energy efficiency attributes when purchasing an energy using durable such as a car or new appliance. If it takes time and effort to figure out the energy costs associated with a product, it may be rational for a consumer to ignore this attribute when making a purchase decision. Real estate transactions and the contracts involved can be very complex, thus the inattentiveness problem could apply to commercial buildings as well. Buildings have multiple attributes that affect the discrete purchase or rental decision and the stream of future energy costs may be low on the list of attributes that gets attention in this complex process. This inattentiveness may result in choices that are ex post sub-optimal."

Palmer and Walls cite three respects in which municipal benchmarking and disclosure programs might perhaps mitigate these problems that give rise to the energy paradox for commercial buildings:

> "First, if building owners are currently inattentive to energy costs, the simple act of entering energy use and building characteristics into [EPA's Energy Star] Portfolio Manager [the software program that nearly all of the cited cities require commercial building owners to use for organizing, reporting and benchmarking their energy usage information] may bring energy issues into focus and lead to some reductions that might otherwise be ignored. Seeing their energy use benchmarked against other buildings may reinforce that effect; peer effects have also been shown to influence energy consumption. …
>
> Second, if tenants prefer to lease space in more efficient buildings and the disclosure laws provide new energy information to the marketplace, this could lead to improvements in efficiency. Prospective tenants may get value from both private and public good aspects of energy efficiency … In terms of private benefits, tenants may prefer to rent in efficient buildings in order to lower their energy bills or because they are more comfortable. But prospective tenants may also have "green" preferences. … Building owners would respond to these market pressures by making improvements and retrofits as a means of competing for tenants. This market pressure argument is the main rationale that the cities give for adoption of the programs.
>
> A third way that the programs may have an effect is through investor behavior. Many commercial buildings are owned by real estate investment fiduciaries or real estate investment trusts (REITs). REITs are similar to mutual funds and are traded on public stock exchanges. Investors could prefer more efficient buildings, either because the lower energy costs increase net income or because of "green" preferences. This increased demand could drive up the value of more efficient buildings."

In a working paper, Leisten, Palmer and Walls (2014) and also in Palmer and Walls (2014), the authors report the results of their analysis on whether these benchmarking and disclosure programs have had any of these desired effects in causing a reduction in energy usage among affected commercial buildings. The authors analyzed data on utility expenditures in affected investor-owned commercial buildings in Austin, New York City, San Francisco and Seattle before and after implementation of these cities' benchmarking and disclosure requirements.

These four cities have been the earliest adopters of these requirements, and the authors' dataset for the analysis included somewhere between one and three years of post-implementation data for each of these cities. The authors found that:

> "… disclosure laws have had a statistically significant effect on utility expenditures. In the central specification, which includes property-level fixed effects, the results show that, all else equal, utility expenditures per square foot are approximately 2 percent lower after the laws are passed in buildings covered by the laws. This finding is robust to several alternative specifications of the model, including specifications with additional covariates and spatial fixed effects instead of property fixed effects; specifications with alternative control groups; regressions that consider only two of the four cities; and a model that eliminates observations around the time of the law's passage. …
>
> We speculate that the effect we measure, which is relatively small, is probably an estimate of the "attentiveness" effect of reporting rather than any change attributable to retrofits or improvements in response to market pressures. It is early days yet for these programs so long-term impacts are not captured in this study. However, the robustness of the results in the study suggests that the laws are having some effect. Moreover, because the results are based on utility expenditures reported to NCREIF and not the EUIs disclosed by law, we feel that they provide an independent assessment of the programs. On the other hand, there is no way to separate energy expenditures from water in the utility expenditures, thus there could be some measurement error in the data. In addition, the sample of buildings is investor-owned office and retail buildings. While investor-owned properties make up a large portion of commercial real estate, the sample omits properties that are in traditional sole ownership, partnerships, and LLCs."

The authors' working paper that fully describes the methodology and results of this analysis is not yet available, so we are unable to evaluate these findings thoroughly. We nevertheless would tend to agree with the authors' speculation to the effect that the 2% reduction in utility expenditures after the date of program implementation relative to those before implementation reflects heightened "attention" to utility costs by property owners and subsequent behavior change rather than benchmarking program-induced investments in energy efficiency that reduce usage. The one to three years of elapsed time between benchmarking and disclosure in these four cities and the end of the researchers' data series is sufficiently short so that building owners were unlikely to have had sufficient time to consider and implement much in the way of energy efficiency investments in their properties. To the contrary, we guess that the process that the municipal ordinances required commercial building owners to go through -- pulling together the data on their buildings' energy use, and then benchmarking their buildings' energy use against other buildings they own and also against reference values -- caused at least some building owners to pay more attention to the energy efficiency issue than they may have previously. We think it likely that such owners would then identify and implement some changes in how they operate their buildings that could quickly and easily reduce unnecessary or low priority energy uses. Perhaps these might include revising thermostat settings, identifying inaccurate/over-reading meters, disconnecting unnecessary electrical loads, and the like. In contrast, energy conserving investments, if they are to be induced by the benchmarking/reporting requirements, are likely to occur only after more thought and study, probably at least a couple of years after implementation of the municipal requirements. In our view, then, the Palmer and Walls study likely provides some evidence for a small, short-term, behavior-based change in commercial building energy usage following labeling. Evidence on whether the municipal benchmarking and disclosure requirements for commercial properties cause market value changes which in turn induce energy efficiency investments would likely require additional time to emerge, if it were to emerge at all.

Benchmarking and energy savings for Energy Star commercial buildings in the U.S.

EPA has developed a series of fact sheets providing a summary of the data from the commercial buildings that have benchmarked their energy performance using the Energy Star Portfolio Manager software (U.S. EPA, 2012). As of the end of 2011, more than 260,000 commercial properties of all sorts (e.g., offices, retail, schools, hotels, supermarkets, hospitals, etc.) representing about 40% of the total national commercial market have reported their energy usage in one or more years since 2006 via Portfolio Manager. EPA analyzed the data submitted by the more than 35,000 buildings that entered complete energy data in Portfolio Manager and received Energy Star scores for each year from 2008 through 2011, thus providing a database for this subset of buildings showing three years of change from a 2008 baseline. EPA found that these buildings that consistently analyzed, reported and benchmarked their energy usage:

- Realized a 7% savings in weather-normalized energy usage per square foot over this three year period, for an average reduction of 2.4% per year; and

- Improved their Energy Star score by an average of 6 points over the three years.[21]

EPA interprets this information as providing evidence that benchmarking results in reduced energy consumption -- buildings that consistently benchmark their energy performance will reduce their energy use. On its face, EPA's conclusion seems generally consistent with Leisten, Palmer and Walls' (2014) finding that utility expenditures decreased about 2% for a large sample of commercial office buildings in four cities some one to three years after implementation of mandatory benchmarking and disclosure requirements in these cities.

We believe to the contrary that EPA's Energy Star Portfolio Manager information needs more analysis before it should be interpreted as supporting a conclusion that benchmarking and disclosure leads to a reduction in energy usage for commercial buildings:

[21] The Energy Star score is an assessment of a building's energy efficiency as compared with other buildings of the same type (e.g., office, school, warehouse, hospital, etc.) nationwide. The score ranges from 1 to 100, with 50 representing the median energy use intensity (EUI, representing the building's energy usage per square foot) for all buildings of a given type in the Department of Energy's nationally representative Commercial Building Energy Consumption Survey (CBECS). The Energy Star score is normalized for weather. To qualify for Energy Star certification, a building must earn a score of 75 or higher, thus achieving a lower weather-normalized EUI than ¾ of all buildings of the same type nationally. The most recent CBECS provides data for 2003. Thus, strictly speaking, a building has been able to qualify for Energy Star certification in each year since 2003 by achieving a lower weather-normalized EUI than ¾ of all buildings of the same type nationally in 2003. Like the Energy Star certifications for other sorts of items or products, Energy Star certification for a building has thus required an increment of performance over non-certified buildings that has declined in recent years as the average EUI of all commercial buildings in general has improved. A new CBECS with data for 2012 is now being completed. After the 2012 CBECS data are analyzed, the certification standard representing better performance than ¾ of all buildings of the same type will be made more stringent, reflecting the better performance of the entire building stock as represented by the 2012 CBECS in contrast to the 2003 CBECS.

- All the buildings that were included in EPA's analysis had been chosen by their owners to participate in the Portfolio Manager program and to be benchmarked. We presume that most owners chose to submit these buildings to the Portfolio Manager program because the owners believed that their buildings would somehow benefit from being scored. It is likely that very few of the buildings included in EPA's analysis are ones that the owners did not want to have benchmarked. None of the city ordinances requiring mandatory commercial building benchmarking and disclosure, either in the four cities that Palmer and Walls (2014) analyzed or in other cities, were implemented before 2009, as would have been necessary if buildings required to be benchmarked were to be included in EPA's analysis. In sum, the owners of the buildings included in EPA's database are, on average, likely much more interested in energy efficiency and much more inclined to believe that benchmarking and disclosure will benefit them than the owners of the buildings in Palmer and Walls' database. We doubt that any conclusions regarding the impact of benchmarking obtained from the selected buildings in EPA's data set would apply also to commercial buildings in general. We would interpret a 2%/year reduction in energy usage by the buildings in Palmer and Walls' database as a much stronger indication of energy savings from benchmarking than a 2%/year reduction in energy usage by the much more "favorable-to-benchmarking" buildings in EPA's database.

- EPA's inclusion in the Agency's analysis of only those buildings that generated Portfolio Manager scores for themselves for the four consecutive years from 2008 through 2011 likely further restricts EPA's data set to only those property owners who are very positively inclined to value and respond to energy benchmarking information. Many property owners who participated in Portfolio Manager in 2008 did not participate in subsequent years, perhaps because they did not feel that the program had benefited them. Buildings that "persisted" for four consecutive years in the Portfolio Manager program are probably far more likely to show benefits from the program than buildings that tried the program in 2008 but then dropped out in a subsequent year. It appears that roughly 80,000 commercial buildings were scored in Portfolio Manager in 2008, but only about 35,000 of these buildings then continued with scoring in each year through 2011 and were included in EPA's database. Again, EPA's database appears to include not a representative sample of buildings, but instead largely buildings that were selected because they would benefit from benchmarking.

- Much if not all of the observed reduction in energy usage in EPA's data set of benchmarked commercial buildings appears to be attributable to secular trends in energy usage rather than attributable to benchmarking in particular. Weather-normalized energy use intensity across all commercial buildings in the U.S. appears to have decreased over the recession-affected period from 2008 through 2011 by an amount roughly similar to, or perhaps even larger than, that which EPA found for buildings that had been benchmarked. We calculate based on DOE data that average energy use intensity across all commercial buildings declined by 4.2% from 2008 to 2010 (224.6 thousand Btu/sq ft in 2010 vs. 234.4 thousand Btu/sq ft in 2008).[22] We further calculate based on DOE data

[22] U.S. Department of Energy. Buildings Energy Data Book. 2010 Edition. Table 3.1.3. Commercial Delivered and Primary Energy Consumption Intensities, by Year.

that *weather-normalized* average energy use intensity across all commercial buildings declined by more, by 5.75% from 2008 to 2010 (220.9 thousand Btu/sq ft in 2010 normalized to 2008 weather, vs. 234.4 thousand Btu/sq ft in 2008).[23] DOE has not developed data for 2011, so we cannot calculate a 2011 figure for weather-normalized EUI for direct comparison against EPA's estimate from the Agency's Energy Star Portfolio Manager database to the effect that weather-normalized EUI declined by 2.4% per year between 2008 and 2011 (7% decline in total across these three years). However, if the rate of decline in weather-normalized average energy use intensity of 2.835% per year that we calculate as the average across all commercial buildings in the U.S. between 2008 and 2010 were to have continued for a third year through 2011, then the decline for the three years for all commercial buildings would be 8.3% relative to 2008, a larger decline than EPA has estimated for the Portfolio Manager-benchmarked sample.

In our view, EPA's analysis provides no evidence that Portfolio Manager benchmarking has induced any incremental reduction in energy usage among participating buildings beyond that which has occurred as a result of secular trends among all commercial buildings.

Results of energy labeling and disclosure programs in Europe

Evaluation of the impact of Denmark's labeling program

Kjaerbye (2008) conducted a statistical evaluation of the impact of the Danish home energy labeling program on natural gas consumption for heating single-family homes. More than 80% of energy consumption in Danish homes is for space heating, and the predominant heating fuel is natural gas. Kjaerbye found that the Danish home energy labeling requirement -- where an audit and labeling is mandatory when a home is sold -- had no statistically significant impact in reducing natural gas usage in up to four years after a home was sold and labeling occurred.

Denmark has had a mandatory energy labeling program for single-family homes since 1997. When a home is put on the market for sale, the owner must pay for an energy audit (cost typically 300 to 500 euros) and provide the results of the audit to the purchaser. The audit is comprehensive in addressing insulation, the building envelope, appliances, and the heating system. The audit is to identify cost-effective potential energy conserving investments, their cost, their payoff, and their rate of return. The audit also generates a rating and label for the home, from A1, most energy-efficient, to C5, least energy-efficient. In addition to the audit report and labeling result, the purchaser will receive information on the home's actual historical energy usage and a comparison benchmarking the home's energy usage against that for other similar homes. After the first 6 ½ years of the Danish labeling program, about 20% of the

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[23] This calculation requires additional data. Information on the amount of primary energy by end use for commercial buildings in 2010 is available in Table 3.1.4 of the Buildings Energy Data Book. With this data, we estimate that the two end-uses substantially affected by weather, space heating and space cooling, accounted for 20.1% and 14.5%, respectively, of total primary energy use by commercial buildings in 2010. With further data on nationwide heating and cooling degree days (from U.S. Energy Information Administration. Annual Energy Review. Tables 1.7 and 1.8: heating and cooling degree days by month, 1949 - 2011) we can normalize the quantities of energy used in 2010 for space heating and space cooling to reflect 2008 weather rather than 2010 weather..

nation's single-family homes had been labeled. As of the mid-2000s, about 50 - 60% of the Danish homes involved in sales were labeled, but with significant differences in participation in the labeling program across different regions of the country. Compliance with the labeling requirement is less than universal since there are apparently no significant consequences if labeling is not performed.

Kjaerbye created a database of about 4,000 homes sold during the period 1999 - 2002 that used natural gas for heating, and obtained information on their characteristics, occupants, local weather, and gas usage for up to four years following sale. A little more than half of these homes had been labeled in connection with their sale, and a little less than half (these served as "controls") had not been labeled. Kjaerbye proposed and tested two hypotheses:

1. The average energy saving for a labeled home vs. an unlabeled "control" should be positive and growing, or at least not decreasing, over time. The researcher reasoned that nearly all of the energy-saving suggestions included with the label are in the nature of investments that, once implemented, should yield a relatively constant and continuing annual stream of energy savings. Some investments suggested in the audit might be implemented shortly after purchase whereas others might be implemented several years later, and if the label information really did contribute to an increase in implementation of energy-saving investments, then the annual savings as more investments are implemented among labeled homes should grow over time.

2. The energy savings due to the labeling information should be greatest for the most inefficient labeled homes (C-labeled) which should generally have the largest set of cost-effective energy efficiency investments available. Savings should generally be less for B-labeled homes and less again for A-labeled homes.

The author divided his data sample into twelve subsamples: A, B, and C-labeled homes, in each of years 1, 2, 3, and 4 after sale. For each subsample, he compared natural gas usage for labeled homes against natural gas usage for non-labeled control homes after correcting for the influence of home characteristics, occupancy and weather (heating degree days). Kjaerbye determined that various factors systematically affected whether a home would be labeled in connection with its sale or not. He used regression analysis to estimate the likelihood or "propensity" of a home with various characteristics being labeled upon sale, and he then compared the energy usage for labeled homes against the energy usage for unlabeled homes after statistically adjusting so as to give the average labeled home in each subsample an identical "propensity score" as the average among the control homes in that subsample. Kjaerbye did not find any reduction in energy consumption after homes were labeled and sold:

- For 10 of the 12 subsamples, there was no statistically significant difference in natural gas usage between the labeled and non-labeled homes.

- Two of the subsamples showed statistically significant differences between natural gas usage for labeled and non-labeled homes. A-labeled homes during the first year after purchase showed an average of 14% less natural gas usage than non-labeled homes, and A-labeled homes during the second year after purchase showed an average of 8% less gas usage. However, Kjaerbye regarded the statistically significant results for these two of twelve subsamples as spurious because: 1) A-labeled homes did not show any statistically significant reduction in natural gas usage relative to non-labeled homes in years three or four, and thus the entire group of A-labeled homes does not show the hypothesized pattern of increasing energy savings over time as more of the audit's recommendations are implemented; and 2) B- and C-labeled homes showed no significant energy savings at all relative to non-labeled homes at any time after sale, meaning that the energy savings among labeled homes do not match the expected pattern where average savings among C-labeled homes are the largest, followed by B-labeled homes, followed by A-labeled homes.

Kjaerbye concluded that: "We do not find significant energy savings due to the Danish Energy Labeling Scheme." He speculates about some of the reasons why the program appears not to have been successful in creating significant energy savings:

- Others studying the Danish experience previously found that it was not classical barriers like money constraints, lack of interest or knowledge that prevented homeowners from investing in energy-efficient solutions. Instead, the problem was that homeowners found other factors more important than consumption of energy and energy saving. Functional and visual improvements were more important, such as a new kitchen or new bathroom. Improving the home's energy efficiency was lower priority than many other activities and investments.

- Many of the energy-saving investments suggested in the audit reports accompanying the label did not have rapid payback periods. The author cites results from a Danish Energy Agency study that found "only 20% of house owners are willing to spend more than 30,000 DKK (about $5,000) on energy improvements of their house, and they are not willing to accept a return on their investment of more than 6 years."

- The author cites another study (published as Gram-Hanssen, et al. 2007) in which families that bought labeled homes in Denmark or Belgium were interviewed about the impact of the label information on their subsequent behavior. The study concluded that "the respondents remembered the label, they found that the labeling scheme was a good idea, but they had not really used the information from the label."[24]

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[24] Gram-Hanssen et al. (2007) is one study among the extensive literature that aims at understanding why homeowners very frequently fail to act on information about potential energy-saving investments or behavior changes, even when the suggested actions are customized for their dwelling and clearly economically attractive. The authors concluded after interviewing homeowners in Denmark and Belgium who had experience with their countries' energy labels:

> … the idea of households as rational economical actors who will renovate their homes in an energy efficient way if they are just given the right knowledge has to be abandoned. This does not mean that people in general are irrational or that they do not take care for their own interest, it rather means that rational behaviour from an everyday life perspective includes many other elements than just economy, as for instance identity and social comparison, convenience, time use, etc. This however does not mean that the energy labels on buildings are a bad idea but they should be seen as one input among others to people's own knowledge and communication about their house and its renovation. Furthermore, we would recommend the focus on payback time be toned down and substituted by information on cost of investment and possible savings, to let

We believe that Kjaerbye (2008) is an important study. It is the only study of which we are aware that evaluates the impact of an energy label or certification directly on subsequent energy use, in contrast to assessing the impact on market values and then presuming that the prospect of higher market values will induce additional investment in energy efficiency. The analytical methodology is good (see below), the sample size is large, and the study evaluates the impacts from an energy labeling program that provides more information -- and thus might be expected to have a greater impact in encouraging energy conserving investments -- than virtually any other. In contrast to most other energy labeling programs, the Danish program provides all of the following: an easily understandable graded label; an audit report with specific recommendations for the new owner including cost estimates and payoff/return calculations; benchmarking of the home's energy use against other similar homes; and information on actual historical energy usage in the home. The Danish label focuses squarely and accurately on most of the important elements of a home's energy efficiency in contrast to, for example, the Australian labels that address only the efficiency of the building envelope, or various "green" labels which address in a potentially confusing manner a wide range of sustainability concerns in addition to energy efficiency. The thorough nature of the Danish energy label is evidenced by its high cost -- at 300 to 500 euros ($400 - $700 at historical exchange rates) it is more expensive than most U.S. home energy audits or ratings. Furthermore, the Danish labeling must be carried out by an experienced consulting engineer or architect specially trained in home energy evaluation, and it seems unlikely to raise the concerns about potential conflict of interest, objectivity and/or "greenwashing" that may serve to diminish the value of some U.S. energy labels in the eyes of homeowners. If the Danish energy labeling scheme does not appear successful in inducing significant energy-savings among homeowners, it seems unlikely that other, less thorough and less comprehensive labeling schemes would be more successful.

We will comment briefly on the analytical methodology used by Kjaerbye (2008). The researcher's two-step analytical procedure is much superior to making a simple, raw comparison between the average energy usage of labeled homes against the average energy usage across non-labeled homes. It is also superior to comparing each labeled home against a few selected unlabeled homes that serve as controls, another approach that has often been used for this sort of analysis. We are not familiar with the particular two-stage "propensity score matching" approach used by the author, but it appears roughly parallel to the two-stage approach used in some of the more sophisticated hedonic regression studies which consider first the impact of various characteristics of a property on the likelihood that it will be certified or labeled and which then in a second step estimate the market impact of certification or labeling with the characteristics of the labeled and non-labeled groups of properties having been adjusted so as to make the two groups statistically equally likely to have been labeled (e.g., see Brounen and Kok, 2010).

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people judge for themselves. Finally, the Belgian experiences encourage to think about a system where the expert comes to the house after the new owners have bought it rather than the normal idea of the label, where you get the information before buying. To buy a house however is different than buying appliances, and the Danish interviews show that people do not use the labels to decide which house to buy: they rather use it to decide what to do with the house when they have bought it.

Other assessments of European nations' experience with Energy Performance Certificates for buildings

The European Union (EU) has long been concerned with improving the energy efficiency of buildings as a cost-effective way to reduce greenhouse gas emissions. In the Energy Performance of Buildings Directive (EPBD) in 2002, the European Union required member nations to establish a variety of programs to encourage better energy efficiency in buildings, including a specific requirement that each nation implement a program whereby Energy Performance Certificates (EPCs) would be developed for buildings in each of several categories. The EPC was to be a label that displays the energy performance of an individual building and compares it against the energy performance of other buildings of the same sort. The EPC could also include or be accompanied by other materials that provide cost-effective recommendations for investments that would improve the thermal efficiency of the building. The EU's Directive required that "when buildings are constructed, sold or rented out, an energy performance certificate is made available to the owner or by the owner to the prospective buyer or tenant." The EU's rationale was that EPCs would increase the availability of information on the energy performance of buildings, thus increasing the accuracy with which real estate markets reflect the energy costs involved in operating buildings, and thus presumably increasing the market incentive for property owners to make cost-effective investments in building energy efficiency.

Progress by EU member nations in implementing the EPBD has been uneven and generally less rapid than supporters had hoped. The European Council for an Energy Efficient Economy (ECEEE) in 2010 characterized the response to the original EPBD as follows:

> "During the transition period for the first EPBD, preparations for implementation were poorly done and many Member States asked for delays. As a result, many Member States presently are being served legal notices of non-compliance. The European Commission is in the final stage of starting court proceedings against 22 Member States for their non-implementation of the original EPBD. This level of non-compliance symbolises that improving energy efficiency in buildings is a low priority for too many Member States." (ECEEE, 2010)

To accelerate progress in reducing energy use in buildings, the EU reworked the original EPBD and in 2010 issued a "recast" Directive that strengthened what was asked of member countries. With respect to EPCs in particular, the Recast Directive requires that an EPC should include:

- Information on both the energy performance of the building or unit and reference values for other buildings or units;
- Recommendations for cost-effective improvement of the energy performance of the building or unit; and
- An indication as to where the owner or tenant can receive more detailed information on the costs and effectiveness of the recommendations for the building or unit.

Member countries shall require that the energy performance indicator of the EPC is to be included in any advertisements for sale or rent of the building or unit. The EPC is also to be displayed in any building exceeding 500 square meters of floor area that is owned or occupied by public authorities and frequently visited by the public. Member countries are to demonstrate leadership by implementing the upgrade recommendations included in EPCs for buildings they own. The Recast Directive also tightened the compliance requirements, both for EPCs and for the other requirements of the Directive:

- Systems must be developed to ensure the technical quality of the EPCs and the recommendations included in them;

- Countries must randomly select "at least a statistically significant percentage of all the EPCs issued annually and subject these certificates to verification"; and

- Countries must establish rules prescribing "effective, proportionate and dissuasive" penalties for violations of the EPBD requirements, and must take all measures necessary to assure that these requirements are implemented.

Despite the strengthened EPBD in 2010, progress continues to be slower than hoped. Reviewing the developments in the EU in 2011 regarding the EPBD generally and the requirement for EPCs more specifically, one observer commented:

> "… the report card up to this year has been mixed. In general, most countries have been late. Some, like Spain, have received official reprimand from the European Commission, and won't have a functioning system in place for years. The case of Hungary is worse still: the government struggles to set up a mandatory system because any policy can by overturned by public referendum. Most countries, however, have at least put forward functional programs, though few sit well with the masses. The UK government ignored the pleas of the real estate industry to expand mandatory disclosure of operational ratings to private buildings, and a recent study in Germany suggests that Energy Performance Certificates are 'perceived as the least useful information source' in a property transaction. The EU has made incredible effort to impact the efficiency of its building stock, but there is work to be done. Luckily, some of that is underway. Evaluations of existing programs, best practice aggregation, and a standard 'cost-effective methodology' for building energy performance assessment are all in the works." (Leipziger, 2011)

Two sorts of reviews of European EPC programs have been conducted. The first set of reviews addresses a country's administrative progress in implementing the EPBD and required EPCs. The second set of reviews addresses, for a country where an EPC program has been implemented for some time, how the country's EPC program is performing in encouraging building owners and others to make increased investments in energy efficiency. The second set of reviews is of much greater interest to us in this paper than the first, but there are relatively few assessments of EPC program performance that have been published thus far. We will briefly summarize some of the administrative reviews of countries' progress in establishing EPC requirements and we will then provide more detail on the few reviews that assess the success or lack thereof that more established EPC programs have had in encouraging energy-saving investments in buildings.

Two country reviews have been conducted that are intended as “success stories” in documenting how smaller EU countries have developed an extensive EPC program in response to the original EPBD (“Successful EPC Schemes in Two Member States: An ECEEE Case Study”; ECEEE, 2009):

- In *Portugal*, an EPC program was launched in July, 2007, and by September, 2009, certificates had been issued for about 150,000 buildings. About 85% of these certificates were issued for existing buildings during the first nine months of 2009, following expansion of the program in January of 2009 beyond new buildings. An EPC must be acquired for all new buildings or major renovations following construction, and for all existing buildings upon sale or rental. Penalties for non-compliance range from 250 to nearly 45,000 euros. The energy certificate includes a rating of the building using the A-G format commonly in use in Europe for EPCs as well as for household appliances, and a set of recommended energy upgrades for the building. The information on each suggested upgrade includes an estimate of costs, savings and payback, and the impact on the building’s energy rating if all upgrades were implemented. For non-residential buildings that use particularly high levels of energy, an energy efficiency plan must be prepared and all measures with payback shorter than 8 years must be implemented within three years.

  EPCs in Portugal are issued by trained and licensed private sector experts. Information from each EPC must be entered by the expert into a national database that provides for public disclosure, compliance tracking and, eventually, program evaluation. The Portuguese Energy Agency administers the program and conducts quality assurance and audit functions, aiming to visit the building site and inspect and review nearly 4 % of the EPCs that have been issued each month.

  Although the Portuguese EPC program appears to be proceeding smoothly, there are apparently no studies yet investigating the degree to which the program has encouraged implementation of energy-saving measures. Commenting in this regard, the Portuguese program documentation prepared for a series of conferences in September, 2011 on “Consumer Response to Energy Labels in Buildings in Ten European Countries” stated:

  > “A lot of dissemination campaigns have been carried out to motivate the key players to comply with the mandatory legislation, but many times the information is not well understood by the consumers. Consumers are paying for the Certificate to avoid paying penalties, rather than to realize the potential savings.”[25]

- In *Ireland*, a Building Energy Rating (BER) has been mandatory for new homes since January, 2007, for new non-residential buildings since July, 2008, and for all property transactions since January, 2009. The BER is a form of EPC that adopts the A-G energy label, but with two to three subcategories so that the label ultimately consists of 15 possible rating levels. Accompanying the BER is to be an Advisory Report, which provides a list of suggested upgrades to the building along with cost and payback

[25] IDEAL-EPBD. EPBD Implementation in Portugal. At: http://www.ideal-epbd.eu/index.php?option=com_content&view=article&id=21&Itemid=4&lang=en

information. BERs are prepared by trained assessors with a relevant background in the building industry. Final exams for their certification are held at the 41 driving test centers around the country.

An assessor visits the building and completes the assessment supported by a government software tool. The assessor enters relevant data into a database, and the software generates the BER and Advisory Report and enters much of the information into a national database. The assessor then provides the documents to the building owner. Assessments are audited by the government both on a random basis and as a result of any unusual or suspect data.

Irish government administration of the program is revenue-neutral. Revenues derive from a registration fee for assessors (2,500 registered domestic property assessors, 200 for non-domestic properties) and a fee of 25 euros per BER. The average cost to a homeowner for the assessment is about 200 euros, paid to the assessor.

Compliance by building owners with the mandatory assessment requirement seems to be good. As of October, 2009, over 75,000 domestic BERs and 2,000 non-domestic BERs had been issued, at a rate of roughly 300 domestic BERs and 10 non-domestic BERs per day. No information is available on the success of the program or lack thereof in encouraging energy efficiency investments.

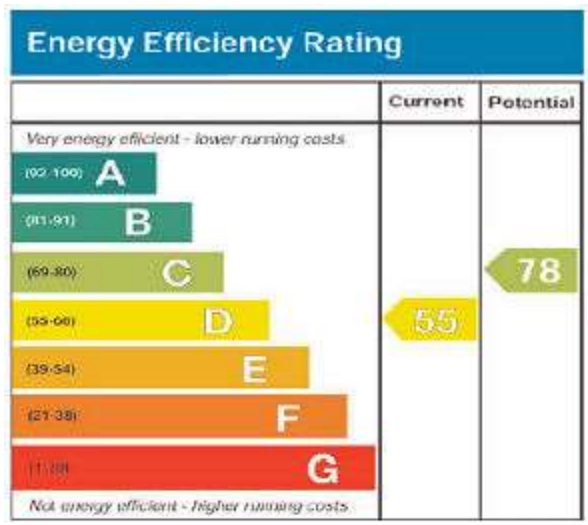
Brief reviews of ten EU countries' performance in implementing the EPBD requirements for EPCs were prepared in connection with the EU's IDEAL-EPBD project which was conducted from October, 2008 through September, 2011. The ten reviews appear for the most part to have been prepared in 2009 or early 2010, and a few highlights follow:[26]

- Belgium has chosen to implement EPC's on a regional rather than national basis. Most regions have not yet established a program.
- Bulgaria has begun implementing a program only for larger buildings of greater than 1000 square meters.
- The Czech Republic requires certification for nearly all new buildings and larger existing buildings upon renovation. The great majority of existing homes are not addressed.
- Denmark has had an extensive program for EPCs in place for many years.
- Finland and Latvia have adopted legislation but have made little progress in implementation. EPCs will be optional for most homes.
- Germany has implemented an extensive program for all sorts of buildings. Since July, 2008, buildings or apartments that are rented, leased or sold must have an energy label.
- The Netherlands has had an extensive program for many years. As of January, 2008, EPCs are mandatory for all dwellings rented or sold, but the buyer and seller can mutually agree to forego the label, which occurs very frequently.

[26] The ten reviews are grouped under the heading "How has the EPBD been implemented in my country?" and they are available at: http://www.ideal-epbd.eu/index.php?option=com_content&view=article&id=3&Itemid=4&lang=en

- Portugal's program (as well as Ireland's) has been described in some detail as a "success story".
- England and Wales since October, 2008 have required EPCs for all residential buildings on construction, sale and rental.

Most of the European countries that have implemented EPC programs have adopted as a label some variant of the A through G color-coded rating scheme that was adopted first for labeling the energy efficiency of appliances. The following is a picture of a British home energy efficiency label or certificate.



Most of the European programs also have other materials that accompany the certificate, often including a reverse side to the certificate, a report on energy-saving recommendations for the building, and perhaps financial calculations, benchmarking, a record of past energy usage or bills for the building, and more.

There are a few qualitative reviews on how well the various European EPC programs are performing in encouraging energy conserving investments in buildings, and only one quantitative review that we are aware of -- the Kjaerbye (2008) study that we summarized earlier. In general, most reviewers have found that the EPC programs have been ineffective in encouraging accelerated investment in energy efficiency of buildings. The reasons cited for these programs' ineffectiveness have varied: limited public awareness of the EPC requirements, consumers frequently choosing not to avail themselves of EPCs when they are optional rather than mandatory, lack of understanding of the EPCs when they are generated, skepticism about the objectivity and accuracy of the energy ratings, and owners' lack of interest in following through on energy-saving steps recommended in EPCs for their homes.

The EU has recognized the very limited impact thus far from member countries' EPC programs. In connection with the Recast EPBD Directive, the EU funded and concluded a three-year research effort with participation from ten member Nations to better understand the lack of success for EPCs in motivating homeowners. The research project is known as the IDEAL-EPBD. The reasons for IDEAL-EPBD are described as:

> "In countries where the directive has been implemented for a while, the energy label hardly seems to motivate people to improve the energy performance of their dwelling. At the same time, however, improving the dwelling based on the label and the advice given can save the new owner large amounts of money in the long term. The IDEAL-EPBD project was investigating why the response of households towards the energy label is limited so far:
>
> - What are the reasons behind whether or not homeowners take the energy label into account?
> - What are the reasons behind whether or not homeowners take the additional proposed measures?" (Intelligent Energy Europe, 2012)

In the course of IDEAL-EPBD, researchers distributed more than 3,000 electronic questionnaires and conducted more than one hundred in-depth interviews with homeowners in ten countries, including some homeowners who volunteered to participate because of their interest in EPCs, others who were selected to participate because they had received EPCs, and others who were randomly selected and may or may not have had any exposure to EPCs. Because of the mixed character of these groups of respondents, the quantitative results from the surveys are difficult to interpret. The results cannot be taken to represent a cross-section of the populations in these ten countries and no quantitative estimates have been developed regarding how much has been invested in energy efficiency upgrades or how much energy has been saved. Instead, the researchers emphasize the qualitative results from the interviews -- what seems to motivate homeowners to be interested in EPCs, what determines whether or not they take note of and remember EPCs, and what factors affect homeowners' decisions about whether or not to implement recommendations in an EPC. And, based on these qualitative findings, the researchers have proposed a number of improvements to make EPCs more effective. The following are some of the project's key findings, excerpted from the project final report (ECN, 2011):

> "More than one hundred in-depth interviews and a large-scale survey among more than 3000 homeowners revealed how little impact the Energy Performance Certificate (EPC) currently has on home owners' decision-making.
>
> > '*Of course I have the certificate, it is stored in a drawer… It is there, waiting to be shown to the municipality*.' (AB, man, Portugal, 55 years old, psychologist)
>
> Many reasons for this lack of impact have been identified, for example lack of availability, lack of awareness, and lack of understanding. One approach to tackle these issues is, of course, to increase the visibility and availability of the EPC. However, this does not mean that people will pay more attention to it, take it more into consideration and that it therefore will have more impact. For this to happen, the EPC needs to provide the kind of information that is most meaningful and relevant to people. …
>
> To realise the large energy saving potential in European housing stock, the EPC needs to become an active and engaging tool, rather than a passive information "device". Of course, trust plays a role and the key to influencing behaviour is providing competent, tailored information, advice and support. Clearly, the EPC cannot deliver all of that, but it can point the way to help people find the kind of information and support they

specifically need. In other words, the EPC needs to succeed in connecting people and information in order to enhance its impact. …

General findings and EU-level policy recommendations

1. The current impact of EPCs during home purchasing is low, but it can be increased by making the EPC better available and providing more useful and meaningful information.

The large-scale survey showed that the EPC currently has very little effect on people's decision-making when considering to buy a home. Other factors, such as property price, location and availability of outdoor space, play a much more influential role. However, expected utility costs were mentioned as important by 60% of the survey respondents and type of heating system by 40%. In fact, expected utility costs rank 9th among factors that play a role. In other words, energy-related factors do play a role in decision-making, implying that the EPC could also play a bigger role than it does today.
To increase the impact of EPCs on people's home purchase-related decision-making, the energy label needs to provide information that is interesting, useful and meaningful to people. Although this sounds straight-forward and obvious, it is not an easy task to communicate complex information in a way that is easy to understand and meaningful to all. Potential differences between countries and people need to be taken into account. …

2. The current impact of EPCs during home improvements is low, but it can be increased by making the EPC better available and providing improved and trustworthy information.

Survey and interview findings show that the EPC plays only a minor – if any – role in homeowners' decision-making regarding home improvements. The most important factors influencing people's considerations are the age and condition of their dwelling, comfort and financial issues. Finance plays a dual role: on the one hand, it can motivate people to invest in improved energy efficiency to save on energy cost in the long term or to increase the value of their property. Increasing energy efficiency and reducing energy bills are important factors according to about 40% of the survey respondents. On the other hand, finance can pose a big hampering factor if the necessary money to invest in home renovation is lacking. …

3. An energy efficiency rating with distinct categories (e.g. A-G scale) is more effective in communicating energy efficiency information than a continuous scale.

The survey … showed that there is a significant difference in the comprehensibility of EPCs. In particular, German respondents reported having trouble understanding the energy efficiency rating of their home as shown on the EPC, while on average much fewer respondents in other countries shared similar problems. Of all five countries included in the survey, Germany was the only one with a continuous scale that indicates the energy rating of a building, while all other countries had labels with distinct label categories, from A-G. …

4. The inclusion of practical recommendations and tailored advice increases people's trust in and perceived usefulness of the EPC.

The survey among over 3000 homeowners in five European countries showed that trust in the EPC increases with the availability of recommendations on the EPC, homeowners' awareness of these recommendations, homeowners' understanding of the EPC, and trust in the person issuing and presenting the EPC.

One way to increase the usefulness and effectiveness of EPCs would be to make the inclusion of recommendations obligatory. … Furthermore, making the calculation method that is used to arrive at an energy efficiency rating of a building and all factors considered more transparent to people can help to increase trust. Finally, an accreditation system for EPC issuers can help to ensure higher and more consistent quality.

The survey also showed that the inclusion of practical recommendations increases perceived usefulness of the EPC. Ideally, the recommendations would provide information about different energy efficiency measures and associated cost and about where to go and whom to consult for further information and advice, as this is what the majority of homeowners indicated as being most useful." (ECN, 2011)

Several independent reviews of consumer response to EU country EPC programs have reached conclusions similar to that of IDEAL-EPBD regarding the ineffectiveness of these programs.

Amecke (2011) studied how effective EPCs have been in helping purchasers of dwellings in Germany to incorporate energy efficiency into their home purchasing decisions. EPCs have been required in Germany since 2009 for sale or rental of new and existing homes. They are optional for the dwelling owner, but are mandatory upon request by a prospective purchaser/tenant. Amecke conducted a well-designed survey, obtaining 662 responses from resident owners who had purchased their dwelling since the German EPC program took effect. The author concluded:

"… the EPC, as currently designed, has only played a limited role in purchasing decisions in Germany. …

Purchasers frequently do not use the certificate, despite having a high awareness of it.

81% of respondents were aware of the EPC, and 78% used the EPC at some point during their home search. However, only 35% of respondents reported that they viewed the EPC for a dwelling that they were closely considering. The EPC was actively promoted to them for 24% of these dwellings. …

Purchasers understand the information but often do not trust or remember it.

Most respondents indicated that they find the information in the EPC understandable. Yet, only a fraction correctly remembered the information on the EPC and only 44% of respondents found the EPC trustworthy. … An international study found that purchasers are in general very skeptical of information on energy efficiency in the home purchase process …

The EPC does not show the information that purchasers want: financial implications.

> The financial implications of energy efficiency matter most to purchasers. Yet, the EPC is perceived as the least useful information source for conveying information about the financial implications of energy efficiency (6th out of 6), trailing, for example, energy utility bills, site visits, external professional advice, and other information sources. … In Germany, the EPC only shows the energy efficiency of a dwelling by color (green to red) and in kWh/m^2. The conversion of this information into expected utility costs in EUR requires expertise that most purchasers likely do not have. One remedy could be the inclusion of financial implications in the EPC.
>
> **Purchasers do not care strongly about energy efficiency.**
>
> Energy efficiency is considered to be only a minor purchasing criterion, ranking 9th out of 13 criteria measured in our survey. The relevance of the EPC is likely limited by the relevance of the purchasing criterion which it informs. … Home purchase involves a wide variety of criteria of which energy efficiency is only a minor one." (Amecke, 2011)

In their quantitative analysis of the impact of Dutch EPC requirements on the market value of labeled homes, Brounen and Kok (2010) also provided some information on the limited public interest in the audit and labeling program. Though the inspections and certificates are mandatory, there are many exceptions, including a provision to the effect that the homebuyer can sign a waiver that eliminates the seller's obligation to certify the dwelling. Only 17% of the nearly 200,000 homes sold from January, 2008, when the labeling program began, through October, 2009 were labeled. The percentage of homeowners participating in the labeling program declined from 25% at the start of the program to 7% at the close of the study period. The authors attributed this drop in labeling to the public's increasing lack in confidence in the significance of the home labels due to a lack of uniformity in the energy audit process. The authors found that the market value differences associated with each level of label generally declined over time concurrent with the apparently declining confidence in the significance of the labels.

Similar conclusions about the limited impact of EPCs were reached in two studies in Great Britain.

In a study conducted by one of Britain's largest consumer organizations, Lainé (2011) summarized the results of more than 2,000 face-to-face interviews in early 2011 with individuals who had recently bought or rented a property. Since October, 2008, Great Britain has required the owner of any residential property who wishes to sell or rent the property to obtain an EPC and make it available to the purchaser or renter before the transaction closes. Presumably, then, all of the interviewees in Lainé's study should have been given -- or at least had the opportunity to see -- an EPC for the home they had chosen and in which they lived at the time of the interview. Lainé's conclusion about the ineffectiveness of the EPC is suggested by the title of her report: "Room For Improvement: The Impact of EPCs on Consumer Decision-Making." Once in their new home, seventy nine per cent of those interviewed admitted that they hadn't carried out any of the ways to help them save money and energy that were suggested in the EPC for their home. Lainé concluded from the interviews:

- "Location, location, location remains the main decision factor after cost and size of homes, but 14 per cent of prospective buyers and tenants do consider energy issues to be important

- Too many consumers are not receiving information, and this is of particular concern in the rental sectors

- Although most consumers say the EPC is clearly laid out, the EPC has little impact at present:
  - It influenced decisions by 18 per cent of recipients
  - Information is very rarely used as part of negotiating the sales or rental price
  - Only 17 per cent of recipients acted on recommendations

- Consumers think that the potential energy bill for the property would be useful information when buying or renting a property, along with advice on how to save money on energy bills." (Lainé, 2011)

In a similar study, Watts, et al. (2011) surveyed British homeowners who bought homes within a year after October, 2008, when EPCs became mandatory in Britain. The authors concluded that the required EPCs:

> "… had little impact on decision-making or price negotiation. Where retrofitting measures have been undertaken, results are inconclusive as to whether retrofitting was done as a result of EPCs. Energy efficiency was not found to be a priority for homebuyers."

Many individuals and organizations in the real estate industry in Britain have opposed the nation's initial EPC requirements and subsequent tighter regulations because the certificates are widely viewed as ineffective. For example, the National Landlords Association

> "… says that the certificates are often at the bottom of prospective renters' lists of requirements, if they even feature at all, with many tenants seemingly unaware of the law. Added to that, the average rating for a rented property in England and Wales is 'D' which means it's unlikely to have much bearing on a tenant's choice. … It seems many landlords are left wondering about the effectiveness of an EPC. What has become apparent is that tenants don't seem to be interested in them…"[27]

And, in July of 2011, it was reported that 60% of Britain's estate agents planned to boycott a new government requirement to the effect that the full EPC document, not only the rating, must be attached to the materials included when a property is listed for sale.[28]

In sum, in the European experience thus far, EPCs appear not to have played a significant role in informing home purchase or rental decisions, nor have they been successful in encouraging increased homeowner investment in energy efficiency. A good deal of attention has been devoted to the questions of why they have not been successful, and how the existing EPC requirements in those European nations that have them can be reconfigured to improve their effectiveness.

[27] At http://www.findaproperty.com/displaystory.aspx?edid=00&salerent=0&storyid=23217
[28] At http://energyassessormagazine.com/AgentstoBoycottNewEPBRegs.aspx

The Australian experience with energy labeling for buildings

The Australian Federal government in 2002 adopted a policy declaring that improved energy efficiency for residential and commercial buildings offers a particularly cost-effective means of reducing greenhouse gas emissions, and since then the government has supported a variety of policies and initiatives to this end. The government has promoted both rating the energy performance of new and existing buildings and mandatory disclosure of the rating information when buildings are to be sold or rented. In the mid-1990s the Federal government had developed software tools for rating the thermal performance of buildings, including a National House Energy Rating Scheme (NatHERS) for detached homes and the National Australian Built Environment Rating System (NABERS) for several varieties of commercial buildings. These rating schemes have summarized the energy efficiency of buildings on a scale that is demarcated in stars: a building is rated as having anywhere from zero stars (highly inefficient) to six stars (highly efficient). Recently the rating scale for homes was expanded up to ten stars in order to reflect gradations in the performance of highly efficient new homes; ten stars now signifies a building with zero net energy consumption. Also, for several categories of commercial buildings, a coalition of green building interests developed Green Star, another sort of rating scheme that is multidimensional in addressing water efficiency and various other aspects of sustainability in addition to energy efficiency, much like LEED in the U.S. Thousands of buildings in Australia -- mostly highly energy-efficient buildings seeking market recognition -- have been rated on a voluntary basis using these tools.

Australian Federal, State and Territorial governments have mandated use of these and other energy efficiency ratings in various ways:

- As of 2010, the Building Code of Australia requires all new homes to be constructed to a standard of at least six stars, an increase relative to the four-star standard that applied beginning in 2003 and the five-star requirement adopted mid-2004. Requirements for new commercial buildings and major renovations were similarly increased to the equivalent of six stars.

- Beginning in 1999, the Australian Capital Territory (ACT, an area comprising the capital city of Canberra and surroundings and accounting for about 2% of all the dwelling units in Australia) has required the owner of a residential building offered for sale to obtain an Energy Efficiency Rating (EER, usually developed by an accredited energy assessor using the NatHERS software) and to disclose it to prospective purchasers. The ACT similarly requires the owner of a rental property to disclose any EER that exists to prospective tenants. (Obtaining an EER is not mandatory for rental property owners, but any rental property that has an EER -- probably either because it has been sold since 1999 or because a rating was obtained voluntarily -- must have that EER disclosed upon rental.)

- Since January 1, 2010, the State of Queensland (northeastern Australia, accounting for about 19% of all dwellings in Australia) has required an owner selling a home or apartment to complete a "sustainability declaration" and provide it to prospective purchasers. The sustainability declaration is a checklist that identifies which of more than twenty energy-, water- and access/safety-related features the property includes, as well as the property's star rating if known. While the sustainability declaration is not exactly an energy rating, it serves most of the same purposes. It also includes information suggesting the approximate cost savings that the purchaser would accrue from each sustainability feature that is currently present in the home, and from each additional feature that is not present but might be installed by the purchaser.

- Australia's over-arching Council of Australian Governments (COAG) has agreed that all Australian States and Territories (in addition to the ACT and Queensland who have already done so) should adopt legislation and regulations requiring mandatory disclosure of energy, greenhouse gas and water performance by owners of residential buildings. The exact dimensions of this disclosure are to be determined by the individual jurisdictions:

    - What should be the nature of the rating that is developed and then disclosed? Must the rating be developed by a certified assessor, or can it be developed by the homeowner alone? Should the rating rely on a sophisticated simulation of home energy use, on a less complex simulation, on some sort of on-line self-assessment, or might it be a simple checklist?
    - Should the rating be mandatory, or should a homeowner be able to opt out of obtaining one in some manner?
    - Should disclosure of any rating that exists for a dwelling be mandated at the time of advertising the property, at the time when the transaction closes, or both?
    - Should the requirements apply only to home sales, or also to rentals?

  The COAG commissioned a major study evaluating the options and estimating their costs and benefits (Allen Consulting Group, 2011) and then held a series of consultation workshops throughout the country in September, 2011, in order to receive comments. The study concluded that the option with the largest total national net benefits (costs of AUD2.1 billion/yr, benefits of AUD3.0 billion/yr, net benefits of AUD0.9 billion/yr) would involve a mandatory quantitative rating prepared by a certified assessor using relatively simple software (cost for the assessment would be about AUD175), to be required for both sales and rentals. The consultation workshops elicited mostly positive comments on mandatory energy efficiency ratings and disclosure, and several Australian governments are moving ahead in drafting legislation accordingly.

- Energy efficiency ratings and disclosure are already mandatory for most office and government buildings throughout Australia. Beginning November 1, 2010, all such buildings in Australia were required to obtain NABERS ratings and to disclose these materials to prospective buyers and tenants; and since November 1, 2011 they were required also to assess lighting options for tenants and to investigate potential energy efficiency improvements. The COAG is considering extending these requirements to other sorts of commercial buildings (e.g., warehouses, medical centers, hotels, retail space) and to mixed-use buildings, and may extend the requirements also to renovations as well as sales and rentals.

Some of these building rating and/or disclosure programs have been implemented for sufficient time to allow for their evaluation. In the following paragraphs we summarize the findings of several evaluation efforts.

<u>Review of an ACT requirement to prepare and disclose a building's energy efficiency rating</u>

A study in 2008 tracked compliance with one of the Australian Capital Territory's (ACT's) requirements regarding disclosure of energy efficiency information about a residential building (Lee, et al., 2008). The ACT adopted in 1999 a requirement that the owner of or agent for any residential building that has had an energy efficiency rating (EER) prepared[29] must disclose the EER in any advertisement for rental of the building. The study reviewed advertisements for homes offered for rent to see whether the advertisements included the EER, if one existed for the home, as required. Every quarter from late 2002 through mid-2008, the study compared the fraction of homes advertised for rent that included an EER in the advertisement against the estimated fraction of all rental homes that had had an EER prepared previously and that therefore, by law, should have had the EER included in the rental advertisement. Lee, et al. concluded that non-compliance with the disclosure requirement was widespread. Over the entire period, an average of 12.2% of rental property advertisements included the property's EER, whereas the estimated fraction of rental properties for which EERs had been prepared ranged from about 25% at the beginning of the study period to about 52% at the end of the study period. The "compliance rate" -- the fraction of advertised rental homes that included the EER relative to the fraction of rental homes that had had an EER prepared and thus available for disclosure -- has ranged from only about 20% to about 60%. The compliance rate was highest at between 50% and 60% in early 2003 when a government agency threatened vigorous enforcement of the requirement. The compliance rate then fluctuated between about 20% and 35% until jumping to near 40% in mid-2008 with another government statement threatening enforcement.

The authors suggest two reasons for the low compliance rate with the rental property energy efficiency disclosure requirement:

- Little enforcement by the government; and

- Little interest by the public in the energy efficiency rating. The authors quote the Real Estate Institute of the Australian Capital Territory (the leading membership organization of real estate professionals in the area) as stating that their members believe the EER is

[29] An EER was required in the ACT beginning in 1997 for all new homes and, in 1999, for all homes offered for sale. An EER has not been mandated for homes offered for rent. Thus, after 1999, a home offered for rent should have had an EER completed for it previous to the rental effort if the home were either new since 1997 or sold or offered for sale since 1999. However, homes offered for rent that were neither new since 1997 nor had been sold or offered for sale since 1999 likely had not had an EER prepared, unless the owner of the rental property had voluntarily obtained an EER for his property, which was rare. Based on the rate at which new homes were constructed and the rate at which existing homes were sold, Lee, et al. (2008) estimated the changing fraction over time of rental homes in the ACT that should already have had EERs prepared by the time they were offered for rental. Lee, et al. estimated that in 2002 about 25% of homes in the ACT offered for rent should have had EERs prepared previously, and that this fraction increased by about 1.6 percentage points per quarter so as to reach 52.2% in September, 2008, when the study concluded.

> "… of little or no interest to the market in terms of the decisions people make about their accommodation."

The authors suggest that "If a substantial number of prospective tenants were self-interestedly demanding this information, the policing effort required of the Government would be substantially reduced." The authors note that the disclosure requirement is advantageous to energy-efficient homes and disadvantageous to inefficient homes, and compliance rates are consistent with this pattern.

> The key problem with the current system is that it is likely to be followed only by the property owners who stand to gain -- those with houses with a high EER. It is likely that the houses for which known star ratings were suppressed were generally the poorer thermally performing houses. (Lee, et al., 2008, p. 9)

Even with vigorous government enforcement of the requirement to disclose the energy rating for a rental home that had one, though, there would still be nothing to "prevent poor-performing houses from hiding behind the façade of not having been rated." The authors conclude by suggesting that there should be a new requirement that makes it mandatory to obtain an energy efficiency rating in advance of renting a house or apartment.

Review of Queensland's requirement for a sustainability declaration

Since January 1, 2010, the State of Queensland has required the owner of a dwelling intended for sale to complete a checklist indicating which among 21 sustainable features are present, and to make this sustainability declaration available to potential purchasers. In November, 2010, a firm under contract to the State government conducted a stratified random sample of 900 homeowners and renters in Queensland to assess experience and attitudes toward the sustainability declaration program (Winton, 2010).

Among the general population of homeowners and renters -- including mostly individuals who had not had any experience buying, selling or looking to buy or sell a dwelling during the period since the sustainability declaration requirements had come into effect:

- 37% claimed to be aware of the Sustainability Declaration without prompting, while an additional 17% claimed to have heard of it when it was described.

- Roughly 90% of the respondents stated that each of the following aspects of the Sustainability Declaration would be at least "quite useful" when they are contemplating buying a home: 1) Having information about the home's sustainable design features; 2) Using this information to compare houses to buy; and 3) Having information about the savings in terms of money, energy and water for each sustainable design feature.

- About 1/3 of the respondents said they would be prepared to pay up to 10% more for a house if it contained a number of sustainability features, and a further one-quarter said they would pay an extra 15% or more.

- If they were buying a house, just over six in ten people (62%) would prefer to buy a house with sustainable design features already in place, whereas three in ten (31%) would prefer to choose those features they want to include in the house themselves.

- If they received timely advice on measures to improve the sustainability of a house they had purchased, including possible monetary, energy and water savings, some 85% of people said they would be at least quite likely to make investments in these measures, following the purchase.

- Less than half the people (46%) said that that they would be likely, prior to advertising their house for sale, to undertake sustainability improvements to increase the marketability of the property to prospective buyers. Most of those who would not undertake improvements did not believe that they would get their money back from such improvements.

A little less than 1/5 of the 900 survey respondents had actively participated in the market for Queensland homes as actual or prospective buyers or sellers since the Sustainability Declaration program had gone into effect. These respondents had actual experience with the program, and their opinions were rather different from the very positive (but hypothetical) responses of the general population.

- Among buyers or prospective buyers, for only 28% was a Sustainability Declaration available at most or all of the homes they looked at. Among actual buyers, a Declaration was available at the particular house they purchased in 92% of all instances.

- Among buyers or prospective buyers, 39% said the Sustainability Declaration was informative about the sustainable design features at a house, while a similar 36% said it was not informative.

- Among buyers or prospective buyers, most did not make use of the information in the Sustainability Declarations. 21% used the information to compare one house with another, 8% used the information as a bargaining tool to lower the price, and only 6% used the Declarations to estimate the likely total energy and water and money savings for a house.

- Among sellers or prospective sellers, about 70% completed a Sustainability Declaration for their home prior to its listing for sale, and among them, about two-thirds displayed their Declaration prominently during the sale period.

- Approximately three-quarters of the sellers/prospective sellers had installed one or more sustainable design feature in their home prior to offering it for sale (though the installation may have been before the date at which the Sustainability Declaration requirement was adopted). Among those who installed a sustainable design feature, 13% thought that would increase the home's resale value "a lot", 44% thought it would help "a little", 32% said "not at all", and 20% were unsure.

- Only 3% of the sellers/prospective sellers thought that the information in the Sustainability Declaration form influenced prospective buyers "a lot", while 37% said "a little", and 53% said "not at all". A substantial majority thought that little importance was placed on the Sustainability Declaration in the market.

We interpret these survey results as suggesting broad public support for Sustainability Declarations in concept, but much less belief among the fewer individuals who had been actively involved in trying to buy or sell a home that the Declarations had made a significant difference in practice.

<u>Australian study of options for a national home rating and disclosure program</u>

A thorough Australian benefit-cost analysis of building energy labeling and disclosure options (Allen Consulting Group, 2011) considered the important question of how often as a result of the labeling/disclosure process the purchaser of a labeled home with recommended energy efficiency improvements would undertake the suggested investments. The researchers estimated that, depending on the specific nature of the labeling/disclosure program, somewhere between 15% and 30% of all the recommended investments would be implemented. The researchers emphasized that there was little data available with which to estimate this "uptake rate":

> "Uptake rates represent the proportion of all Residential Building Mandatory Disclosure assessments that result in an investment in energy and water efficiency measures. … Expected levels of uptake under Residential Building Mandatory Disclosure are a key area of uncertainty. Indeed, there is limited evidence from existing schemes on the degree to which disclosure of information through an assessment stimulates investment in energy and water efficiency measures." (Allen Consulting Group, 2011, page 121).

The researchers based their assumption of 15 -30% uptake on a study (not available on the internet) conducted in 2006 that assessed the impact of the mandatory home energy performance ratings (EER) and disclosure program that had been implemented for more than five years in the Australian Capitol Territory. The study involved focus groups and 300 interviews with home buyers and sellers in the ACT. The study interviews reportedly found that about 16% of ACT home purchasers had implemented improvements recommended in their new home's EER report, while an additional 15% intended to make such improvements. Based on this information, the researchers preparing the nationwide benefit-cost analysis assumed that uptake resulting from a mandatory home assessment and rating and disclosure would range from 15 to 30% as a function of the specifics of the assessment and rating program:

- They assumed a minimum 15% uptake rate for a simple assessment/disclosure program where the seller fills in a checklist indicating the energy-efficient features that his house does and does not have (like Queensland's Sustainability Determination).

- They assumed an incremental 4 to 5% in additional uptake if the assessment and rating is quantitative rather than qualitative, thus allowing buyers to compare one home's quantitative rating against the ratings for other homes.

- They assumed an additional 1 to 3% uptake if the assessment and rating were to be prepared by an independent assessor instead of the homeowner. The independent assessor's rating would presumably be more objective and accurate and thus more likely to promote investment by the new homeowner consistent with the recommendations in the assessment.

- They assumed an additional 3% uptake if the assessment and rating were to be based on a relatively simple quantitative model simulating the thermal performance of the home. Again, the researchers believed that a more sophisticated assessment would be more accurate and more likely to promote investment.

- They assumed a further 4% uptake if the assessment and rating were to be based on a complex and more accurate simulation model, which requires as inputs a floor plan, dimensions and information on materials in the home being simulated.

The researchers thus estimated a minimum of 15% uptake for a very simple, seller-prepared checklist of energy-efficient features that are present or absent in a home, to a maximum of 30% uptake (15 + 5 + 3 + 3 + 4 = 30) for a system involving professional assessors collecting data on the home and running sophisticated software in order to generate a quantitative simulation and ranking with highly tailored home-specific recommendations for upgrades.

We believe these estimates by the Australian researchers are probably too optimistic regarding the likely effectiveness of various rating/disclosure schemes in prompting energy efficiency investments by home purchasers. We offer several comments on the researchers' estimates:

- In the ACT interviews on which the researchers based their estimate that rating and disclosure would prompt 15 - 30% of new homeowners to undertake energy conserving investments, the homeowners were asked if they had implemented <u>any</u> of the energy-conserving investments recommended in the EER for their new home. Evidently, 15% of these new homeowners answered "yes". It seems inappropriate for the researchers to interpret this 15% of the ACT sample who indicated they had installed at least one recommended efficiency measure as suggesting for the benefit-cost analysis that a similar 15% would install <u>all</u> the efficiency measures recommended for a home pursuant to the potential new national rating and disclosure scheme. More specifically, one of the energy efficiency investments most frequently recommended in the EER for a home under the ACT program has been to install shades, glazing or tinting to reduce the home's thermal gain from solar radiation through windows. It seems to us that installing window shades is a measure that many purchasers of a home would undertake soon after moving in for a variety of reasons that could have little to do with energy conservation -- for example, to enhance privacy and security, reduce noise, improve appearance, avoid sun-bleaching of indoor fabrics, etc.. It seems inappropriate for the researchers to extrapolate some homeowners' willingness to install inexpensive window shades for a variety of reasons in the home they recently purchased to imply that other new homeowners would similarly be willing to install a full list of other much more expensive improvements solely for the purpose of saving energy.

- More importantly, home buyers in the ACT survey evidently were not asked whether they installed any of the energy efficiency measures recommended in their EER specifically because the measures were recommended in the EER. The survey did not inquire about why they installed the measures. Perhaps (probably?) many home buyers would have installed whatever recommended measures they did install -- window shades, insulation, double pane windows, ventilation fans, etc. -- whether the EER had recommended these measures or not. In our view, the researchers for the Australian national benefit-cost analysis were wrong in presuming causality. The recommendations that home purchasers received in the ACT EERs were likely not the primary motivating factor that caused the homeowners to install whatever energy efficient upgrades they did install, and it is not appropriate for the benefit-cost researchers to attribute all the credit for whatever energy-efficiency upgrades get installed at the national level to the potential national home rating and disclosure scheme. Instead of estimating the total uptake of energy efficiency measures after introduction of a national rating/disclosure scheme and attributing all of the resulting energy savings to the national program, the researchers should have attempted to estimate only the incremental uptake or incremental savings that might be attributable to the scheme.

- More generally, studies throughout the world have shown that programs attempting to prompt homeowners to make recommended investments in energy efficiency have typically been much less effective than anticipated. This seems true even when the recommendations: i) are tailored specifically for the owner's home and appear in an audit report that the homeowner asked for; ii) appear to offer very quick payback; and iii) are subsidized by the government. Energy efficiency investments, no matter how attractive in their own right, appear generally to be significantly lower priority for homeowners than making other investments in one's home for other reasons, such as enhancing comfort, improving appearance, adding functionality, accomplishing needed repairs and deferred maintenance, etc. For example, in a large national survey on home renovation activity in Canada, the Canadian Mortgage and Housing Corporation found that only 7% of households that conducted a renovation project in 2010 cited energy efficiency as one of the many possible reasons why they undertook the project (CMHC, 2011). For example again, Neme, et al (2011) argues that if larger jurisdictions (e.g., nations, States, Canadian Provinces) are to meet their carbon reduction goals, they will need to achieve penetration rates for whole-house residential retrofits that average at least 5% of targeted existing homes per year. In reviewing the accomplishments of existing retrofit programs, though, the authors find that:

> "While there are examples of initiatives that have achieved annual market penetrations at that level or higher such as the Hood River, Oregon project of the early 1980s, such examples are of a much smaller scale than an entire state or entire country and involved a level of financial subsidy that is unlikely to be politically feasible at a statewide or national level. [e.g., 100% subsidy in the Hood River project] No large jurisdiction can claim to have developed and demonstrated an approach to residential retrofits that is capable of averaging a market penetration of 5% per year. Indeed, no country or jurisdiction of any size is currently reaching even 2% of the housing stock annually through whole-house approaches." (Neme, et al, 2011, page 14)

In fact, most of the national and State programs the researchers identified had achieved penetration rates of less than 1% per year.

The Australian researchers' lower bound estimate that a national program of energy ratings and disclosure would induce at least 15% uptake results ultimately in their estimating that the national program will reduce total annual residential energy use in Australia by at least 1.8%.[30] This level of impact seems unlikely relative to the lower reductions in residential energy use that have been obtained in practice by more intensive programs elsewhere.

Other commentary on Australian building labeling and disclosure programs

States and Territories in Australia are moving steadily to increase the fraction of the nation's buildings that are covered by mandatory rating and disclosure programs. This would seem to suggest general agreement that the existing programs are working well and should be expanded. For example:

- Compliance appears to be good with the nationwide requirement effective November 1, 2011, that owners of larger office buildings (2000 square meters or more) must assess and disclose the energy efficiency of their space upon sale or rental. New requirements regarding a lighting assessment for tenants and identification of energy efficiency improvements have also been complied with. The Federal government is moving to extend these requirements to other sorts of commercial buildings, including hotels, retail properties, schools and hospitals.

- In May of 2011, the Federal government raised the nationwide standard for new home construction to six Stars. These requirements will be extended from new homes to major renovations of existing homes. The energy efficiency rating requirements for new homes in the Australian Building Code that formerly applied largely to the building shell only have been extended now to air conditioning, hot water systems, lighting, and the orientation of homes relative to the sun.

- The state and territorial governments that do not yet have mandatory rating and disclosure requirements for homes upon sale or rental are moving toward adopting legislation establishing these programs. Queensland, which has an existing program

[30] In the benefit-cost analysis, the Allen Consulting Group estimated that by the end of the first ten years after adoption, a relatively lax national rating and disclosure program (Option 4, including only an owner-prepared checklist of energy efficient features in the home, similar to Queensland's Sustainability Disclosure program) would achieve 15% uptake and a cumulative savings in residential energy consumption of 81.1 petajoules (Allen Consulting Group, 2011, page 113). The projected average savings per year would thus be 8.11 petajoules. (The program is estimated to have an increasing impact over time as an ever-increasing number of homes are sold and affected by the rating and disclosure, so the projected savings in year 10 after implementation would be much more than the average over the 10 years.) Even if the annual savings were only the projected 8.11 petajoules average over the first ten years, this would still represent at least a 1.8% savings relative to estimated Australian total residential energy use in 2010/2011 of approximately 440 petajoules per year (ibid, page 13). We doubt that the relatively lax national rating and disclosure program analyzed as one option by the authors could, by itself, yield a 1.8% savings in total residential energy use when more extensive programs -- including financial incentives, cost sharing, technical assistance and more -- are unable to achieve participation at even 2% per year.

requiring a sustainability declaration, is proceeding to modify the program to require instead an energy rating.

On the other hand, there have been frequent objections raised to the potential expansion of Australian building energy labeling and disclosure programs for homes:

- The Australian Broadcasting Corporation's national news on April 26, 2011 included a feature story about errors in rating homes under the compulsory standards.[31] "According to academics and some in the building industry, the star ratings can be deeply misleading, with wide variations in their results and loopholes in their use." Homes built to the 5-Star standard applicable at the time were found subsequently to perform at much lower levels in practice. Homeowners were upset that they did not experience the low energy bills that were implied when they had higher-Star ratings. Academics and building professionals discussed the inaccuracies in the three alternative software programs approved for use in generating the star ratings. "There's 1.5 million-odd people to date or home buyers who've been subject to this faulty (energy rating) software. So in fact they've been charged for something that they're not getting."

- There is a growing concern that mandatory rating and disclosure requirements will likely adversely affect the market value of several classes of homes, including two-story "McMansions", Californian bungalows, renovated worker's cottages, traditional raised homes in Victoria, and older homes more generally.[32]

  > "Homeowners caught in a sliding market after a week of financial upheaval could lose thousands of dollars more when selling or even renting their house**.** The possibility of the Gillard Government imposing an energy rating on houses is something homeowners don't need as they see the value of their houses dropping. But it also has the potential to increase the cost of some houses for homebuyers. No one can be sure of who will have to bear the brunt of what can be seen as a new greenhouse energy tax. The homeowner would have to pay for the energy rating, which might undermine the value of older houses and energy-inefficient McMansions. Like the Gillard Government's carbon tax next year, an energy rating will add to costs across the board. Again, like the carbon tax, Australians are in no mood to pay out on something they don't want or need in a challenging financial climate." (Editorial. *The Herald Sun* [Melbourne]. August 13, 2011)

- Expanded requirements for testing, labeling and disclosing the rating of homes have become something of a political issue, having been criticized widely by politicians opposed to the currently governing Australian Labor Party coalition. The major objections to expanding the requirements have included: concern over the cost of the expert assessment that will be needed to develop the house rating; lack of interest from potential purchasers and renters in energy efficiency information; and opposition from

[31] See Australian Broadcasting Corporation. Home energy rating system questioned: More than a million and a half houses nationwide could be incorrectly rated under the compulsory energy standards that have been progressively introduced by state and territory governments in the past seven years. Broadcast April 26, 2011. Transcript available at: http://www.abc.net.au/7.30/content/2011/s3200765.htm

[32] See, for example: Ben Pike and Kirsten Craze. "Federal Government green scheme to hit price of 'McMansions'". *The Courier-Mail* (Brisbane). August 13, 2011.

owners of several sorts of relatively energy-inefficient properties to mandatory labeling requirements that will likely result in a reduction in market value for these properties..

- Real estate interests have largely opposed mandatory rating and disclosure programs for homes: [33,34]

> "I think they are patronizing people who are making the biggest purchase decision of their life by thinking a rating system will influence that decision. It's already hard enough to buy and sell a home and this is just another financial impost that also has the potential to delay the sale of a property." (Greg Troughton, chief executive of Real Estate Institute of South Australia)

Landlords will likely pass the cost of energy ratings on to tenants: "This will be an extra cost to working families who have to rent because they can't afford a mortgage. And we need this like a hole in the head …" (John Darley, legislator and former chief property tax assessor for South Australia)

Others have written in various publications expressing skepticism that there is as much real estate market interest in energy efficiency as is suggested by the ACT property value study; expressing fear about the likelihood of abuse when both the homeowner who is paying for the rating and the assessor who is developing the rating are interested in a home receiving a high efficiency score; and expressing concern about the mandatory nature of the home rating requirement and its high cost. (e.g., Wakelin, 2011)

Summary regarding the impact of energy labeling and disclosure programs in encouraging energy efficiency investments

Evidence from Europe and Australia after at least several years of experience with widely applicable labeling and disclosure programs suggests that these programs have had relatively little impact in significantly reducing energy use in labeled homes and/or in significantly accelerating energy-conserving investments in these buildings. The three studies in the U.S., where there has been much less experience with these programs also indicate no substantial impact. Owners of older homes in Austin, Texas, appear not to follow through significantly on the recommendations of the home energy audits that are required upon property transfer. Owners of commercial buildings in four large cities that have adopted mandatory benchmarking and disclosure requirements are estimated to have reduced their energy usage by about 2% some one to three years after implementation of these programs, but these reductions appear to have resulted largely from relatively easy behavior changes rather than new investments in energy efficiency. EPA's study of changes in energy use intensity in commercial buildings benchmarked using Energy Star Portfolio Manager appears to show no greater reduction in average energy usage among benchmarked buildings than among all commercial buildings. We

[33] See: David Nankervis. "Homes forced into energy audits". *The Sunday Mail* (South Australia). February 6, 2010.

[34] Also: Michelle Collins. "Real estate industry launches backlash on home energy ratings." *The Sunday Mail* (Queensland). November 6, 2011.

want to speculate briefly now about why these programs appear to have shown disappointing results.

In our view, energy labeling and disclosure programs for buildings have obtained the expected initial results in terms of market response. As demonstrated in the first chapter of this report, labels or certificates that provide information about the energy efficiency of a labeled home or other property have consistently prompted a significant market response -- energy-efficient homes that receive a favorable label accrue a substantial premium in the market, while energy-inefficient properties that receive an unfavorable label get discounted in the market. Where the labeling programs prove to be much less effective, though, is in the next step: the potential increase in a home's market value with a more positive label signifying greater energy efficiency, while this change may be substantial in magnitude, is apparently nevertheless usually insufficient to induce the homeowner to invest in further energy efficiency measures. These results for labeling are similar to what has typically been obtained from other sorts of programs aiming to encourage homeowners to invest in energy efficiency or otherwise reduce their energy use, including subsidies, cost-sharing, loans, technical assistance, free audits, behavior-based strategies (e.g., social marketing, goal setting, smart meters, benchmarking, rewards), and more. It appears difficult by any means to motivate homeowners to significantly change their energy-using behaviors or to accelerate their investments in energy efficiency upgrades.

3. Could an Energy Label Serve to Reduce a Property's Market Value?

Could an energy label have a negative rather than a positive effect on a property's market value? Nearly all of the studies from around the world that we have reviewed suggest that a label or certificate indicating that a home or office building is energy-efficient will increase the labeled property's market value. Could the inverse be true also -- will a label indicating that a property is energy-inefficient serve to decrease the property's market value?

Certainly. Just as information suggesting a desirable quality of a property is likely to increase the property's market value, information suggesting an undesirable aspect of the property will tend to decrease the property's value. For example, there are many studies documenting a loss in market value -- sometimes substantial -- for properties with perceived environmental faults. Later in this section we will provide several examples of such studies. In a parallel manner, any information suggesting that a property is energy-inefficient, whether that information comes in the form of an energy label or in some other manner, will also tend to decrease the property's market value.

Many of the energy labels or certifications or ratings that we have discussed in this paper provide only positive information about the energy efficiency of a property. Many programs identify and then label, rate or certify only particularly efficient buildings or, more broadly, particularly "green" buildings: Energy Star, LEED, Green Building Standard, Earth Advantage, Built Green, EarthCraft House, BREEAM (U.K.), Green Globes (Canada, U.S.), Green Star (Australia), EnerGuide (Canada) and more. These labels are conferred only on exemplary buildings and they are unidirectional in the sense that they convey only good, positive and favorable information about a labeled building. These labels are intended to draw attention to and validate positive features of a building and, as such, they can only increase the market value of a building that has been awarded the label. Virtually all of the studies that we have reviewed confirm that these unidirectional labels do in fact serve to increase the market value of the select buildings that receive these labels.

Other sorts of energy labels or certifications or ratings, however, are bi-directional in the sense that they can provide either positive or negative (or neutral) information about a labeled building. Bi-directional energy labels are intended to be used for buildings spanning the full range of energy efficiency, from buildings that are very inefficient ("energy hogs") to buildings that are highly efficient (even "net zero" buildings). A bi-directional energy label signals to the market in a (hopefully) easily understandable and accurate manner how energy-efficient or energy-inefficient the labeled building is. A bi-directional energy label can serve either to increase or to decrease the market value of a labeled property. The two perhaps most widely used bi-directional energy labels are:

- The European Community's Energy Performance Certificate (EPC), which for most EU countries is formatted as a letter grade for the building ranging from A (shown in green, highly energy-efficient) through D (shown in yellow, roughly average energy efficiency) down to G (shown in red, very poor energy efficiency). Most EU countries' EPCs also include an energy efficiency score ranging from 0 (highly energy inefficient) to 100 (highly efficient) as well as the letter grade. See page 101 for an example EPC.

- The Energy Efficiency Rating (EER) in Australia. This rating is denominated in stars, with a highly inefficient building receiving zero stars, the very most efficient buildings (net zero energy consumption) receiving ten stars, and most buildings with intermediate efficiency receiving between one and five stars. Several different software packages have been approved for use in Australia to assess the energy efficiency of a building and determine the number of stars at which it should be rated, including NatHERS, NABERS, and FirstRate.

In the U.S., there is no bi-directional energy label that has been very widely used, either for commercial or for residential buildings.

Commercial buildings in the U.S. Several State, county and local governments require owners of some types of commercial buildings to develop energy efficiency ratings for these buildings via software programs such as USEPA and DOE's Energy Star Portfolio Manager and Energy Star Target Finder. Most of these jurisdictions further require the commercial buildings' owners then to disclose these ratings to the parties involved in sales, leasing or financing transactions for the building, sand in some cases they require disclosure of the ratings to the general public. But in most instances throughout the country neither the State nor local government has mandatory energy rating and disclosure requirements for commercial buildings. In most of the country, the owner of a commercial building is thus free to choose: a) whether or not to rate the building using Energy Star or other tools; and then b) whether or not to report the results if the building was rated. Buildings that are rated and achieve a sufficiently high score can qualify for Energy Star and/or LEED certification, and the owner of a qualified building will often seek and publicize the certification since these certifications increase the building's value. In the jurisdictions where rating/labeling is not mandatory, a building owner is unlikely to choose to pursue energy rating and labeling if he believes his building is relatively inefficient and would not qualify for Energy Star, LEED, or other sorts of certifications.

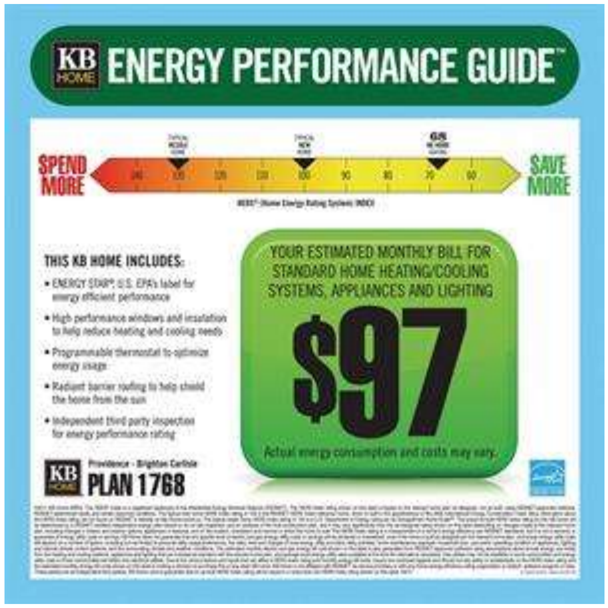
The result of energy labeling being voluntary for commercial buildings in most places in the U.S. is that Energy Star and other energy certifications serve in practice almost exclusively as positive labels. Only a relatively efficient building can qualify for Energy Star and other certifications, and a certification, if obtained, signals only positive things about the building and can serve only to increase the building's value. On the other hand, the rating or scoring systems that underlie the certification (e.g., Portfolio Manager or Target Finder, which are calculated in order to determine whether a commercial building can qualify for the Energy Star label) could perhaps function in a different, bi-directional manner. A relatively inefficient building will get a low/poor Portfolio Manager score, while a relatively efficient building will get a high/good score. If all or nearly all commercial buildings were required to be rated and these ratings were disclosed whether good or bad, some buildings would get good energy ratings and would gain market value, and some would get poor energy ratings and would lose market value. If energy rating and disclosure were mandatory, this information would have bi-directional impact. This pattern of some commercial buildings gaining value and some losing value is the likely result of the mandatory labeling and disclosure requirements that have been adopted in the States of California and Washington, and cities of Boston, Chicago, New York, Minneapolis, Philadelphia, San Francisco, Seattle and Washington, D.C. As the labeling programs in these jurisdictions are implemented and data accumulates, leasing and sales transactions can be analyzed to determine the degree to which inefficient/poorly rated commercial buildings lose value in leases or sales. Absent any such data yet from locations in the U.S. where both inefficient and efficient commercial buildings have been labeled, there are no U.S. studies to date that can document a loss in value for any commercial buildings due to energy labeling. In most U.S., jurisdictions thus far, Energy Star, LEED and other rating systems function only as positive labels: the more efficient commercial buildings that qualify for the label display it and gain a market premium, while the great majority of the less efficient buildings do not seek the label and neither gain a premium nor suffer a discount.

Residential buildings in the U.S. A few U.S. jurisdictions require owners of larger multifamily residential buildings to calculate and disclose energy efficiency ratings using Energy Star software. Many builders of new single-family homes aim to meet one or more energy or green certification requirements for some or all of their homes, including Energy Star, LEED, NAHB Green Building, DOE Builders' Challenge and several regional or State certifications. In practice, these programs for residential buildings currently provide largely unidirectional, positive labels, as is the case for commercial buildings in the U.S. Mostly on a voluntary basis, some residential builders and property owners seek to distinguish more energy-efficient homes and apartment buildings from others and to increase their properties' market value by meeting the requirements to obtain one of these selective certifications. For an energy label for residential properties to function in a bi-directional manner instead of simply increasing the value of all the labeled properties, more homes and apartments would need to be rated and labeled, including both relatively efficient and relatively inefficient ones.

There are several recent developments in the U.S. that could perhaps lead eventually to the widespread use of bi-directional energy labels for residential properties:

- Austin, Texas requires older homes to undergo an energy audit prior to sale, with the results of the audit required to be provided to potential purchasers. The audit information and report presumably serves as a sort of bi-directional label -- homes with high energy efficiency, low projected energy costs and energy audits that find relatively little that should be done will presumably gain value in the market, while inefficient homes with a lengthy list of suggested audit upgrades will presumably lose value.

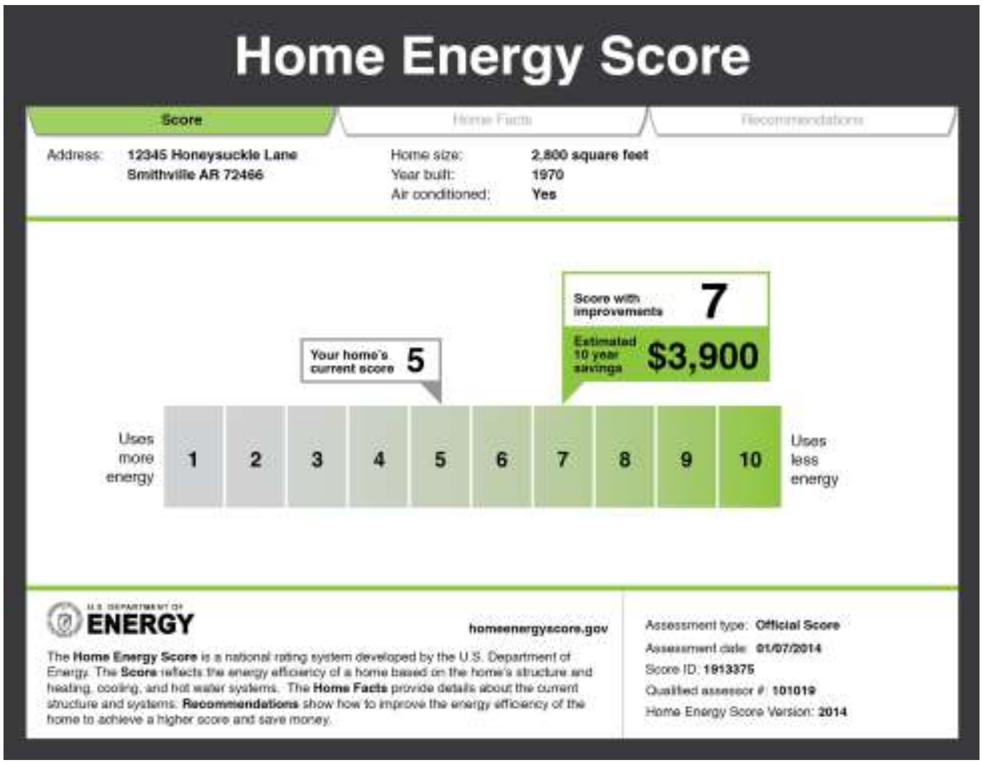
- A substantial number of builders of new homes have begun to label all their homes in a manner that suggests to prospective purchasers both the amount of energy costs that they might face if they were to buy the home and how these costs might compare against expected energy costs for other comparably sized new or resale homes. This, for example, is a label used by KB Home for one of their new homes:



The projected monthly energy bill for this new home is based on the HERS (Home Energy Rating System) Index, the same system that underlies EPA's Energy Star homes program. KB Home claims that all of their new homes meet the standards for Energy Star certification, and their "Energy Performance Guide" sticker shown above includes the Energy Star logo. Meritage Homes claims to be the first national U.S. builder to build all of their new homes to exceed the Energy Star standards and to label them with both a numerical score and the Energy Star logo. At least fifteen additional national homebuilding companies and more than a hundred regional and State companies have committed similarly to score their new homes using HERS and then to market them using a comparative "thermometer" as above; these builders have thus been designated as "Energy Smart Builders" by the Residential Energy Services Network (RESNET).

These builders have presumably chosen to use this sort of energy label because they believe it will increase the value of their labeled homes. These companies intend the label as unidirectional and positive. It is easy to envision, however, how this sort of label could be used in a bi-directional manner -- for example, if more jurisdictions required that such a label be developed and displayed for <u>all</u> new homes (Santa Fe, NM already does), or for <u>all</u> new and existing homes. And, in communities where a large number of labeled new homes are being built, this label could already by having a bi-directional impact as the many labeled new homes serve to slightly depress the prices of competing unlabeled new and existing homes.

- The Department of Energy (DOE) has developed a Home Energy Score (HES) and label that State and local governments might adopt as a basis for labeling and disclosure programs for existing homes. The HES rates the energy efficiency of an existing home in comparison to its peers. DOE is now implementing a program with more than 25 DOE "Partners" (utilities, State and local governments and non-profits, now covering much of the country) to make the scoring system available throughout the U.S. When a homeowner requests an assessment from one of the Partners, a qualified and certified "Assessor" conducts a walk-through of the home and collects about 40 data points, then uses the DOE Home Energy Scoring Tool -- an online free software program -- to estimate the home's energy use, convert that into a score and develop recommendations for energy improvements in the home. The homeowner then receives a packet including the comparative score, the label and a report indicating cost-effective measures the homeowner might undertake to improve his home's score. More than 16,000 homes have been scored as of January, 2015. The Home Energy Score could serve as a bi-directional energy label if a large number of both energy-efficient and energy-inefficient homes were to be scored, as would be the case if a jurisdiction were to mandate its use for all existing homes. The score itself ranges from 1 ("uses more energy") to 10 ("uses less energy") efficient), as shown below.



Bi-directional energy labeling or rating programs such as these will serve to increase the value of relatively efficient labeled buildings and to decrease the value of relatively inefficient labeled buildings. A unidirectional label, in contrast, can have a positive impact only -- it will increase the market value of the (efficient) buildings that qualify for the label or certification, and it will have no or virtually no impact in decreasing the market value of non-labeled buildings.

We are concerned about the negative impact that a bi-directional labeling program may have on the value of relatively energy-inefficient labeled buildings. Neighborhoods or communities with a preponderance of older, energy-inefficient, non-renovated homes could perhaps see a substantial decline in property values if a mandatory, bi-directional energy labeling program were implemented. Commercial buildings in older, non-renovated business areas could suffer similarly.

By what amount might property values decline in areas that would be negatively affected by a mandatory bi-directional energy labeling requirement? How much value have energy-inefficient properties been found to lose in studies analyzing the impacts of bi-directional energy labeling programs? In the next section of this report we review the findings from several such studies. As we noted previously, Europe and Australia have had much more experience with mandatory bi-directional energy labeling programs than the U.S., and all four of the relevant studies are foreign.

Loss in market value for energy-inefficient properties after "bi-directional" labeling

Brounen and Kok (2010) analyzed the impact of the Netherlands' mandatory home energy labeling program on selling prices for nearly 32,000 labeled homes that sold between January, 2008 and October, 2009. The Netherlands requires the owner of most dwellings constructed before 2000 that are sold or rented to obtain an energy performance audit and to provide a certificate indicating the results of the audit to the prospective buyer or tenant. The Dutch certificate, a version of the Energy Performance Certificate required by the European Union for all EU member countries, assigns each dwelling one of seven grades, ranging from A, signifying a building with exceptionally high energy efficiency, to G, signaling very poor energy efficiency. D-labeled homes have roughly average energy efficiency. The researchers used hedonic regression analysis techniques to estimate the impact of the label grade on a home's selling price while holding other factors affecting sales price constant. They estimated that a G label reduced a home's value by an average of 4.8% relative to a D-rated home, while an F label reduced this value by 2.3%. Relative to the estimated average price of about €231,000 in 2008/2009 for a Dutch home with average energy efficiency (D-label), the estimated 4.8% loss incurred by an inefficient home that receives a G label would amount to roughly €11,000, or about $14,000 to $17,300 at the exchange rates prevailing during that period. This amount would represent a substantial loss in value due to the mandatory labeling program for owners of inefficient homes.

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The Australian Department of the Environment, Water, Heritage and the Arts analyzed the impact of the Australian Capital Territory's mandatory energy labeling program on transaction prices for more than 5,000 homes sold during 2005 and 2006 (DEWHA, 2008). (The ACT consists of the capital city, Canberra, and surrounding suburbs.) The ACT's program, variants of which seem likely to be adopted by much of the remainder of the country, assigns homes an energy efficiency rating and a label ranging from zero stars (a highly inefficient home) to six stars (highly efficient). Researchers with DEWHA used hedonic regression analysis to analyze the impact of various factors, including the home's energy efficiency rating (EER), on the prices of houses sold in the ACT during 2005 and 2006. The researchers found that a home's EER was highly statistically significant in explaining the home's sales price. Other things being equal, a home was estimated to gain or lose an average of 1.59% in market value for each half star change in energy rating. An Australian home of average energy efficiency now would rate at approximately two stars. Applying the researchers' estimate of 1.59% change in home value per half star change in rating, an inefficient home that rates at zero stars (perhaps typical for uninsulated, drafty homes built before 1990, with no subsequent energy-saving renovations) would have a value estimated at 6.36% less than that for an otherwise comparable two-star Australian home of average energy efficiency. Relative to an average-efficiency Australian home at the national median home sales price of AUD450,000 in late 2011, an inefficient home that receives a zero-star energy efficiency rating and label would thus suffer a loss estimated at nearly AUD29,000 in market value. At the exchange rate prevailing at that time, this would equate to a loss in market value of about $30,000 in U.S. dollars. As appears to be the case also for an inefficient home with an energy label in the Netherlands, an energy-inefficient home in Australia would thus lose a substantial amount of value with a mandatory energy labeling program.

Similar to the Brounen and Kok (2010) study in the Netherlands, Fuerst, et al (2013) evaluated the impact of the letter grade assigned as a part of Great Britain's Energy Performance Certificate (EPC) on sales prices for homes in England and Wales from 1995 through 2011. Like the Dutch certificate and those of most of the other EU member countries' EPCs, the British EPC also assigns the rated property one of seven letter grades, ranging from A, most energy efficient, to D, neutral, to G, least energy efficient. The authors' database included more than 320,000 homes that had been sold at least twice during this period, representing approximately a 10% random sample of such homes in England and Wales. Fuerst, et al estimated that a G label reduced a home's value by an average of 7.6% relative to an otherwise comparable but neutral, D-rated home, while an F label reduced this value by 1.6%. Relative to an estimated average home price of about £180,000 in the researchers' database for a British home with average energy efficiency (D-label), the estimated 7.6% loss incurred by an inefficient home that receives a G label would amount to roughly £13,700, or about $20,000 to $28,000 at the exchange rates prevailing during much of that period. This amount again represents a substantial loss in value due to the mandatory labeling program for owners of inefficient homes.

Kok and Jennen (2011) analyzed the impact of the Netherlands' mandatory 7-category energy labeling program for office buildings, which like other EPCs assigns ratings ranging from A (highly efficient) through D (neutral) to G (highly inefficient). Using hedonic regression analysis, the researchers found at a 99% statistical confidence level that buildings with "green" labels (A through C) had rents per square meter averaging 6.5% higher than otherwise comparable office buildings with non-green labels (D through G). Alternatively, the researchers could be said to have found that office buildings with non-green labels rented for 6.5% less per square meter than offices with green labels. The researchers have not configured these findings in the particular manner that we are most interested in (i.e., they do not compare the impact of labeling on the market value for the most energy-inefficient offices against the impact of labeling on the market value for offices of average efficiency), but the findings nevertheless indicate that mandatory labeling has caused one grouping of office buildings (those with D through G labels) to lose market value relative to another category of office buildings (those with A through C labels). The 6.5% lower average rent that D- through G-labeled office buildings receive relative to A- through C-labeled offices represents a reduction in average rents of about $1.40 per square foot (U.S.).

None of the studies of energy labeling for U.S. commercial office buildings have yet investigated the market impact of a mandatory bi-directional energy labeling program. It appears that sufficient data are not yet available for such analysis from New York, San Francisco, Washington DC, or other cities with mandatory label requirements for commercial buildings. All the studies of energy labeling for U.S. office buildings that we have reviewed address Energy Star or LEED certifications, which are unidirectional labels in the sense that a building receiving one of these certifications can only have its value increased, not decreased.

The following table summarizes the results from the four studies we have cited where the researchers investigated the market impact of a bi-directional energy labeling program on groups of properties with relatively low energy efficiency.

Study Findings on Impact of Energy Label on Lower Efficiency Properties

Study	Energy Label Program	Impact of Label on Lower Efficiency Properties	Impact in U.S. Dollars
Brounen & Kok (2010)	Netherlands: Energy Performance Certificates for homes	Homes in lowest label category get 4.8% reduction in value relative to homes in middle label category	Loss of $14,000 - $17,300 in value
DEWHA (2008)	Australia: Energy label for homes in Australian Capital Territory	Homes with lowest rating (zero stars) get 6.4% reduction in value relative to homes with middle rating (2 stars)	Loss of about $30,000 in value
Fuerst, et al (2013)	Great Britain: Energy Performance Certificates for single-family homes	Homes in lowest label category get 7.6% reduction in value per square meter relative to homes in middle label category	Loss of $20,000 - $28,000 in value
Kok & Jennen (2011)	Netherlands: Energy Performance Certificates for office buildings	Offices with non-green labels (D thru G) get 6.5% reduction in value relative to offices with green labels (A thru C)	Reduction in rent by $1.40/sq. ft.

The conclusion from these studies is that mandatory energy labeling is likely to cause energy-inefficient properties to lose market value relative to otherwise comparable properties that are more energy-efficient. The loss in market value can be substantial. This conclusion should not be surprising. Many studies have found similarly that a property loses value when information is available suggesting that the property has some other sort of environmental shortcoming.

The market responds to energy-inefficiency similarly as to other environmental concerns

The following are a few of the studies that have investigated the impact of environmental concerns on property values. The studies have consistently found that an environmental impairment, whether it comes to light via a label or via some other sort of disclosure or investigation or publicity, reduces the market value of the affected property. As for most of the studies estimating the impact of energy labels, nearly all of the following studies used hedonic regression analysis as the methodology for estimating the impact of an environmental impairment on property values while controlling for the impact of other factors that also likely affect property values.

- *Proximity to hazardous waste sites.* A literature review developed by the U.S. EPA summarizes a dozen published, peer-reviewed studies that investigated whether there is a reduction in home prices with proximity to hazardous waste sites. Ten of the twelve studies found statistically significant reductions in home prices near waste sites, ranging from roughly 3% to 27%. (U.S. Environmental Protection Agency. “Challenges in

Applying Property Value Studies to Assess the Benefits of the Superfund Program." January, 2009. See Table 1, in particular.)

- *Location in a "cancer cluster".* A study found a 14 - 16% reduction in market value for homes located in a county with an unexplained very high incidence of pediatric leukemia. (Lucas W. Davis. "The Effect of Health Risk on Housing Values: Evidence from a Cancer Cluster." *American Economic Review*. December, 2004.)

- *Air pollution.* In a nationwide study, housing values were found to decline 2.5 - 3.5% for a 10% increase in levels of total suspended particulates, probably the most significant air pollutant in terms of impact on public health in the U.S.. (Kenneth Y. Chay and Michael Greenstone. "Does Air Quality Matter? Evidence from the Housing Market." *Journal of Political Economy*, 2005, vol. 113, no. 2.)

- *Water pollution.* A substantial worsening in fecal coliform water quality in the Chesapeake Bay (going from current average levels to a level that would often require beaches to be closed) was estimated to result in a loss of $5,000 to $10,000 in the average value of waterfront properties on the Bay. (Christopher G. Leggett and Nancy E. Bockstael. "Evidence of the Effects of Water Quality on Residential Land Prices." *Journal of Environmental Economics and Management*, 2000, 39(2), 121-144.)

- *Radon.* In most instances when testing prior to sale has found that the radon concentration in a home exceeds recommended levels, the homeowner has taken steps to reduce this concentration at a cost ranging from a few hundred to a few thousand dollars. (Aceti Associates. "Strategies for Promoting Radon Mitigation: A Literature Review." 2006. At: http://www.acetiassociates.com/pubs/RadonMitStrategyReview.pdf) A 1995 study in Sweden found the average home moderately contaminated with radon has a market value 21,300 SEK (equivalent to about $3,000) less than an uncontaminated but otherwise similar home, an amount apparently somewhat higher than the typical cost for radon remediation. (Tore Soderqvist. "Property Values and Health Risks: The Willingness to Pay for Reducing Residential Radon Radiation." *Scandinavian Housing & Planning Research*, 12: 141-153, 1995.)

- *Electric power lines and pylons.* A literature review found a decline in the value of nearby properties attributed to the visual and aural impacts of overhead power lines. Studies have occasionally found further losses attributable to fears of health impacts. (Sally Sims. Oxford Centre for Real Estate Management. "The Effect of Public Perception on Residential Property Values in Close Proximity to Electricity Distribution Equipment." January, 2002. At: http://www.prres.net/Papers/Sims_Effect_Public_Perception_Values_Electricity_Equipment.pdf)

- *Lead paint.* A study found that the average market value of individual apartments or apartment buildings needing lead paint abatement was $3,813 per unit or $15,250 per structure lower than the value of comparable properties without lead paint. (Deborah Ford and Michele Gilligan. "The Effect of Lead Paint Abatement on Rental Property Values." *Real Estate Economics*. Vol. 16, No. 1 pages 84 - 94, March 1988.)

- *Mold.* Two researchers reported the results they obtained from three different approaches for assessing the impact of mold on real estate values. First, they surveyed awards resulting from litigation filed by property owners with mold problems. Awards for affected homeowners varied widely, ranging from $200,000 up to several times the pre-mold value of the property. A class action settlement averaged $11,700 per plaintiff. Second, they conducted a contingent valuation survey asking nearly 200 homeowners how the amount they might bid for a home that had a remediated toxic mold problem would compare against the amount they would bid for the same home if it had never had a mold problem. A remediated mold problem caused bids to decline typically by 20 - 37%. Third, costs averaged about $8,200 per unit (typically about 5 - 15% of market value) in a program in Cleveland, Ohio, where more than 80 homes or apartments with mold problems were remediated. It is likely that the loss in market value for these units would exceed these remediation costs due to stigma and perhaps fear of residual contamination and health effects. (Robert Simons and Ron Throupe. "An Exploratory Review of the Effects of Toxic Mold on Real Estate Values." *Appraisal Journal*. Vol. 73, No. 2, Spring 2005.)

These and many more studies have consistently found that a property will lose value when the market somehow becomes aware that the property has an environmental shortcoming. It should be no surprise that the market will respond similarly when an energy label makes it apparent that a property is energy-inefficient.

4. Stigma Associated With a Negative Energy Label

Could a property receiving an unfavorable energy-efficiency rating be stigmatized, and suffer a loss in market value that substantially exceeds the capitalized cost of the additional energy the inefficient property is likely to use?

Yes. The studies that we have referenced in the preceding sections indicate clearly that a favorable or positive energy label or rating (i.e., representing the property as energy-efficient) will, on average, increase the property's market value. The opposite appears to be true also: an unfavorable or negative energy label, signifying that the property is energy-inefficient, will on average decrease the property's value.

Does the gain or loss in market value from a positive or negative energy label accurately reflect the objective information on the property's likely future energy use that underlies the label? Does the gain in market value for a positively labeled home match the value of the underlying future stream of energy cost savings that the positively labeled home is likely to accrue relative to a home of average efficiency? Does the loss in market value for a negatively labeled office building roughly match the cost of the additional energy that the owners and tenants of this building is likely to use in the future?

We are going to use the terms "cachet" and "stigma" to represent the portion of any market response to an energy label that exceeds the value of the underlying future energy costs signaled by the label. We say that an energy label involves some amount of positive "cachet" when the gain in market value that an energy-efficient property receives after being given a favorable label exceeds the capitalized value of the energy cost savings the efficient property will accrue relative to an unlabeled property of average efficiency. The same energy label might also create some amount of negative "stigma" for a different set of properties -- for energy-inefficient properties when the loss in market value resulting from a negative/unfavorable energy rating exceeds the capitalized value of the additional energy costs that an inefficient property will accrue relative to an unlabeled property of average efficiency. Cachet and stigma are two sides of the same coin -- they can both occur when the market interprets a bi-directional energy label as signifying something about the labeled property beyond whether the property's future energy costs will be low or high. It is not clear what the market may interpret an energy label as signaling about a property in addition to something about the magnitude of the property's future energy costs. Different individuals may have differing opinions about whether an energy label suggests something further about a building than the building's future energy costs, for example:

- Some may believe that a building that is labeled as energy-efficient is also likely to be comfortable, probably with fewer drafty areas and more even heating and cooling;

- Some may believe that a building that is labeled as energy-efficient is likely to have been constructed and maintained well, and that an energy-efficient building will thus also have lower future maintenance and repair costs as well as lower future energy costs; and

- Some may value an energy-efficient building highly because it has societal benefits beyond the private cost savings that will be realized by the building owner -- including reduced greenhouse gas emissions and the possibility that choosing an energy efficient building can set a "green" example for others.

There may thus be a variety of reasons why the market response to an energy label may exceed the value of the energy savings or costs underlying the label.

How close usually is the match between the value the market assigns to an energy label and the value of the underlying energy costs for the labeled property? Are cachet and stigma usually large or usually small? Does the nature of an energy label affect whether cachet and stigma are likely to be larger or smaller? These questions are important for several reasons:

- Those who are designing an energy labeling program should be concerned about both the effectiveness and the accuracy of the label. The intended purpose of an energy label is to make the energy consumption characteristics of a property apparent to the market and to encourage building owners and purchasers to make cost-effective energy conservation investments. The more effective the label is in generating a market response -- an increase or decrease in the value of the labeled property -- the greater will be the incentive for energy-conserving investments. However, an energy label that is effective in generating higher market values and higher sales prices for positively labeled properties will eventually lose this effectiveness and come to be viewed as inaccurate and deceptive by the market unless favorably labeled properties do in fact eventually provide the energy cost savings that are implied by their labels.[35]

[35] A set of policy issues that we have not addressed in this paper involves the accuracy with which an energy label and the information included in the label projects the amount of energy that occupants of the labeled building will use. How accurate is the label with regard to actual energy use? Which will consumers judge to be more accurate and more useful, labels and benchmarks based on asset ratings or on use ratings? There is a growing amount of useful literature on these questions. We will quickly cite three examples.

Aydin, Brounen and Kok (2013) state that "In order to have an effect on consumer choice, energy labels need to meet three conditions, they need to be available, understandable, and reliable." They examine the degree to which these criteria are met for the Dutch EPC, using a database including the EPC rating, energy use data and household characteristics for nearly 800,000 Dutch homes. They conclude that the EPC rating is highly but far from perfectly correlated with a home's natural gas usage. The EPC rating tends to underpredict usage in more energy-efficient homes and overpredict usage in less energy-efficient homes. One reason for this is the so-called "rebound effect", where consumers tend to respond to a gain in efficiency of some item or product by using more of it, though typically not in sufficient amount to outweigh the efficiency gain. In this instance, the researchers found that households in efficient homes tended to use somewhat more energy than their income and other household characteristics would suggest, and, *vice versa*, households in less efficient homes tended to use somewhat less energy than their characteristics would suggest. G-labeled homes were predicted to use 150% more natural gas compared with A-labeled homes, but in reality they used only 39% more. The rebound effect was estimated at 32% for owner-occupied dwellings and 48% for rental dwellings. The authors believe their findings have several implications: i) The payback times estimated for efficiency investments suggested for a home in its EPC are likely inaccurate because they do not account for the rebound effect as efficiency improvements are made; and ii) National targets for reductions in primary energy usage and CO_2 emissions will be more difficult to achieve than has been estimated.

In recent years there have been a series of studies addressing the question of whether LEED-certified buildings save energy over otherwise comparable buildings. What does LEED certification imply in terms of energy efficiency? Stephens (2013) provides a good summary of the recent literature on this issue.

- The research we have reviewed indicates that "bi-directional" energy labels are likely to increase the market value of positively labeled, energy-efficient properties, and to decrease the market value of negatively labeled, energy-inefficient properties. We are concerned about the loss in market value that properties receiving an unfavorable or negative rating on an energy label will incur. If the loss in market value includes not only some reflection of the property's higher future energy costs, but also an additional penalty due to an intangible "stigma" associated with the negative label, the decline in market value could be substantial and problematic. Entire neighborhoods or commercial sections of cities that have concentrations of older, non-renovated and perhaps poorly maintained buildings, which are generally energy-inefficient and which receive predominantly negative energy labels, could be stigmatized and suffer large declines in real estate market values. Declining real estate values, as we know from recent experience in much of the U.S., can cause a variety of social and economic problems. We are generally concerned about this "downside" from bi-directional energy labels, and the magnitude of the downside could be greatly increased if a negative or unfavorable label causes a substantial stigma impact in addition to reflecting the discounted present value of the future stream of higher energy costs in an energy-inefficient building.

In this section of the paper, we summarize the results of several analyses that we or others have developed to investigate the question of whether energy labels create a substantial amount of cachet and stigma. How does the magnitude of the market response to an energy label – the gain or loss in market value for a property as a result of it being labeled – compare with the capitalized value of the property's energy savings or costs underlying the label?

A few of the energy label studies that we have reviewed in this paper provide information on both:

1. The impact of the label on a property's market value; and

2. The average annual energy costs for labeled vs. non-labeled properties, or for properties at different levels of the label.

For these studies, we can do a calculation that converts the stream of future annual energy costs inherent in #2, above, into a capitalized present value, and we then compare this capitalized value of the energy costs or savings that underlie the label against #1, the value that the market ascribes to the label. To the extent that the change in a property's market value resulting from the label exceeds the value of the underlying energy costs or savings for the property, we say that there is cachet or stigma associated with the label.

Cachet and stigma for labeled homes in Australia

An Australian design/build architecture and engineering firm has investigated the extent to which an additional star in the Australian home energy rating system reduces energy costs for a typical

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Cluett and Amann (2013) provide a summary and review of policies in the U.S. and abroad regarding residential energy use disclosure. They discuss both asset and operational (use) ratings and the strengths and weaknesses of each.

homeowner (Brutal Art, 2010). This firm's estimate of how much an energy star is worth in terms of energy cost savings can be compared against the study estimate we discussed previously for how much a star is worth in terms of market value (DEWHA, 2008). This comparison provides insight on the questions we are concerned with -- is there stigma or cachet associated with the Australian energy rating, and how small or large might any stigma and cachet effects be?

The design/build firm started with a floor plan for what they termed a "typical suburban three bedroom home with double garage." The firm then assigned a set of design features to this model home that would cause the home to rate 3 Stars under the Australian labeling scheme:

- Wall construction is brick veneer with no insulation;
- Ceiling insulation is minimal (R value 1.0);
- Sub-floor construction is timber with no insulation; and
- Windows are single-glazed aluminum.

The firm then increased the energy efficiency of the model house by adding improvements in these four areas (wall construction, ceiling insulation, subfloor construction, windows) that would individually serve to increase the energy efficiency of the house one star at a time. The result when these features were combined in various ways were three more model homes, each more energy-efficient than the baseline 3 Star home. The firm then used the FirstRate energy rating assessment software (one of several software tools approved for calculating the energy rating for Australian homes) to estimate both the number of stars and the annual energy consumption for the four model homes. After assigning a typical unit cost for electricity and presuming 3.5% inflation annually, the firm then calculated the estimated total energy bill for each model home over a period of seven years. The results were as follows:

Model Home	Energy Star Rating	Energy Cost Savings Over 7 Years Relative to Baseline Home
Baseline: brick veneer wall, R1 ceiling, timber subfloor, single-glazed aluminum windows	3.0 Stars	---
Better: brick veneer + R2 wall, R3.5 ceiling, concrete slab, single-glazed aluminum windows	4.9 Stars	10,663 AUD
Better yet: reverse brick veneer + R3.5 wall, R5 ceiling, concrete slab, single-glazed timber windows	6.3 Stars	14,972 AUD
Best: Hebel block + R3.5 wall, R5 ceiling, concrete slab + R1, double-glazed PVC windows	8.3 Stars	20,551 AUD

We performed a simple linear regression analysis on this data, explaining the three better model homes' cost savings as a function of their incremental number of stars. Our conclusion from the regression analysis using the design/build firm's data is that an additional Star in the home's energy rating results in an estimated average reduction in 7-year energy bills of 4,193 AUD.

In their study of energy ratings and market values for homes sold in the ACT, the Australian government found that homes sold in 2005 gained an average of 1.23% in market value for each half Star in energy rating, while homes sold in 2006 gained 1.9% for each half Star (DEWHA, 2008). Applying these estimated percentage gains in market value to the median sales price of

AUD 521,238 for detached homes sold in Australia in 2010[36], a half Star increase in energy rating would be expected to increase the market value of the median house in Australia by somewhere between AUD 6,411 (1.23% of AUD 521,238) and AUD 9,904 (1.9% of AUD 521,238) in 2010. We can thus compare the projected increase in market value from a one Star gain in energy rating with the estimated (7-year) energy savings that would also be expected to result from a one Star gain in energy rating:

Estimated Impact Of One-Star Change in Energy Rating for Median Home in Australia, 2010

Increase/decrease in market value for one-Star gain/loss in energy rating	AUD 12,822 - 19,808
Decrease/increase in 7-year energy costs for one-Star gain/loss in energy rating	AUD 4,193
Amount of cachet/stigma associated with one-star gain/loss in energy rating	AUD 8,629 - 15,615

The results of this analysis are striking. Less than 1/3 of the average change in market value that is estimated to result from a one-Star change in the median Australian home's energy rating can be attributed to the underlying change in the home's energy costs associated with the different energy rating. More than 2/3 of the change in market value with a change in energy rating is unexplained and due to something other than the change in energy consumption and costs that underlies the change in rating. We refer to this unexplained portion of the energy label's impact on market value as "cachet" when the home has a high Star rating and the impact is to increase the home's market value. We refer to the unexplained portion of the energy label's impact on market value as "stigma" when the home has a low Star rating and the impact of the rating is to decrease the home's market value.

Several of the States and Territories in Australia, in addition to the ACT, have been considering a requirement that homes obtain and disclose an energy rating when they are offered for sale. If the stigma or cachet associated with this energy rating is of the magnitude that we have estimated here, the energy rating could become a significant factor in the Australian residential real estate market. Consider, for example, a typical Australian home built in about 1990 without subsequent renovation. This home will get an energy rating of about 1 Star on the NatHERS scale.[37] Relative to a more energy-efficient but otherwise comparable new home built in 2003 when the Building Code of Australia mandated that new homes be constructed to attain a minimum 4-Star rating, the unfavorably rated 1-Star 1990 home will have an average market value estimated as some 40,000 to 60,000 Australian dollars lower.[38] About 1/3 of this home's estimated large 40,000 - 60,000 AUD loss in market value due to labeling is an objective result

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36 Source: Real Estate Institute of Australia. REMF: Real Estate Market Facts. 3rd quarter 2010. We chose to multiply the estimated percentage gain in market value for an additional one-half star in rating by the median house price in 2010 in order to express the gain in 2010 Australian dollars for comparison against the energy cost savings figures developed by Brutal Art (2010) which were similarly expressed in 2010 Australian dollars.

37 See http://www.nathers.gov.au/eer/index.html. This is the Australian national government web site on house energy ratings. Concern for energy efficiency and use of any insulation at all were relatively rare in homes built in Australia in 1990 or earlier.

38 The 1-Star home has a rating three stars (or six half-stars) lower than the 4-Star home. DEWHA (2008) estimated that a home loses 1.23% (based on 2005 data) or 1.9% (based on 2006 data) for each half star in energy rating (2005 data). The 1-Star home will thus have a market value between 7.4% (6 x 1.23%) and 11.4% (6 x 1.9%) lower than an otherwise comparable 4-Star home.

of the poorer energy performance of the home, while 2/3 of the negative impact is due to some additional unexplained stigma resulting from the home having been rated and having obtained a low/bad rating. The owners of such poorly rated homes would be much better off if they had not been required to obtain and disclose a rating for their home. If stigma or cachet are so large for the Australian star rating system as to generate a market impact that is roughly three times as large as the objective value of the energy cost differentials underlying the rating, we could imagine seeing real estate prices substantially depressed in neighborhoods or communities with mostly older, energy-inefficient homes, and substantially increased in newer neighborhoods or communities with more efficient homes.

Cachet and stigma for labeled homes in the Netherlands

In their study of the Netherlands' Energy Performance Certificate (EPC) program, Brounen and Kok (2010) provide information on both the impact of a home's energy score on the property's market value and on the underlying average differences in annual energy costs for homes with different scores. With this information, we can compare the average value that the market assigns to a particular improvement in a home's energy score against the underlying value of the average energy cost savings for that particular score improvement. The result when we make this comparison is that the expected change in market value far exceeds the estimated value of the underlying energy cost savings. We conclude that much of the market response to this particular energy label consists of "cachet" or "stigma".

In the Dutch EPC program, homes are rated and labeled in seven steps from A to G, with an A-label signifying an exceptionally efficient home and a G-label signifying very high energy consumption (often a minimally renovated historic home with original materials and little or no insulation). A-labeled through C-labeled homes receive green-colored labels; E-labeled through G-labeled homes receive red labels. D-labeled homes have roughly average energy efficiency and are labeled in yellow. In the researchers' database of nearly 32,000 labeled homes that had been sold between January, 2008 and October, 2009, about 32% had green labels (A, B or C), 27% had neutral (D) labels, and 40% had red (E,F, or G) labels.

The researchers obtained information from the Dutch government on the average monthly energy costs for homes in each label category, ranging from €231/month for G-labeled homes to €105 per month for A-labeled homes. F-labeled homes had average energy costs of €199 per month, while the researchers did not present corresponding monthly energy cost figures for the other label categories.

What is the value of the stream of monthly energy cost savings that accompanies a better-labeled house? The researchers suggest capitalizing the stream of energy cost savings with a more efficient, better-labeled home by assuming that Dutch homeowners as of 2007 apply a risk-free discount rate of 4%/year and stay in their homes for an average of 12 years. By our calculation, then, the €126 per month cost savings for an A-labeled home relative to a G-labeled home is worth a present value of €14,190, while the much lesser €31.5 per month cost savings for an F-labeled home relative to a G-label is worth a present value of €3,548. In the table below, we compare these estimated capitalized values of these two streams for A- and F-labeled homes relative to G-labeled homes against the researchers' estimates of the average market value increments for A and F labels relative to G labels.

Estimated Additional Market Value of Homes With Favorable EPC Labels Compared Against Estimated Capitalized Value of These Homes' Underlying Energy Savings (Based on Brounen and Kok, 2010)

Label Category for Home	Increased Home Values Due to Better Label			Capitalized Value of Energy Savings		% Stigma or Cachet
	Home Value	Relative to G	% Relative to G	Relative to G	% Relative to G	
A	€254,028	+ €34,378	+ 15.7%	+ €14,190	+ 6.5%	59%
F	€225,418	+ €5,768	+ 2.6%	+ €3,548	+ 1.6%	38%
G	€219,650	---	---	---	--	--

Relative to an otherwise comparable G-labeled home, the researchers estimated that a home with an A label would gain an average of more than €34,000 in market value, a gain of nearly 16%. The estimated capitalized value of the average underlying energy cost savings for this A-labeled home relative to the G-labeled home is much smaller at about €14,000, or 6.5% relative to the average price of the G-labeled home. Thus only about 41% of the €34,000 market response to the A label consists of energy cost savings while 59% of the market response consists of "cachet" -- some sort of value that the market assigns to the energy label above and beyond the real value of the energy cost savings that underlie the label. The conclusion is similar when we compare the incremental market value of an F label against the estimated value of the energy savings underlying the F label -- in this case the value of the underlying energy cost savings constitutes about 62% of the market response to the better label, and 38% of the market response is cachet.

It is apparent that the gain in market value from a better label greatly exceeds the value of the reduction in energy costs that underlies the better label. The opposite is true also -- the loss in market value from a poorer label greatly exceeds the loss from the additional energy costs that underlie the poorer label. The table shown above could easily be re-formatted to make this opposite point by showing the decreased home values and increased energy costs for F- and G-labeled homes relative to A-labeled homes.

Cachet for green-labeled homes in California

Kok and Kahn (2012) estimated that a green-labeled home (LEED, Energy Star, Green Point) in California received a market premium averaging about 9%, or $34,800 relative to an average market price of about $400,000 for an unlabeled but otherwise similar home. The researchers also estimated that a typical 2,000 sq. ft. home in California would incur energy costs of about $200/month, and that an efficient Energy Star home might in contrast use about 30% less energy for a savings of $60/month and $720/year. At this rate of saving, it would take the purchaser of a green-labeled home nearly 50 years to accumulate sufficient energy savings to outweigh the additional cost to purchase such a home. This suggests that there must be something substantially beyond the energy cost savings that makes home buyers believe they are receiving a sufficient return for the nearly $35,000 average premium that they must pay for a green-labeled home.

Looking at these figures in another way, it might be reasonable to require a minimum cap rate of about 5% for a real estate investment, even for an owner-occupied, single family home. At this low cap rate, the minimum annual return associated with the green label for a property with a $34,800 green premium would have to be $1,740 per year to make this a reasonable investment. The projected annual energy savings associated with this label thus accounts for only at most about 41% of the capitalized market value of the label. At least 59% of the market value of the label appears to be attributable to something other than the expected energy cost savings -- to cachet. (Note that the green labels considered in this study represent unidirectional labels -- they can serve only to increase the value of a labeled property and cannot serve to decrease the value of a property. There can thus be no stigma or unexplained loss in value associated with these labels, there can be only an unexplained gain in value or cachet.)

The authors make several further observations in the study regarding the portions of the label's value that represent the capitalized value of the expected energy savings and that represent something else, or cachet:

> "From the perspective of a homeowner, the benefits of purchasing a labeled home, or of "greening" an existing dwelling, include direct cost savings during tenure in the home. Indeed, we document some consumer rationality in pricing the benefits of more efficient homes, as reflected in the positive relation between cooling degree days in a given geography and the premium rewarded to a certified home. … The results show that the resale premium associated with a green label varies considerably from region to region in California, and is highest in the areas with hotter climates. It is plausible that residents in these areas value green labels more due to the increased cost of keeping a home cool."
>
> "Presumably, the capitalization of the label should at least reflect the present value of future energy savings. … Compared to the increment for green-labeled homes documented in this paper, that implies a simple payback period of some 48 years. … Quite clearly, there are other (unobservable) features of green homes that add value for consumers. This may include savings on resources other than energy, such as water, but the financial materiality of these savings is relatively small. However, there are also other, intangible benefits of more efficient homes, such as better insulation, reducing draft, and more advanced ventilation systems, which enhance indoor air quality."
>
> "Of course, we cannot disentangle the energy savings required to obtain a label from the unobserved effects of the label itself, which could serve as a signaling measure of environmental ideology and other non-financial benefits from occupying a green home."
>
> "Quite clearly, the capitalization of "green" varies substantially by heterogeneity in environmental idealism: In areas with higher concentrations of hybrid vehicle registrations, the value attributed to the green certification is higher. These results on the larger capitalization effect of green homes in more environmentally conscious communities are consistent with empirical work on solar panels (Samuel R. Dastrup, et al., 2012) and theoretical work on the higher likelihood for the private provision of public goods by environmentalists (Matthew J. Kotchen, 2006)." …

> "The premium is also positively correlated to the environmental ideology of the area, as measured by the rate of registration of hybrid vehicles [Toyota Prius]. In line with previous evidence on the private value of green product attributes, this correlation suggests that some homeowners may attribute value to intangible qualities associated with owning a green home, such as pride or perceived status."

Cachet for green-labeled homes in Austin, Portland and the Research Triangle

Walls, et al, (2013) provide an extensive analysis comparing the expected capitalized value of the energy cost savings from a green-certified home against the increased price required to purchase such a home in their study of Austin, TX, Portland, OR, and the Research Triangle area, NC. They conclude, similarly as do the other studies reviewed in this section, that the market response to a green certification substantially exceeds the value of the underlying energy cost savings. The authors conclude:

> "This suggests that the certifications either embody other attributes beyond energy efficiency that are of value to homebuyers or that buyers are overpaying for the energy savings. Further research is needed to better understand how consumers interpret home certifications and how they value the combination of "green" characteristics that many of those certifications embody." (Walls, et al, 2013)

In developing their comparisons between the energy cost savings for certified homes and the price premiums for certified homes, the authors followed a somewhat different series of steps than were employed in the other studies referenced in this section, but they ultimately obtained similar results. Walls, et al:

- Estimated the annual energy cost savings for a certified home relative to a non-certified home that would be needed to justify the amount of the premium pad for the certification. They did so assuming that a potential buyer of a certified home would seek a real rate of return of at least 5% per year on the additional investment needed to purchase a certified home rather than a non-certified home, and that s/he would evaluate the investment over three possible alternative time horizons -- 7, 15 and 30 years.[39] The authors used these assumptions to calculate the amounts of annual energy cost savings that would just barely justify the certification premiums that they

[39] We believe the authors' choice of discount rate and time horizons does not reflect the very short payback periods that homeowners often appear to require in practice in order to invest in energy efficiency. We might suggest instead assuming instead a real discount rate of 7%/year and a time horizon for recovery of the investment of 5-7 years. The authors cite seven years as the average length of time a household in the U.S. lives in a particular house. We think many homeowners would want to recover any investment they might consider making in their home's energy efficiency before they will move out of the home, and thus in seven years or less.

We also question the authors' apparent use in performing these calculations of an amortization function where it is assumed that that the payment is made or received at the beginning of each year subsequent to the investment. We think a better assumption in this situation would instead be that the energy cost savings will be accrued mid-way through each year after purchasing the home, not at the start of each year. Despite our misgivings about the authors' choices in performing these calculations, will cite the particular figures from the authors' analysis that they calculated at a discount rate of 5% and a time horizon of 7 years.

had estimated for each combination of city, type of green certification and vintage of home. Thus, for example, the authors calculated that the 5.8% premium ($14,504) that they had estimated for Energy Star certification for a house built between 1995 and 2006 in Austin would be just barely justified (assuming a 5% discount rate and a 7-year time horizon) if the annual energy cost savings for such a home was $2,387.

- The authors did not have information in their database of home sales in the three cities on the amounts that the homeowners actually spent for residential energy usage. The authors did, however, have information from the MLS and other sources on the characteristics of these homes (square footage, number of rooms, vintage, type of heat and air conditioning, appliances, and more) and on other variables (occupant age and income, number of heating and cooling degree days) that allowed them to apply a set of modeling equations developed by Alberini et al (2011) in order to estimate the average annual quantities of electricity and natural gas that a household in a non-certified single family home was likely to have consumed in 2007 and 2010 in each of the three cities. The authors then applied average retail energy prices in these areas at these times in order to estimate the average household's annual energy costs. In Austin, for example, in 2007, the average household was estimated to spend $2,322 for residential energy usage.

- The authors then asked how the likely stream of energy cost savings associated with a certified vs. non-certified home compares with the minimum amount of savings that would be needed to justify the estimated certification premium. The authors estimated, based mostly on documentation regarding the various certifications, that annual energy usage and energy costs for a certified home are likely about 15 - 30% lower than those for a non-certified but otherwise comparable home. For Austin in 2007, then, where the average annual energy bill for the owner of a non-certified home was estimated at $2,322, the annual costs if the owner was in a certified home instead would be estimated at about $1,625 to $1,974, representing an annual savings of $348 to $697 (15 - 30%). The authors then compared this expected annual energy cost savings from purchasing a certified home against the minimum annual savings that was estimated as necessary to justify paying the premium associated with the certification. In the instance of an Energy Star certified home in Austin built between 1995 and 2006 and given 2007 energy prices in Austin, the annual energy cost savings necessary to justify the $14,504 market premium for such a certified home amounts to a minimum of $2,387. The actual annual energy cost savings that the purchaser might anticipate to accrue from this more efficient home is estimated at $348 to $697, only about 15 - 29% of the amount needed to justify the additional cost to purchase such a home. In this instance, using our terminology rather than the authors', 71 - 85% of the market premium for the Energy Star certification in this instance is thus estimated to consist of "cachet".

Walls, et al (2013) performed parallel calculations of this sort comparing the likely energy cost savings from certification against the market premium for certification for each of the authors' various combinations of city, certification and home vintage. We show their results in the table below, but we revise the presentation format used by the authors instead so as to meet our goal of dividing the estimated certification premium into a share attributable to the value of the expected stream of energy cost savings for a certified home and the residual share due to cachet.

Comparison Between the Annualized Value of the Market Premium For a Certified Home and the Value of the Underlying Energy Cost Savings -- Results from Walls, et al, 2013

City	Certification	Year of Analysis	Home Vintage	Minimum annual savings req'd to justify certification premium	Annual energy cost savings estimated for certified homes		Percentage of certification value due to cachet	
					Low (15%)	High (30%)	Low	High
Austin	Energy Star	2007	1995-2006	$2,387	$348	$697	71%	85%
	Energy Star	2010	1995-2006	$2,387	$323	$645	73%	86%
Triangle	Energy Star	2007	1995-2006	$7,289	$358	$717	90%	95%
	Energy Star	2010	1995-2006	$7,289	$325	$649	91%	96%
Portland	Energy Star	2007	1995-2006	$1,828	$308	$615	66%	83%
	Energy Star	2010	1995-2006	$1,828	$275	$550	70%	85%
Austin	AEGB	2007	2007	$4,756	$316	$632	87%	93%
	AEGB	2010	2007	$4,756	$292	$584	88%	94%
	AEGB	2010	2008	$9,619	$300	$600	94%	97%
	AEGB	2010	2009	$6,379	$295	$590	91%	95%
	AEGB	2010	2010	$10,674	$286	$571	95%	97%
Portland	Earth Advantage	2007	2000 - 2005	$6,004	$311	$621	90%	95%
	Earth Advantage	2010	2000 - 2005	$6,004	$275	$550	91%	95%
	Earth Advantage	2010	2008	$2,953	$265	$530	82%	91%
	Earth Advantage	2010	2009	$3,388	$259	$517	85%	92%
	Earth Advantage	2010	2010	$3,776	$261	$523	86%	93%

Under all circumstances that Walls, et al, analyzed, the value of the underlying stream of energy cost savings is far short of the increased value that the market has accorded to these energy certifications. Between 66 and 97 percent of the market premium given to certified homes was found to consist of cachet, with only 3 to 34 percent of the premium attributable to the energy cost savings inherent in a certified home.

Walls, et al, conclude:

> For average homes, it appears that buyers (of pre-2006 Energy Star certified homes) may either be overpaying for the energy savings embodied in the Energy Star certification, may place a large premium on increased comfort that can come from building shell features required for certification, or may be using this certification as a proxy for other house attributes. The green certification schemes in Austin and Portland are clearly capturing something other than energy savings. ... a home meeting either the Earth Advantage or AEGB certification standards is meeting a large number of requirements related to water efficiency, types of materials used in construction, landscaping, and a host of other specifications. These could account for the large premiums associated with sale (and resale) of these homes. According to the certification agencies themselves and local builders in Austin and Portland, there is a strong sense that the certifications are more a symbol of overall home quality than any single green feature of the homes, including energy efficiency. (Walls, et al, 2013, page 23)

The market value of an Energy Star label exceeds the value of the underlying energy cost savings for office buildings in the U.S.

The several more reliable estimates of the average increment in market value associated with an Energy Star rating or label for a U.S. commercial office building range from 8% to 26% (see summary table on page 35). Eichholtz, Kok and Quigley (2010) is in our view the best single study investigating the market premium resulting from energy labeling for U.S. office buildings -- these authors use a reasonable methodology and analyze the largest sample of buildings over the longest time period -- and this study estimates that Energy Star certification provides an average increase of 14% in a building's value. At an average sales price of $267.80/sq ft for the more than 5,000 non-certified, "control", office buildings that were sold between 2004 and 2009 in Eichholtz, Kok and Quigley's database, the average 14% premium for the Energy Star label would represent a gain of about $37.50/sq ft in value for such a certified building.

We will compare this estimated gain in market value from the Energy Star label against the average value of the underlying energy savings that an Energy Star-rated building accrues relative to a non-labeled building.

The average annual savings in energy costs for an Energy Star-rated office building relative to a comparable non-Energy Star-rated building has been estimated at about $0.50 per square foot. This $0.50 per square foot per year figure is used by the U.S. EPA in discussing the benefits of the Energy Star label,[40] and it also matches the estimate provided by Miller, Spivey and Florance (2008) after analyzing the CoStar database for the years 2006 and 2007. To convert this stream of annual energy cost savings from the average, more efficient Energy Star building into a corresponding capitalized value, we apply an appropriate cap rate for commercial office buildings.

As of early 2007, the midpoint of the Eichholtz, Kok and Quigley (2010) 2004-2009 data set for their commercial office building sales analysis, the cap rate for office real estate was about 6.2%.[41] Over the period from 2004 through the end of 2008, the cap rate for better-grade CBD office space began at about 8.5%, then declined steadily to 5.5% at the end of 2007, and then began increasing.[42] The office market cap rate reached a recent high of 8.2% at the end of 2009, and then declined to about 7.1% at the end of 2011.[43] Overall then, during the 2004 through 2009 period of the Eichholtz, Kok and Quigley analysis, the cap rate for commercial office buildings ranged from about 5.5% to about 8.5%, with a value of 6.2% at the midpoint of this period. Applying these cap rates to the $0.50 per sq ft/year estimated value of the energy cost savings associated with an Energy Star-rated office building, the capitalized value of this stream of operating cost savings would range from $5.90 to $9.10 per square foot, with a single value at about $8.10 per square foot.

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[40] See http://yosemite.epa.gov/opa/admpress.nsf/0/6A9D6902E0784DF6852579DD007A59D0 (April 11, 2012) for a representative U.S. EPA press release in which this figure is cited. This figure is apparently derived from U.S. EPA (2006) (page 4) and represents the average energy cost savings realized by nearly 1,200 Energy Star-labeled buildings relative to comparable non-labeled buildings between 1999 and 2004.

[41] Cornerstone Real Estate Advisors LLC. Cap Rates & Real Estate Cycles: A historical perspective with a look to the future. June, 2009. Available at: http://www.cornerstoneadvisers.com/_pdf/CREACapRates.pdf

[42] Ibid.

[43] Reis, Inc. ReisReports: Cap Rate Trends. Available at: http://www.reisreports.com/blog/2012/02/cap-rate-trends-2/

The capitalized value of the energy cost savings associated with the Energy Star label thus amounts to somewhere between $5.90 and $9.10 per square foot, while the market accords this label an average value of $37.50 per square foot. It is clear that the market assigns a value to the Energy Star label far in excess of the value of the underlying energy cost savings stemming from the more efficient building. Using our terminology, the "cachet" associated with the Energy Star label for a commercial office building comprises roughly 75 - 85% of the value of the label; the value of the underlying energy cost savings amounts to only 15 - 25% of the market value of the label.

It is not clear whether there are sufficient tangible values in addition to energy cost savings to account for the remainder of this high market valuation for the Energy Star label, or whether the market in some sense misperceives and overvalues the label. There is a growing literature on the subject of benefits from green and/or energy-efficient commercial buildings in addition to reduced energy costs, such as increased employee productivity, reduced absenteeism, greater comfort of building occupants, and reductions in other sorts of building operating costs -- see, for example, Kats (2003) and Miller and Pogue (2009). We will not review this literature in this paper. We note at this point only that the market value of the Energy Star label conferred on a qualifying office building appears to substantially exceed the value of the building's underlying energy cost savings relative to an otherwise comparable but non-Energy Star building. To the extent that the interest in energy labeling of buildings is based on the desire to encourage greater implementation of cost-effective energy conservation investments in buildings, one should be concerned about any substantial mismatch between the value the market assigns to a label and the value of the energy cost differentials that actually underlie the label.

Note that there is no concern about "stigma" with respect to the Energy Star (or LEED) label. Since the Energy Star label is what we have termed a "unidirectional" or "positive" label, it can serve only to increase the market value of a building that receives the label. Cachet for a positive label can serve to increase the market value of a labeled property beyond the value of the underlying energy cost savings corresponding to the label. In contrast to a "bi-directional" or "neutral" energy label -- which can serve either to increase or to decrease the market value of a labeled property -- the Energy Star label cannot reduce a property's value. The Energy Star label can produce cachet but not stigma.

Much of the market response to an energy label reflects cachet and stigma

The following table summarizes the results of the five analyses where the authors or we have compared the magnitude of the market response to a label against the magnitude of the energy cost differentials between labeled and non-labeled properties or between positively labeled and negatively labeled properties.

Five Analyses Evaluating Impacts of Energy Labels	Value of the Label as Established in the Market (A)	Capitalized Value of Difference in Energy Costs (B)	% of Market Impact that is Due to Cachet and Stigma (A-B)/(A)
1. Gain or loss of 1 Star in energy rating (EER) for a median Australian home	±12,822 to 19,808 AUD	±4,193 AUD	67 to 79%
2. Netherlands: A-labeled (very efficient) home relative to G-labeled (very inefficient) home	+ €34,378	+ €14,190	59%
F-labeled (inefficient) home relative to G-labeled (very inefficient) home	+ €5,768	+ €3,548	38%
3. Green-labeled (LEED, Energy Star, Green Point) homes in California	+8.7%, or $34,800 relative to average home price of $400,000	≤ $14,400 ($720/yr, assume cap rate of at least 5%)	≥ 58%
4. Energy Star and 2 local certifications for single-family homes in Austin (TX), Portland (OR) and Research Triangle (NC)	Varies with the certification, city and home vintage. One example: Energy Star in Austin for older homes was worth +5.8% ($14,504) or $2,387/yr	Varies. For the Austin example, $323 to $697/yr	66 - 97%. For the Austin example: 71 to 86%
5. Energy Star office building in U.S. compared w/non-certified and less efficient but otherwise comparable office building	8 to 26% higher value for Energy Star bldg. Best estimate: 14% premium in value, roughly $37.50/sq ft	+$5.90 to $9.10/sq ft	76 to 84%

The leftmost column shows the energy label being analyzed. The five analyses address: i) the Australian Energy Efficiency Rating (EER); ii) the Netherlands' version of the EU's Energy Performance Certificate (EPC); iii) green-labeled homes in California; iv) Energy Star and two other local certifications in three U.S. cities; and iv) Energy Star certification of office buildings in the U.S. The second column in the table shows the market value of this particular energy label as estimated by researchers in some of the better studies that we review in the body of this report. For the Australian EER, for example, DEWHA (2008) provides information indicating that an Australian home of median energy efficiency would gain between 12,822 and 19,808 Australian dollars in value if the home's energy efficiency were improved sufficiently to gain one Star in the EER labeling scheme, and the median home would lose a similar amount of value if its energy efficiency were to decline by the equivalent of one Star in the EER rating. The third column shows our estimate, developed based on data from the original researchers and further analysis, of the value of the energy cost differential represented by the label. For the Australian EER, for example, the entry in the third column shows that a one-Star gain in the median Australian home's EER would result in a stream of energy cost savings over time that we estimate as equivalent to a present value of 4,193 Australian dollars.

Note at this point how the figures in the second column compare with the corresponding figures in the third column. In all five instances (rows) in the table, the figure in the second column exceeds the figure in the third column. The market response to the energy label (second column) exceeds the estimated value of the energy costs or savings underlying the label (third column).

For the Australian EER, for example, a one-Star gain in the energy efficiency of the median home would cause an increase in market value for this home of between 12,822 and 19,808 Australian dollars, while the energy cost savings corresponding to this one-Star gain in the home's energy efficiency are worth only 4,193 Australian dollars. The remaining 8,629 to 15,615 Australian dollars of market value increase from the one-Star label improvement are attributable to "cachet". Or, conversely, a one-Star loss in the home's energy efficiency would result in a decrease in market value for this home of between 12,822 and 19,808 Australian dollars, while the energy cost penalty corresponding to this one-Star loss in the home's energy efficiency amounts to only 4,193 Australian dollars. In this instance, the additional 8,629 to 15,615 Australian dollars in lost market value over and above the energy cost penalty represents "stigma".

In all five rows of the table, the impact of the label on a property's market value exceeds the value of the energy cost differential underlying the label. In each case, therefore, cachet and stigma contribute to the label's market impact. In fact, as shown in the final column of the table, in four of the five cases (in all but one of the two Netherlands scenarios), cachet and stigma are responsible for the majority of the label's market impact.

In each of the five analyses, we find that much of the market response to the energy labels consists of cachet and stigma. For each of these labels, the difference in energy costs between otherwise comparable labeled and non-labeled properties accounts for only a fraction, and usually only a small fraction, of the difference in market value between the properties. If we can generalize from these three perhaps most widely used of all sorts of energy labels for real estate -- the Australian NABERS label, the EU's EPC, and Energy Star in the U.S. -- it appears that cachet and stigma account for the majority of the market response to most energy labels.

One might view this large cachet and stigma effect as suggesting that the market typically over-responds to these labels, making more of each of them than what the label objectively means in terms of a property's energy costs. Alternatively, one could view this as evidence that the market ascribes substantial value to some attributes of a property other than energy costs that may also be suggested by an energy label: perhaps comfort, perhaps the magnitude of future maintenance costs, perhaps reduced greenhouse gas emissions, etc. In either case, the potentially large magnitude of the cachet/stigma response to an energy label heightens our concern about the likely property devaluation impact that could result for those properties that receive a negative label in a geographic jurisdiction that adopts a mandatory, bi-directional labeling/disclosure program. The market appears to react quite strongly to a building's energy label. In jurisdictions where labeling and disclosure are mandatory, property values could decline substantially for those homes or commercial buildings that receive unfavorable labels as the market devalues these properties both because of their higher energy costs and because of an additional unexplained stigma impact associated with the unfavorable label.

<u>Several studies suggest that both a green label and the cachet portion of the label's value may be luxury goods sought primarily by higher income buyers</u>

In their study of the value of a green label in Tokyo's condominium market, Fuerst and Shimizu (2014) found that the price premium paid for a green label increases substantially with the income of the potential buyer. Green-labeled condominiums purchased by buyers in the lower two income quartiles showed no price premium over comparable non-labeled condominiums purchased by these lower income buyers. Buyers in the next-to-highest income quartile paid an average of 2.8% more for green labeled condominiums relative to comparable unlabeled condominiums, while buyers in the highest income quartile paid an average of 3.4% more for green labeled condominiums than for comparable unlabeled condominiums. The authors commented about this finding as follows:

> "… we find that the average price premium paid for green-labeled properties is mainly driven by households with above-average incomes. Given that these are percentages on the total price, a base which is higher for more affluent buyers buying more expensive properties, the spread in terms of absolute monetary values of these price premia is even more pronounced. This finding is significant in that it demonstrates for the first time that 'green' features are more likely to attract higher-income buyers despite arguments to the contrary that claim energy efficiency and the resulting lower utility bills are a larger concern for more income-constrained households."

In their study of home prices in California, Kok and Kahn (2012) found that the green label premium is positively correlated to the environmental ideology of the area, as measured by the rate of registration of hybrid vehicles. They believe this correlation suggests that some homeowners may attribute value (cachet) to intangible qualities associated with owning a green home, such as pride or perceived status.

A study by Fuerst and Oikarinen (2014) on the impact of Finland's energy efficiency rating[44] on sales prices for apartments in Helskinki from 2007 through 2012 makes a perhaps similar point. The authors compiled data on both the apartment's energy efficiency rating and, from a different source, on the maintenance costs for the building within which the apartment is located, including energy costs. This might appear to be a good dataset from which to estimate the degree to which cachet and stigma contribute to an energy label's price signal. However, the study has not yet been published (only a conference presentation describing some of the findings is available) and the authors thus far have provided no results comparing the magnitude of the label's price premium against that of the underlying energy costs. However, the authors have reported estimates of the label price premium under two different regression specifications, one in which both the building's maintenance costs and the apartment's label rating are included as independent variables, and one in which only the apartment's label rating is included. The authors find virtually no difference in the estimated impact of the label rating on the apartment's price between the two regression specifications. (The second and third columns of the following table are very similar.)

[44] A variant of the Energy Performance Certificate (EPC) that the EU requires of its member countries, with seven letter grades ranging from A, the highest efficiency, to D, neutral, to G, the lowest efficiency.

Estimated Impact of Finnish EPC on Helsinki Apartment Prices (per square meter), From Fuerst and Oikarinen (2014)

Energy Rating (A best, G worst)	Est. Price Impact (regression w/out maintenance costs)	Est. Price Impact (regression with maintenance costs)
A and B	+ 8.7%*	+ 8.1%*
C	+ 2.6%	+ 2.6%
D (used for comparison to others)	---	---
E	-1.9%*	- 2.0%*
F	- 0.9%	- 1.1%
G	+ 0.6%	+ 0.3%

* Statistically significant

Taken literally, this finding means that the estimated effect of the label rating on the apartment's market price is unaffected by the magnitude of the building's maintenance costs. Presumably the building's energy costs constitute a significant fraction of the building's maintenance costs, and presumably also the apartment's label rating correlates strongly with the building's energy costs.[45] One would expect then, if there were to be no cachet or stigma included in the price impact associated with the label, that energy costs (or maintenance costs, to the extent that energy costs constitute a large fraction of maintenance costs) would be a much more important explanatory variable than the label energy rating. One would expect that the price effect coefficients estimated for the label energy ratings in a regression that includes the maintenance costs as an explanatory variable would: i) Not be statistically significantly different from zero; and ii) Would be substantially different from the coefficients estimated in a different regression that does not include the maintenance costs as an explanatory variable. In our view, then, the most likely explanation for the researchers' surprising finding to the effect that the label is important in explaining market prices but that maintenance/energy costs are not is that the label's impact on prices is nearly entirely due to cachet and stigma, and minimally due to the energy cost differentials underlying the various label ratings. The authors make a similar observation, though not using the terms *cachet* and *stigma*:

> "Energy efficiency ratings affect housing values ... even when catering for [accounting for the impact of?] the observed maintenance costs that include the energy costs, i.e., ratings have an 'independent' impact on housing prices. …
>
> We find a significant price premium for the high-rated (A-B) apartments even when catering for maintenance costs. 'Clientele effect:' there is a small share of 'environmentally aware' buyers that aim to buy the highest rated units (increases demand and thereby prices for these units); willingness to 'live green' & expected fast growth of energy prices."

[45] The authors do not present either of these sets of information in the available conference presentation. On the latter point, though, the authors do indicate that, over the entire study period, the Finnish label rating was based on the actual energy consumption of the building -- i.e., the Finnish label was a "use" rating and not an "asset" rating, The label rating thus undoubtedly correlates strongly with the building's energy use.

Designing an energy label so as to limit cachet and stigma

If a jurisdiction decides that it wishes to implement a mandatory labeling and disclosure program, we suggest that the jurisdiction take care in designing the label to minimize the amount of cachet and stigma that the label will prompt. In our view, the content and appearance of a label can be designed in ways to generate either more cachet and stigma or less. We believe it would be best if an energy label were to prompt a relatively precise and limited market response, with the difference in market value between two dissimilarly labeled but otherwise comparable properties reflecting mostly the difference in energy costs between the two properties and very little additionally in the way of cachet and stigma. Minimizing the amount of cachet and stigma would have two desirable effects:

- Over a span of years, consumers would grow to trust the label more, as properties are found eventually to deliver energy cost savings or losses that roughly match the market premium or penalty initially accorded to the label. In the contrary situation, if the label were designed to create a large amount of cachet and stigma, properties would deliver much less in the way of energy cost savings or penalties than how the market had valued the label, and the credibility of the label would deteriorate over time.

- Upon being labeled, an inefficient property will suffer a reduction in market value due only to the property's high energy costs. If the label instead involved substantial stigma impacts also, an inefficient and unfavorably labeled property would suffer a much larger reduction in value. Minimizing the degree to which a label creates stigma will reduce the extent and severity of any property devaluation. Neighborhoods or commercial zones with older, unrenovated and inefficient properties will not suffer as much decline in market value after labeling as they would if the label were to create substantial stigma impacts.

Others may disagree with our view that energy labels should be designed to minimize cachet and stigma. One might emphasize instead that the purpose of an energy label and disclosure is to facilitate market recognition of a property's energy efficiency, and thus to encourage property owners to make energy conserving investments in order to receive higher market values for their properties. Under this line of argument, the more the market responds to the label the more incentive will be created for energy efficiency investments. Heightening the market response by using a label that generates a substantial amount of cachet and stigma would have a positive impact by increasing the magnitude of the incentive effect and thus presumably increasing the volume of eventual energy efficiency investments.

We will discuss briefly some ideas about how to design a label that generates a more precise market response to energy efficiency information about the property with little in the way of additional cachet and stigma.

We believe that cachet and stigma arise when the market interprets an energy label as signaling attributes of the labeled property that may be desirable or undesirable, beyond the property's energy efficiency and potential energy costs. To avoid this, an energy label must both: 1) Provide information in a straightforward, easy-to-understand manner about the energy costs the property owner is likely to incur; and 2) Carefully avoid implying anything else about the property beyond its energy efficiency. To minimize cachet and stigma, the label should provide accurate, meaningful information about the property's energy costs, and it should imply nothing more than this.

There has been extensive research on how a label can provide accurate and meaningful information on a property's energy costs. Two of the better references on this subject are the European Union's evaluation of the EU's Energy Performance Certificate (EPC) requirements,[46] and research in the U.S. sponsored by the Department of Energy on how better to motivate home energy improvements.[47] Here are a few suggestions from this literature on design elements that will contribute to a label that effectively communicates a property's energy efficiency:

- Personalize and tailor the label to the extent possible. Make the label specific to the particular property and perhaps also to the sort of individual that is interested in the label. This could mean having differing label information for a property for the owner, for a prospective purchaser and for a prospective renter.

- Focus the label on the likely energy *costs* for the property, not on energy *consumption*. This will require having information on local utility rates so that estimated usage for the property can be converted to estimated costs.

- Be clear about the degree to which the energy usage or cost projections for the property are premised on assumptions about how the property will be used. For example: "these estimates assume that two adults and one child live in the home. Your actual energy use and savings will depend on how you maintain your home, how many people live there, your day-to-day habits and weather."[48]

- Estimate both the current energy costs for the property and how much these costs would decline if a set of cost-effective improvements were made to the property. Summarize the suggested, cost-effective improvements. Indicate where the owner or tenant can receive more detailed information on the costs and effectiveness of the recommended measures for the building or unit. Indicate how the owner can pursue the suggested cost-effective improvements.

- Benchmark the estimated current energy usage or costs for the labeled property against the estimated usage or costs for comparable size and type of properties.

In contrast, we have not found anything written on how to design a label to limit its implications to energy costs only.

Cachet and stigma occur when a label suggests something desirable or undesirable about the property in addition to its energy costs. The additional suggestions about a property that a label may convey may be explicit or implicit, precise or uncertain, and intended or unintended, but any

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[46] The internet home page for the EU's project on "Improving Dwellings by Enhancing Actions on Labelling for the EPBD" (IDEAL EPBD) is: http://www.ideal-epbd.eu

[47] Links to publications summarizing some of the DOE-sponsored research are available at: http://www1.eere.energy.gov/buildings/homeenergyscore/related_links.html

[48] This text is from DOE's draft Home Energy Score (HES) label.

such suggestions will generate cachet for a favorably labeled property and stigma when the property is negatively labeled.

Some energy score/label systems that are in current usage *intentionally* provide information on a topic or topics additional to the property's energy efficiency, such as the greenhouse gas emissions directly and indirectly resulting from energy usage at the property. Those who are designing a label should consider carefully whether or not to address such additional topics with the label. Addressing additional topics: i) provides greater transparency, adding further information about the property that the market can decide how to value, which at least in theory is desirable; but addressing additional topics also ii) runs the risk of diluting or confusing or distracting from the energy efficiency message that the label is primarily intended to convey. In the case of an energy label that also provides information on the property's carbon footprint, we have several concerns about providing this additional information:

- Are most consumers going to understand the carbon footprint information? Are those who don't understand it going to misinterpret it, and if so, how? Are those who don't understand it going to dismiss the entire label because this part of it is unclear? Should some additional portion of the label be devoted to attempting to explain the carbon footprint information? If this is done, does the carbon footprint information begin to outweigh or distract from the energy efficiency information conveyed by the label?

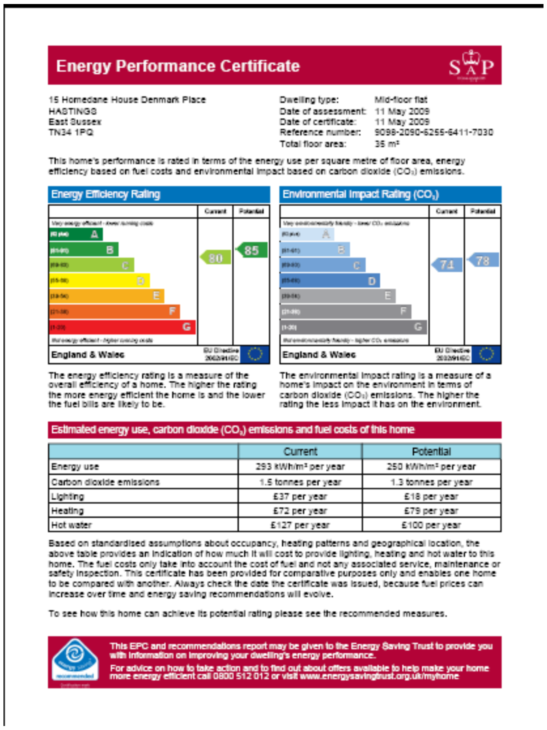
- Are some consumers going to react adversely to presentation of the carbon footprint information? Climate change and whether there is a significant anthropogenic contribution to climate change are controversial topics. Some consumers will likely object to the government including such information on the label, and will regard the entire label as being manipulative on the part of the government. They will likely then dismiss the energy efficiency information also included in the label.

These sorts of issues need careful thought before an energy label is expanded to address additional topics.

Other energy score/label systems that are in current usage may *unintentionally* suggest something further about the labeled property. Often a label is designed in a manner that seems to provide some sort of comprehensive judgment on the overall quality of a property; suggesting something about the general desirability of the property in addition to providing information about the property's energy efficiency. In our opinion, several of the most widely used energy labels have design attributes of this sort that seem likely to generate substantial cachet and stigma.

For example, LEED, the National Association of Home Builders' Green Building Standard, Green Star (Australia), and other similar "green" labels are explicitly intended to attest to a property's good performance across a wide range of sustainability concerns in addition to energy efficiency. These green labels are very effective in creating cachet. They could be similarly effective in creating stigma if negative, "non-green" or "brown" versions of these labels were developed. It is likely that few individuals viewing these green labels know exactly what they mean. Few individuals who might consider purchasing or renting in a LEED building understand which particular building attributes are considered in the LEED qualification scoring, nor are they likely to know how the particular LEED-qualified building performs with respect to each of these attributes. The LEED scoring system is multidimensional, complex and somewhat obscure. Most individuals, we expect, would interpret a LEED certification as meaning simply that the building is ecologically superior, but they would not be able to cite any more specific attributes that are promised by the label.

The following is the EPC for the United Kingdom, which is typical of the energy labels adopted by European Union countries pursuant to the EU's Energy Performance of Buildings Directive.



Energy Performance Certificate

15 Homedane House Denmark Place
HASTINGS
East Sussex
TN34 1PQ

Dwelling type: Mid-floor flat
Date of assessment: 11 May 2009
Date of certificate: 11 May 2009
Reference number: 9098-2090-6255-6411-7030
Total floor area: 35 m²

This home's performance is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO_2) emissions.

The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills are likely to be.

The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO_2) emissions. The higher the rating the less impact it has on the environment.

Estimated energy use, carbon dioxide (CO_2) emissions and fuel costs of this home

	Current	Potential
Energy use	293 kWh/m² per year	250 kWh/m² per year
Carbon dioxide emissions	1.5 tonnes per year	1.3 tonnes per year
Lighting	£37 per year	£18 per year
Heating	£72 per year	£79 per year
Hot water	£127 per year	£100 per year

Based on standardised assumptions about occupancy, heating patterns and geographical location, the above table provides an indication of how much it will cost to provide lighting, heating and hot water to this home. The fuel costs only take into account the cost of fuel and not any associated service, maintenance or safety inspection. This certificate has been provided for comparative purposes only and enables one home to be compared with another. Always check the date the certificate was issued, because fuel prices can increase over time and energy saving recommendations will evolve.

To see how this home can achieve its potential rating please see the recommended measures.

This EPC and recommendations report may be given to the Energy Saving Trust to provide you with information on improving your dwelling's energy performance.
For advice on how to take action and to find out about offers available to help make your home more energy efficient call 0800 512 012 or visit www.energysavingtrust.org.uk/myhome

As for most of the European Union building label schemes, energy-efficient properties get ratings shown in green color with letter grades A, B or C, while inefficient properties get labeled in red color with letter grades E, F, or G. The green/red color scheme perhaps suggests to some potential purchasers either to go or to stop when considering purchasing the labeled property, while the green labels additionally suggest that energy-efficient properties may be ecologically desirable in general ("green"). The letter grades suggest school report cards -- presumably no one would like to be given a grade of E or F when buying a house, and labeling a home in this manner likely causes a further decline in its value. Fully half of the label is devoted to carbon footprint issues. This sort of label seems likely to generate a substantial amount of cachet and stigma.

The following is an example of the NABERS label used for many commercial buildings and some residential buildings in Australia.


PART 1 – NABERS* ENERGY RATING

BUILDING DETAILS

NABERS ENERGY RATING

This building has achieved

3-STAR NABERS ENERGY RATING**

NABERS

BUILDING CONSUMPTION & EMISSION DETAILS

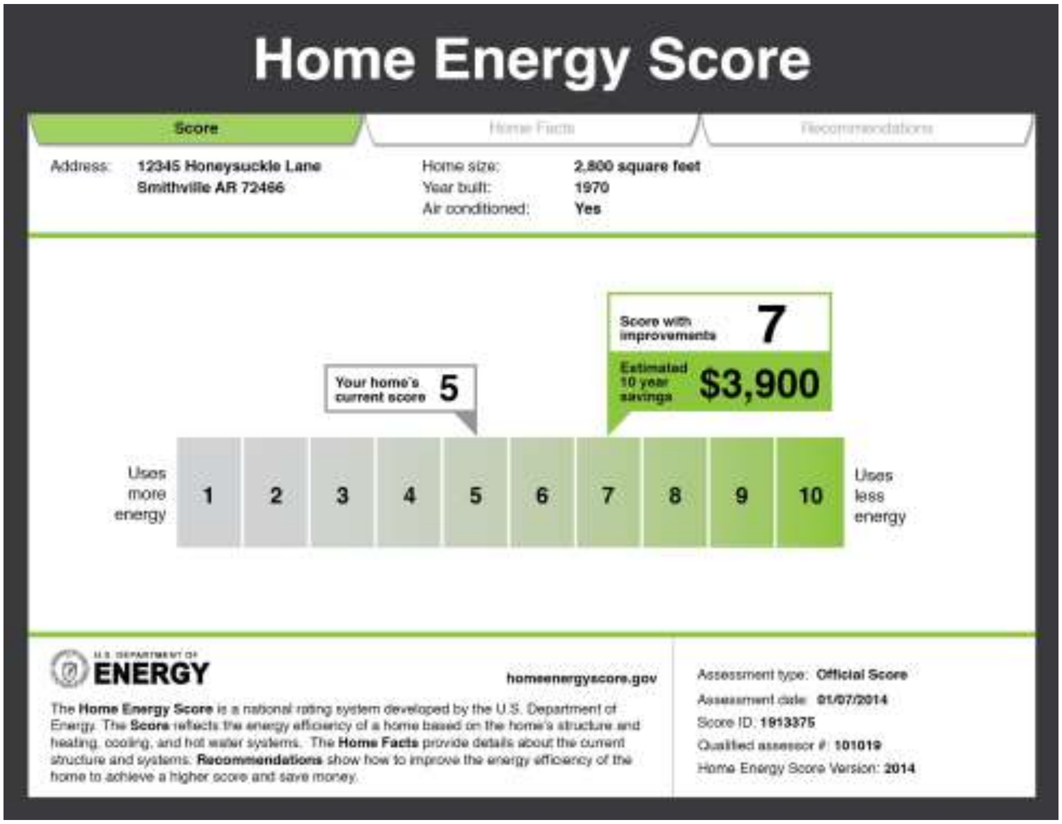
NABERS ASSESSOR DETAILS

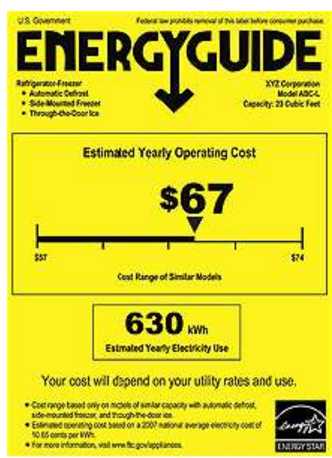
ABOUT NABERS ENERGY RATINGS

0	Very poor
1	Poor
2	Below average
2.5 to 3	Average
4	Good
5	Excellent
6	Market leading

In Australia, highly energy-efficient properties can get labeled with five to ten stars, while particularly inefficient properties will be labeled with zero or one star (in contrast to the maximum of six stars at the time of the label pictured above). This star-denominated labeling system may suggest in the mind of a prospective purchaser a variety of other instances in which getting zero stars is bad and getting many stars is good: in rating movies, in rating hotels, in rating public restrooms, in rewarding good behavior and scoring homework in elementary school. Again, the label may be read as suggesting that a property is generally good or generally bad in some respects beyond the narrow issue of whether it is energy-efficient or inefficient.

In contrast to the broadly suggestive energy labels used in the EU and Australia, the label design for DOE’s Home Energy Score (HES) seems relatively straightforward in providing information about likely energy usage and costs in the labeled home without suggesting anything additional that is positive or negative about the home. In this respect, the HES label seems parallel to the miles per gallon fuel efficiency stickers applied to new vehicles and to the EnergyGuide stickers for new appliances. None of these labels should generate much in the way of cachet and stigma, we expect.





Each of these labels indicates energy usage and/or the cost to operate a home, vehicle or appliance without respect to the owner's behavior and without suggesting additional good or bad attributes of the labeled item. We suggest that jurisdictions that wish to adopt an energy labeling requirement consider this sort of approach for minimizing cachet and stigma.

References

Abrahamsee, et al, 2005. Wokje Abrahamse, Linda Steg, Charles Vlek, Talib Rothengatter. A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, Volume 25, Issue 3, September 2005, Pages 273–291

Alberini, et al, 2011. Anna Alberini, Will Gans and Daniel Velez-Lopez. Residential Consumption of Gas and Electricity in the US: The Role of Prices and Income. *Energy Economics* 33: 870-881. 2011.

Allen Consulting Group, 2011. The Allen Consulting Group. Mandatory Disclosure of Residential Building Energy, Greenhouse and Water Performance. Consultation Regulation Impact Statement. July, 2011.

Amecke, 2011. Hermann Amecke. The Effectiveness of Energy Performance Certificates - Evidence from Germany . August, 2011. Available at: http://climatepolicyinitiative.org/wp-content/uploads/2011/12/Effectiveness-of-Energy-Performance-Certificates.pdf

Aroul and Hansz (2010). Ramya Rajajagadeesan Aroul and J. Andrew Hansz. The Value of "Green:" Evidence from the First Mandatory Residential Green Building Program. *Journal of Real Estate Research*, Volume 34, Number 1, 2012. Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1888778

Aufhammer and Sanstad (2011). Maximilian Auffhammer and Alan H. Sanstad. Energy Efficiency in the Residential and Commercial Sectors. Resources for the Future Backgrounder. January, 2011.

Aydin, Brounen and Kok (2013). Erdal Aydin, Dirk Brounen, and Nils Kok. Energy Labels in the Housing Market: Matching Predictions and Realizations. Presentation at 20th Annual European Real Estate Society Conference, Vienna, Austria. July 5, 2013. Available at: http://library.eres.org/eres2013/presentationupload/88.pdf

Brounen and Kok, 2010. Dirk Brounen and Nils Kok. On the Economics of Energy Labels in the Housing Market. Working Paper No. W10-002, Institute of Business and Economic Research, University of California, Berkeley. August, 2010. Available at: http://urbanpolicy.berkeley.edu/pdf/BK_Energy_Labels_NK082410_wcover.pdf

Brutal Art, 2010. Simone. Energy Efficient House Design: How Much is Each Energy Star Really Worth? *Architecture and Design*. August 3, 2010. Available at: http://brutalart.com.au/architecture-design/energy-efficient-house/

Burr, Keigher and Leipziger, 2011. Andrew Burr, Caroline Keicher, and David Leipziger. Building Energy Transparency: A Framework for Implementing U.S. Commercial Energy Rating and Disclosure Policy. The Institute for Market Transformation. July, 2011. Available at: http://www.buildingrating.org/Building_Energy_Transparency_Implementation_Report

Burr, Majersik and Zigelbaum, 2010. Andrew Burr, Cliff Majersik, and Nick Zigelbaum. The Future of Building Energy Rating and Disclosure Mandates: What Europe Can Learn From the United States. Available at: http://www.imt.org/files/FileUpload/files/Benchmark/IEECBPaper33.pdf

CHMC, 2011. Canada Mortgage and Housing Corporation. Renovation and Home Purchase Report. 2011.

Chegut, Eichholtz and Kok, 2010. Andrea Chegut, Piet Eichholtz and Nils Kok. A Global Perspective on the Value of Green Buildings. Presented at the 17th Annual European Real Estate Society Conference in Milan, Italy, July, 2010.

Cluett and Amann, 2013. Rachel Cluett and Jennifer Amann. Residential Energy Use Disclosure: A Review of Existing Policies. American Council for an Energy-Efficient Economy. Report No. A131 . April, 2013.

Deng, Li, and Quigley, 2011. Yongheng Deng, Zhiliang Li and John M. Quigley. Economic Returns to Energy-Efficient Investments in the Housing Market: Evidence from Singapore (April 19, 2011). Available at SSRN: http://ssrn.com/abstract=1672364

DEWHA, 2008. Department of the Environment, Water, Heritage and the Arts. Commonwealth of Australia. Energy Efficiency Rating and House Price in the ACT. 2008.

Earth Advantage, 2011. Earth Advantage Institute. Certified Homes Outperform Non-Certified Homes for Fourth Year. June 8, 2011. Available at: http://www.earthadvantage.org/resources/library/research/certified-homes-outperform-non-certified-homes-for-fourth-year/

ECEEE, 2009. European Council for an Energy Efficient Economy. Successful EPC Schemes in Two Member States: An ECEEE Case Study. 2009. Available at: http://www.eceee.org/buildings/CaseStudyEPCschemes.pdf

ECEEE, 2010. European Council for an Energy Efficient Economy. The Energy Performance of Buildings Directive. Policy Brief. October, 2010. Available at: http://www.eceee.org/buildings/eceee_buildings_policybrief2010_rev.pdf

ECN, 2011. Energy Research Center of the Netherlands (ECN). Key Findings & Policy Recommendations to Improve Effectiveness of Energy Performance Certificates & the Energy Performance of Buildings Directive. September, 2011. Available at: http://www.ideal-epbd.eu/download/pap/Final_IDEAL_EPBD_result_oriented_report.pdf

Eichholtz, Kok, and Quigley, 2009. Piet Eichholtz, Nicholas Kok, and John M. Quigley. Doing Well by Doing Good? Green Office Buildings. Working Papers, Berkeley Program on Housing and Urban Policy, Institute of Business and Economic Research, University of California at Berkeley. May, 2009

Eichholtz, Kok, and Quigley, 2010. Piet Eichholtz, Nicholas Kok, and John M. Quigley. Sustainability and the Dynamics of Green Building. Report sponsored by The Royal Institution of Chartered Surveyors. April, 2010. Available at: http://www.rics.org/site/scripts/download_info.aspx?fileID=8862

EPA, 2006. United States Environmental Protection Agency. Energy Star. Summary of the Financial Benefits of Energy Star Labeled Office Buildings. EPA 430-S-06-003. February, 2006.

Fuerst and McAlister, 2009. Franz Fuerst and Patrick McAllister. An Investigation of the Effect of Eco-Labeling on Office Occupancy Rates. *Journal of Sustainable Real Estate*. Volume 1, 2009, pages 49-54. Available at: http://www.costar.com/josre/archives_vol1_num1_2009.aspx

Fuerst and McAlister, 2011. Franz Fuerst and Patrick McAllister. Green Noise or Green Value? Measuring the Effects of Environmental Certification on Office Values. *Real Estate Economics*. Volume 39, No. 1, pages 45 - 69. 2011.

Fuerst and McAlister, 2011a. Franz Fuerst and Patrick McAllister. The Impact of Energy Performance Certificates on the Rental and Capital Values of Commercial Property Assets. *Energy Policy*. Volume 39, Issue 10, October 2011, Pages 6608–6614.

Fuerst and Oikarinen, 2014. Franz Fuerst and Elias Oikarinen. How Important is Building Energy Efficiency in Markets with Cold Winters? Pricing and Liquidity Evidence from Finland. Presentation at European Real Estate Society Conference, Bucharest, June 2014. Available at: http://eres.architexturez.net/doc/oai-eres.id-eres2014_40

Fuerst and Shimizu, 2014. Franz Fuerst and Chihiro Shimizu. Green Luxury Goods? The Economics of Eco-Labels in the Japanese Housing Market. CSIS Discussion Paper 133 (The University of Tokyo). Available at: http://www.csis.u-tokyo.ac.jp/dp/133.pdf

Fuerst and Wyatt, 2012. Franz Fuerst and Pete Wyatt. How does BREEAM impact on the pricing levels of commercial offices in the UK? Presentation at European Real Estate Society Annual Conference, June 15, 2012. Abstract at: http://eres.architexturez.net/doc/oai-eres.id-eres2012_179.

Fuerst, et al, 2013. Franz Fuerst, Pat McAllister; Anupam Nanda, Peter Wyatt. Is Energy Efficiency Priced in the Housing Market? Some Evidence from the United Kingdom. Working Papers in Real Estate & Planning, Henley University of Reading. January, 2013. Available at: http://dx.doi.org/10.2139/ssrn.2225270

Fuller, 2009. Merrian Fuller. Enabling Investments in Energy Efficiency. May, 2009. Available at: http://wpui.wisc.edu/files/webcontent/reports/Residential%20Financing%20White%20Paper.pdf

Fuller, et al, 2010. Merrian C. Fuller, Cathy Kunkel, Mark Zimring, Ian Hoffman, Katie Lindgren Soroye, and Charles Goldman. Lawrence Berkeley National Laboratory. Driving Demand for Home Energy Improvements. September, 2010.

Gillingham and Palmer. 2014. K. Gillingham and Karen Palmer. Bridging the Energy Efficiency Gap: Policy Insights from Economic Theory and Empirical Evidence, *Review of Environmental Economics andPolicy* 8(1): 18- 38.

Griffin, et al., 2009. Ann Griffin (Earth Advantage Institute), Ben Kaufman and Sterling Hamilton. Certified Home Performance: Assessing the Market Impacts of Third Party Certification on Residential Properties. May 29, 2009. Available at: http://www.earthadvantage.org/assets/uploads/Final_report_from_web_from_greenresourcecouncil.org_site.pdf

Intelligent Energy Europe, 2012. Intelligent Energy Europe. IDEAL-EPBD - A European Project On Consumer Response To Energy Labels In Buildings. 2012. Available at: http://www.ideal-epbd.eu/

Jaffe and Stavins, 1994. The Energy Paradox and the diffusion of conservation technology. *Resource and Energy Economics* 16 (1994) 91-122.

Kats, 2003. Greg Kats. The Costs and Financial Benefits of Green Buildings. A Report to California's Sustainable Building Task Force, October 2003. Available at: http://www.dot.ca.gov/hq/energy/The%20Costs%20and%20Financial%20Benefits%20of%20Green%20Buildings/CostBenefitsGreenBldg.pdf

Kjærbye, 2008. Vibeke Hansen Kjærbye. Does Energy Labelling on Residential Housing Cause Energy Savings? AKF, Danish Institute of Governmental Research. December, 2008.

Kok and Jannen, 2011. Nils Kok and Maarten Jennen. The Value of Energy Labels in the European Office Market. Unpublished research paper. May, 2011. Available at: http://www.nilskok.com/2011/11/the-value-of-energy-labels-in-the-european-office-market.html

Kok and Kahn, 2012. Nils Kok and Matthew E. Kahn. The Value of Green Labels in the California Housing Market. Unpublished research paper. July, 2012. Available at: http://www.pacenow.org/wp-content/uploads/2012/08/KK_Green_Homes_0719121.pdf

Lainé, 2011. Liz Lainé. Room For Improvement: The Impact of EPCs on Consumer Decision-Making. *Consumer Focus*. 2011. Available at:: http://www.consumerfocus.org.uk/files/2011/02/Room-for-improvement.pdf

Lee, et al., 2008. T. Lee, J. McMahon and J. Stewart. E.E.R. Disclosure Non-Compliance in the A.C.T. Rental Market. Paper presented at the 3rd International Solar Energy Society Conference -- Asia Pacific Region. November, 2008. Available at:: http://www.exemplary.com.au/download/Lee%20and%20McMahon%20and%20Stewart%20v3.pdf

Leipziger, 2011. David Leipziger. 2011: Year in Review. Available at: http://www.buildingrating.org/content/2011-year-review

Leisten, Palmer and Walls, 2014. Matthew Leisten, Karen Palmer, and Margaret Walls. Does Information Provision Shrink the Energy Efficiency Gap? A Cross-City Comparison of Energy Benchmarking and Disclosure Laws. Resources for the Future Working Paper, forthcoming.

Matthews and Cahill, 2011. Carson Matthews and Carol Cahill. Atlanta Green Home Sales Reports. Available at: http://www.greentothescene.com/

Miller, 2010. Norm Miller. Does Green Still Pay Off? *Journal of Sustainable Real Estate*. June, 2010. Available at: http://www.costar.com/JOSRE/doesGreenPayOff.aspx

Miller and Pogue, 2009. Norm Miller and Dave Pogue. Green Buildings and Productivity. *Journal of Sustainable Real Estate*. Volume 1, Number 1.

Miller, Spivey and Florance, 2008. Norm Miller, Jay Spivey and Andy Florance. Does Green Pay Off? *Journal of Real Estate Portfolio Management*. Vol. 14, No. 4, Oct-Dec., 2008. Available at: http://www.uli-la.org/files/Does%20Green%20Pay%20Off.pdf

Neme, et al, 2011. Chris Neme, Meg Gottstein and Blair Hamilton. Residential Efficiency Retrofits: A Roadmap for the Future. May, 2011. Available at: http://www.raponline.org/featured-work/tapping-efficiency-in-homes

Nevin and Watson, 1998. Rick Nevin and Gregory Watson. Evidence of Rational Market Valuations for Home Energy Efficiency. *The Appraisal Journal*. October, 1998.

Newell, MacFarlane and Kok, 2011. Graeme Newell, John MacFarlane and Nils Kok. Building Better Returns: A Study of the Financial Performance of Green Office Buildings in Australia. September, 2011. Available at: http://www.lowcarbonaustralia.com.au/sites/default/files/upload/Building%20Better%20Returns%20from%20Australian%20Property%20Institute.pdf

Novak, 2010. Shonda Novak. Impact of home energy audit rule less than expected. Number of upgrades far below city goal; fears about effect on sales appear overblown. *The Austin American-Statesman*. July 16, 2010.

Olofsson, Meier and Lamberts (2004). Rating the Energy Performance of Buildings. *The International Journal of Low Energy and Sustainable Buildings*. Vol. 3, 2004. Available at: http://escholarship.org/uc/item/52j7d39x

Palmer et al., 2011. Karen Palmer, Margaret Walls, Hal Gordon, and Todd Gerarden. Assessing the Energy-Efficiency Information Gap: Results from a Survey of Home Energy Auditors. Resources for the Future Discussion Paper DP 11-42. October, 2011. Available at: http://www.rff.org/rff/Documents/RFF-DP-11-42.pdf

Palmer and Walls, 2014. Karen Palmer and Margaret Walls. Can Benchmarking and Disclosure Laws Provide Incentives for Energy Efficiency Improvements in Commercial Buildings? Paper prepared for the MIT Energy Initiative Symposium, May 12, 2014. Available at: http://mitei.mit.edu/system/files/2014-MITEI-Symposium-Palmer-Can-Benchmarking-and-

Disclosure-Laws-Provide-Incentives-for-Energy-Efficiency-Improvements-in-Commercial-Buildings.pdf

Pivo and Fisher, 2010. Gary Pivo and Jeffery Fisher. Income, Value, and Returns in Socially Responsible Office Properties. *The Journal of Real Estate Research.* Volume 32, no. 3. Jul-Sep 2010.

Reichardt, et al, 2012. Alexander Reichardt, Franz Fuerst, Nico B. Rottke, and Joachim Zietz. Sustainable Building Certification and the Rent Premium: A Panel Data Approach. *The Journal of Real Estate Research.* Volume 34, no. 1, 2012.

Russell, 2006. The Relationship Between Home Energy Costs And Energy-Related Remodeling Activity. Joint Center for Housing Studies, Harvard University. Report N06-2. June, 2006.

Stavins, 2013. Thinking About the Energy-Efficiency Gap. Available at: http://www.robertstavinsblog.org/2013/06/19/thinking-about-the-energy-efficiency-gap/

Stephens (2013). Brent Stephens. Do LEED buildings save energy? Yes, no, it depends… Blog from the Built Environment Research Group, Illinois Institute of Technology. Available at: http://built-envi.com/do-leed-buildings-save-energy-yes-no-it-depends/

U.S. EPA (2006). United States Environmental Protection Agency. Summary of the Financial Benefits of ENERGY STAR® Labeled Office Buildings. EPA 430-S-06-003. February, 2006.

U.S. EPA (2012). United States Environmental Protection Agency. Portfolio Manager DataTrends. Fact sheets available at: http://www.energystar.gov/buildings/about-us/research-and-reports/portfolio-manager-datatrends. October, 2012.

Wakelin, 2011. Monique Sasson Wakelin. Ten-Star Waste. Eureka Report. *Weekly Review*. August 25, 2011. Number 277. Page 34. Available at: http://www.eurekareport.com.au/iis/iis.nsf/pages/DAEA8A200F6269F8CA2578F6000AB31E/$file/110825-EW277.pdf?OpenElement&rand=AYKdPq&k=/PDF/&d=iis&p=iis

Walls, et al. (2013). Margaret Walls, Karen Palmer, and Todd Gerarden. Is Energy Efficiency Capitalized into Home Prices? Resources for the Future Discussion Paper 13-18, July 2013. Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2296032

Watts, et al. (2011). Christabel Watts, Mark F. Jentsch, Patrick A.B. James. Evaluation of Domestic Energy Performance Certificates in Use. *Building Services Engineering Research Technology*. November, 2011 vol. 32 no. 4. Pages 361-376.

Wiley, Benefield and Johnson, 2010. Jonathon Wiley, Justin Benefield and Ken H. Johnson. Green Design and the Market for Commercial Office Space. *The Journal of Real Estate Finance and Economics*. 41(2): 228–243.

Winton, 2010. Winton Sustainable Research Strategies Ltd. Research to Inform the Sustainability Declaration Review. Final Report v.2. December, 2010.