DOE Commercial Building Energy Asset Rating: Market Research and Program Direction

Nora Wang, Pacific Northwest National Laboratory
Cody Taylor, U.S. Department of Energy
Molly McCabe, Hayden Tanner

ABSTRACT

This paper presents the development of a voluntary energy asset rating program to evaluate the physical characteristics and as-built energy efficiency of new and existing commercial buildings. The energy asset rating program is intended to enable commercial building stakeholders to directly compare expected as-built energy performance among similar buildings and to analyze the potential for capital improvements to increase energy efficiency cost-effectively. Market research has been performed to understand the market demand and how to communicate energy and cost savings to owners, investors, financiers, and others, to overcome market barriers and motivate capital investment in building energy efficiency. The paper discusses the findings of the market research. Building owners are concerned about redundancy, conflicting requirements, and cost. They also pointed out a data gap and desire a rating program that identifies improvement opportunities. A meaningful linkage between the energy asset rating and other rating systems is essential. Based on the findings, criteria for a successful energy asset rating program have been developed to direct the program design, including validity of ratings, actionable, cost-effective recommendations, effective quality control, integration with other rating systems, and necessary training and education. In addition to the rating system, an asset rating tool is being developed to reduce cost and increase standardization, allowing for consistent and reliable comparisons among and between buildings. The asset rating tool is the first step in the process by which owners can enter information about their building structure and receive information on the building's modeled performance and recommended efficiency measures.

Introduction

Over the past several years, there has been a growing need in building energy efficiency to develop a national asset rating program for comparing energy use in commercial buildings. Currently, the primary standard for comparison is the U.S. Environmental Protection Agency (EPA) ENERGY STAR Portfolio Manager (ESPM). ESPM looks at the whole building "in use" and evaluates a property on the basis of its utility bills (after weather normalization). ESPM provides a percentile ranking by requiring users to submit limited building characteristics. It is easier and less expensive than a rating system that requires an energy audit or modeling. However, the actual in-use performance of the building is not only related to the as-built system efficiency but is also highly dependent on operations and maintenance, as well as plug loads and occupant behavior. Energy performance of a building is subject to wide variation because occupancy, usage, and management are likely to change. Depending on the nature of the occupant, building owners may have limited control over the usage of the building and its systems. Measured ratings (such as ESPM) alone provide an incomplete picture of the potential energy performance of the building. Separating out building characteristics prior to layering on occupancy and operation can gauge the intrinsic energy efficiency of a building from which an apples-to-apples comparison can be made.

To address the need for a standard means by which to make such comparisons, the U.S. Department of Energy (DOE) is developing a voluntary commercial building energy asset rating program. Using a standardized approach to model building energy use, the energy asset rating system will evaluate the physical characteristics of the building as built and its overall energy efficiency, independent of its occupancy and operational choices. An energy asset rating breaks out the infrastructure piece so that as-built efficiency and building operation can be considered separately. Eliminating the wide variation due to differences in operation, plug loads, and occupancy allows buildings to be compared on equal footing and provides the means for an owner to determine if the building is performing well because it is highly efficient or because it is well managed. The ability to disaggregate the energy profile of a building enables building owners to focus on those aspects over which they have control. The detailed information provided by the energy asset rating program can enable building owners, operators, and investors to identify, prioritize, and justify energy investments and strategies. It also provides a foundation for tracking building upgrades and their impacts on performance over time.

The energy asset rating system will use a standardized approach to model building energy use to allow evaluation of the as-built physical characteristics of the building and its overall energy efficiency. The model will take into account the building envelope, the mechanical and electrical systems, and other major energy-using equipment (e.g., commercial kitchen appliances in a restaurant). The energy asset rating program will assess the building's current energy use on a rating scale, identify potential opportunities for cost-effective efficiency improvements, and note what impact those opportunities might have on reducing the building's energy use and its position relative to the rating scale.

In summary, the objectives in creating a commercial building energy asset rating program are:

- to facilitate cost-effective investment and energy efficiency in commercial buildings,
- to provide a tool that will allow owners to benchmark their building(s) against peers,
- to create a basis for valuing and financing energy-efficiency improvements, and
- to provide a means to view the relative efficiency of different buildings, explicitly distinct from operations and maintenance, occupant behavior, plug loads, and scheduling.

Market Research

To support the development of the energy asset rating program, market research was conducted to identify the specific needs for a commercial building asset rating program, to identify the benefits and market value of an energy asset rating to industry stakeholders, and to illustrate and address the impact of an energy asset rating on the decision criteria of building owners, investors, developers, operators, and financiers. The market research also assessed existing national and international rating programs to identify best practices/lessons learned and surveyed industry stakeholders to provide market-based feedback for DOE use in designing the program.

Research Approach

Research work consisted of a literature review of relevant writings, examination of existing asset and operational rating schemes and tools, interviews with industry stakeholders, a series of webinars, focus group gatherings, an in-depth stakeholder meeting, and an analysis of the potential impact of asset and operational rating systems on commercial properties and owner decision making.

The literature review was focused not only on topics related to asset and operational ratings but also on real estate sustainability and value; impact of financial and policy mechanisms; energy pricing and utility regulation; cost of sustainable improvements; and change of occupant behaviors and management activities. Eight state and local programs, four national rating systems, and seven asset or operational rating schemes worldwide were researched in depth (McCabe & Wang 2012). Stakeholder interviewees included property owners, institutional and private equity investors, financiers, appraisers, property and asset managers, and senior managers from nonprofit organizations and state and federal government agencies. To obtain input from stakeholders and other parties interested in its asset rating program, DOE issued a Request for Information (RFI; DOE 2011a) on August 9, 2011, and hosted seven webinars that same month (DOE 2011b). Subsequent outreach activities included holding four focus groups, interviewing more than 60 people, and facilitating a stakeholder workshop in December 2011. Through these efforts, DOE has outreached to 226 unique organizations as well as a number of independent individuals. The RFI alone received more than 400 comments from 52 unique respondents. The market research analyzed the linkage between energy asset ratings and value, particularly in terms of the financial and competitive impact. The practical implications of developing an energy asset rating diagnostic tool and providing associated energy upgrade recommendations were assessed.

Market Demand

Although awareness of energy efficiency is rising, it seems to be mainly housed in the large commercial property sector in the urban areas. Retrofits and efficiency measures are not readily undertaken in the Tier 2 (and 3) real estate markets,[1] much less by owners of small- and mid-size buildings in any market. Even for large commercial properties, there has been limited interest in doing deep retrofits that could significantly impact energy use. Lack of forward momentum can be ascribed to three factors: lack of information and awareness, split or conflicting incentives (when the landlord is responsible for the capital costs for making the building more efficient but the tenants benefits from the savings), and comparatively small profits. Given the economy and tight lending practices in some markets, capital constraint could also be a barrier.

[1] Tier 1 cities are generally defined as major metropolitan areas in a country with populations greater than 4 million people and that attract high levels of investor interest. These cities typically reflect high levels of real estate occupancy. Tier 2 cities are smaller, typically 1–4 million in population, and are considered growth cities. Tier 3 cities have populations under 1 million people and are considered emerging cities.

Implementation in the broader market continues to suffer because of the lack of basic information. Gaining basic, granular information can be expensive; the information itself may not be easily accessible, and skilled contractors are not always available. Many building owners have little working knowledge of what makes up the components of their energy use, what can be done to increase efficiency, and what is the potential efficiency for the building, given its structural makeup. Ultimately, there is a need to establish a baseline from which recommendations may be made.

Ideally, an owner would contract for a detailed third-party energy audit. However, with utility costs in U.S. office buildings averaging about \$2.20/ft^2, a 20% reduction in energy use yields savings of \$0.44/ft^2 (DOE 2011c).Further, a comprehensive energy audit and modeling analysis can cost up to \$0.50/ft^2 (California Energy Commission 2000). The cost of audits depends on the location, level of detail, size, and complexity of the facility. For example, one consulting firm changes a base fee of \$200 plus \$0.25/ft^2 for a level-1 audit (walk-through analysis) and \$200 plus 0.35/ft^2 for a level-2 audit (energy survey and analysis).[2] Therefore, detailed audits and modeling can often be cost-prohibitive for all but the largest buildings and commercial building owners. In addition are the significant contextual complexities—such as distinguishing among savings due to more efficient equipment, those due to occupancy changes, or those due to unusual weather. A number of building managers say it is hard to convince the owner of the building to purchase an efficient-building energy package because of its complexity. Few owners see the need or the benefits in taking on a more detailed retrofit without being further educated on the results.

A March 2011 survey of large corporate energy users in the commercial and industrial sector (E Source 2011) asked a variety of questions about past energy management successes and future priorities for managing energy. The replies from 54 energy manager respondents indicate that tracking facility energy performance data on an increasingly granular level is a growing priority. In the recent past, energy managers have been focused on achieving cost savings through maintenance and procurement practices. However, now they are being asked to focus on measuring, understanding, and managing micro-scale energy use.

A 2011 survey completed by CBRE, Inc. of its portfolio of managed properties shows the focus over the last 2 years has largely been on solutions directly under the control of building managers—primarily operational in nature or low- to no-cost improvements such as installation of compact fluorescent lighting (Pogue and Laquidara-Carr 2011). A more far-reaching analysis is planned in the future with survey respondents looking at occupancy sensors and light-emitting diode lights. Building managers who participated in the survey noted the greatest impact comes from updates to heating, ventilating, and air conditioning (HVAC) systems, retrofits to lighting, and the installation of energy management systems.

Market Feedback

Responses from stakeholders led to several key findings about the market response to an energy asset rating program. Stakeholder feedback consistently highlighted the desire for a strong and meaningful linkage between the asset rating and other rating systems, such as ESPM and LEED. It is essential for an energy asset rating to develop a linkage with ESPM, the most

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[2] http://www.bluegillenergy.com/whatwedo/commercial/commenergyaudits/faqs.

commonly used energy rating system in the United States. Most large real estate owners have incorporated ESPM into their business models. They are familiar with the requirements and are used to benchmarking against the tool. In addition, most investors use ESPM as a baseline for evaluating the energy efficiency of their buildings; the program provides a year-over-year comparison in terms of cost per square foot. Owners will react more favorably to something that integrates with ESPM. Some stakeholders expressed unease over redundancy, conflicting requirements, label "fatigue," and confusion among existing and proposed rating systems. Therefore, a clear message stating the difference between the asset rating and ESPM systems and how the energy asset rating can complement ESPM is essential at the beginning of the program development.

Although ESPM is the predominant rating system currently in use in the United States, stakeholders identified components that limit its usability. These limiting components include the following:

- ESPM benchmarking rules require that all buildings, including those with mixed uses, benchmark as a single structure.
- Ratings are predicated on a relative scale (currently based on non-updated 2003 CBECS data), giving a building's rating in comparison to only those buildings within the data set. Due to the lack of homogeneity and sample size in the CBECS database, some property types—for example, mixed-use buildings, restaurants, college campuses, libraries, museums, and laboratories—cannot use ESPM to generate a rating. State-level benchmarks (or anything geographically smaller) are also not available. (Other localized data sources, such as the California Energy Use Survey (CEUS), are beginning to address this need.)
- Although all properties are able to use ESPM to track their energy use, not all can achieve a rating. Ratings are predicated on 12 months of continuing operations and minimum occupancy that preclude new buildings or those with low lease-up from participating. Whole-building utility data are not always readily or legally available for multitenant buildings.
- The rating scale at the top end is insufficiently granular to differentiate substantive efficiency improvements.
- Although owners can make reasoned guesses about the drivers of energy use, the tool does not provide the means to isolate the components of building form, operations and maintenance, and occupant behavior.
- There is no feedback loop between the energy design and construction function and "in-operation" performance of the building.

The real estate industry looks to building ratings and certifications as a proxy for quality. For example, a March 2011 study of 1,100 recent rental transactions in the Dutch market shows offices with a "green" asset rating are achieving average rental rates 6.5% higher than comparable non-green buildings (Kok & Jennen 2011). Stakeholders interviewed for the asset rating program indicated they believe ENERGY STAR certified buildings consume fewer resources, implying lower cost. This belief is generally borne out by the fact that ENERGY STAR certified buildings do typically reflect an average of 35% lower energy consumption than peer buildings. Correspondingly, a recent study of the U.S. market supports previous conclusions showing that buildings rated by ESPM as more efficient reflect rental premiums of 3.5% and value premiums of 4.9% per dollar of energy savings (Eichholtz, Kok & Quigley 2011, p. 19). More evidence comes from published studies that found investment in energy efficiency (retrocommissioning and retrofitting) leads to financial returns greater than institutional hurdle rates (Goldman, Hopper & Osborn 2005; Mills 2009).[3]

Additional concerns cited by owners and managers include the cost to implement a rating program in terms of actual cash outlay and time impact on staff. On the positive side, the values of an energy asset rating program cited by stakeholders include the following:

- Stakeholders suggested they would use information provided by an asset rating tool to support investor due diligence and capital allocation. In a potential acquisition, some investors noted being more concerned with replacement costs than with historic energy expenses.
- A free asset rating tool could both ease the cost burden of evaluating buildings and help target the use of limited incentive (government and utility) and capital (private investment) dollars to those buildings with the greatest potential for improvement.
- Owners, lenders, investors, and occupants could gain insight into a building's value distinct from maintenance and occupant behavior.
- Feedback tying the asset rating system to ongoing performance metrics will likely make financing more feasible and drive accountability on the part of designers, contractors, and energy modelers.
- Tracking benchmarking, or comparing a building to itself over time, is useful in identifying changes in building performance.

Comments on the rating scale were also received during the market research. Investors generally expressed preference for using a scale consistent with ESPM. A slight majority of respondents expressed preference for a technical scale over a relative one, similar to that used by ESPM. A technical scale is a grade-based system calibrated and set without the use of a database of energy data such as CBECS, based instead on a reference value. Several respondents supported the use of a ratio scale such as the Zero Energy Performance Index (Eley 2009), although concerns around using net zero as a fixed end-point were raised. Respondents suggested the scale be periodically revisited to take into account improvements in building technology.

Lessons Learned from Existing Rating Systems

The lessons learned from the existing rating systems include the need for reliable and actionable recommendations, cost and quality balance, and linkage with the existing rating systems. For example, a study of over 7,000 buildings in the UK showed no apparent correlation between their Energy Performance Certificates (EPCs) and total return on commercial properties (Cudworth et al. 2010). The key issue was strong concern over the accuracy of the EPC rating. In the development of a Building Energy Rating, Energy Ireland has paid specific attention to

[3] Note, however, that this applies to "institutional investor returns" who generally invest in Class A space, which itself implies the lowest (although presumably safest) hurdle rates.

balancing issues like practicality, costs, clarity and consistency, which has resulted in relatively high public acceptance and awareness of that country's asset rating system.

The key program challenge is balancing the validity of results (via rigor of data collection and modeling) with the cost to implement. Accurate data input and consistent modeling methodology is necessary. Qualified and trained building assessors are needed to enhance the quality of the rating system. Data input requirements need to be simplified and limited. More simplified data acquisition requires a lower level of expertise and less time and effort from the assessors, thus resulting in lower costs for the assessment. It is critical to have the right balance between default values and data acquisition. Design should involve multidisciplinary stakeholders to ensure the correct balance between default values and data acquisition. Innovative technology may be used to reduce input and modeling error and increase scalability.

The credibility of the asset rating certificate and relevance of energy efficiency recommendations rely on reproducible and reliable modeling results. Efficiency improvement recommendations must be both reasonable and relevant to the target building (type and size as well as practical and cost-effective). The program must provide actionable strategies for the building owner to make appropriate energy-efficiency improvements. Training, education, and outreach are essential. Support functions such as a help desk and technical assistance have been shown to be useful.

Consistent use of input values, certificate design, and terminology across platforms will increase market acceptance and usage. A rating certificate should be familiar to the general public and in line with existing rating systems. A link between calculated and measured performance should be established. Asset rating must include integration with operational performance data and must reflect a building's improvement over time.

Program Design

Based on the findings of our market research, design of the DOE energy asset rating program is focused on three areas. First, a centralized modeling tool has been developed to facilitate ease of application, reduce cost, and increase standardization, allowing for consistent and reliable comparisons. Second, the energy asset rating program will provide not only an overall efficiency rating but also building system evaluations and actionable strategies. Third, the energy asset rating program will establish linkage with existing rating systems such as ESPM. The method will be further explored through the coming pilot project.

Energy Asset Rating Tool Development

The energy asset rating tool is a web-based application with a simplified user interface built on an inference engine and a centralized modeling engine (Figure 1). The model inputs were separated into categories based on their overall energy impact, difficulty level of data collection, and variability among buildings. The grouped variables correspond to the input thresholds for two use cases, each having a unique purpose and target users and so having different levels of requirements for data accuracy (Figure 2). The first application corresponds to the simple level variables listed above. The application for this set of inputs represents a preliminary analysis of building performance and guidance in finding potential areas for building performance upgrades. These variables are generally quick to collect and do not require a high level of building energy domain expertise to accurately ascertain. Any of the other variable types can be entered to refine the result of the simple-level application, up to the complete set of simple and advanced levels of variables, at which point there is sufficient detail to meet the needs of an advanced-level application. The advanced-level application will be used to generate a verified rating. These inputs have been selected to produce more robust predictions of building energy use and likely areas for cost-effective asset upgrades.

Figure 1. Asset Rating Tool

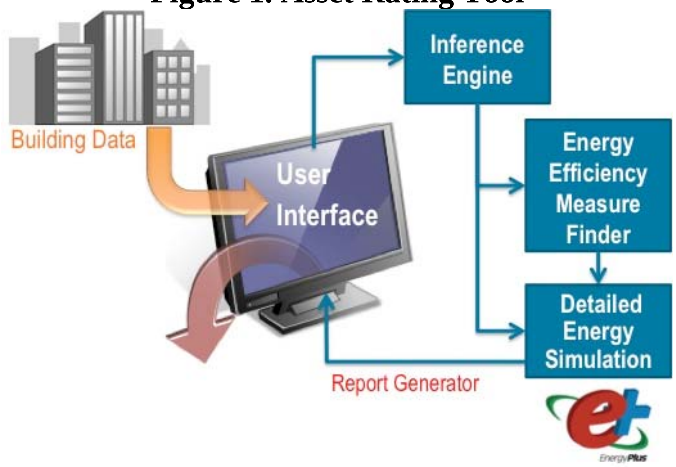
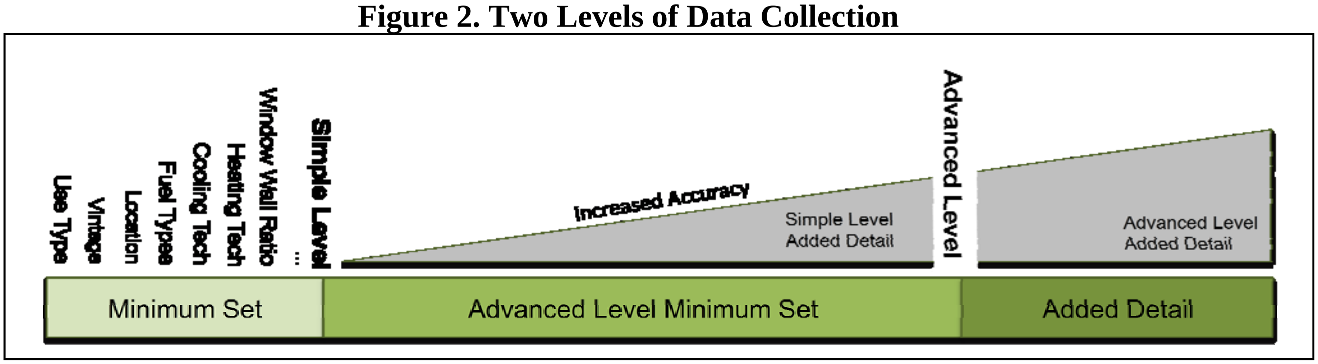


Figure 2. Two Levels of Data Collection



The approach will allow all key variables to be inferred from some reduced set of variables while at the same time allowing users to enter many more variables if they have reliable details. Any user will be able to use the free web application to enter the required energy and building information, generate a preliminary building asset rating, and receive an analytical report. A professional with specific approved qualifications will be required to validate building information inputs for a building to be eligible for a verified energy asset rating, which can be used for public display or during real estate transactions. DOE is developing a guideline to specify the credentials a professional must hold in order to generate a verified asset rating.

Asset Rating Report

The energy asset rating tool not only generates a standard building energy asset rating but also provides added value in the first step of a building assessment by describing some possible upgrade opportunities. It is not intended to replace a full energy audit of a building but rather produce a preliminary energy report. The objective of the tool is threefold: to give property owners the means of gauging the efficiency of their properties as compared both to a potential efficiency and to similar properties, to provide guidance on key actions to motivate owners to make reasoned and value-conscious investments, to enable the targeting of limited capital resources toward those areas that will produce the greatest return.

The asset rating report currently includes three sections: the rating, the system evaluation, and identified opportunities. The rating page includes basic building information (address, floor area, year built, use, type, and so on), standard operating assumptions, site and source energy use intensities by fuel type, current energy asset rating, and potential rating that can be achieved with identified upgrade opportunities. A building's rating is generated using a 100-point technical scale, with zero energy at the 100-point end.

The system evaluation section includes site and source energy use intensity by system, as well as evaluations of the building systems for envelope (roof, wall, window), lighting, HVAC, and hot water systems. This information can help users identify the part of the building in need of attention. For two buildings with the same asset rating, the system-level evaluations can help users gain insights into the problems and potential of the two buildings.

The building upgrade section provides identified energy saving opportunities and associated energy savings and payback period. Based on the entered building information, the energy asset rating tool will identify potential opportunities in areas of HVAC equipment, wall and roof insulation, glazing, hot water system, and lighting and control. The identified opportunities are based on life-cycle cost analysis using regional energy and equipment costs.

DOE is also considering working with interested partners to include local benchmark information on the asset rating report for comparison. For example, a state might wish to include information pertaining to average asset ratings for a specific building type within the state. Additional information that is not currently in the report may be provided in the future, such as a reference point to help users understand how their building score compares to a specific energy code, indication of whether the building has systems to provide a certain amount of energy from onsite renewables, and assessment of greenhouse gas emissions.

Summary and Path Forward

The energy asset rating program is aimed at providing a cost-effective means for building owners and operators to gain insight into the energy efficiency potential of their buildings. The development of an asset rating tool enables reduced modeling time and expertise requirements while maintaining accuracy and the ability to support the variability and complexity that exist in buildings. The primary users of the energy asset rating tool are expected to include commercial property operators and managers. Large-property owners actively using ESPM to benchmark their building stock are likely to use the asset rating tool to do a first pass on their portfolio to assess retrofit options. Secondarily, they will use the verified data as a further means of differentiating their assets from those of their competitors. Owners of small and mid-size buildings are more likely to use the tool and accompanying recommendations as a cost-effective means of determining what types of improvements may be made to their properties. These asset owners may be less likely to do the requisite validation to receive a verified asset rating certificate. The energy asset rating report will enable lenders, potential buyers, and lessees to gain insight into the long-term energy cost of a building, informing their valuation of the building. This information will also be useful for financing sources, valuation experts, utilities, green building societies, and municipalities and local government.

The rollout of the energy asset rating program has been organized in a phased approach, focusing first on building types with typically the fewest complexities and about which we have more information to develop a rating system. Phase I rollout includes buildings in these categories: office, educational, retail, and unrefrigerated warehouse. Phase II includes lodging, food service, food sales, public safety, and religious worship, and mixed-use buildings that incorporate in Phases I and II. Phase III buildings are either those with more complex systems or those for which we currently have a limited body of information, such as data centers, laboratories, refrigerated warehouse, health-care facilities, public assembly, and so on. Public assembly and service building types have very diverse subtypes and therefore need further investigation before being properly classified.

The energy asset rating program is applicable to both new constructions and existing buildings. Currently, only 2% of construction projects are for new buildings, while 86% of construction dollars go into renovation of existing building stock (ASHRAE 2011). For new construction, it is a benchmark tool for preconstruction evaluation to provide comparison to a peer group. For existing buildings, it serves as a tool to obtain system evaluation and measures to improve performance. As a cost-effective means of evaluating potential energy efficiency improvements, the asset rating tool can be used prospectively and enable building owners to plan future renovations to take into consideration efficiency improvements.

The asset rating system will be tested further during the pilot project, which has been launched in the spring of 2012. The pilot project will collect feedback on the estimated data collection time and resources, test the accuracy of the asset rating energy model, examine the relevance of the energy efficiency recommendations, and establish the linkage with ESPM.

References

[ASHRAE] American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. 2011. “ASHRAE Seeks Public Comment on Standard for Existing Buildings.” Atlanta, Ga: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.

California Energy Commission. 2000. *How to Hire an Energy Auditor to Identify Energy Efficiency Projects*. P400-00-001C. Sacramento, Calif.: California Energy Commission, Energy Efficiency Division.

Cudworth, C. et al. 2010, Analysing Energy Performance Certificates (EPCs) with financial performance information in the commercial property industry of England & Wales. Third draft. RICS Education Trust/IPD, London, UK. Information available at http://www1.ipd.com/Pages/DNNPage.aspx?DestUrl=http%3A//www.ipd.com/sharepoint.aspx%3Ftabid%3D3070 (November 2011).

[DOE] Department of Energy. 2011a. “Commercial Building Asset Rating Program. Request for Information.” In *Federal Register* Vol. 76, No. 152, August 8, 2011, pp. 48152-48158.

[DOE] Department of Energy. 2011b. "Commercial Building Asset Rating Program." Webinar slides. http://www1.eere.energy.gov/buildings/commercial_initiative/pdfs/asset_rating.pdf. Washington, D.C.: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy.

[DOE] Department of Energy. 2011c. "Office Building Markets and Companies." Chapter 3 in *Buildings Energy Data Book.* Washington, D.C.: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy.

[EPA and DOE] U.S. Environmental Protection Agency and U.S. Department of Energy. 2011. *ENERGY STAR Performance Ratings Technical Methodology – General Overview*. Washington, D.C.: U.S.Environmental Protection Agency and U.S. Department of Energy.

[EPA and DOE] Environmental Protection Agency and Department of Energy. 2012. "Guidance for Benchmarking Mixed Use Properties in Portfolio Manager." Washington, D.C.: U.S. Environmental Protection Agency and U.S. Department of Energy.

Eichholtz, P., N. Kok, and J.M. Quigley. 2011. *The Economics of Green Building*. Berkeley, Calif.: UC Center for Energy and Environmental Economics.

E Source. 2011. "E Source Announces Energy Management Survey 2011 Results." Boulder, Colo.: E Source Companies LLC.

Goldman, C.A., N.C. Hopper, and J.G. Osborn. 2005. "Review of US ESCO industry market trends: an empirical analysis of project data." *Energy Policy* 33(3):387–405.

Kok, N., and M. Jennen. 2011. "The value of energy labels in the European office market." http://www.buildingrating.org/content/value-energy-labels-european-office-market. Washington, D.C.: Building Energy Rating and Disclosure.

McCabe, M.J., and N. Wang. 2012. *Commercial Building Energy Asset Rating Program – Market Research*. PNNL-21310. Richland, Wa.: Pacific Northwest National Laboratory.

Mills, E. 2009. *Building Commissioning – A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions*. Berkeley, Calif.: Lawrence Berkeley National Laboratory.

Pogue, D.L., and D. Laquidara-Carr. 2011. "Do Green Buildings Make Dollars & Sense?" http://www.buildingrating.org/sites/default/files/DoGreenBuildingsMakeDollarsAndSense-v3.pdf. Washington, D.C.: Building Energy Rating and Disclosure.