Recognition Of Energy **Costs** and Energy **Performance** in Real Property Valuation

Considerations and Resources for Appraisers

Second Edition

May 2012

IMT Institute for Market Transformation

Appraisal Institute®
Professionals Providing Real Estate Solutions

RECOGNITION OF ENERGY COSTS AND ENERGY PERFORMANCE IN REAL PROPERTY VALUATION

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About the Institute for Market Transformation

The Institute for Market Transformation (IMT) is a Washington, DC-based nonprofit organization dedicated to promoting energy efficiency, green building, and environmental protection in the United States and abroad. Much of IMT's work addresses market failures that inhibit investment in energy efficiency. For more information, visit http://www.imt.org.

About the Appraisal Institute

The Appraisal Institute (AI) is a global membership association of professional real estate appraisers, with nearly 23,000 members in nearly 60 countries throughout the world. Its mission is to advance professionalism and ethics, global standards, methodologies, and practices through the professional development of property economics worldwide. Organized in 1932, the Appraisal Institute advocates equal opportunity and nondiscrimination in the appraisal profession and conducts its activities in accordance with applicable federal, state and local laws. Members of the Appraisal Institute benefit from an array of professional education and advocacy programs, and may hold the prestigious MAI, SRPA and SRA designations.

Credits and Acknowledgements

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We have drawn upon many helpful resources in composing this document. We note especially the valuable perspective of various documents written by Theddi Wright Chappell, Scott Muldavin, and James Finlay. See also the Resources section.

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1. Introduction

Various factors affect the value of real property – location, the composition and condition of structures, operating history and potential future use, and many others. Each factor affects the income and investment potential of property. Each has its own influence on investor and occupant preferences, which ultimately determine how money flows for financing, purchasing, and rental in the real estate market.

Energy consumption is one of these factors. It usually has significant effects on net income from buildings – effects often higher than any other operating expense, and at times higher than property taxes. Therefore buildings that are energy efficient can create significantly greater net income for owners than otherwise similar buildings that are not so efficient.

Because energy and energy efficiency are invisible, with effects revealing themselves incrementally over time, they have long been hard to track and easy to overlook. As a result, market players have failed to fully recognize energy performance as a factor affecting property value. This situation has changed dramatically since the Institute for Market Transformation (IMT) issued the first edition of this document in 2000. Investors and the general public around the country have become increasingly aware of the importance of energy efficiency. The track record of energy-efficient technology and high-performance buildings has become longer and better documented. Assessment tools, energy rating systems, and energy-performance databases for buildings have become well established, and even required in several major jurisdictions nationwide. As a result, not only do owners more closely track their own buildings' energy performance, they and other market stakeholders can actually find convenient and meaningful comparables (comps) for energy use in similar buildings. And wide segments of the market are recognizing and indeed hotly demanding "green buildings," a concept that encompasses energy efficiency as well as many other approaches to environmental sustainability.

Purpose of This Guide

As the market has become more aware of energy efficiency and green buildings, the importance of providing real estate appraisers with necessary information to thoroughly analyze the effects of energy performance on property value has increased as well. There are several areas of opportunity that can be addressed through education and awareness, including understanding how and to what extent energy efficiency affects the bottom line; enhancing the availability and credibility of supporting information; and positioning appraisers to recognize potential market reactions to energy performance.

We address all of these issues directly in this document. Our ultimate aim is **to increase credibility and reliability of property valuation by helping appraisers and other interested parties to understand, find, and rigorously apply available information** on energy performance in buildings.

Our resource guide is organized into six sections, including this introduction.

Section 2 discusses why energy matters, with a discussion of the typical magnitude and variability of energy's effects on cash flow and net income.

Section 3 discusses how to assess energy performance in buildings, including identification of equipment and components, examination and normalization of energy bills, and engineering simulations.

Section 4 presents how to compare or "benchmark" building energy performance — that is, how to generate energy-related comps.

Section 5 discusses technical qualifications, certification, and other assurances of the competence and professional responsibility of preparers of energy-performance documentation.

Section 6 discusses how the market values energy efficiency in buildings, presenting case studies of how buyers and renters do recognize and place incremental value on energy performance and green building.

Finally, the ***Appendix*** provides a brief overview of common energy-efficient measures, including sections on insulation, windows, lighting, and heating, ventilation, and air-conditioning systems.

Limitations

We recognize that appraisers' needs and priorities vary widely from practice to practice and from case to case. We therefore present options spanning a range of complexity, cost, and accuracy.

There exist myriad tools and approaches for tracking and modeling energy performance in commercial buildings. While it would be impractical to address all methods in detail, we have endeavored to include those which represent or have the immediate potential to represent widely-used industry standards. The chosen methods cover a broad range. Still, in certain cases, appraisers may receive energy-related information based on methods not addressed here. In these cases, the appraiser should attempt to assess independently whether it meets criteria of credibility and technical rigor.

2. Energy, Operating Costs, Cash Flow, and Value

Energy and Net Operating Income in Buildings

In most building types, energy costs are a major component of operating costs, cash flow, and overall net operating income (NOI). Energy consumption and energy costs are also highly variable, depending on the efficiency of the building and its equipment, as well as building type, location, age, and other important factors. Thus, insofar as NOI and discounted cash flow are foundations of building value, accurate assessment of energy costs is an important element of accurate valuation.

This linkage applies especially in commercial and multifamily residential real estate, where building owners tend to be well informed and methodical about reducing costs and raising net income. Furthermore, market stakeholders are increasingly recognizing other advantages to energy performance and sustainability in buildings, including occupant comfort and health, productivity, and employee and tenant retention, as well as fulfillment of social and ethical responsibility. This market recognition may reflect itself in increased rents and sale prices of energy-efficient and green buildings, as documented in a growing body of published literature.

High energy prices amplify the importance of energy as a factor affecting NOI. The average natural gas price for residential buildings in the United States stood at $6.37 per thousand cubic feet (tcf) in Jan 2000. By January 2009, this price had nearly doubled to $12.49/tcf. Despite a significant retreat in prices since then, natural gas still had an average price of $9.79/tcf in January 2011, or an increase of almost 54 percent.[1] Average U.S. electricity prices also rose significantly between January 2000 and 2011 – by 43 percent, from 8.24 cents per kilowatt-hour (¢/kWh) to 11.79¢/kWh.[2]

The importance of energy arises not only from the relative *magnitude* of energy costs as a portion of NOI, but also in the *variability* of energy costs in buildings. Differences of at least 20 to 30 percent in energy costs can be achieved via energy efficiency retrofits to existing buildings. And even within populations of comparable buildings, the range of energy costs between the most efficient and

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[1] U. S. Department of Energy (DOE). Energy Information Administration (EIA). *U.S. Price of Natural Gas Delivered to Residential Consumers*. http://www.eia.gov/dnav/ng/hist/n3010us3m.htm. Retrieved in December 2011.

[2] U. S. DOE. EIA. *Average Retail Price of Electricity to Ultimate Consumers*. http://205.254.135.7/electricity/data.cfm#electriccosts ("retail price to consumers" link). Retrieved in December 2011.

the most energy-intensive buildings covers an even greater percentage difference.

Energy-cost variations from energy efficiency retrofits can influence overall NOI by up to ten percent.

Application of the income capitalization approach to valuation, in which NOI is divided by a capitalization rate (cap rate) determined by the appraiser, translates effects on NOI into effects on value. Table 1 below shows an example, reported in an appraisal conducted by a Certified General Appraiser in California, for a medium-sized motel that underwent a rather standard energy efficiency upgrade, including improvements to windows, heating and cooling systems, and controls. **In this case, an annual reduction of energy costs by 45 percent led to an increase in the calculated value by 8.5 percent, assuming no change in any other line items or in cap rate.** Note, furthermore, that an appraiser might even choose to adjust cap rate downward in a case like this, because of reduction in operating risk after retrofit. In this case, the incremental value would be even higher.

Figure 1

Effects of an Energy Upgrade on the Value of a Motel as Calculated by the Income Capitalization Approach

(based on an actual appraisal; all figures in $)

	Pre-retrofit		**After energy upgrade**	
INCOME				
Room	503,029.00		503,029.00	
Other	3,595.00		3,595.00	
Gross Scheduled Income	506,624.00		506,624.00	
Vacancy Rate 35%	177,318.40		177,318.40	
Net Scheduled Income (NSI)	329,305.60		329,305.60	
		% of NSI		% of NSI
OPERATING EXPENSES				
Electric	**18,766.00**	**5.70%**	**10,450.00**	**3.17%**
Natural Gas	**5,447.00**	**1.65%**	**2,850.00**	**0.87%**
Water	2,886.00	0.88%	2,886.00	0.88%
Janitor	5,475.00	1.66%	5,475.00	1.66%
Landscape	3,900.00	1.18%	3,900.00	1.18%
Taxes Real & EMP	31,059.00	9.43%	31,059.00	9.43%
Television, Cable, and Satellite	4,897.00	1.49%	4,897.00	1.49%
Insurance	2,450.00	0.74%	2,450.00	0.74%
Pest	275.00	0.08%	275.00	0.08%
Maid	10,950.00	3.33%	10,950.00	3.33%
Laundry	23,500.00	7.14%	23,500.00	7.14%
Repairs	7,566.00	2.30%	7,566.00	2.30%
Management	38,500.00	11.69%	38,500.00	11.69%
Advertising	2,550.00	0.77%	2,550.00	0.77%
Legal & Accounting	1,500.00	0.46%	1,500.00	0.46%
License	500.00	0.15%	500.00	0.15%
Bed Tax 10.0%	32,930.56	10.00%	32,930.56	10.00%
Reserve 2.5%	8,232.64	2.50%	8,232.64	2.50%
Subtotal Expenses	201,384.20	61.15%	190,471.20	57.84%
Net Operating Income	**127,921.40**	**38.85%**	**138,834.40**	**42.16%**
Cap Rate 8.75%	**Formula Employed**	Net Operating Income / Cap Rate		
Opinion of Value	1,461,958.86		1,586,678.88	
Gross Energy Retrofit Effect			**124,720.00**	
Cost of Energy Retrofit			**27,680.00**	
NET ENERGY RETROFIT EFFECT			**97,040.00**	

Importance of Energy Costs by Building Type

The relative significance of energy costs is different for different building types. Obviously, a building which uses very little energy, such as an unconditioned warehouse, will have comparatively low and insignificant energy costs. Conversely, energy costs can be quite significant in a building with large energy consumption. It is therefore useful to have a general understanding of the building types and characteristics for which energy strongly influences operating costs.

Buildings which have significant equipment or process energy costs will usually top the list. For manufacturing or special process buildings with energy-intensive equipment, energy costs can be of primary importance. Examples would include refrigerated warehouses, hothouses, and other specialized structures. In more typical buildings, energy use from equipment and processes can also be significant. Grocery stores have large refrigeration loads, and commercial kitchens have large cooking and refrigeration loads, as well as large ventilation loads from exhaust hoods.

Ordinary building energy uses – lighting, heating, cooling, and ventilation – can be more significant in some building types than others. Buildings with large numbers of people, such as theaters or gymnasiums, require large quantities of ventilation air that must be provided through fans and duct systems, and which must be heated and cooled. Buildings with specialized lighting requirements, such as theaters, museums, or jewelry stores, will require unusually high lighting energy use. Buildings with unusually large window areas, such as glass-façade office buildings or automobile dealerships, will experience unusually large heating and cooling loads.

Buildings with unusually long operating hours or extreme environmental influences will have significantly higher energy usage. For example, hospitals operate 24 hours a day all year long. Some types of businesses, such as grocery stores, also have nearly full-time operating hours. Finally, buildings exposed to constant wind or extreme temperatures, such as those at seaside locations or on mountaintops, will have unusually high energy consumption. Some or all of these factors may be present in a building and can be recognized in the appraisal process.

In sum, energy performance strongly affects cash flow and net operating income from some buildings. The influence of energy performance arises from both its magnitude and its variability. Therefore, accurate reflection of energy costs is a critical part of accurate valuation via the income capitalization approach.

We present further information on *how* to obtain and use credible information on energy costs in Section 3.

Assessing Uncertainty in Energy-Reporting Methods

Energy-reporting methods, as with other elements of appraisal, involve a degree of uncertainty — a natural consequence of making estimates with imperfect data, and projecting future income streams and market preferences based on present information. Appraisers therefore tolerate some uncertainty in all aspects of the appraisal, while seeking to keep it to a minimum.

Uncertainty is no worse a problem with energy than with other factors affecting value.

Sources of uncertainty fall into two general categories — the inherent spread of data points (statistical variation) and the imperfection of data collection and analysis (measurement and modeling error). True, energy cost estimates are subject to uncertainty in both of these areas. But it is also apparent that uncertainty is likely no worse a problem with energy than with other factors affecting value.

Inspection of the *Experience Exchange Report* of the Building Owners and Managers Association (BOMA) indicates that utility costs are typically the largest single itemized expense for office buildings, constituting about a third of total operating costs in most urban areas. Moreover, the *variability* of energy costs is about the same as for the other revenue and expense categories. In other words, the problem of statistical variation is probably comparable between energy costs and other elements of NOI. It follows further that the degree of care and precision that appraisers apply to estimates of non-energy components of NOI should also apply to estimates of energy costs.

Even when measurement and modeling error is unavoidable, an appraiser can seek to minimize error by using reliable, building-specific data grounded in well-substantiated technical methods. The following sections discuss in more detail various types of data sources on building energy use and costs.

3. Assessment of Building Energy Performance

Once the appraiser sets out to include energy costs in NOI and/or discounted cash-flow calculations, the objective should be to make as accurate and well-substantiated an energy-cost estimate as possible. But common methods for energy-cost assessment by appraisers often suffer from questionable credibility and poor accuracy. The following section describes problematic methods of energy assessment and reporting, then outlines alternative techniques to obtain more technically accurate, building-specific estimates of energy costs that appraisers can confidently use.

Energy Cost References

Where owners' disclosures are suspect or absent altogether, appraisers may seek energy-cost information from standard references such as the *Experience Exchange Report* of BOMA and *Income/Expense Analysis* publications of the Institute for Real Estate Management (IREM). These sources collect survey data from owners on income and expenses, and present results as average figures for given locations and building types.

Appraisers sometimes use these averages as default energy-cost figures for NOI calculations. This approach, while certainly convenient, can pose challenges to credibility. Given the range of building types, vintages, features, and equipment, treating all buildings as average does not tell the entire story. It is more appropriate to use standard references and averages as indicators of a reasonable range of energy costs, rather than as default figures for the subject property.

Use of regional-average default figures for energy costs poses serious concerns about accuracy.

Equipment Reference Guides With the Cost Approach

With new construction, in employing the cost approach to valuation, appraisers may try to obtain cost figures for the individual energy-related equipment in buildings. Many refer to Marshall & Swift statistics or various data sources from RS Means, which include figures on the prices of various lighting, heating, ventilation, and air conditioning (HVAC) equipment. Some RS Means sources offer some comparisons between the annual cost of conventional versus energy-saving equipment in terms of their annual energy consumption, cost, and expected lifetime, as well as various lighting quality indices.

For the cost approach, these references are essential — but when appraisers also want to take into account future cash flows, these sources have their limitations. Many energy efficiency measures pay their incremental costs back rapidly — lighting measures in less than a year, commonly, and HVAC measures in three to five. Therefore, a cost-based estimate of the incremental value of energy efficiency will tend to fall below an estimate based on income capitalization or discounted cash flow. Even when the equipment reference guides do present estimated operating costs as well as initial costs, their data are based on manufacturing and engineering specifications, as opposed to tested performance of the measures in actual buildings.

Moreover, energy-efficient buildings are often designed in a highly integrated way, in which building systems and equipment are chosen for optimal performance with each other. This integration can lead not only to reduced operating costs, but also lower initial costs than would be reflected in piecemeal selection and pricing of building elements.

Considerations of Methods for Energy Performance Assessment

Billing histories

One of the most direct methods of assessing building energy costs is to examine the building's utility bills. Examination of bills themselves, particularly multiple years' worth, is more time-consuming than reviewing summary financial statements, but also removes the potential that the owner is fudging or obscuring the numbers. Bills are also preferable to standard reference sources in the sense that billing records are specific to the building itself, and at some level will reflect the presence of efficient built features or operations.

The problem with billing histories is that they reveal little about *why* bills show the numbers they do. A building may have low energy use (relative to the levels that appraisers might normally encounter) because it has advanced, well-maintained energy-efficient features; on the other hand, it may have broken equipment or an owner who is willing to sacrifice occupant comfort for energy-cost savings by running the HVAC system in a miserly way. Bills may also be anomalously low or high because of abnormal weather conditions, partial vacancies, unusually long operating hours, or the presence of unusual energy-using equipment. Furthermore, in older buildings, there may be more than one utility meter; also, the metered floor area may not correspond to the floor area used in the NOI calculation.

In assessing billing histories, an appraiser should ask for evidence that the energy cost levels result from working features, not erratic external conditions like weather or anomalies like broken equipment.

Given the number of confounding factors, it is less than optimal to use energy bills alone—even multiple years' worth—in estimating energy costs for a calculation of NOI. In addition to the bills, an appraiser can ask for evidence that the building's energy costs result from the presence of desired features, not undesired anomalous factors or erratic external conditions.

There are two ways to show that low energy bills result from efficiency rather than other conditions. The first way is to verify the presence of efficient features, either visually or through a record of installation and performance verification, or ideally, both. The second way is to normalize the bills by correcting for the effects of building space use, weather, occupancy, and other factors.

Energy bills plus verification of efficient features

The simplest approach to using energy bills for appraisal purposes is to supplement the bills with a procedure to verify the presence of working energy-efficient measures. The purpose of this verification is to document the energy efficiency measures which help to determine the magnitude of the utility bills. Under this approach, an appraiser could verify the presence of efficient building features through a visual inspection, using a checklist. (See Appendix for a discussion of energy-efficient technologies and materials commonly found in commercial buildings.) Any appraiser could complete a checklist of simpler building features; for more complex measures, special training or qualifications would be needed to identify measures and to assess their working condition. To supplement the identification of measures, the appraiser could ask the owner for a written record of installation and performance histories for special efficiency measures.

Measure-by-measure performance verification is a common element of energy performance contracts, in which an outside contractor provides an energy-efficient upgrade for which the building owner pays over time as savings are gradually achieved. Since savings levels are the basis for repayment terms, protocols for measurement and verification of savings under these contracts tend to be rigorously specified.

The International Performance Measurement and Verification Protocol (IPMVP) is the standard for verification of energy efficiency measures in the performance-contracting field. While the Protocol provides for varying degrees of precision (and level of effort) in verifying energy efficiency savings, all are based on best practices in energy analysis and assessment.

Energy bills normalized for weather, occupancy, operating hours, and other factors

While appealing in its simplicity, verification of features does not always provide complete answers to explain high or low energy bills. For example, if a building had consistently average energy bills, they could be the result of reliable energy efficiency measures which were offset by a history of unusually long hours of operation, or by a stretch of extreme weather patterns. This building, then, under normal operation and weather, would be expected to have lower than average utility bills because of its efficiency features.

Normalization controls for extraneous variables and isolates the effects of high-performance features.

Energy bills may be corrected for various confounding variables through a process called normalization, which essentially breaks down a series of energy bills into their component parts so that the extraneous variables can be controlled for, isolating the efficiency performance variables to predict future energy savings. In this process, bills over an extended period are analyzed and correlated to the variables in question, which may typically include outdoor air temperature, occupant density, and operating hours. The billing patterns are then expressed as a multivariate linear function of the variables. This equation can then be used to predict the building's energy performance based on specified "normal" conditions.

The big advantage of normalization is that it provides a much more rigorous treatment of the energy bills than the simple verification method. In some ways normalization is simpler, because it does not require a detailed survey of all the building energy features (although listing them would be an informative complement to the analysis). Normalization does, however, require reliable historical data on a number of independent variables, such as heating and cooling degree day data, hours of occupancy, numbers of occupants, internal and equipment loads, etc. It may also require data on physical parameters that have a direct relationship to energy usage, such as floor area, glazing area, or ventilation rates. The more complicated the building, the more independent variables will need to be analyzed. Moreover, while normalization techniques are well understood, their application to a particular building can require a certain amount of trial and error to develop the most descriptive regression equation that makes the best use of the available information about the building.

Use of normalized billing is relatively common among building managers and building energy consultants, covering a range of applications. Owners and managers may use normalized billing to simply track energy use and trends, to forecast operational cash flow, and to help identify opportunities for energy cost savings via retrofits, maintenance, or improved operations. Normalized billing is also used as a basis for energy-efficiency performance contracts. In this case, normalized bills can be used to project a baseline level of energy consumption against which the post-retrofit actual energy use can be compared.

Normalization of energy bills is sometimes carried out by a contracted specialist, but can also be done by non-experts, especially via the use of desktop utility-tracking software such as *Metrix* and *EnergyCAP*. A normalized billing analysis and projection from such tools should generally be a reliable source of energy-cost information for use in appraisal.

The ENERGY STAR building label Normalized billing now has another important application through the ENERGY STAR building label program of the U.S. Environmental Protection Agency (EPA). Under this program, the ENERGY STAR label, which is best known as a mark of energy-efficient performance in appliances, copiers, computers, and homes, may be assigned to energy-efficient buildings in a wide range of categories, including office buildings, hotels, retail stores, medical office buildings, hospitals, senior care facilities, schools, and others.

The EPA system for assessing buildings and assigning the label is based on normalized billing. An applicant collects 12 consecutive months of utility billing information, along with information on a number of normalization factors — occupant density, space use, floor area, numbers of personal computers per person, hours of operation, and outdoor temperature. The collected data is entered into a program called Portfolio Manager, in which a calculation engine then normalizes the bills for the given factors. Building owners and managers can then use Portfolio Manager data to monitor performance, track changes over time, and identify opportunities for upgrading energy efficiency.

Notably, Portfolio Manager also generates an ENERGY STAR rating, a score on a 0-100 scale that indicates how a building stacks up against other buildings with similar physical and operating characteristics. A closely related program called Target Finder allows an owner to start with a desired ENERGY STAR rating score and identify the energy consumption levels needed to qualify, thus defining goals for design and/or retrofit. A rating score of 75 or higher qualifies a building for the ENERGY STAR label. Please see Section 4 for a discussion of the use of ENERGY STAR ratings as a basis for energy-performance comps against other buildings.

Normalization does have its limitations. With the EPA normalization and benchmarking tool, as with other normalization software, it should be understood that results may vary depending on the normalization factors chosen. In certain cases, normalization may not recognize important anomalous factors that strongly affect energy use. For example, a building may have stuck dampers or incorrect setpoints in the HVAC system, leading to high energy use that weather, occupancy, and other normalization corrections will not catch. Normalization will also be unlikely to reveal cases where low energy use results from underheating and undercooling of occupied areas, though EPA does require that any buildings qualifying for an ENERGY STAR label must have an engineer's certification that minimal comfort conditions are met.

Design simulation

For some buildings (including, most obviously, new buildings) energy billing data may be absent. For other buildings, the magnitude of energy costs may warrant a more detailed assessment of the energy performance and how it is influenced by the equipment and operation of the facility. In these cases, an owner may be able to provide the appraiser with the results of a computer simulation of the building's energy performance, based on the building's built features, its location, and other factors. Simulations are most commonly conducted in conjunction with design of new buildings or comprehensive retrofits. In other cases, it may be worth the time and expense to develop such a simulation model of an existing facility specifically for the appraisal.

A computer simulation model is essentially a sophisticated engineering calculation of the energy flows in a building and their cost. Much as NASA scientists use simulations to study the effects of space flight, building engineers use simulations to study the energy performance of buildings and their equipment. As with any simulation model, the results can only be as good as the input data, so there must be a reasonable amount of effort expended to adequately describe the building and its operation. The energy analyst must necessarily make simplifying assumptions about the building, so it is also necessary that the simulation be performed by a person with the training and experience to make these simplifications in a way that does not compromise the accuracy of the simulation. Done properly, however, energy simulations provide the ultimate tool for predicting energy costs for a building in a way that recognizes the performance of the specific energy features of the building.

DOE-2

The longtime standard for building energy performance simulation is a computer program called **DOE-2**, which was developed by the U.S. Department of Energy (DOE) more than 25 years ago and has been undergoing periodic improvements and revisions ever since. DOE-2 requires voluminous input data on the geometry, materials, equipment, and controls of the building. It also considers internal heat gains within the building, the effects of solar radiation incident on the building, the relevant utility rate schedule, the daily and weekly variations in operating and occupancy schedules, and other factors. DOE-2 calculates hourly expected energy consumption for the building, taking into account historical hourly weather files for the building location. Summed over

DOE-2 is the industry standard energy simulation tool for buildings, with results generally falling in the range of +/- 5% accuracy.

the entire year, hourly consumption estimates can yield an estimate of whole-building consumption.

The DOE-2 simulation procedures are available in a range of software packages (user interfaces), ranging from simple text-based programs to interactive graphics-intensive tools, for use by architects, engineers, building scientists, and building operators. Most users currently use the programs on standard desktop personal computers. A list of commercially-available versions of DOE-2 may be found at http://gundog.lbl.gov/dirsoft/d2vendors.html.

DOE-2 is a rather specialized computer program, and one must possess a college engineering level of understanding of building energy and analysis principles to use it with confidence. In particular, it is necessary to ensure that input information on building parameters is accurate and reasonable; some DOE-2 versions automatically reject unreasonable input data, but in many cases, verification of inputs can only be conducted through third-party review.

Yet despite these caveats, DOE-2 is among the most widely used energy analysis tools, and is accepted as rigorous and accurate for building simulation purposes; results generally fall in the range of plus or minus five-percent accuracy.

DOE-2 may be especially accurate in predicting energy use when the simulation model is “calibrated” to past energy bills. In the calibration process, the user actually adjusts the calculational engine of the simulation model so that it accurately “backcasts” (as opposed to “forecasts”) past bills.[3] The modified simulation model is then used to forecast future energy consumption and costs. Figure 2 depicts actual energy costs for an average large commercial customer in Con Edison’s service territory in New York (10,800 kWh and 31 kilowatts per month), compared to a fictitious simulation of energy costs, before and after simulated calibration.

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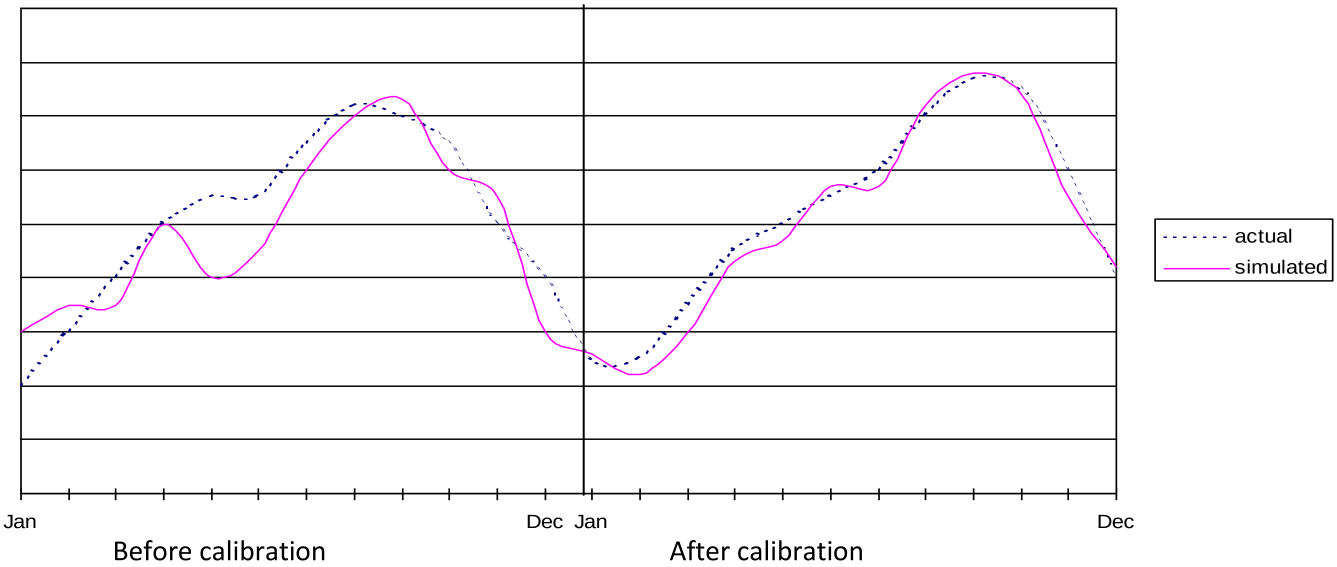
[3] The accuracy of a calibration (that is, the closeness of fit between the simulation and the past bills) is commonly quantified by means of two statistical indices: mean bias error, or MBE, and coefficient of variation of the root mean square error, or CV(RMSE). The lower these indices are, the closer the fit. Generally, a simulation model is considered calibrated if its MBE falls within ±10%, and if CV(RMSE) is within ±30%. (Stein, J., 1997.)

Figure 2. Calibration of Building Energy Simulation



The advantage of calibrated simulation is that by tuning the model to past bills, one should, in theory, generate a model that is more accurately representative of the energy-use behavior of the specific subject building. The problem, however, is that tuning the model is a highly sensitive and ultimately subjective endeavor; the model may inevitably be tuned in any of a number of ways, which will likely yield different patterns of forecasted energy use. Therefore it is imperative that the specialist performing the calibration be a real expert not only with the software, but also with technical aspects of building science, in order to assure that calibration adjustments represent reasonable engineering assumptions, not random guesswork.

Other simulation and analysis tools

Other energy-simulation tools, which target various building types and cover a range of cost and complexity, may also yield information for use in appraisal.

EnergyPlus, like DOE-2, is a whole-building energy simulation program. Based on user inputs about building features and HVAC systems, EnergyPlus calculates heating and cooling loads and energy consumption. It is regarded as more of a full-featured tool than DOE-2, in its capacity to deal with more complex HVAC systems. Also like DOE-2, EnergyPlus was developed by the U.S. Department of Energy for free release into the public domain; it now has several commercially-developed interfaces.

The HVAC giants ***Trane*** and ***Carrier*** both offer proprietary building-simulation services, which are generally used to determine heating and cooling loads to help ensure selection of correctly-sized equipment. Simulations from both companies can also be used by building owners to demonstrate compliance with federal tax-deduction provisions based on energy efficiency in buildings.

A more comprehensive and regularly updated list of commercial and residential energy-simulation tools, with useful discussion of the features, uses, strengths, and weaknesses of each, is available at http://apps1.eere.energy.gov/buildings/tools_directory/subjects_sub.cfm.

Billing histories and design simulation: which to prefer?

In gathering comments from appraisers and energy-analysis specialists on these proposed tools, IMT has observed a rather distinct disparity in each professional sector's preferences. Appraisers widely consider billing histories to be acceptable for use in the valuation process, and simulation tools somewhat less so. Energy specialists tend to hold the opposite position; they are skeptical about billing-based assessment, and more confident in simulation methods, particularly those that involve calibration to measured performance.

Both enhanced billing histories and design simulation are preferable to straight non-normalized bills and lookup of regional averages — and both can enhance accuracy without significant incremental burdens for the appraiser.

There are various possible reasons for this divergence. Appraisers' preference for billing histories may be based on a sense that bills represent information that is more tangible than the results of an engineering calculation. Appraisers may be able to apply their own judgment more constructively to billing histories, which require relatively little technical background, than to simulation, which is a "black box" to all but the most highly trained programmers and engineers. Enhanced billing methods may also be more popular among appraisers in that they resemble currently-applied methods more closely than simulations do; changing practice by enhancing billing assessment would be a manageable incremental step, whereas assessing and trusting a simulation would be more of a leap in practice.

Energy specialists, on the other hand, prefer simulation methods because they are able to take into account the detailed dynamics of building performance, including the effects of various specific technologies in the building. They are familiar with these tools, work with them regularly, and not surprisingly, generally view the more advanced tools such as DOE-2 and EnergyPlus as the leading edge in their work. To them billing methods are, technically speaking, much blunter instruments, subject to confounding factors and gaming as described above.

4. Benchmarking and Energy Performance Comps

Appraisers often seek information on buildings with comparable characteristics when estimating property value as a whole, and for confirming or arriving at ranges for particular expenses, such as energy costs. The purpose of this section is to highlight tools that can be used to evaluate currently-available data sources on comparable properties (“comps”) for use against subject buildings, including government building survey results and data from private agencies and companies.

We emphasize that comp data should be used only as *checkpoints* for estimates of energy costs, but *not* as default figures for the energy costs of the subject building. For estimating energy costs for the subject building itself, the appraiser should refer to Section 3.

Ideally, energy-related comps should fulfill the following criteria:

- The comp building set should represent the **same specific building type** as the subject building.
- The **same energy cost calculation method** should be employed for both the subject building and the comp data set.
- A sufficiently representative or large data set should be sampled.

The appraiser may conclude that, after applying these criteria, none of the available databases can offer a rigorous enough energy cost for comparison to the subject building. In this case, the appraiser will have to make a subjective judgment as to what level of credibility to assign given energy cost figures, or may request corroborating information from other analytic methods applied to the subject building.

Existing Baseline Databases

The building databases enumerated below are widely accessible and convenient, but have relatively small sample sizes and informal collection methodologies. These databases examine costs only; they lack information on the specific built features of buildings. Therefore, these sources only weakly satisfy the above criteria.

Building Owners and Managers Association (BOMA)

The BOMA *Experience Exchange Report*, available through online subscription only, has data from more than 6,500 buildings and 250 markets. The dataset covers office buildings only. Energy consumption is broken down by utility and presented as dollars per square foot per year. Data are presented for downtown and suburban sectors of metropolitan areas, in aggregate and broken down by floor-area ranges. Sample sizes vary widely according to location and floor-area category.

CBECS (Commercial Building Energy Consumption Survey)

The CBECS database is the only national-level survey of commercial buildings and their energy suppliers, put together by the Energy Information Administration of the U.S. Department of Energy. The main advantage of the survey is that it collects information on the physical characteristics of buildings, building use and occupancy patterns, equipment use, conservation features and practices, and types and uses of energy in buildings. Monthly utility bills are also reviewed to corroborate energy consumption and expenditure claims. Its disadvantages are that it is only conducted quadrennially and that it does not allow searches by geographic location to levels of resolution finer than the nine US census regions. CBECS data come from multiple sources for each building: interviews with building owners, tenants or managers; documentation from energy suppliers; energy simulation model runs; and weather data.

The most recent CBECS was completed in 2003, and consisted of interviews covering more than 5,200 commercial buildings. There are more than 4.8 million commercial buildings in the nation, and the buildings in the sample were selected to represent them as closely as possible. As has been detailed more extensively elsewhere,[4] CBECS is mostly limited by the difficulty inherent in representing such a large number of buildings with such a small sample size. There are also concerns that some portion of the collected data may be inaccurate and that some important factors impacting energy use are left out entirely. To add to these challenges, CBECS is now two updates behind schedule, which means the data is a snapshot of the nation’s building stock as it stood nearly a decade ago.

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[4] See http://www.srmnetwork.com/pdf/whitepapers/Building_Energy_Benchmarking_BEPN_Apr10.pdf

Other Methods

Simulated reference buildings

In many states, developers have the option of demonstrating energy-code compliance by conducting an energy simulation for a building and comparing the results to those of a similar simulation for a hypothetical minimally code-compliant reference building made with stipulated features and materials. Comparison with the reference building thus can tell the code official (and the appraiser) how the energy performance of the subject building compares to minimum code requirements.

Since codes set forth the same basic energy-efficiency requirements that apply to all new buildings within a given type, this method also provides a possible means for comparing buildings against each other. For example, one new building may be shown to have energy consumption 30 percent lower than its code-defined reference building, while another may show levels only five percent lower than its respective reference building.

Comparison to a simulated reference building is preferable to using database comparison methods because it employs the same tool to estimate energy performance between buildings, inherently represents the same building type, and avoids the issue of needing a large comparison data set.

Simulated reference building comparisons are useful because they employ the same tool to estimate energy performance between buildings, inherently represent the same building type, and obviate the need for a large comparison data set.

Rating systems

Energy performance documentation in the form of a rating delivers energy cost information to the appraiser with a built-in baseline, in that it represents where the subject building stands in relation to other buildings.

As introduced in Section 3, the **ENERGY STAR** benchmarking tool and its underlying programs, Portfolio Manager and Target Finder, provide a rating of the normalized energy consumption of the given building.

Portfolio Manager compares the results of the normalization analysis with statistical information from the 2003 version of CBECS. This comparison yields a rating for the subject building, on a percentile scale of one to 100. Buildings with a rating of 75 or higher (that is, those that outperform 75 percent of similar buildings in CBECS) qualify for the ENERGY STAR building label.

The **HERS Index** (Home Energy Rating System), developed and overseen by RESNET (the Residential Energy Services Network), provides a rating of a building's energy efficiency on a scale of 0 to 100 and beyond. This rating is based on an assessment by a certified professional home energy rater, including a comparison with a simulated reference building minimally compliant with the 2004 edition of the International Energy Conservation Code (IECC), which is the basis for many required residential energy codes throughout the United States.

Notably, in the HERS system, the lower the rating, the better in terms of energy efficiency. A score of 0 means that the building consumes no net energy, while a score of 100 means that the home is minimally compliant with the IECC. Scores below or above 100 reflect the deviation in energy consumption from the IECC reference level. Therefore, a building with a score of 80 consumes 20 percent less energy than the IECC level, while a home with a score of 150 consumes 50 percent more.

HERS ratings are already recognized by the real estate finance sector as a robust tool for energy assessment. They are the basis for "energy-efficient mortgages," which offer owners or buyers of rated energy-efficient homes increased financing for purchase or energy efficiency improvements. Fannie Mae, Freddie Mac, the U.S. Department of Veterans Affairs, and the Federal Housing Administration all have special underwriting guidelines for energy-efficient mortgages, using HERS ratings.

The U.S. Green Building Council oversees another certification and rating system for buildings, called **LEED**, which stands for Leadership in Energy and Environmental Design. LEED includes various specific systems for rating different types of buildings, including new construction, existing buildings, retail, homes, schools, and others. For all the various types, LEED rating systems are applied on a 100-point scale, with a hierarchy of designations from Certified (40+ points) to Platinum (80+ points). In the decade since its creation, LEED has grown to become the preeminent green building label, widely accepted as the market standard. Today, more than 1 billion square feet of space are LEED certified.

Appraisers should note that LEED ratings are not quantitative indices of energy cost or energy consumption alone. Points are awarded for criteria ranging from site selection to the use of recycled construction materials. The LEED rating, while the authoritative measure in its chosen area, is ultimately a subjective measure of environmental quality, rather than an objective index of energy cost or consumption.

Still, energy is a significant part of a LEED rating, accounting for up to 35-38 points out of the possible 100. Moreover, the methods for assigning LEED points for energy employ the same best-practice approaches described above – for new commercial construction, a comparison against minimal code compliance; for existing buildings, a comparison with similar buildings via ENERGY STAR and Portfolio Manager; and for homes, a comparison with the HERS index. Therefore if a LEED rating is available for a building, a rigorous underlying energy comp should be too.

Benchmarking mandates: a growing trend

Across the country, cities and states looking to cut their energy consumption and raise their green profiles are adopting "rating and disclosure" laws. While the specifics vary, the theme is consistent: building owners are required to track energy use and submit the data to a central database, which is either partially or wholly public.

With these mandates, policymakers are betting that readily available information on building performance will fuel market demand for energy-efficient buildings, motivating owners to retrofit existing stock and think green when planning new construction. As this report went to press, rating and disclosure policies were in place in New York City, San Francisco, Washington DC, Austin, Seattle, California, and Washington State, and under consideration in several other cities and states. IMT's 2011 report, Building Energy Transparency, provides a more detailed summary of specific policies and emerging best practices.

All of the benchmarking and disclosure mandates now in force in the United States require the use of Portfolio Manager and the Energy Star rating scale, where applicable. As a result, these jurisdictions will soon have databases of building performance data of unprecedented scope and quality.

Exact details are still being worked out, but in New York City, Washington DC, and San Francisco, the data from the buildings required to benchmark will be made available on a public website in some form. At a minimum, each building's ENERGY STAR rating and energy use intensity (consumption per square foot) should be available. Additionally, as the data flow in, these jurisdictions will be performing city-wide analyses and releasing useful summary statistics and performance metrics, creating an unprecedented opportunity in terms of energy use comparison. ***Most notably, buildings in these databases will be available as comps with each other, not just comps with CBECS samples of similar buildings.***

Other jurisdictions are employing various transactional triggers, designed to ensure that prospective tenants have access to performance data before a contract is signed. This disclosure format does not present as clear an opportunity for appraisers as a public website. However, if the jurisdictions aggregate and analyze the data, and make the results public, these policies should create very significant new sources for appraisers and others to use in generating energy comps.

5. Technical and Legal Assurances From Preparers of Energy Documentation

Real estate appraisers are subject to intense scrutiny and liability. Appraisers' work is shaped by multiple laws and interests, including the Uniform Standards of Professional Appraisal Practice (USPAP), the scope and expectations for the assignment as stipulated by lenders, as well as the risk of potential litigation from disgruntled parties. In this context, it is imperative that appraisers ensure the credibility of the data that they use, and of any third parties providing such information.

The reliability of energy assessment and comparisons, no matter how well-tested and technically robust the given methods, depends heavily on the competence of the person performing the analysis. Therefore, not only should an appraiser verify the technical basis of energy performance documentation as discussed in Section 3; he or she should also seek assurances about the technical credibility and responsibility of the preparer. This section describes three types of such assurances:

- **Assurance of technical competence** in the form of a professional license or other related training or experience;
- **Assurance of legal responsibility** for the document contents in the form of a signed statement;
- **Assurance of coverage by professional liability insurance**.

Technical Assurances

To some extent, the level of technical complexity of the energy assessment tool used defines the required level of expertise of the energy performance document provider. Therefore, someone preparing a building's utility bills and list of efficient features will not require the same level of qualification as someone who conducts a sophisticated whole building simulation such as DOE-2. In some cases, the tool itself may be designed for either a technical or non-technical user. In this instance, the documentation provider would not require special certification at all.

Appraisers agree that appropriate licensure of documentation providers is very important as protection against future liability. For this reason, appraisers may not want to change an appraisal to reflect unusually low energy costs if the statement comes from an unlicensed expert rather than a Professional Engineer (PE). This section discusses a number of both licensed and degree course training—from professional engineer certification to utility or industrysponsored course work in efficient building operation. Evidence of relevant training in any of the forms below should elicit confidence from the appraiser in the competence of the document preparer and its contents.

Professional Engineer/Licensed Architect certification

Energy-performance documentation may be certified by a PE or a licensed architect. PEs render services such as consultation, investigation, evaluation, planning, or design of public or private utilities, structures, machines, processes, circuits, buildings, equipment, or projects. This includes evaluation and certification of buildings' energy performance. Architects, of course, are the professionals responsible for building design, and in some cases may also conduct analyses of energy performance as part of the design process.

Like other professions that are tested and licensed, upon filling legal requirements engineers and architects obtain licenses via state offices or boards, which in most states not only qualify and license individuals, but also establish and enforce laws and regulations. Accountability to state licensing board oversight is in itself one of the most powerful aspects of the assurances embodied in the two types of licenses. Low energy-cost information verified by an architect or PE would likely give appraisers the greatest confidence that the figures are attributed to energy-efficient measures in a building.

To become a PE, an individual must pass rigorous experience and exam requirements, including graduating from an engineering program accredited by ABET (formerly known as the Accreditation Board for Engineering and Technology, Inc., and with the initials now constituting the official name), fulfilling 12 years of education/experience acceptable to ABET, and passing the Fundamentals of Engineering and Principles and Practice of Engineering exams. Many PEs belong to the National Society of Professional Engineers.

For architects, licensing requirements generally include providing verification of a bachelor's or higher accredited degree in architecture, a minimum of three years of architectural work experience, and successful completion of a series of written examinations.

The ENERGY STAR building label requires that applications be certified by a PE. (Architects are not recognized under this program.) In this way, the credibility of the preparer is essentially “built in” to the tool, and does not require additional verification by the appraiser. Other billing normalization methods, as well as DOE-2 and other simulation tools, do not contain the intrinsic assurances that ENERGY STAR does.

Although DOE-2 is more technically sophisticated than the ENERGY STAR benchmarking method, neither DOE-2's users, nor the tool's output documentation, are required to be certified in any way. In some states, code compliance based on DOE-2 simulation must be certified by a PE stamp.

It should be noted that both the PE and licensed architect designations only provide a limited degree of technical assurance insofar as they do not guarantee specific expertise in energy performance assessment. Ideally, the appraiser should seek additional evidence regarding the preparer's technical competence, such as their area of specialty, training, or experience.

Equivalent training or background

In the absence of any of the above certifications, appraisers might consider alternative qualifications from the energy performance documentation provider of a building, such as equivalent course work or project experience. The following is an overview of certification programs, courses, and training that specifically cover energy performance in commercial buildings, and should be recognized when evaluating energy-cost documentation in an appraisal.

Building Operator Certification

Developed by the Northwest Energy Efficiency Council (NEEC) more than a decade ago and now active nationwide, the Building Operator Certification (BOC)[5] is a program for training and certification of building operators and facility managers. The program offers voluntary courses for individuals who are responsible for the energy- and resource-efficient operation of building systems. Certification is granted at two levels. Level 1, which covers building systems and equipment, requires 56 hours of classroom study and five long project assignments; Level 2 emphasizes troubleshooting and maintenance, and requires 49 hours of classes and three projects. BOC graduates are required to take continuing-education credits to maintain their certification. Typical registrants include individuals from both the public and private sector: engineers, utility company employees, energy service company representatives, electricians, general foremen, and facility operators.

Utility-offered training

Verification of energy bills by the utility provider can provide additional assurance that low cost figures are valid and therefore worth reporting in an appraisal, as opposed to relying on rule-of-thumb references from standard sources. Preparers of such energy-performance documentation may

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[5] http://www.theboc.info/

demonstrate technical qualifications via a certificate of completion of a utility-sponsored training course in whole-building energy analysis tools.

Degree courses

A growing number of degree courses are now available to those in the energy sciences or engineering field, and if presented by the documentation provider, should offer some assurance to appraisers in their technical competence in energy. Many courses are offered by both state and private schools.

Certifications from ASHRAE

ASHRAE is an international organization of 50,000 members, organized to advance the sciences of HVAC for the public's benefit through research, standards writing, continuing education, and publishing. Energy efficiency in buildings is a major focus of the organization.

ASHRAE offers several certifications for trained experts in building energy performance assessment. These include the following designations:

- Building Energy Assessment Professional
- Building Energy Modeling Professional
- Commissioning Process Management Professional
- High-Performance Building Design Professional
- Operations & Performance Management Professional.

All these certifications require submittal of an application, review of guidance materials, and taking a proctored examination in person. The presence of any of these certifications is a credible indication of substantial training and/or experience in the given field.

HERS rater certification and quality assurance

HERS raters are certified after receiving a full week of required training from RESNET-accredited providers, passing a comprehensive written examination, and performing two ratings in the presence of a certified trainer. Aspiring raters may also take the test without formal classroom training, instead relying on experience and self-study.

Furthermore, even after accreditation, HERS raters are subject to oversight of their work by accredited "rating providers." Such oversight includes desk audits of a minimum of ten percent of ratings and field inspection for a minimum of one percent.

Taken together, training and quality assurance of HERS ratings and raters are among the most comprehensive of any energy efficiency programs in the country. Note, however, that HERS ratings apply to residential homes only, not commercial buildings. But RESNET, IMT, and other groups are now working on COMNET, a system applicable to commercial buildings, which is ultimately intended to generate ratings with similar rigor and quality assurance as with HERS.

Assurance of Professional Responsibility

While the various certifications and assurances of technical competence described above will provide the appraiser with some degree of protection against liability, additional assurance should be sought in the form of a signed statement from the documentation provider. With the understanding that, as with all areas of appraisal, the energy cost estimates of NOI may be contested at some future time, IMT recommends that the third-party energy performance documentation provider (the preparer, reviewer, building owner, or contractor) should certify in writing that the information being provided is true and correct to the best of their knowledge.

Appraiser disclaimers and limiting conditions

In addition to requesting assurance of professional responsibility from the documentation provider, appraisers should also be certain to protect themselves in the appraisal by including disclaimer and limiting conditions language. Language already used by appraisers, such as: 1) a clearly and conspicuously presented Extraordinary Assumption per the Uniform Standards of Professional Appraisal Practice (USPAP) in which uncertain information is presumed to be true, or 2) that suggested by the International Valuation Standards Committee[6] should suffice for purposes of estimations of energy cost as well. Eventual integration of energy documentation requirements into state or national appraisal standards would also protect appraisers against liability.

Other typical general assumptions and limiting conditions are listed below as they may appear in an appraisal report:

- *The information furnished by others is believed to be reliable. However, no warranty is given for its accuracy.* [7]

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[6] "The statements of fact contained in the report are believed to be true and correct. The Valuer should **identify the sources of data relied upon, indicate whether there was reliance on data supplied by others**, and if data from others is relied upon, state whether there was further verification of that data by the Valuer." *Section 7.2.2. Assumptions and Limiting Conditions.*

[7] *The Appraisal of Real Estate*, p. 582 (AIREA, 9th Ed., 1987)

- *The forecasts, projections, or operating estimates contained herein are based upon current market conditions, local energy prices, anticipated short-term supply and demand factors, and a continued stable economy. These forecasts are, therefore, subject to changes in future conditions.*[8]

Information contained herein is obtained from sources deemed reliable but not guaranteed by the appraiser, who is not an expert in these matters.[9]

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[8] *The Appraisal of Real Estate*, p. 582 (AIREA, 9th Ed., 1987)

[9] Suggested language from a CA Certified General commercial real estate appraiser, 12/1/98.

6. Market Demand for Energy Efficiency and Green Buildings

Beyond energy efficiency – green buildings and sustainability

The concept of “green buildings” takes energy efficiency strongly into account, but goes further in also considering water use, sustainability of source materials, waste reduction, air quality, land use, and other factors. Value of green buildings arises from many of the same factors cited above for energy-efficient buildings, including direct cost reductions from lower utility bills, increased attractiveness of buildings, and occupant comfort and health.

Social responsibility has become a key motivator for many businesses, especially larger corporations, as well as universities, government agencies, and other major economic entities in the United States. The concept of social responsibility includes various elements, including treatment of employees, service to the community, and limitation of environmental impact. In the latter regard, many of these institutions now recognize that the selection of which buildings to own and/or lease is a significant way to exercise social responsibility. Choosing energy-efficient and green buildings, to many, is simply good citizenship worth some extra effort and expense.

Going green with buildings goes beyond fulfillment of ethical missions and doing good for its own sake. For many businesses, owning and occupying green buildings can be good marketing too. Energy-efficient and green buildings can help project a desired image, not only of community connections and social responsibility, but also of technical savvy and readiness to innovate. Earning a positive LEED designation or an ENERGY STAR label is not just something to feel good about within a company – it is something to project to the public.

The increasing prevalence of energy-performance disclosure mandates will likely greatly magnify both the internal and external motivations for building owners to pursue energy efficiency and sustainability. Under the mandates, not only will owners know about their buildings – they will know about everyone else’s, and everyone will know that each other knows! This transparency can be expected to lead to unprecedented competition among building owners. Such competition will apply not only to a few super-progressive companies trying to out-green each other at the top of the efficiency and sustainability ratings. It will also create powerful motivation among owners of underperforming buildings to improve energy performance and shed embarrassingly low ratings and the reputational drag associated with them.

Evidence of energy-related value

All these factors collectively have spurred a significant shift of the real estate market in the United States toward greater recognition of value associated with energy-efficient and green buildings. Market recognition of the value of energy efficiency and sustainability applies especially to larger commercial properties, but has been well documented in other sectors too. Evidence of this transformation is still scattered, but it is accumulating steadily.

Statistical studies

Recent published research has repeatedly concluded that buildings rated as energy-efficient and sustainable have higher occupancy rates, fetch higher rents, and sell for more than comparable but unrated and less efficient buildings.

- *University of Arizona and Indiana University study of office-building investment data from National Council of Real Estate Investment Fiduciaries.*[10] In a 2010 study published in *The Journal of Real Estate Research,* Gary Pivo, professor at the University of Arizona, and Jeffrey Fisher, director of the Benecki Center for Real Estate at Indiana University, examined data from the National Council of Real Estate Investment Fiduciaries on investment performance for nearly 1,200 office properties. Using controls to isolate effects, they found that buildings with the ENERGY STAR label had significantly stronger financial performance than unlabeled similar buildings. ENERGY STAR buildings had *10 percent lower utility costs, 4.8 percent higher rents*, *1 percent higher occupancy rates*, and ultimately, *5.9 percent higher net income per square foot and 13.5 percent higher market values*. ENERGY STAR buildings also showed lower cap rates than non-labeled properties, indicating expectation of stable cash flows over time.
- *University of California and Maastricht University study of effective rents and sale prices of rated office buildings.*[11] This study examined a data sample from October 2009 of nearly 21,000 office buildings, comparing

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[10] Pivo, Gary, and Fisher, Jeffrey D. "Income, Value, and Returns in Socially Responsible Office Properties." *The Journal of Real Estate Research.* Jul-Sep 2010. 32 (3), page 243. http://www.u.arizona.edu/~gpivo/PIVO%20FISHER%20RPI%20Feb%2010.pdf. Retrieved December 2011.

[11] Eichholtz, Piet, Nils Kok, and John H. Quigley. "The Economics of Green Building." *Review of Economics and Statistics,* forthcoming (2011 or 2012).

rents and sale prices per square foot of those with ENERGY STAR and LEED ratings versus those without such ratings, while correcting for variation in other factors. These samples, taken from CoStar databases, included almost 21,000 rental buildings and 5,000 buildings sold since 2004, of which 2,687 had ratings under ENERGY STAR or LEED.

Effective rents, which are a function of rent amount and occupancy rate considered together, were 8 percent higher on average for rated buildings than for non-rated ones. Similar comparison of sale prices showed a premium of about 13 percent.

Growing demand and market share for energy efficiency and green buildings

- *Market share of green buildings.* The market share of green commercial and institutional buildings in the U.S. rose from 2 percent of total sectoral value in 2005 ($3 billion) to about 10 to 12 percent ($24-29 billion) in 2008. This share is expected to grow to 20 to 25 percent ($56-70 billion) by 2013.[12]
- *Willingness to invest in energy efficiency*. A November 2009 report by Jones Lang LaSalle found that 74 percent of corporate real estate executives are willing to invest in retrofitting spaces they own to save energy and improve sustainability. This figure represented a rise from 53 percent in a similar survey the previous year. The report stated that 89 percent consider energy use and other sustainability criteria when looking to buy or lease office space. This study also found that 37 percent of respondent companies would pay a lease premium of 1 to 10 percent for sustainable building space.[13]

Case studies

There are many case studies that document how energy efficiency and green building design have led to lower energy costs, improved financial performance, and other benefits for owners.[14] Much less common are studies that show actual quantitative effects of documented energy performance on the appraised

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[12] *Commercial & Institutional Green Building: Green Trends Driving Market Change*. McGraw-Hill Construction and the U.S. Green Building Council, 2008. Cited in *Energy Efficiency and Real Estate: Opportunities for Investors.* Mercer LLC and Ceres. 2010. http://www.imt.org/files/FileUpload/files/Benchmark/Energy_Efficiency_&_Real_Estate_2009.pdf. Retrieved December 2011.

[13] http://www.joneslanglasalle.com/Pages/NewsItem.aspx?ItemID=18110. Retrieved December 2011.

[14] See especially Chappell, Theddi Wright, and Corps, Chris. *High Performance Green Building: What's It Worth?* Cascadia Region Green Building Council, Vancouver Valuation Accord, and Cushman & Wakefield. May 2009. http://cascadiagbc.org/news/GBValueStudy.pdf. Retrieved December 2011. See also http://www.nrdc.org/buildinggreen/casestudies/default.asp.

value or market-defined sale price of the building. The lack of such evidence is presumably largely a matter of research effort and access, not necessarily lack of relevant cases. But in 2005, IMT did carry out two studies that definitively demonstrated such effects.

Morrison Manor *(Troy, N.Y.).*[15] This 83-unit multifamily residential building was purchased for $750,000 in 2000. The new owner then installed a variety of energy efficiency measures, including replacement windows, added insulation, and new gas-fired heating and domestic hot water systems replacing electric baseboards and water heaters. The owner then decided to capture the savings by paying utility bills himself, passing along those costs to tenants as increased rent. These rents increased by 11 to 36 percent, with no accompanying rise in vacancy rate. The owner attributed "at least $85,000 and possibly much more" in increased rent per year to the retrofits. He sold the property for $1.79 million in 2005, just five years after initial purchase and less than two years after completion of the retrofits.

Pine Harbor *(Buffalo, N.Y.).*[16] In this complex of 208 subsidized rental units, the owner pays utility bills. A switch from electric to gas heat in most units and some common areas yielded ***an increase in appraised value of 33 percent***, or $4.68 per square foot. This appraised increase does not take account of greatly improved indoor comfort and tenant-landlord relations, with probable effects on tenant retention and reduction in vacancy rates; if such effects could be quantified, it would be reasonable to expect even higher incremental value effects.

Conclusion

The value of energy efficiency and sustainability in buildings goes beyond merely theoretical or calculated energy savings and financial performance. Now more than ever, this value is the reflection of real market demand and willingness of tenants and investors to pay more for efficient and green buildings. Increasing statistical evidence and case studies support this value trend. As the market share of green and energy-efficient buildings continues to grow, market awareness and preferences for efficiency and sustainability will likely become more and more evident via sales comps to appraisers everywhere, with effects pushing in both directions – toward increased value for efficient and green buildings, and toward diminished value for

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[15] http://www.imt.org/Papers/MM-CaseStudy.pdf. Retrieved December 2011.

[16] http://www.imt.org/files/FileUpload/files/Papers/PineHarborCaseStudy2004.pdf. Retrieved December 2011.

underperforming buildings with greater expenses and larger negative environmental impacts.

Market value of energy efficiency and sustainability is rising and becoming more definitive for many reasons, including evolving social and cultural priorities, increased public awareness about energy and sustainability in buildings, more accessible information tools and comps, and an expanding track record of technical know-how and implementation success in practically all subsectors of the real estate market. No longer invisible and oft-overlooked, energy performance and sustainability have become standard, even central criteria for defining and distinguishing value in buildings.

7. Appendix: Fundamentals of Energy-Efficient Measures in Buildings

This appendix has three goals:

1. **To assist the appraiser in understanding the basic categories of energy efficiency measures** in buildings, and the specific sectors in which certain measure types are most important;

2. To advise the appraiser about how to identify and compare energy-performance levels of specific building materials and components;

3. **Where available, to identify specific information sources** with more information on how measure types affect energy consumption and energy costs.

With some measure types, especially lighting, energy savings and effects on cash flow are relatively easy to quantify. With other measures, however, it is usually quite difficult to assess how individual energy-efficiency measures will perform in terms of savings and payback. In an appraisal, therefore, use of this appendix to identify energy-efficient measures would have to be carried out *in conjunction with* examination of billing histories, operating expense statements, or engineering analyses of whole-building performance. See Section 3.

Insulation

The amount of heating and cooling that a building requires usually depends very heavily on transmission of heat through the “building envelope” — its outer shell of walls, windows, doors, roof, and bottom floor. Insulation of the building envelope, especially top-floor ceilings, is therefore a very important way to reduce a building’s energy bills.

Insulation can be made of various materials, including synthetic foam, cellulose fiber, mineral fiber, and fiberglass. The performance of insulation is expressed in terms of its “R-value,” or thermal resistance — the higher the R-value, the better the protection against heat transmission.[17] R-values are usually visibly

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[17] Specifically, R-value is the inverse of the amount of heat that passes through a square foot of surface area, per degree of temperature difference on either side of the surface.

marked on insulation products, but note that R-value will depend on the thickness of the insulation (as, for example, with double layers of fiberglass in an attic) and most importantly, on installation quality. Absence of gaps and avoidance of moisture and compression are essential for the durability and proper function of insulation.

Insulation is especially important in small buildings (for example, single-family residences), which have a larger ratio of surface area to volume than larger buildings. Though we usually think of insulation as a protection against heat losses during cold weather, insulation also helps buildings to stay cool in the summer. In both hot and cold weather, insulation offers benefits in occupant comfort as well.

Windows

Windows strongly affect a building's energy consumption because of their contribution to the building's heat losses in cold weather and heat gains in warm weather. Windows transmit heat, either from indoors to outdoors or vice versa, by several means: 1) transmitting heat through the window panes; 2) transmitting heat through the window frame; 3) leaking cold or warm air through small seams between pane and frame or between frame and wall; and 4) allowing sunlight to enter the building and warm the indoors.

There are various types of window frames and window glass. Frame types include aluminum (which is light and durable but transmits heat readily); aluminum with thermal breaks (in which outer and inner layers of aluminum are separated by an insulating layer); wood; insulated and regular vinyl; fiberglass; and hybrid/composite. Windows may have one, two, or three panes of glass, with or without special coatings or films to encourage or inhibit transmittance of light or heat. Some windows are made of sealed multilayer glass units filled with argon, a gas with especially good insulating properties.

In colder and temperate parts of the country, the most important energy-related aspect of windows is their thermal performance — that is, their ability to retain heat in the building during the colder times of year, and to keep heat out during hot weather. The figure of comparison for window thermal performance is called *U-factor*. Note that U-factor, somewhat confusingly, has units that are the *inverse* of R-value for insulation; therefore the lower the U-factor, the better. Another potentially relevant factor is the solar heat gain coefficient (SHGC), which is an index of how well a window blocks out heat caused by sunlight; the lower the SHGC, the less heat gain through the window.

(SHGC is most important in warmer climates, where cooling needs predominate.)

In both residential and nonresidential sectors, the National Fenestration Rating Council (NFRC)[18] rates and labels windows for their U-factor and SHGC, as well as visible light transmittance coefficient. NFRC certification is recognized in the building-code compliance process in many states.

Aside from their direct impact on a building's energy bill, the thermal properties of windows also have a major effect on the comfort of building occupants. When the indoor surfaces of an inefficient window become cold in the winter, people may sense the chill from the cold surfaces even at some distance away. Further, cold indoor surfaces can prompt the condensation of moisture or even the formation of frost, which can lead to an array of problems — including mildew and water stains, peeling of paint, and rotting and deformation of frames and sills.

Lighting

Lighting upgrades are among the most popular energy efficiency measures in major commercial building sectors, including office buildings, retail, health care, and educational facilities. Energy-efficient lighting measures have a long and successful track record, are relatively simple to install, and provide reliable, easily quantified energy savings.

Lighting typically accounts for more than 30 percent of electricity consumption in commercial buildings, and as much as 50 percent in some office buildings. Lighting upgrades can significantly reduce electricity consumption by as much as 65 percent while maintaining or even enhancing lighting quality. In addition, efficient lighting systems also generate less heat than inefficient systems, and therefore can help to reduce cooling costs.

Several elements of lighting systems present opportunities for energy savings: lamps (including bulbs and fluorescent tubes), ballasts, fixtures, controls, and daylighting.[19]

Fluorescent lamps are the most commonly used commercial light source in North America. They come in various shapes and sizes. T12 lamps, which are

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[18] For more information, see www.nfrc.org.

[19] The remainder of this section is drawn largely from *Lighting Fundamentals* in the Lighting Upgrade Manual issued by the Green Lights Program of the U.S. Environmental Protection Agency, February 1997. See www.epa.gov/buildings/esbhome/lightingfund.pdf for more details.

four-foot tubes 1½ inches in diameter, are the most common. Narrower, more efficient T10 and T8 lamps often replace T12s in routine lighting upgrades.

Compact fluorescent lamps (CFLs) replace conventional incandescent bulbs in various fixtures, especially overhead lighting. They cost several times more than conventional bulbs, but consume about 65 to 75 percent less energy, and last up to ten times longer. CFLs are not usually compatible with dimmable switches and fixtures.

Ballasts are the devices that deliver and stabilize electric current in fluorescent lighting tubes of various types. *Magnetic ballasts* (which are also called electromagnetic ballasts), in turn, encompass several types. Standard core-coil magnetic ballasts are the least efficient ballasts. So-called "high-efficiency" core-coil ballasts are about ten percent more efficient than standard ones, but despite the terminology, are still much less efficient than electronic or hybrid ballasts.

Electronic ballasts can replace magnetic ballasts in most fluorescent lighting applications, and consume about 12 to 25 percent less electricity for equivalent amounts of light. They also offer reduced noise and flicker, and are compatible with dimming in some cases. *Hybrid ballasts* (also known as cathode cut-out ballasts) are core-coil magnetic ballasts with some electronic components. They are approximately as efficient as electronic ballasts.

Ballasts are also used for high-intensity discharge lamps (HID lamps), a broad category that includes mercury vapor, metal halide, and sodium lamps. Such lamps are most common in industrial and outdoor lighting applications, though some HID lamps, especially metal halide, are also used indoors in office or retail settings. Selection of ballasts for HID lamps can have very important effects on lamp efficiency, lamp life, and maintenance costs.[20]

Light fixtures (also called luminaires) direct and distribute light by means of their orientation, reflectors, and shielding. The primary purpose of fixtures is to enhance visual comfort; in certain cases the use of reflectors may distribute enough light to targeted areas to allow for removal of some superfluous lamps, resulting in energy savings.

Lighting controls include timers that shut off lights according to scheduled hours of occupancy; motion sensors which switch lights on and off as people come and go; and manual and automatic dimmers. Such controls are especially

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[20] More information on HID ballast selection is available in *Lighting Fundamentals* (see footnote 4).

important in office buildings, in which people leave rooms and workstations unoccupied periodically during the day and for long stretches every night.

Smart building design for maximum natural light (also known as “daylighting”) can therefore be an important source of added value. Natural light reduces the need for artificial light and accompanying electricity costs. Also, perhaps even more importantly, daylighting can make indoor spaces more pleasant for occupants. Daylighting has been shown to increase productivity in offices and even to increase sales in retail settings.

Of course the arrangement of windows and skylights are key aspects of daylighting design. Light shelves and clerestories near windows can help to reflect natural light deep into interior spaces. In some newer office settings, you might encounter automated systems that measure ambient natural light and respond by delivering only needed quantities of artificial light.

Heating, Ventilation, and Air Conditioning (HVAC) Systems[21]

HVAC systems vary widely in size and complexity, and cover a broad range of equipment, pipes and ducts, and controls. It is beyond the scope of this brief appendix to address the entire gamut of HVAC equipment and their efficiency ranges. Here we present a brief overview of major system types and key components, and discuss some general principles for equipment selection and management that make for efficient systems.

Packaged HVAC systems are relatively small, complete units that offer heating and cooling, and are ready for installation when purchased off the shelf. Packaged systems include units intended to serve entire buildings, as well as window or wall units that serve one room. *Central HVAC systems* are typically used in larger buildings. Central HVAC systems are custom designed and built, and collectively encompass a broad range of equipment types. Central systems can be quite complex.

High-efficiency HVAC systems can use 35 to 40 percent less energy than conventional new systems. Savings can be even greater when new systems are custom-engineered or replace old systems. A number of factors can contribute to greater efficiency in packaged or central systems:

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[21] This section is adapted from the SmarterEnergy equipment guides of the Pacific Gas & Electric Company. See http://www.pge.com/customer_services/business/energy/smart/html/central_hvac_guide.html and http://www.pge.com/customer_services/business/energy/smart/html/phvac.html.

Efficient equipment. The overall efficiency of an HVAC system depends largely on the efficiency of the primary heating and refrigeration equipment in the system. All packaged systems have certified efficiency ratings, which may serve as a basis for comparison one against another.[22] The key components of central HVAC systems, including chillers and boilers, also bear certified efficiency ratings. Installation of a high-efficiency chiller in a central HVAC system for a multi-story office building can reduce electrical consumption by 35 percent.

Heat pumps use a refrigeration cycle to provide either heating or cooling. For cooling, they operate like conventional air conditioners; for heating, they essentially run the refrigeration cycle in reverse, removing heat from the outdoor air or the ground and sending it indoors. Heat pumps can be efficient when it is not very cold outside, since they use “free” heat instead of fuel for a portion of the building’s heating needs. (When it is cold outside, heat pumps must provide supplementary heat, usually with electric resistance heating, which is relatively expensive and inefficient.)

Economizers. An economizer allows outside air to be used for cooling when its temperature is lower than the temperature inside the building. Rooftop units are particularly well suited for using this “free” cooling, and economizers are available as an option for many off-the-shelf units. Economizers can also be retrofitted to existing packaged and central systems, especially ones that are not too old.

Variable air volume systems. Larger, more complex buildings usually have multiple zones with simultaneously different space-conditioning needs. One highly inefficient way to meet differing heating or cooling loads in each zone involves reheating the cool supply air as desired just before it enters the room. This system is called “terminal reheat.” Also highly inefficient and costly are dual-duct systems, which maintain separate supplies of heated and cooled air, and mix them via thermostatic controls before delivering the air to rooms — essentially, heating and cooling the room at the same time!

A much more efficient alternative, variable air volume (VAV) systems control the amount of hot or cold air flowing into each area, as needed. The systems control the flow of conditioned air by any of various means. Most efficient is the use of an adjustable speed drive (ASD) to match the speed of the supply fan to the amount of air needed. ASDs are not currently available for off-the-shelf rooftop

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[22] Numerous types of efficiency ratings are used, reflecting subtle differences in the types of operating performance being measured. A detailed glossary of efficiency rating terminology for HVAC equipment may be found at http://www.pnl.gov/fta/2_appc.htm.

units. Manufacturers can outfit custom and semi-custom units with ASD fan controls.

Evaporative cooling*.* Some packaged and central systems employ evaporative cooling, in which air is cooled by evaporating water. Evaporative cooling cuts the work that the system's refrigeration equipment must do, raising the capacity of the system.

Controls. The most basic energy-saving HVAC controls are programmable which turn heating or cooling systems down or off when facilities are unoccupied. Even more savings may be achieved by means of energy management systems (EMS), which coordinate HVAC operations among multiple units and multiple zones, helping to prevent problems such as adjacent units working against each other (one unit heating a space, another cooling the adjacent space). Upgraded energy management systems can often reduce overall energy use by 15 percent or more. In addition, these devices maintain system start-up and set-back schedules to optimize building occupant comfort.

Thermal storage. Thermal storage systems operate at night when electric rates are lower, storing cold or heat for use during daylight peak hours. Though thermal storage systems do not save energy, they do reduce energy costs, as well as offering the societal benefits of reducing the need for new power plants.

Monitoring and maintenance. Regular monitoring and maintenance of HVAC systems is absolutely critical for efficient performance, especially with advanced and complex systems. Control failures in particular — including malfunctioning thermostats, misprogrammed EMS, and stuck dampers in VAV systems — can negate any advantages that an efficient system is supposed to provide. In addition, seemingly simple problems such as slipped fan belts, clogged filters, and fouled surfaces can also have major deleterious effects on system efficiency.

Commissioning is the systematic examination of building systems and operations for opportunities to fix problems, assure proper function, and optimize energy performance. Commissioning of HVAC systems by an experienced practitioner, either upon initial construction or during the building's operating life, can be an important way to assure that efficient systems are operating as they should, and that expected energy savings will be reliably achieved.

HVAC equipment sizing. Appropriate sizing of HVAC equipment is critical. Building owners and managers often choose redundant or oversized cooling equipment for reliability against failure or for assurance of sufficient cooling during the hottest weather. In these cases, the frequent result is that the cooling system operates only at a fraction of its capacity — and at suboptimal efficiency — the rest of the time. Oversized HVAC systems can therefore lead to lower overall efficiencies and higher operating costs.

This disconnection between system size and efficient system performance demands that an appraiser be especially careful in accounting for HVAC systems, which are the most expensive sets of equipment in many buildings. A cost-based valuation approach will favor larger, more expensive systems, but if oversized, these same systems will have less value in terms of the income approach than a smaller, less expensive, correctly sized system.

8. Other Resources

The following documents offer some illuminating discussion of energy performance, green building, and property value. Note that the latter three tend to emphasize investment and underwriting perspectives, rather than appraisal itself.

Finlay, James. *Valuation Techniques of High-Performance Real Estate*. Presentation to UCLA *Real Estate Market Analysis.* August 23, 2010.

Finlay, James. *The Resource Appraisal: Due Diligence Reporting for Energy/Resource Performance Retrofit Financing.* Presentation to *Strengthening the Green Foundation: Research and Policy Directions for Development and Finance.* Tulane University. March 10, 2011.

High-Performance Green Building: What's It Worth? Cascadia Region Green Building Council, Vancouver Valuation Accord, and Cushman & Wakefield. Primary authors Theddi Wright Chappell and Chris Corps. May 2009.

Muldavin, Scott R. *Value Beyond Cost Savings: How To Underwrite Sustainable Properties*. The Muldavin Company, Inc. 2010.