Risk-Based Building Energy Modeling to Support Investments in Energy Efficiency

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ABSTRACT

Underwriting financing for energy projects requires investors to evaluate the risks, benefits, and costs associated with efficiency improvements. Unlike other investment opportunities, energy projects do not report the uncertainty associated with key finance parameters, such as cost savings. To attract more investments, the buildings industry must do a better job of analyzing, managing, and reporting risk.

An energy modeler is the service provider that is responsible for projecting energy cost savings during design. However the application of building energy modeling (BEM) often is inadequate to address investors' needs. Further, energy modelers currently speak a different language than investors and are not familiar with their informational needs.

The paper presents an expanded vision of the energy modelers' role and the way their work is presented. It proposes that energy modelers account for direct and indirect benefits and risks associated with energy project performance improvements. The paper reviews current supporting efforts and proposes new endeavors to facilitate such an approach. The discussion provides a starting point to develop streamlined BEM methods, tools, and guidelines to capture the most investment value at the least cost. We believe endeavors fundamental to achieving the vision include: 1) the ability to incorporate uncertainty analysis as part of energy performance calculations; 2) the documentation and widespread use of BEM best-practice methods, such as the BEM Framework and Library; 3) the automation of complex but routine procedures to streamline BEM and provide quality assurance control, such as the COMNET Modeling Guidelines and Procedures (MGP), and 4) the definition of report guidelines and support templates.

Introduction

Those seeking capital for energy project investments need to do a better job presenting risk information to decision-makers. Simple-payback, return-on-investment, or even life-cycle-cost models do not provide sufficient information on risk and rewards. Investors cannot properly assess cash flow forecasts without a discussion of risk and risk mitigation.

For example, imagine two 5-year streams of cash flow, one that generates a 15% return and one that generates a 7% return—which is better? Clearly, it depends on the level of risk in achieving the forecasted benefits. If the 7% return is based on seasoned existing cash flows it might be highly preferable to a 15% return predicated on executing construction, lease-up and other execution risks.

The recently reported $279 billion market opportunity for U.S. building energy efficiency retrofits that could total more than $1 trillion in energy savings over 10 years (Rockefeller Foundation 2012) highlights the significant investment opportunity that exists for energy projects. Just as methods were defined to support the emerging Energy Service Performance

Contracts (ESCO) market fifteen years ago, today the industry has a similar need. To realize the investment potential, the industry needs to address the informational needs of third party investors. To do so will require defining effective terminology and formalized processes for evaluating estimated energy savings.

The initial estimated energy cost savings is a critical value for investors considering energy projects. The risk associated with the value is that the actual building fails to live up to performance expectations and the anticipated cost savings are not achieved. Unfortunately, savings estimates are typically calculated as a single number and do not indicate a probable range or an estimated uncertainty. In addition, risk can be introduced into the project through poor process execution, and energy-efficient feature underperformance. Failure to provide information about uncertainty leaves the financial analyst with no means to price the appropriate rate of return. This causes the financial analyst to increase the required rate of return or to derate the savings before applying the financial model. This practice undermines the viability of energy projects.

The Role of the Energy Modeler

The building energy modeler is responsible for estimating initial energy cost savings. The modeler utilizes building simulation software to project energy use and costs. Within the software, the modeler characterizes the building's geometry, material thermal characteristics, and energy-using systems. By evaluating and comparing performance, the modeler determines the benefits of building siting, space layout, passive design elements, and energy-efficient components. The modeler also identifies occupant comfort issues. Building energy modeling (BEM) is often applied in the design of high performance buildings to evaluate proposed and alternate integrated-design solutions that satisfy aggressive energy reduction targets. To support investors, information must be provided that describes the risk associated with cost savings estimates and indirect benefits of improvements so their value beyond costs can be considered. The energy modeler is well-positioned to fulfill this documenting and reporting role.

Muldavin outlines an extensive checklist of items investors should take into account as part of the financial valuation of benefits, costs, and risks associated with sustainable properties (Muldavin 2010). To understand how an energy modeler can support investor needs, it is necessary to review their job responsibilities. Recent research outlines typical modeling tasks grouped into assessment, analysis, and documentation categories (DOE 2011). Table 1 includes a subset of items from Muldavin's checklist that overlap with DOE's energy modeling tasks. In the table, items in **bold** indicate informational needs that the modeler can quantify. The other items may be addressed through a qualitative assessment resulting from design team deliberations. Ideally the modeler can garner and document this information so the financial analyst can apply it to fully value the energy project.

This paper focuses on three approaches to better meet investors' needs for energy projects, including: 1) ***quantifying*** energy savings risk, 2) ***managing*** risk through the design process, and 3) ***documenting and reporting*** financial valuation information.

Table 1. Energy-Efficiency Considerations Related to Project Costs, Benefits, and Risks

Costs	Benefits	Risks
• One-for-one equipment replacement (business as usual) • **Energy-efficiency features** • **Integration, downsizing and/or simplification of systems** • **Annual energy cost savings** • Maintenance costs • Training costs • Certification fees • Higher cost design services • Higher rents • Reduced tenant turnover • Reduced potential loss of value	• **Lower emissions** • Better operator control of systems • Improved occupant control of space and lighting comfort • Fewer occupant complaints • More reliable systems • Improved ability to meet space user demand • Reduced liability of building related health issues • Increased demand for rentable space due to energy efficiency features	• **Uncertainty of energy savings estimates** • Chance of building not operating as designed • Change of product or system failure • Reduced potential loss of value due to obsolescence • Improved ability to meet future regulatory requirements • Increased liability of building related health issues • Energy-efficiency feature installation problems • Building operating problems • Uncooperative tenants

Quantifying Estimated Cost-Savings Uncertainty

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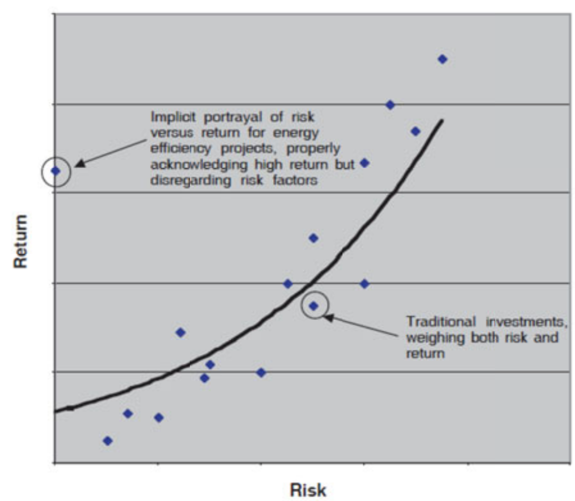

The risk associated with energy projects is viewed differently by different parties. An investor may accept greater risk if the potential for an enticing return exists. A lender is more risk averse since the interest they accrue on loans is typically fixed, limiting their ability to share in higher returns or value that may be generated. Owner occupants are concerned about initial cost and savings risk, but also about how the investment will affect the value of the enterprise overall.

The estimated cost-savings is a key value for financiers. If the investor has a higher level of confidence, then it may decrease the required rate of return or decrease the amount the savings is derated before being applied in the financial model. As illustrated in Figure 1, traditional investments consider levels of risk, and higher risks translate into higher rates of return. Without uncertainty quantification for the energy cost savings, investors are left to estimate the risk with ad hoc procedures. For instance, published data show a range of 100% to less than 50% of cost savings guarantees made by ESCOs for their energy projects (Hopper, Goldman & Birr 2004). When projected cost savings are reduced by derating, the anticipated profitability of the project is smaller, making some investments less attractive (Mills et al. 2003).

To date the estimation of uncertainties and its associated risks for energy projects has not been widely applied, but at least two modeling methods are currently active research topics and a third, actuarial-based technique exploits results from simulations as well as data from the field. These methods are introduced below. Of the first two methods, one focuses on new designs and one on retrofits. In the actuarial approach, data from simulated efficiency projects or field implemented projects are categorized by key building parameters and incorporated into a database. Data from the database are drawn upon to inform cost savings estimates and their corresponding uncertainties. While this actuarial scheme generates no building models, all three techniques benefit from the application of defined best-practice modeling procedures and methods, which is discussed in a later section.

Modeling methods

For new designs, researchers (Eisenhower et al. 2011) employed a Monte Carlo sampling technique for multi-dimensional spaces of 700 to 1,000 input parameters. This technique efficiently samples a space centered on a proposed design configuration where the input parameters are allowed to vary uniformly over a ±30% range. After a sufficient number of simulations, modeled energy consumptions are histogrammed by each fuel type producing a frequency distribution for the calculated energy consumption. Statistical analysis of the distribution results in the mean energy consumption and a corresponding standard deviation for each fuel type. Depending on the confidence level desired, the uncertainty interval can be derived from this standard deviation. Of course analyses for the baseline and variants are required before energy cost savings and their estimated uncertainties may be calculated. In the research study, the ±30% variation is arbitrary. It does not necessarily characterize the possible range based on actual installations.

For existing buildings, estimates of the energy cost-savings require calibrated models. Using an analysis technique that simultaneously calibrates and simulates a normative model, researchers calculate energy savings, and estimate its uncertainty (Heo, Choudhary & Augenbroe 2012). Unlike Eisenhower's algorithm, which makes no assumptions about the importance of the input parameter, this approach employs judgment to identify parameters that can be critical. Using sensitivity analysis and Bayesian techniques with Monte Carlo to sample the parameter space, initial probability distribution guesses are informed through building energy simulations and feedback from actual monthly utility energy consumptions profiles. After multiple iterations, these distributions for the input parameter morph so that fuel consumption fits the utility data. At this point a variant of the Eisenhower scheme could be used to establish energy consumption distributions as described above. Of course the means and standard deviations from the building energy models must be combined with the operational data and their uncertainties to produce the final energy saving cost and its uncertainty.

The time required to perform these modeling calculations may impact the practicality of applying these uncertainty analysis techniques. In their study of calibrated building models, Heo et al. compared the results of their simple normative model with their "equivalent" EnergyPlus model. They found that each normative simulation ran in under one second whereas the EnergyPlus simulation ran in 3 minutes. Furthermore, Eisenhower et al. required one week on a Linux cluster consisting of 184 processors to complete two EnergyPlus analyses, equivalent to a baseline and a variant. Thus the time factor may be critical to the feasibility of bringing these complex and compute-intensive calculations within the reach of routine modeling and financial analysis. However, there is no track record as yet, and market testing is an essential next step.

Actuarial method

The actuarial method (Mathew et al. 2005) seeks to develop a portfolio of energy conservation method (ECM) data. Fundamentally each ECM would be categorized by system, ECM group, ECM type, and a limited set of detailed parameters. Data within this multi-parameter space can be sorted into cost bins for retrofits effectively building a distribution summarizing building projects whether they were actually implemented or not. Those built would have actual energy savings intensity metrics while those only modeled would have estimated energy savings intensity metrics. The mean and standard deviation of this data set could be used as an estimate for similar buildings in this category.

Managing Process Risk

Risk can be reduced and managed in energy projects at the process level. Designing for and achieving building energy efficiency relies on applying best-practice methods. On the other hand, poor execution can lead to negative consequences, including suboptimal design, occupant discomfort, operational issues, and increased costs. In general, process risk for energy projects can be mitigated by addressing the building design, delivery, and operation process. To manage risk, the project should utilize capable service providers, incorporate integrated design/delivery methods, include commissioning services, and continuously monitor and track actual energy performance to identify and reconcile underperformance.

To evaluate process risk, the financial analyst will want to vet information provided about the energy project. The vetting may include seeking answers to questions like those listed in Table 2 (Muldavin 2010), which we have grouped into three key risk-management categories. An energy modeler can support investor needs by being accountable for and/or reporting on these concerns.

While we are not aware of examples that demonstrate process risk management on the front end of energy projects (e.g. during design), there are examples for risk management on the back end (e.g. post install) spawned from the energy service performance contract (ESCO) industry. In the mid-1990s, the ESCO concept emerged as a new business model. The model involves the ESCO providing the up-front capital for an energy project. In exchange, the owner provides a series of payments to the ESCO, which are tied to the verified energy savings. In these contracts, the ESCO is the investor and the service provider. As a result, risk management procedures focused on owner concerns about reported savings. Eventually this resulted in the creation of the measurement and verification (M&V) protocols to outline industry-accepted procedures for determining savings in a repeatable and transparent fashion.

Just as methods were defined to support a new efficiency market fifteen years ago, today the BEM industry has a similar opportunity. Now we need to focus on the front-end risk considerations of energy projects. To address these concerns, new terminology and formalized processes for evaluating the design and modeling process must be developed. We are calling this expanded view of the modeling process “risk-based” BEM. Ideally, a risk-based BEM approach would reduce the vetting needed to qualify the energy project for financing. The concerns associated with many of these questions can be addressed through a robust modeling process accomplished by meeting assessment, analysis, and reporting requirements. The requirements can be captured as modeling guidelines developed specifically for improving investor confidence (EDF 2011).

Table 2. Energy Project Information Vetting

Demonstration of modeler competence	What is the modeler's level of experience? Has this modeler been successful in projecting savings in the past?
Best practice procedures and quality assurance checks	Did the modeling include benchmarking? Uncertainty analysis? Sensitivity studies?
	What benchmark energy cost data are available from comparable, conventional properties?
	Have aggressive energy-use targets been identified?
	Was the energy model capable of evaluating all features proposed?
	Were system interactions assessed by modeling bundles of strategies together?
	Were different bundles of strategies considered?
	Does the design meet the owner's requirements? Code requirements? Certification requirements?
	Has the design team addressed possible negative performance or comfort impacts?
Feature performance	What are the risks and risk mitigations associated with implementing the feature(s)?
	What is the success or failure experience associated with implementing the feature(s) (e.g. case studies) ?
	What is the theoretical link between the feature(s) and all possible beneficial financial outcomes (such as higher rents, lower expenses)?
	How will the building performance be monitored over time?
	Is there a process in place to identify and reconcile underperformance?

Concerns such as savings opportunities and inaccuracies in savings estimates will be managed through the development of a risk-based BEM process. This will require addressing key elements that impact execution, including: 1) modeler competence, 2) BEM best practices, 3) quality assurance procedures and 4) general risk mitigation efforts. Below, we outline these risk considerations, describe current supporting efforts and present new approach ideas.

Modeler Competence

Modeler competence can be demonstrated through professional certifications, project experience, trainings and education. Currently, the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) and the Association of Energy Engineers (AEE) both offer modeling certification programs, which involve passing an exam. To qualify, modelers must meet prerequisites regarding education and work experience.

Formal education programs that include building energy modeling coursework are available at approximately 25 U.S. universities[1] within mechanical engineering or architectural engineering programs. Much modeling expertise is learned by doing. There are training

[1] A partial listing of facilities with building-science programs include: AZ State University, Drexel State University, GA Institute of Technology, OR Institute of Technology, Penn State University, Stanford, Texas A&M, University of CA, Berkeley, University of CO, Boulder, University of KS, University of NA, University of WI.

opportunities for professionals. However, most of these are centered on the use of particular building simulation software programs. The International Building Performance Simulation Association (IBPSA-USA), has developed a full-day modeling training course that covers fundamental and advanced topics (IBPSA 2012).

The Department of Energy (DOE) recently published a report that identifies an energy modeler's job tasks and associated knowledge, skills, and ability requirements (DOE 2011). Developed through an expert group consensus process, the goal of the effort is to create national guidelines, which will define a body of knowledge to which any training organization can align. DOE will also use the body of knowledge to help meet the requirements of the Federal Buildings Personnel Training Act of 2010.

BEM Best-Practice Procedures

Currently, detailed industry-accepted best-practice procedures are not defined for the modeling process. Most modelers learn their skill on the job and applied methods are inevitably inconsistent. Developing and documenting BEM best practices will support modeling consistency and instill greater confidence. BEM best practices should address process issues, such as: following an integrated design approach to maximize savings opportunities, establishing aggressive savings targets, and exploring synergistic design alternates. BEM best-practices should be simulation software neutral but provide general modeling guidance for: developing a baseline building model, calibrating an existing-building model, and sufficiently characterizing ECMs within simulation software.

Resources that guide modelers for their process and procedures are available in various forms. For the design process several modeling guidelines provide direction on effectively using energy modeling (GEO 2011, NEEA 2010). Some are rooted in practical experience gained through applied methods (Kaplan & Caner 1995). One of the earlier documents outlines the modeling process and provides guidance for evaluating and selecting building simulation software (CIBSE 1998). A recently published book balances theory with practice to cover current issues in simulation modeling (Hensen & Lamberts 2011). Directed at advanced students in engineering, it covers topics in terms of building science, computational methods, and application aspects. As modeling efforts becomes increasingly commonplace, we expect to see more detailed requirements being developed. For example, the USGBC has developed a technical manual to clarify baseline and special-case modeling procedures acceptable for LEED Energy & Atmosphere credit 1 submittals (USGBC 2010). A few endeavors that address key best practice needs are underway. Specifically these are the BEM Library and the COMNET MGP (Majersik 2011).

BEM Framework and Library. The idea for developing a BEM Framework and Library emerged from the Rocky Mountain Institute (RMI) BEM Summit held in March 2011 (Tupper et al. 2011). Responding to the need to develop BEM best practice procedures, the BEM Framework would provide a structure for organizing "chunks" of BEM knowledge representing best practice procedures. Ideally, the modularized approach would enable the consistent use of the same procedures across a wide variety of modeling applications, including: green building certification, code compliance, energy-efficiency strategy evaluation, existing building performance evaluation, etc.

Franconi (2011) has proposed a structure for the framework and an example is presented in Figure 2. The structure recognizes that BEM procedures must differentiate between overarching modeling objectives to either compare, comply, or predict. BEM procedures may also differ based on the nature of the comparison. Depending on the application, this comparison may involve only the development of the proposed design and its alternatives, the development of a baseline building model, or the development of a calibrated existing-building model. In addition, there may be slight variations in best practice procedures based on the point-in-time in which the modeling is completed, such as during design phases (schematic design, design development construction documents), construction or operation.

Figure 2. Benchmarking Example for the Structure Proposed for a BEM Framework

Modeling Objective	Comparison Basis	Benchmarking				
		SD	DD	CD	C	O
Compare	Proposed vs Alternates					
Comply	Proposed vs Baseline					
Predict	Proposed vs Actual					
Predict	Actual vs Proposed					
Predict	Actual vs Baseline					
Predict	Actual vs Existing					
Predict	Actual vs Sector					

The BEM Library refers to the repository of BEM best practice procedures that have been modularized in accordance with the BEM Framework. Currently, members of the COMNET Quality Assurance Committee are initiating the development of the first BEM Library component ─ benchmarking. It is envisioned that the library will offer best practice procedures as building blocks to create modeling guidelines. Later after vetting and industry acceptance, the library components can also become the basis for modeling standards.

Automatic Creation of the Baseline Model. The baseline model represents current energy-efficiency best-practice and is a comparative process for performance assessment. For example LEED projects use it to earn performance points. It is defined in accordance with standards (e.g. ASHRAE 90.1 Appendix G) or codes (e.g. California Title-24). Due to complexity and ambiguity in its specifications, modelers often spend an inordinate amount of time creating models. Based on USGBC LEED certification program submittals, it became apparent early on that energy modelers were encountering problems interpreting requirements. Baselines were often being improperly modeled and ambiguities permitted within Appendix G resulted in inconsistencies.

Using funding from foundations, the COMNET team addressed these ambiguities by defining an algorithmic process to derive baseline buildings from the proposed building design. This procedure is intended to be automated in software and addresses different baseline standards specified by 90.1-2001, 90.1-2007 and paragraph 179D for federal tax deductions. COMNET also sought to assemble guidance for modelers for the operational input parameters (e.g. plug loads), which are unregulated under 90.1. As a result, the team created the COMNET Modeling Guidelines and Procedures (MGP) Manual to consistently and automatically develop the baseline model. The MGP also specifies output report schema for automating submittals to regulating authorities.

Since COMNET is not intended to produce software, it is reliant on software vendors to embrace and implement the software algorithms. While several software vendors have implemented the standard output report schema, no vendor yet offers a COMNET compliant simulation tool. Some software developers are concerned that some of the requirements of 90.1

Appendix G are specific to load-based calculations and do not apply to the underlying algorithms of all simulation software, especially new innovative programs. Another vendor concern is the cost to incorporate COMNET into their software.

While there are challenges facing COMNET's implementation by software vendors, other entities are embracing and building on the concept. Currently the California Energy Commission (CEC) is updating its tools used for Title 24 compliance. The CEC is leveraging the COMNET data dictionary and the DOE-developed building simulation software, EnergyPlus. The CEC plans to define and develop rules-based compliance checking as well as automated baseline building generation for Title 24. The rule-set approach allows for the rapid retooling of the software to accommodate new specifications from updated standards.

Modelers, regulating authorities and investors would benefit from the automatic generation of baseline buildings, which would improve BEM consistency and productivity. IMT estimates that automatically generating a baseline building will save approximately $20,000 per project (savings shared between the design team and the LEED certification review entity) (Majersik, Nelson & Contoyannis 2011). However, the concerns of the software vendors are significant. Stakeholders will need to work together to weigh the benefits and costs of such an endeavor. As part of this, the applicability of proposed simpler approaches (Eley 2009) should be investigated to understand the most effective path for the industry.

Quality Assurance

To build investor confidence, the BEM process should include quality assurance checks at critical points during the project. Franconi (2011) has indicated where such points exist based on the DOE Energy Modeler Job Task Analysis (DOE 2011). Further analysis is needed to discern the best type of intervention. Automated tools can be used to support these efforts and provide cursory checking.

Following its work with the MGP, COMNET offers a post-modeling tool: the COMNET Web Portal Version 1.0. In general the Web Portal automates submission of BEM outputs to regulating authorities. Version 1 works only for USGBC submissions. This initial release collects outputs from compliant simulation programs (eQUEST and Trane Trace), generates inputs for LEED Automation, and transmits the data. The automated checking is limited to simulation outputs only, e.g. flags hours not meet if in excess of the 300-hour limit. The function of the portal has been vetted by the USGBC.

Following DOE and CEC collaborative development of the BEM-geometry and BEM-systems schemata and the development of an automated rules-based compliance engine, COMNET will modify the web portal to integrate the rule-based compliance checking into the web portal. In collaboration with the USGBC and GBCI, COMNET will develop rule packages for LEED such that submissions through the portal may check both inputs and outputs.

General Risk Mitigation

The BEM process should acknowledge areas that introduce uncertainty and take steps to mitigate when possible. Currently, there is no formalized methodology to identify the relative importance of different modeling parameters and characterize them accordingly for controlling uncertainty. Such judgment calls are made regularly by experienced modelers, but their methods are rarely documented. However a recent article by Pappas (Pappas & Reilly 2011) outlines methods that distinguish between known, less known and unknown modeling parameters. The authors outline their process to select and vary input parameters to calibrate an existing building model to match utility billing data. First they update their initial input values based on site observations, measurements or referenced data. They recheck the calibration then choose a subset of remaining unknown parameters to vary to complete the calibration. The subset selected improves the calibration but does not significantly impact the performance analysis of the improvements. The remaining unknown parameters are set equal to a typical mid-range value. Defining this and similar approaches as part of best-practice methods demonstrates the incorporation of risk-based methods into the BEM process.

The industry already routinely characterizes efficiency strategies in terms of their possible risk for under performance and verified-savings accuracy in M&V applications. We can borrow and build from the M&V approach and apply it to front-end modeling considerations. Within M&V, one strives to find the balance between the cost of determining verified savings accurately and the value of increased accuracy. The risk versus value proposition for M&V is to choose an M&V method that is rigorous enough so that the savings are verified with sufficient accuracy at a nominal expense. For M&V, higher risk strategies are those that have high potential savings and high variability in their operation or efficiency. High-risk strategies include large plant equipment with variable part load performance (e.g. a chiller with variable speed drive compressor) or those dependent on occupant behavior (e.g. plug load management). Low-risk strategies are those that perform consistently and have known operating hours, such as: constant-volume high-efficiency pump or high-performance window replacements.

A similar approach can be followed by modelers during design for characterizing and modeling strategies. To implement this sufficiently and consistently, we recommend that the industry develop modeling strategy characterization templates designed specifically for risk mitigation. Initially, these could be developed for the most commonly applied efficiency strategies. The templates would address: 1) characterization of baseline conditions that might impact the strategy savings estimate, 2) characterization of the strategy as presented in the proposed design, 3) savings analysis approach, 4) indirect benefits and 5) qualitative description of uncertainties associated with the strategy value based on actual installations. Such templates can guide risk-based BEM and help meet reporting requirements.

Documentation and Reporting

While some progress is being made, the inability to quantify estimated savings uncertainty is a barrier to attracting financing. However, there are many other considerations for fully valuing energy-efficient properties as indicated in Table 1. To better meet investors' informational needs, the project documentation should address both direct and indirect energy performance considerations as much as possible. While some of these considerations are beyond the modeler's sphere and require broader input from the design team, a single individual should be identified as the responsible party for providing risk management information with regards to efficiency strategies. It makes sense that this responsibility resides with modelers since their role is to describe the efficiency strategies and report estimated cost savings.

Currently, energy modelers and investors speak different languages. While working to develop common ground, we believe that the industry would benefit from the development of reporting requirements and templates designed to guide the collection and dissemination of information that supports investment decision making.

The documentation requirements for efficiency strategy characterization, bundling of options and performance results have not yet been comprehensively addressed. Reporting forms are available for code certification, green building performance and utility-sponsored design-assistance programs. The format and content of an energy-project report are typically decided upon by the service provider. To better address investor informational needs, we recommend that nominal reporting requirements be defined as part of best practice procedures. In addition, to support quality assurance checking and risk-based BEM methods, we suggest developing owner's project requirements for energy projects that include new reporting elements. These include: 1) the Modeling Plan and 2) performance templates to summarize project information and strategy risk considerations. As is done for M&V, the Modeling Plan would be submitted before modeling commences. It would define the planned approach and address owner and investor concerns. The Modeling Plan review could be conducted by the owner, investor or an independent third party. The templates will guide the modeler to collect and report data most important to investors. Such improved BEM documentation can remove some vetting responsibilities from the investor and foster a strong project start.

Summary

Today's interest in energy efficiency is perhaps the strongest it has ever been. The market potential for existing building retrofits has been reported at $279 billion (Rockefeller 2012). Yet due to market barriers, there is a large gap between investment potential and committed financing capital. A key value for investors is the project estimated energy savings. The building energy modeler is the service provider who is responsible for determining this value. A comparison of investors' informational needs and energy modelers' job responsibilities indicates that the modeler is well-positioned to address needs related to energy performance improvements. However, current modeling methods scarcely address energy cost savings risk. Without risk information, investors presume things are very risky. This causes substantial derating of the cost savings associated with energy projects. We propose creating streamlined tools, guidelines and other resources to support investors and the industry's ability to capture the most value in least cost. Advancements are being made in BEM methods by a variety of contributors. However, many efforts are being driven by the specific needs of individual stakeholders (e.g. California's desire to streamline code compliance and rapidly retool revisions, DOE work force development). This paper ties together disparate efforts for advancing modeling methods to inspire a holistic and collaborative approach. Future work will refine and expand our suggestions for risk-based BEM as part of an industry effort to unlock the potential of the efficiency market.

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