Making the Financial Case for Sustainable Design

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Introduction

Developers and building owners are increasingly considering sustainable design options to enhance marketability, to meet corporate "green goals," or simply as contributions to a more sustainable future. Regardless of motivation, the consideration of green designs is always prefaced with the question of "how much more does a sustainable design cost?" For the growing number of Leadership in Energy and Environmental Design (LEED)-certified design professionals and others interested in promoting sustainable designs, this reluctance to accept anything other than marginal increments over least initial cost options is frustrating and, in some cases, costly. Green designs that are viewed as too "blue sky" can generate concerns that designers are less attuned to cost issues considered important by owners and developers.

The irony in this situation is that many sustainable design components related to energy-efficiency investments provide returns greater than those achieved by developers/owners with other financial investments. One reason for this investment disparity is the traditional use of payback analysis to evaluate energy-efficiency investments, with paybacks of two years or less often required for a project to qualify as a sustainable design option. This rule of thumb decision criterion stands in stark contrast to the sophisticated financial risk-management analysis such organizations use to assess their financial investments.

This paper describes Energy Budgets at Risk (EBaR) (Jackson 2008), a new quantitative energy risk-management process that evaluates and presents risks and rewards associated with incremental investments in energy-related sustainability designs. EBaR analyses and presentations provide a bridge that translates energy-efficiency and green designs into a financial presentation and a language familiar to CFOs and financial administrators. EBaR case study results (Jackson 2008) are presented below to illustrate this process.

Payback Pitfalls

Payback (PB) analysis (investment cost divided by annual savings) is the primary investment criterion used to evaluate the financial impacts of incremental investment costs and incremental energy cost savings associated with energy-efficient building design options. Payback analysis, however, has serious and widely recognized deficiencies, its greatest shortcoming being that it does not consider savings beyond the payback period. For example, the stream of cost savings beyond the payback threshold of a high-efficiency chiller are not reflected in the chiller's payback.

To provide an effective screening of risky projects, the payback rule must be defined with a worst-case scenario; otherwise, risky investments will slip through. However, efficiency investments with less uncertainty over performance, operating hours, or other variables that determine cost savings and those with longer lifetimes will be summarily rejected, even though they may actually reflect little or no risk.

The costs of bypassing efficiency investments with conservative payback requirements are substantial. In addition to reducing energy use and carbon emissions, building owners can increase cash flows because annual energy cost savings are nearly always greater than annualized investment costs.

Payback rules are simply too rigid to guide investment decisions concerning the diverse array of energy-efficient technologies available on today's markets. However, financial managers' preference for easy-to-evaluate decision rules eliminates net present value (NPV) and other business school textbook approaches that require questionable adjustments to future savings to account for risk (Keat and Young 2006).

When it comes to energy savings recommendations, design and mechanical, electrical, and plumbing (MEP) firms typically present payback results and try to bolster the efficiency case by pointing out other advantages of green buildings. There is a better way of evaluating and presenting the case for energy- efficiency investments. These decisions are perfectly suited to modern financial risk-management analysis.

Every building requires lighting, heating, air conditioning, ventilation, and other energy-using equipment. Investing in more efficient energy equipment provides the same services (heating, lighting, and so on) at a smaller cost. As long as the facility is occupied, benefits of the investment will continue. Investment risk arises because of uncertainty over future energy prices, operating performance, weather, and other factors. All these factors can be quantified and incorporated in a financial energy-efficiency risk-management analysis.

Financial Risk Management

Risk associated with financial investments has increased significantly since the early 1970s because of volatility in international exchange rates, commodity prices, interest rates, and geopolitical events (Bernstein 1996). Investment portfolio management now depends heavily on an array of quantitative tools to assess risks and returns associated with financial investments (Crouhy et al. 2006).

The most widely used quantitative tool is value at risk (VaR), which measures the probability that portfolio losses over some period will exceed a set amount at a predetermined confidence level (Holton 2002). A daily VaR of $50,000 at a 99% confidence level means that the probability that the portfolio will lose more than $50,000 in a day is less than 1%. That is, losses of more than $50,000 can be expected to occur no more than 4 days in a year. VaR statistics are calculated by using historical data on returns of

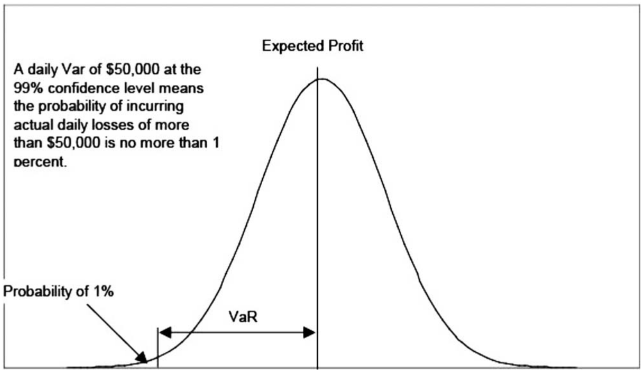

Fig. 1. Value at risk (VaR)

Table 1. Investment Analysis Summary

Item	Value
Total investment cost	$225,000
Estimated energy cost savings	$98,000
Payback	2.3 years
Internal rate of return	42.30%
Net cash flow	$58,300

the individual stocks or other financial investments in the portfolio and are reflected in Fig. 1.

Virtually all investment firms, banks, and financial institutions manage their investment risk using some variant of VaR analysis. VaR is also used by U.S and international regulators to insure the capital adequacy of financial institutions.

EBaR is a new energy-efficiency investment analysis process developed by Jackson (2008) to extend and apply the VaR methodology to assess investment risk associated with energy-efficiency investments. Not only has the basic analytical application applied in EBaR been vetted in the financial industry, it provides the kind of easy-to-evaluate decision variables favored by financial decision makers.

EBaR Investment Analysis

EBaR efficiency investment analysis applies quantitative characterizations of uncertainty associated with each of the variables that determine energy cost savings using Monte Carlo analysis, the same analysis technique used in scheduling and budgeting risk-management software. EBaR analysis results are generated as probability distributions of outcomes. Distributions for the two primary investment variables—internal rate of return (IRR, or annualized return over the life of the equipment) and net savings (energy cost savings minus annualized cost of the investment)—are shown in Fig. 2.

These distributions reflect case study results described in the next section. While $\mathrm{EBaR}_{irr,90}$ indicates that the probability of receiving an internal rate of return smaller than 35.5% is less than 10%, $\mathrm{EBaR}_{\mathrm{netsav},90}$ indicates that the probability of achieving an annual net savings (increase in cash flow) less than $44,000 is less than 10%.

EBaR Case Study

EBaR investment analysis is illustrated in this section by a case study analysis of an energy efficiency option for a five-story, 120,000 sqf Austin, Texas, office building. The least-cost baseline design results in modeled annual electricity use of 16.42 kWh/sqf and natural gas use is 35.1 kBtu/sqf. Energy bills at current prices will be approximately $210,000 per year for electricity and $50,000 for natural gas.

Two efficiency options are considered. The first is a package of lighting technology upgrades, and the second is an HVAC redesign including an energy management and control system. A summary of the efficiency investments is shown in Table 1.

The payback of 2.3 years is longer than the building owner's 2-year requirement. Consequently, even though this investment would reduce the building's annual energy costs by 38%, the investment would not be made because it falls short of the payback criteria. From the owner's perspective, investments with expected paybacks greater than 2 years carry too much risk of unacceptable investment returns.

How does this investment fare when evaluated with the EBaR risk-management framework? Uncertainty surrounding electricity prices, natural gas prices, weather, and operating performance are based on historical data (Jackson 2008). Uncertainty surrounding model-estimated efficiency savings estimates is specified as $\pm 15\%$ for lighting impacts and $\pm 20\%$ for HVAC impacts based on consultations with equipment representatives and internal analysis.

Representing investment returns (IRR) and net savings (cash flow increase) with the distributions in Fig. 2 is not a user-friendly presentation for most financial and other executives. Selecting several levels of risk that match potential decision-maker risk tolerance provides more transparent decision statistics. Table 2

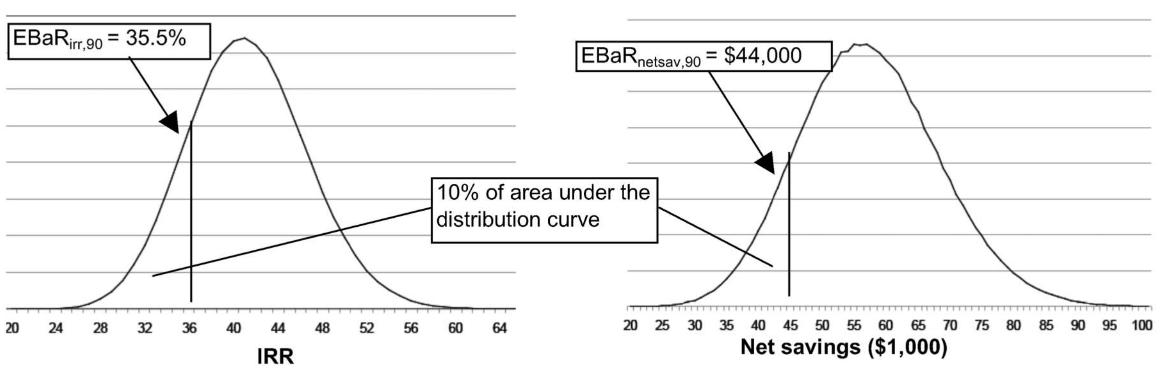

Fig. 2. EBaR IRR and net savings definitions

Table 2. Efficiency Program Returns

Confidence level expected (percent)	Minimum IRR (percent)	Minimum net savings
	42.3	$58,300
90	35.5	$44,000
95	33.5	$40,000
97.50	32.4	$37,800

and Figs. 3 and 4 show IRR and net savings (savings after deducting financing costs) for the lighting and HVAC investment.

As indicated in the table and figures, this investment has an expected payback of 2.3 years and 42.3% IRR with virtually no chance (2.5%) of providing an IRR less than 32.4% and an annual net savings of less than $37,800. Expected returns are great enough and the risk of unacceptable results is small enough to override the payback outcome and recommend the investment.

Fig. 5 shows the expected budget with and without efficiency investments and expected budget variances at three confidence levels. Not only have the investments reduced the expected annual energy budget from $261,000 to $163,000, the size of likely budget variances (the amount by which actual costs exceed the budgeted amount for any year) is reduced by about 45%. Both the annual budget and the budget risk have been significantly reduced.

In addition to reducing annual energy costs and budget volatility, energy-efficiency investments also increase the capital value of the building by reducing its operating costs. With a capitalization factor of 8 and expected net savings of $58,300, the capital value of the building increases by more than $450,000. The EBaR analysis framework also supports scenario analysis so that the impacts of alternative assumptions on variable uncertainty on any of the EBaR statistics can be evaluated.

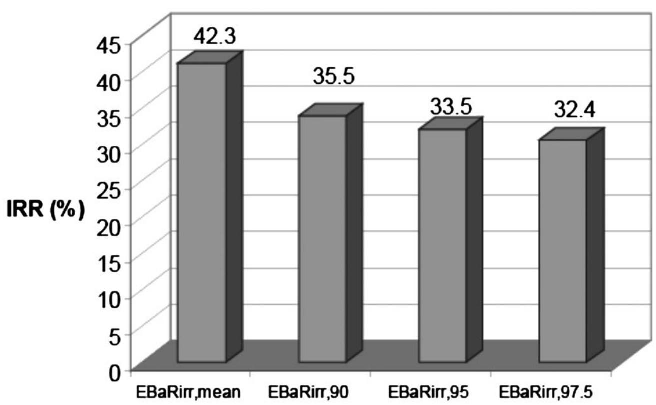

Fig. 3. Investment internal rates of return (IRR)

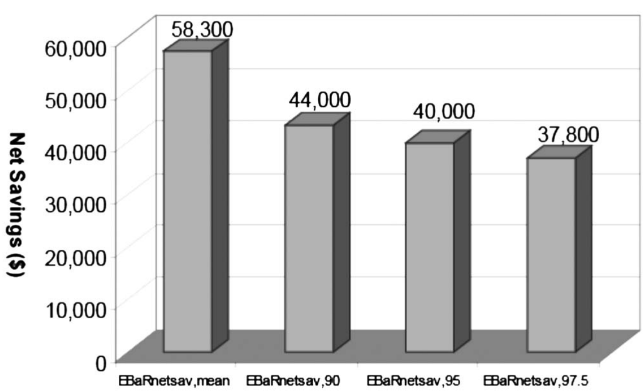

Fig. 4. Investment net savings

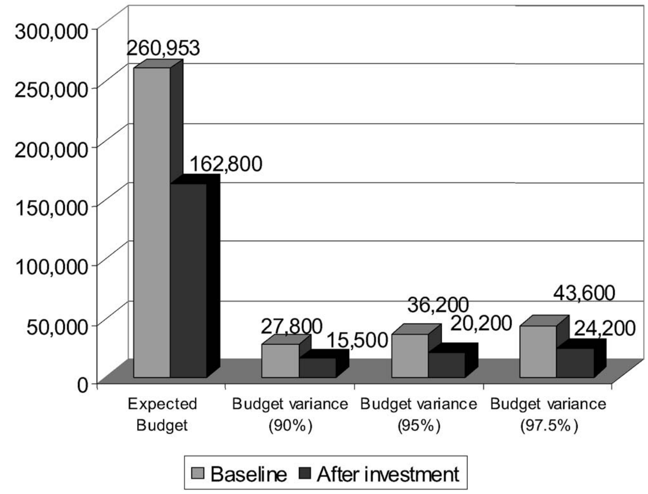

Fig. 5. Expected annual energy budgets before and after investment

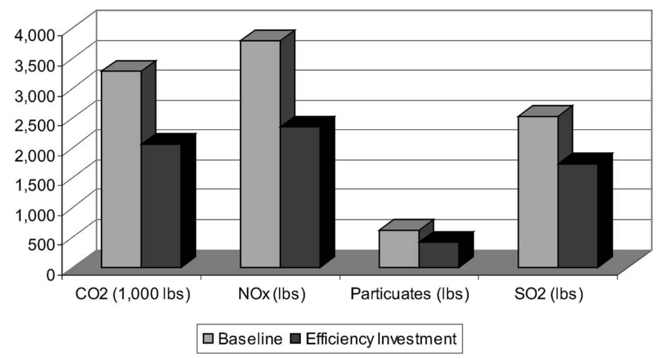

Fig. 6. Reductions in CO_2 emissions

Fig. 6 shows an annual baseline of CO_2, NOx, particulates, and SO_2 emissions, along with emissions with the efficiency investments. Carbon emissions are reduced by 37.4% and reductions in other emissions range from 31 to 38%.

Conclusion

Payback analysis traditionally used to evaluate incremental energy-efficiency investments is designed to avoid investment risk. However, payback analysis does not consider energy cost savings beyond the required payback period, rejecting many profitable building design options—options that reduce annual energy costs by even more than the annualized investment cost.

EBaR analysis provides a new quantitative energy risk-management process based on VaR, a financial risk-management process vetted in financial industry.

EBaR provides information on the least attractive returns likely to occur at various confidence levels and provides this information in a simple decision-variable framework similar to payback analysis; however, EBaR avoids all the limitations of payback analysis. Investments with varying lifetimes, savingsthroughout the life of the equipment, and a comprehensive and explicit accounting for the uncertainty associated with every aspect of the analysis are included in EBaR analysis.

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