Risk Assessment in Efficiency Valuation: Concepts and Practice

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ABSTRACT

Energy efficiency projects can be modelled as investment decisions under uncertainty. Efficiency projects occur in the physical world, but are justified through financial determinants. In the simplest sense, an efficiency project is no different from any other investment. The primary difference is the difficulty in quantifying the value and risk resulting from the investment, and apportioning the rewards to the participants.

A range of financial metrics are applied, such as benefit/cost ratios and simple paybacks. The energy efficiency industry is just beginning to add risk and uncertainty metrics for financial returns. Uncertainty can and should be included in the valuation of projects in a manner that is efficient both in terms of quantification of energy savings (physical settlement) and financial appropriation of the resulting value (financial settlement). Tools for establishing a baseline and measuring the resulting energy savings, such as the International Performance Measurement and Verification Protocol (IPMVP), provide a framework for defining options, but stop short of providing a financial decision framework that includes the costs and benefits of M&V for a particular project. Hence, critical decisions regarding the amount of metering for a particular program or project are typically made using expert judgement, not quantitative analysis. Whereas efficiency investments are becoming an ever more important part of global efforts to optimize productivity and reduce sources of climate change, all participants in efficiency projects will require enhanced guidance on risk reduction through the appropriate use of M&V.

This paper discusses a framework for performing efficiency investment valuation and making decisions based on the combined physical and financial uncertainty, and the value of information resulting from the M&V plan. The authors hope that wider discussion on this topic will lead to a growing body of expertise on efficiency valuation techniques and thereby enhance investment in efficiency.

Context - Efficiency Investments – Assets, Behaviour and Externalities

Global energy use is on the rise[1]. Global electric power capacity is forecast to add 3,000 GW of capacity over the next 25 years (EIA, 2004). Much of this capacity will be generated with fossil fuels. All of this energy growth will occur in the context of increasing concern about the impacts energy systems have on the global environment and the security of energy supplies. A reliable supply of electric power is considered a necessity for development in an increasingly competitive economic world. (Barnett, 2004). The questions facing policy makers, regulatory bodies, private corporations and average citizens around the planet are what techniques to pursue and how much to invest to mitigate the impact of our growing thirst for reliable energy.

[1] It is generally true that energy use is increasing for all fuels and sources. While the concepts are the same for any type of source energy, this paper focuses on verification of energy used in buildings, and on electrical energy in particular.

The most obvious way to mitigate energy impacts is to assure that the energy productivity is maximized. Whether by reducing negligent waste of energy, optimizing existing physical systems, or retrofitting with newly available technology, energy efficiency is a common sense part of the long-term solution. And given that efficiency can eliminate the need for some of the expected investment on the energy supply side; it can provide societal benefits as well. Deciding to pursue efficiency is not difficult, deciding how much to invest in efficiency, whether at the level of nations, regions or households, can be very difficult. Furthermore, having made investments in efficiency programs and projects, it is often very difficult to evaluate the financial benefit of those investments.

Energy supply and demand issues did not begin recently. In most countries the electricity and gas sectors has been regulated and decisions regarding the optimal mix of supply and demand investments took place within a legislative and regulatory environment. In the past 20 years natural gas and electricity markets worldwide have been converting to more market-based approaches. "Deregulation" has added a number of new opportunities for valuing energy efficiency. For the most part however, the energy efficiency market is still experimenting with mechanisms to internalize energy externalities in retail energy prices.

Many energy efficiency advocates and policy makers have called for legislation introducing energy efficiency and energy services as a natural complement to the electricity and gas market liberalisation. Otherwise market failures in the energy sector would lead to lower levels of investment in energy efficiency than is economically and/or socially optimal with the final outcome being additional cost to the whole economy due to an imbalance between the supply side and demand side in the energy sector. Better allocation of resources arising from important non-environmental benefits such as deferred and avoided investment in electricity generation plants and network upgrades and improvements in the reliability of energy supply will result in an increase in social wealth.

Market-based instruments (MBIs) that aim at bringing sustainability to the energy sector have been implemented to promote electricity from renewable energy sources and cut harmful emissions. Quota systems (also known as Renewable portfolio standards (RPS)) coupled with tradable green certificate (TGC) schemes have now been developed and tested in several European countries to foster market-driven penetration of renewable energy sources. Another well-known and widely analysed type of MBI is the tradable CO_2 allowance; the first international CO_2 emission trading scheme took off the ground in the European Union (EU) in January 2005 (Bertoldi, 2006).

MBIs hold the promise of efficiently apportioning the risk and value of energy efficiency investments, but they are still in their infancy (Bertoldi, 2005). Recently a number of European countries (UK, Italy, France, the Netherlands, the Flemish region of Belgium) have introduced or are planning to introduce market-based instruments to foster energy efficiency improvements. Some of these schemes are based on *quantified savings targets* for energy distributors or suppliers, coupled with a certification of the energy savings (via white certificates), and a possibility to trade certificates[2]. This policy instrument often targets parts of the sectors (e.g. power generation) that are subject to carbon reduction targets (mainly under cap-and-trade

[2] A tradable certificate for energy savings (TCES), as known as white certificates portfolio involves four key elements (a) the creation and framing of the demand; (b) the tradable instrument (certificate) and the rules for trading; (c) institutional infrastructure to support the scheme and the market (measurement and verification, evaluation methods and rules for issuing certificates, a data management and certificate tracking system and a registry); (d) cost recovery mechanism in some cases.

schemes). All of these mechanisms would benefit from a standard methodology for accounting for project results.

In response to this need for better tools to predict and measure the results of energy efficiency projects, the US Department of Energy, in 1994, initiated a program to assist the efficiency industry to account for efficiency projects. The result was the International Performance Measurement and Verification Protocol (IPMVP, 1997). The IPMVP has been revised twice and is undergoing its third revision in 2006. The IPMVP is currently the only international standard for assessing efficiency impacts (often mislabelled "savings"). However, there are still large gaps to be filled to establish globally-accepted norms for valuing efficiency. As noted by Jim Waltz, the IPMVP does not provide guidance on how to attribute financial value to physical impacts (Waltz, 2004). The IPMVP has just begun to provide practical guidance on developing program and project M&V plans based on uncertainty and risk. The lack of risk metrics to go along with expected results greatly reduces the attractiveness of energy efficiency investments (Mills et al. 2004).

Recognizing that the current IPMVP was of limited use in assessing the financial viability of energy efficiency investments, the IPMVP organization has adopted a new mission and a new name – the Efficiency Valuation Organization (EVO). The new mission is "to develop and promote the use of standardized protocols, methods and tools (EVO Protocols) to quantify and manage the performance risks and benefits associated with end-use energy efficiency, renewable energy, and water efficiency business transactions." The goal is to create a globally recognized center of excellence on quantifying the physical and financial benefits of efficiency projects. Regions and nations may vary in the policies they choose to address energy impacts, but the underlying economic principals of energy efficiency projects are shared around the globe. Regulators, policy makers and practitioners will benefit from a common terminology and framework for assessing and assigning efficiency value.

EVO will provide guidance on identifying and quantifying all of the value that result from energy efficiency investments. In the simplest case, the only term in the value equation will be the quantity of energy saved times a flat rate for that amount. In more complicated cases the value equation will incorporate risk analysis and advanced economic valuations such as hedge value.

Evaluating Efficiency in public programme and private contracts

Efficiency investments take many forms, but most of us are familiar with two predominant mechanisms – *public programs* and *private contracts* (including internal company decisions). In both of these cases the relevant decision makers seek to calculate the cost and benefit of the efficiency investment. Investment decisions under uncertainty are a common problem that is well addressed in the economic and financial literature (Decisioneering). On the energy supply side, there are a number of tools available that collectively comprise the energy risk management industry. Despite some setbacks to the industry in the U.S., the use of financial risk management tools such as forward contracts, long-term contracts, options and swaps is growing worldwide and is an accepted form of risk sharing. Tools for managing risk on the supply side help to dampen, but not eliminate volatility of demand side estimate for the value of "negawatts". The simple fact is that when one makes an energy efficiency investment, there is often very little chance of knowing what the actual value of savings will be more than a year or two hence. Ignoring this uncertainty, as most energy efficiency planners do now, does not make it disappear. In fact, when energy efficiency is allowed to compete directly with other sources of supply in terms of value *and* risk, it can often provide a more attractive investment. (Mathew *et al.* 2004).

Public Programs

Public programs have had to adapt to meet the changing regulatory structures of energy markets. In the past, regulators would allow or dis-allow certain expenditure of the regulated entity. As efficiency became a higher priority in the 1970's, regulators adopted new methods to unbundle supply and demand investments and incentives, allowing utilities to earn money from it. More recently, deregulation (a partial re-regulation) of energy markets has advanced at different speeds around the planet creating a wide range of regulatory environments. Efficiency valuation in each case is a function of market structure and incentives. In California, while the governor, legislature and regulatory officials have made efficiency investments a priority in resource planning, there is no clear picture on how tariffs and incentives will be designed to implement this policy. It is perhaps ironic that the greatest risk facing many efficiency investments is the lack of a stable regulatory process.

While *California* has allowed uncertainty in tariffs to impede the progress of the efficiency marketplace, it has taken the lead in applying uncertainty analysis to its portfolio of energy efficiency programs. The evaluation of California efficiency programs for 2006-2008 will be based in part on the results of a portfolio-wide risk analysis. The risk analysis provides a framework for assigning evaluation resources, including M&V. (Hall, Jacobs, and Kromer, forthcoming). The current risk analysis utilizes databases of historical results (DEER) and promises to become a long-term approach to managing risk and uncertainty in this very large public program.

The *Italian* White Certificate scheme, started in 2005, uses three physical valuation: (a) a deemed savings approach with default factors for free riding, delivery mechanism and persistence; (b) an engineering approach, and (c) a third approach based on monitoring plans whereby energy savings are inferred through the measurement of energy use; in the latter case all monitoring plans must be submitted for pre-approval to the regulatory authority, AEEG, and must conform with pre-determined criteria (e.g. sample size, criteria to choose the measurement technology, etc.). In practice, most of the projects submitted to date have been of the deemed saving variety. There is ex-post verification and certification of actual energy savings achieved on a yearly basis[3]. In principle the metering approach is a more accurate guarantee of energy saved than the standard factors approach (the latter cannot verify details such as location and operating hours of installed CFLs), but in practice it can be difficult to identify the actual saving (e.g. in households there is only one meter for all electricity usage which increases each year due to growth in appliances and can fluctuate with changing household numbers, lifestyle, weather etc.). It may be reasonable for large installations or projects, but may result in high monitoring costs for projects of smaller size (Rezessy, forthcoming).

In *Great Britain* the Energy Efficiency Commitment (EEC) the savings of a project undertaken under the EEC scheme framework are calculated and set when a project is submitted based on a standardized estimate taking into consideration the technology used, weighted for fuel type and discounted over the lifetime of the measure. There is limited ex-post verification of the energy savings carried out by the Government although this work would not affect the way

[3] E.g. in the case of CHP the plant operator has to prove that the plant has run a certain number of hours, etc.

energy savings are accredited in the current scheme; the monitoring work affects the energy savings accredited in future schemes.

The New EU Harmonized Evaluation Framework

Recently the European Union adopted a new Directive (Directive 2006/32/EC of 5 April 2006) introducing a mandatory annual saving target for Member States of 1% of the total energy consumption (averaged over the past 5 years) for a period of 9 years. This target has to be met with energy efficiency policy measures. The annual saving target has to be measured with a new European Harmonised methodology to evaluate energy savings. The new harmonised methodology will include a combination of bottom-up and top down measurement method (Bowie 2005).

A *bottom-up* measurement system implies that savings (or emission reductions), obtained through the implementation of energy efficiency measures, are expressed in relevant quantities and common units and then aggregated with results from other implemented or planned measures. The aggregation of results can be done at company, local, regional and national level, a task handled very well with standardised templates, websites, databases etc., using standardised lists of measures and assumptions on their average lifetimes, estimates of the average energy saving impact and calculations of the total expected or deemed (technical calculation, often ex ante) energy savings.

In a bottom-up system, the impact of measures can usually be estimated before (ex-ante) actual implementation or metering, using deemed savings: metering is required only to calibrate the real effect of such measures and, when necessary, to verify and this can often be done using representative samples. This is an important characteristic of bottom-up measurements because it means the results can be known without waiting several years to receive statistics on energy consumption. Bottom-up could also be implemented ex-post by using engineering models. An additional advantage of using bottom-up measurements is the additional information obtained on exactly which policies and measures deliver the savings.

While bottom-up measurements could have a high degree of precision for many types of measures, they are difficult to apply to certain types of measures, especially those taken in the past ("early action") and lacking data, and for certain types of more cross-cutting measures such as energy taxes. Unless the total market for specific energy measures is also monitored, bottom-up calculations can fail to capture multiplier effects or market transformation, "*autonomous*" market development and miss "*rebound effects*", "*free-riders*" and "*free-drivers*" (Bowie 2005). In the case of general, untargeted information campaigns, it becomes difficult to calculate the energy savings that result from the behaviour changes induced by the information made available. Bottom up evaluation could sometime result in overestimating the savings, as there may be overlaps between the effect of two different policy measures. A top-down system is thus a necessary part of any national, regional or large system for measuring energy efficiency improvements, not only during the time a harmonised bottom-up system is being developed, but even afterwards.

A *top-down* measurement system is one in which the amount of energy saved is calculated using more aggregated sectoral levels of energy consumption and savings as the starting point. Adjustments of the annual data are then made for a number of extraneous factors such as degree days, structural changes, product mix, purchasing power parity, etc. to derive a measure that gives a fair indication of e.g. total energy used per unit of GDP, energy used per square meter of housing space or energy per person-kilometre.

Top-down calculations often lack the possibility to measure *ex ante.* The long time required for collecting statistics from the EU Member States adds to the problem of using top-down methods to obtain rapid feed-back for making policy decisions. Top-down calculations are also often less accurate than bottom-up systems because aggregations of sometimes heterogeneous sector statistics are used in such calculations.

Private Contracts

In private contracts for energy services, the parties must allocate the responsibility for energy asset purchase, maintenance and long term energy use. A common form of energy service contracting involves a host facility and an Energy Services Company (ESCO) under an agreement called an Energy Savings Performance Contract (ESPC). The ESPC contract outlines the responsibilities of the host and the ESCO. The goal is to optimize the productivity of the host facility. These site-specific contracts allow the parties to allocate all of the risks associated with the project, in addition must establish the baseline and identifies the M&V requirements

The role of the ESCO is often to implement capital stock improvements and to deliver infrastructure improvements to facilities that lack any of the following: energy engineering skills; manpower or management time; capital funding; understanding of risk; and technology information. The ESCO is normally taking a large part of the project risks. Often, the ESCO offer a performance "*guarantee*", which can take several forms. The guarantee can revolve around the actual flow of energy savings from a retrofit project. Alternatively, the guarantee can stipulate that the energy savings will be sufficient to repay monthly debt service costs. One of the key benefits to the facility owner is the removal of *project non-performance risk* which cannot happen in the absence of the ESCO being used. The cost of a guarantee is approximately 8% of total financing costs, but it does mitigate an element of risk for those clients who are risk averse.

However, finding the optimal mix of efficiency investments for any plant requires knowledge of future tariffs and other variables indicated below. The ESCO audit should serve as a financial investment guide as to how the physical assets of an organization can be improved, this new concept has been disseminated as "Investment Grade Audit" (Hansen). Energy performance contracting is primarily a financial transaction, and risk management is essential to its success.

As energy efficiency investments can have terms of well over 10 years, the valuation uncertainty can be significant. Enron Energy Services produced risk-based curves to address this uncertainty in private contracts. (Mathew, et al).

Risk Terms – Time, Cost and Value

Earlier we mentioned that the IPMVP has become the international standard for quantifying the physical results of energy projects. There remains the challenge of translating the physical impact into financial rewards. As discussed in the previous section, energy markets worldwide have attempted to deregulate with varying degrees of success. Even within fully regulated energy markets, the number and complexity of rate structures precludes a simple solution to this problem of translating physical results to financial value. It is perhaps ironic that the classic 1961 text on rate structure design, "Principals of Public Utility Rates," identified the need for price certainty to allow energy consumers to make informed purchasing decisions. (Bonbright, 1961) (http://www.terry.uga.edu/bonbright/about/center/)

Nothing of substance has changed. In regulated markets, the regulators, through the setting of tariffs and other incentives, play a critical role in establishing the uncertainty of efficiency investments. The following are the most important terms in the efficiency valuation equation:

- Tariff: Regulated utilities perform a host of calculations to come up with equitable tariff structures. The impact of tariff design on efficiency incentives is obvious. Recently, there has been an increased interest, and increasing debate, on the role of retail tariffs that include time of use (TOU), real-time pricing (RTP) and demand-response programs (DR). Each of these tools is forced to make a compromise between complexity of implementation and equity among
- Externalities & emissions credits, NOx, SOx, CO2, security: While still in its infancy, there is a growing interest for instruments that efficiently allocate the external costs of energy use. Indications from early trading of CO2 credits has not yet risen to the level that will significantly impact project valuations, but with increased use there is a growing chance that these policy instruments will benefit energy efficiency investments (Bertoldi, 2005)
- Hedge value: Energy consuming assets represent a "short" position in the energy markets. A "short" position is risk terminology that implies a relationship between future energy prices and price risk. Modern energy supply markets allow energy producers and end-users to protect against volatility by using financial instruments known as hedges. Hedges are effectively insurance instruments where a market participant can pay a relatively small amount to reduce the uncertainty in future prices. Energy efficiency projects provide exactly the same risk reduction function, and hence represent an equivalent value to the implementer.
- Productivity – easy to qualify, difficult to measure. The purpose of any energy-using device is to create some value for the end-user. In the case of commercial and industrial end-users, the economic productivity of energy assets can be measured precisely. Technological innovation in energy efficiency often includes innovations that improve the productivity of the system as a whole. One example is the improved lighting quality provided with electronic ballasts. Energy calculations alone may not capture the increased value from improved technology.
- Associated maintenance cost reductions: Owning and operating an energy asset entails costs beyond just the raw fuel. Efficiency valuation must include all of the life-cycle costs of asset ownership.

The Response – Putting a Value on Uncertainty

Assuming that we can assign expected values and uncertainties to the previously mentioned terms in the efficiency valuation equation, what is the role of verification and how much should be spent on it? The IPMVP was designed to help parties to develop an M&V plan for their specific project, but it does not address how the parties should agree on the amount to invest in the M&V. Because the universe of possible projects/investments is effectively infinite, the IPMVP recommends that the parties involved in the contract take three steps.

First, identify all of the values and risks resulting from the energy project. Second, assign responsibility for each of the risks and values. Third, create a cost-effective M&V plan that takes into account the specific risks for that project.

As mentioned above, it is critical to match the physical results to the potential financial value. And it is equally critical that M&V costs be kept reasonable. The goal is to design the optimal "Negawatt meter". The design parameters are the expected uncertainty in the measured system and the measurement uncertainty of the instrumentation. The optimizing equation requires the designer to place a value on the marginal reduction in uncertainty from the last increment spent on the M&V system.

We now get to the final problem of efficiency valuation. We have outlined above how energy efficiency projects are similar to other investments in that there is a unique risk and reward relationship for each project. Some of the project risk results from regulatory and market uncertainty that affect the underlying value of the savings. Other terms in the value equation add uncertainty to project value as a result of related market values such as Carbon mitigation, volatility of energy markets and productivity of the plant. Investment capital will flow to energy efficiency projects and be priced to the degree that these risks and rewards are "better" or "worse" than other investments. It is in this context that the authors see the opportunity for a new approach to energy efficiency investments that focuses equally on risk and reward. The mantra of this new approach is "Identify, Quantify, Manage…. Risk". The expected return from most energy efficiency investments is often well above other investments with equal risk profiles. The leap required to clear the investment hurdle is an effective risk evaluation to accompany the expected value of the investment.

This provides a context to answer the question "how much should I spend on M&V"? Where a value can be placed on identifying and potentially reducing the uncertainty in the investment, the proper expenditure on M&V occurs when the last increment (marginal cost of M&V) equals the marginal value from risk reduction. While easier said than done, this approach informed the M&V planning of a large ($300M) DSM program that sought to optimize M&V expenditures (Mathew, *et al.* 2004).

The goal of the M&V activity was to mitigate, not eliminate, the uncertainty in a large portfolio of energy efficiency investments. The approach to cost-effective valuation included the creation of a data-base of results of energy projects. The database was designed as an actuarial tool. It included reported results from a range of programs and projects. Where possible, uncertainties were included with expected value of project results.

The initial steps that the California Public Utilities Commission (CPUC) Energy Division has taken toward measuring uncertainty and risk in the 2006-2008 energy efficiency portfolio show great promise toward identifying the optimal allocation of limited evaluation resources and improving the reliability of efficiency investment forecasting.

In the European context efficiency valuation is a key component of White Certificates schemes, which impose saving targets on energy distributor or suppliers. Evaluation need to be accurate enough to assist transferable property rights on the energy savings and at the same time not increase the overall system cost. In addition, the new energy saving targets for EU Member States will demand the creation of an harmonised methodology for assessment of national efforts to meet the saving targets, accurate enough to attribute saving to individual policy measures, and at the same time to have a reasonable cost (no more than a few percent of the overall public budget used to achieve the savings).

New financing mechanisms for end-use efficiency are emerging. As M&V protocols become more standardized in the industry, and the possible inclusion of insured savings emerges, the ability to transfer financial risk to larger, more stable financial institutions will arise. Zurich American Insurance already offers such a mechanism to ESCOs (Dan Goldberger, 2003). The approval process is slow for ESCOs to be underwritten due to the lack of uniformity in the industry today. As the industry matures, a large secondary market will start, and performance contracts will become a more liquid form of investment capital to investors seeking strong yields. The Carbon market, and in particular the project based mechanisms such as CDMs, represent a potential source of investment capital for efficiency project. White Certificates is also a new source of financing for energy efficiency projects. All these MBIs rely on M&V protocols, which are accurate enough in attributing property rights of energy savings.

Conclusion

Energy efficiency is a reliable mechanism for managing our energy future. Whether as a common sense decision or a smart financial investment, or imposed through legislation, energy efficiency implementation will benefit from better tools for calculating the value and uncertainty of planned efficiency activities. Efficiency Valuation goes beyond the quantification of physical results by addressing the financial uncertainties associated with the avoided costs. Efficiency Valuation acknowledges risks and seeks to quantify and manage them – not ignore them. The goal of EV is to identify the optimal mix of planning, modelling, measurement and analysis to accompany energy efficiency investment programs and projects. Enhanced efficiency valuation will lead to increased investment in energy efficiency projects. The Efficiency Valuation Organization will build on the international success of the IPMVP to advance the application of cost-effective M&V around the globe.

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