Energy Efficiency (2008) 1:313–321
DOI 10.1007/s12053-008-9019-5

Measurement and verification strategies for energy savings certificates: meeting the challenges of an uncertain world

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Received: 10 November 2007 / Accepted: 13 March 2008 / Published online: 19 August 2008

Abstract End-use energy efficiency is a cost-effective and rapidly deployable strategy for significantly reducing greenhouse gas (GHG) emissions and energy costs. Energy savings certificates (ESCs)—instruments assigning the property rights to energy savings or attributes of those savings—are becoming an effective tool for meeting energy savings and GHG targets. The efficacy of ESCs will depend on the market's ability to (1) verify the amount of savings that they certify along with the uncertainty of those savings (i.e., quantify their value), (2) clearly assign ownership rights to that value (i.e., state exactly who owns what) and (3) efficiently buy and sell those rights between interested parties (i.e., conduct simple transactions). The measurement and verification (M&V) system governing ESCs will critically impact whether these three criteria are satisfied. An M&V system for ESCs requires the fundamental elements of an M&V system for any regulated energy-efficiency program, but must also address more explicitly the above-mentioned criteria. In this paper, the authors discuss the International Performance Measurement and Verification Protocol (IPMVP) and specific elements of an M&V system that address components of an ESC system.

Keywords Measurement and verification · Energy savings certificates · White credits · Energy efficiency · Transaction costs

Introduction

Economist Ronald Coase was awarded the 1991 Nobel Prize for his 1960 theorem arguing that resources will be efficiently allocated if transaction costs are sufficiently low and property rights are clearly assigned (Coase 1960). As the world urgently seeks market-based solutions to mitigate climate change, Coase's theorem is particularly relevant to developing markets for selling rights to the savings generated from energy efficiency—the most cost-effective and rapidly deployable option for significantly reducing greenhouse gas (GHG) emissions.

Energy savings certificates (ESCs) are instruments that assign property rights to the savings or attributes of the savings from energy-efficiency projects. ESCs (also known as White Credits or White Tags) are becoming a useful tool for meeting energy-efficiency and GHG targets in various programs around the world. The efficacy of ESCs will depend on the

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market's ability to minimize transaction costs and clearly assign property rights. Market participants must be able to (1) verify the amount of savings that they certify along with the uncertainty of those savings (i.e., quantify their value), (2) clearly assign ownership rights to that value (i.e., state exactly who owns what) and (3) efficiently buy and sell those rights between interested parties (i.e., conduct simple transactions). The measurement and verification (M&V) system governing ESCs will critically impact whether these three criteria are satisfied.

A well-designed M&V system for ESCs will share many of the same fundamental elements as a well-designed M&V system for a regulated energy-efficiency program. The International Performance Measurement and Verification Protocol (IPMVP) provides a well-established framework in this area and over the past 15 years has proven effective in addressing the critical issues that arise in every energy-efficiency transaction The ESC M&V system must also address more explicitly the above-mentioned criteria. It must be rigorous enough to ensure real, verifiable, energy savings (criteria 1 above), while simultaneously being flexible and efficient enough to minimize transaction costs (criteria 3 above). This is no easy task as the underlying "asset" that securitizes the value of this property—the savings generated by an energy-efficiency project—is, inconveniently, not directly measurable and, therefore, always uncertain.

A growing body of literature discusses the policy context, experiences and benefits of ESCs[1]. Although this paper focuses primarily on the elements of M&V systems that support ESC systems and reduce the transaction costs, briefly revisiting a few of these other issues may be helpful.

As Hamrin et al. (2007, p. 69) concisely state, an ESC program is "a policy tool and not a formal policy." ESCs will be very difficult to value in the absence of a clear policy goal. Examples of such goals include energy-savings targets, energy usage caps, GHG reduction targets and GHG caps. Energy and GHG policy goals can be stated as amounts (i.e., a difference between what actually happens and what would have happened without the given policy), or as caps (i.e., a maximum allowance). The policy definitions, therefore, of baseline and additionality are critical to valuing an ESC and such definitions must be captured by the M&V system. (Additionality will be discussed in more detail below.) ESCs can become more valuable in a broader policy context when coupled with other policy tools such as a GHG cap-and-trade market that gives credit for ESCs or forward capacity electricity markets like that of New England's Independent System Operator (ISO-NE) that allows energy-saving resources to bid along with generation resources into the capacity market.

The primary benefit of ESCs is simply that they expand the market for energy efficiency. This then shifts down its cost-curve, increases the reliability, consistency and transparency of efficiency, and results in more cost-effective savings. The difficulty of precisely isolating and quantifying these marginal effects is compounded by the current existence of many simultaneous market factors as well as the general novelty of ESC markets. (New South Wales, which began the first program in 2003, Italy, France, and Great Britain currently have the only four large-scale ESC markets.)

This paper focuses primarily on the elements of M&V systems that support ESC systems and reduce transaction costs. We begin with the fundamental principles of the IPMVP, which continue to provide a relevant and invaluable foundation the development of M&V systems. We then discuss specific elements beyond the IPMVP that are critical for successful ESC systems, include managing the uncertainty in energy savings, ESC tracking systems, training, standardization and the concept of additionality. We then discuss how these topics can reduce transaction costs. We briefly discuss the policy context of ESCs and conclude with our recommendations.

IPMVP: A foundation for M&V related to ESCs

IPMVP background

The IPMVP was developed as part of a program initiated in 1994 by the US Department of Energy in response to the need for better tools to predict and measure the results of energy-efficiency projects. It has been revised three times since its initial publication in 1997, the most recent completed in mid-2007. The IPMVP is currently the only international

[1] For an excellent overview of ESCs, the authors direct the readers to Hamrin et al. (2007)

standard for assessing efficiency impacts (often mislabeled "savings"), although there are still large gaps to be filled to establish globally accepted methods (Bertoldi and Kromer 2006).

The IPMVP's flexible framework of options allows M&V practitioners to craft the appropriate plan for each situation and instill confidence in those hoping to reap the benefits of the project being evaluated. Clear definitions of terminology and heavy emphasis on consistent, transparent methods are the core precepts of the IPMVP. The details may differ from project to project, but the options and methods presented in the IPMVP have been successfully implemented in thousand of projects and programs in dozens of countries.

IPMVP's principles of M&V

While the 2007 edition included numerous improvements and clarifications, the basic structure of the IPMVP remains the same. This latest version retains the four M&V plan options and maintains a strong focus on drafting and documenting the appropriate M&V plan for each situation (EVO 2007).

The IPMVP starts with a simple premise—"savings" is too general a construct from which to construct settlement methods. Given the transient nature of most energy loads, parties wishing to agree on the results of energy-efficiency projects must craft an M&V plan that addresses all of the ambiguities and complications that arise over the course of a given "performance period." Further, the parties must plan to allocate whatever risks may arise. Due to transaction cost considerations, the parities must make simplifying assumptions. The IPMVP provides general guidelines and standard terminology for crafting specific M&V plans. The principles of the IPMVP are accuracy, completeness, conservativeness, consistency, relevance and transparency.

ESC M&V requirements beyond IPMVP

In 1997, when the first version of the IPMVP was published, its authors considered that improved M&V methodologies could enable secondary markets[2] for energy efficiency and GHG trading schemes. However, the target audience was primarily energy savings performance contractors and participants in regulated energy-efficiency programs. The document provided little discussion on specific issues relating to ESCs or methods relating to secondary markets. The present paper, after discussing three fundamental challenges of M&V systems that the IPMVP does address, discusses five issues not treated in the IPMVP that relate to ESC markets: managing the uncertainty in energy savings, ESC tracking systems, training, standardization and the concept of additionality.

Challenges

The challenges associated with M&V for trading ESCs are similar to those for any other M&V system:

1. *Savings measurement:* The underlying "asset" that securitizes the value of an ESC—the savings generated by an energy-efficiency project—is not directly measurable and, therefore, always uncertain.
2. *Savings persistence:* Savings are inherently dependent on behavior which is driven by many factors beyond energy usage. A factory may choose to either shutdown or extend operations from two shifts to three shifts in response to either shrinking or growing demand. Any ESCs may then be subject to a re-evaluation caused by non-routine adjustments.
3. *Transaction size:* Energy-efficiency projects typically involve multiple investments made across multiple facilities. The savings from these projects are typically small as compared with energy supply resources such as generators or renewable energy. The result of many small, disaggregated projects is high transaction cost per unit of resource.

Clearly, meeting the challenge to develop a sound M&V system in the face of many disaggregated energy resources of un-measurable value and uncertain persistence requires creativity.

Uncertainty

The above challenges result in uncertainty around the value of ESCs. Efficient markets discount the price of products with highly uncertain value. A growing body

[2] Seconday markets might include such financial instruments as bundled loans or other securities

of literature discusses the uncertainty of energy-efficiency projects, and the IPMVP (EVO 2007), ASHRAE Guideline 14–2002 (ASHRAE 2002) and the California Energy Efficiency Evaluation Protocols (CPUC 2006) all emphasize uncertainty analysis for M&V.

Uncertainty can be defined as the difference between what you think will happen and what actually happens. The authors suggest an approach to uncertainty: *identify/quantify/manage*. First, uncertainties must be identified. However, identification alone does not suggest any given course of action. After exploring various methods of quantifying the uncertainty, one can best determine how to manage it.

Markets have historically developed methods for valuing—or quantifying—uncertainty. Credit rating agencies rate debt instruments according to their riskiness or ability to pay back the debt. The more risk, the greater the risk-premium. Rating agencies are sometimes wrong, and markets adjust. In addition, bonds will trade at a market price regardless of these ratings. When the market's implied risk-premium diverges significantly from the rating-body's risk-premium, the market is out of equilibrium and will eventually adjust. This dance continues along the market's experience curve as additional information and data are released.

These market mechanisms have been adopted by ESC markets. For example, Australia's market adds a discount factor of 0.8 for projects that historically have uncertain savings. Enron Energy Services (EES) developed a system to quantify and manage the risk from standard energy-efficiency projects (Mathew et al. 2004). The California Public Utility Commission (CPUC) adopted similar methods to inform the allocation of the 2006–2008 funds to evaluate the energy efficiency programs run by the state's four investor-owned utilities (IOUs) (CPUC 2006). California's largest IOU, Pacific Gas and Electric Company (PG&E) built upon this model to perform an in-house analysis of its risk exposure (Ridge et al. 2007).

The following sections discuss ways to manage uncertainty either by reducing it or pricing it in.

Tracking systems

A well-designed tracking system is critical to the valuation of the ESCs and the reduction of the associated transaction costs, because distribution of property rights requires reliable records of the property and its ownership.

Examples of tracking systems

Although many information technology (IT) systems have been developed around the world to track the results of energy-efficiency projects, renewable energy credits (RECs) and ESCs, we highlight the following four as well-tested, successful examples.

Enron Energy Services EES developed a tracking system for energy-efficiency projects that were commodified and traded in a private wholesale market at EES (Meyers and Kromer 2006). During its three-year life, the web-based Project Capture and Communication System (PCCS) recorded and transacted 3,706 energy-efficiency projects at over 1,000 sites for 22 end-use customers across the United States. These projects represented a portfolio of US $266 million of capital investment with associated energy savings that generated an internal rate of return of 29% (roughly a three-year payback) and nearly 200,000 annual avoided tons of carbon.

California utility A California utility implemented a tracking system for energy-efficiency projects to support a program targeting small-commercial customers (Meyers and Guthrie 2006). The web-based system connected with field-auditors using mobile computing technology at 3,350 customer facilities. Detailed project data including measure-types and unit-counts were sent wirelessly simultaneously to the program administrator's central tracking system as well as to the contractors installing the retrofit. Ex-post M&V was simplified as the M&V professional could view an online inventory of all energy-savings measures which could quickly be verified and instantly uploaded to the central database. The tracking system automatically generated compliance and management reports and was mined to identify best-practices.

Database for Energy Efficient Resources Since 1996, California has maintained the Database for Energy Efficient Resources (DEER) to track well-documented energy savings, peak savings, costs and effective-useful lives of various energy conservation measures (CPUC 2007). The current version holds 130,000 unique records and data on 360 measures. While this database is more knowledge repository than transaction-based system, it has many elements that overlap with transaction-based systems and is being used increasingly to inform calculations in California's IOU energy-efficiency portfolio. Planning is underway to integrate, where possible, the results of the significant evaluation, measurement and verification (EM&V) activity the CPUC is directing for California's 2006–2008 energy-efficiency portfolio. Such activities, performed with a longer-term goal of identifying the most effective and most reliable energy-efficiency measures, could greatly enhance future ESC schemes in California.

Renewable energy credits Leveraging the widespread and robust transaction and tracking systems for renewable energy credits (RECs) should certainly be considered as a viable option for tracking ESCs (AIB 2007). These systems resemble electronic banking systems and record the ownership of the REC from its generation through its retirement. Sixteen European countries are active in the European Energy Certification System (EECS) that has issued more 157 million 1MWh renewable energy certificates. The Association of Issuing Bodies (AIB) was developed to assure the interoperability of tracking and accounting systems in Europe (AIB 2007) and the North American Association of Issuing Bodies (NAAIB 2007) is beginning to coordinate a similar mission in North America with specific objectives to "encourage trade, create a common currency for renewables, prevent double counting, and support existing and emerging markets for renewables." (NAAIB 2007) In the US, each ISO is maintaining a separate system for tracking and trading RECs. However, REC systems are not currently compatible with ESCs, which require more detailed information and originate from more diverse sources.

Elements of successful tracking systems

The following four elements are critical to a successful tracking system and are at the foundation of the above-described PCCS system.

1. *Taxonomy:* A common taxonomy must be developed prior to developing the tracking system to ensure that its users can compare common elements across the system and access the appropriate level of granularity. Users must decide if savings should be captured by technology, end-use or facility. The taxonomy should consider the method of M&V as it is possible that an ESC market may price-in a small premium for a project using different M&V strategies.
2. *Knowledge Base:* A market for ESC requires a tracking system that will increase best practices as the data are mined to quantify and evaluate uncertainties. The tracking system not only becomes an authoritative repository of ownership, but also can serve as a knowledge base that will inform market participants about opportunities. For example, observing a particular energy-efficiency innovation (via a smart design or a smart technology) that is commonly deployed in one region but not in another may identify an untapped source of cost-effective efficiency that has not been accessed or utilized, due to uninformed market participants or market barriers. Another query of the knowledge base may reveal that the particular savings of a commonly deployed technology have a relatively small or relatively large variation. In such a case, the ESCs may increase or decrease any discounting (either implied or explicit) in the price of ESCs for those technologies.
3. *Work-flow support:* Using the tracking system to support the work flow of issuing ESCs keeps transaction costs low and data availability high. System users (including those managing energy-efficiency projects) can enter data directly into a web-based form from which certificates are issued by the issuing body. While some may find this requirement onerous, it eliminates duplicating data entry and, if designed, well, will streamline the overall project management. Data will be current and accurate if doing so is required by the process.
4. *Transaction-based system*: The tracking system should be integral to (or inherently linked with) the transaction system. The platform used to buy and sell ESCs should populate the knowledge base and track ESC resources and ownership. This requirement forces discipline and accuracy. All energy-saving projects and all associated ESCs involved in a transaction will be captured at the time of transaction. There is no need for updating databases. The workflow will be modified as needed.

In addition to the four above-described general design elements, a robust system will also need to support additional detailed functionality, such as managing proper rights, certification, rules that avoid double-counting of value, and a method of tracking a change in a certificate's value that could be caused by non-routine adjustments or updated performance data.

Training

Numerous communities and industries are facing the same questions about verifying and reporting reductions in energy and emissions. A common source of credible expertise is needed to allow everyone to manage the quality and certification of practitioners. EVO, in conjunction with the Association of Energy Engineers (AEE), offers the Certified Measurement & Verification Professional program (CMVP).[3] The objectives of the certification program are (1) to raise the professional standards and improve the practice of those engaged in measurement and verification and (2) to identify persons with acceptable knowledge and award special recognition to those professionals who have demonstrated a high level of competence and ethical fitness for measurement & verification. A training course in "Fundamentals of Measurement & Verification" is offered at various locations for two and one half days prior to the certification examination. The course is available but not required for the CMVP examination.

While EVO's general CMVP training program certifies professionals in the fundamentals of M&V, as defined in the IPMVP. An ESC program could require that practitioners have at least the skills of a CMVP with, perhaps, an "ESC Enhancement" training on the specific rules, goals and systems of each ESC program.

Standardization

Improving M&V and reducing transaction costs requires standardization. Developing standards requires developing a common taxonomy. When the range of performance and operating parameters are well understood, the responsible administrative body can publish values for deemed savings. Research studies that determine these savings must be updated periodically (which may affect the future value of ESCs).

The administrative body can prescribe standard calculation methods, M&V options (potentially based on the four IPMVP options), baseline assumptions or baseline methodologies. Many technical manuals prescribing various methodologies have been developed for programs around the world. Improving these standards and training according to them will improve the consistency of an ESC. For example, about 80% of UK ESCs were generated from improvements in residential insulation. The value of these measures can vary widely based on the existing thermal properties of a home, types of windows, existing insulation levels, occupant behavior, and weather. However, a simple calculation tool could standardize the assumptions. If pre- and post-infrared measurements and blower-door testing significantly improve the reliability of savings claims, the administrating body may conclude these costs are worthwhile and require such measurement prior to certification.

Standardizing measures, however, is not always the most appropriate route for evaluating the most innovative energy-efficiency projects, that integrate various systems and an entire design process in either new construction or advanced retrofits. In such cases, standards can be developed around energy-conversion efficiency or normalized efficiency benchmarks. In a complex chilled water system retrofit, for example, the energy conversion efficiency is the ratio of "useful" power (or energy) out of the system (in tons of cooling, in this case) to electrical power (or energy) into the system (in kW). A standard taxonomy would define measures by end-use and system. When a chiller retrofit applies for a certificate, the systems pre- and post-kW/ton would be recorded and tracked. ESCs of common projects could then be compared to develop a common metric of variability and, hence, uncertainty.

When residential and commercial building codes are in place, the administrative body may provide a calibrated simulation to act as a common baseline. This not only reduces the costs for all market participants, but also ensures that a common set of assumptions is used.

We recommend combining a market-push and a market-pull approach to developing these standards. Enough experience with energy-efficiency programs

[3] Approximately 300 individuals have been CMVP-certified at time of writing. Training has been conducted in South Africa, Taiwan, and China. EVO recently completed its first "train-the-trainer" course in Taiwan. This marks the first attempt to create a sustainable source of trained professionals to conduct IPMVP-standard M&V. See www.evo-world.org for more on EVO's training.

has been gained over the years to know the most effective energy-saving measures for a given region (DEER is the repository for these results in California). From these measures, the standards definition can be developed. Then, these measures can be sorted into those with "deemed savings" and those measured with "standard calculations"[4]. The administrators will continually monitor the mix of projects and determine if new standards should be developed.

Standardization makes both training and verification easier. Standard measures or standard improvements in end-use efficiencies can be documented, demonstrated and trained. In addition, field installation can be sampled and verified when all relevant information is in a database accompanied by a checklist that updates automatically within the same database.

Additionality

Additionality is primarily a policy issue, but it becomes a critical element of M&V when evaluated based on information gained from the M&V. When a public program administrator takes credit for, or funds a portion of saved energy (or avoided GHG), policy-makers and citizens rightly ask, "Would those savings have occurred anyway in the absence of our policy or program?" If the answer is "no," these savings are considered *additional* to the business-as-usual case and satisfy the *additionality* criterion. This difficult and artificial criterion can never be answered with absolute certainty and complicates the allocation of ESCs. Furthermore, if stricter building codes are instituted, raising the baseline energy-performance requirements, an additional test might result in lower savings allocated to projects. These are individual policy and program decisions that have to be consistent with overall program goals.

Determining additionality on a case-by-case basis will increase transaction costs. Therefore, it may be more cost-effective to address it at the technology or portfolio level and add attributional factors. Energy-efficiency programs have used attribution factors to determine program net savings impacts by considering to what the savings were *attributed*. Attribution studies can be highly uncertain, but aim to quantify free-ridership (i.e., energy savings that would have happened without the policy or program), and spillover (i.e., energy savings that were not directly accounted for within a policy or program, but occurred because of some aspects of it).

[4] "Standard calculations" are accepted engineering algorithms that support energy savings estimates

Transaction costs

Quantifying transaction costs

Transaction costs are arguably the biggest hurdle to instituting an ESC system. Current energy-efficiency project transaction costs are estimated to be in the range of 2%–40% of a project's total costs (Mundaca and Neij 2007). Transaction costs have been difficult to compare across programs and projects because the elements of transaction costs are not defined consistently and, therefore, not accounted for consistently. Mundaca and Neij (2007) describe various determinants of transaction costs in their report to the European Commission's Intelligent Energy Programme.

Reducing transaction costs

Instituting standards and tracking systems will significantly reduce transaction costs. More transparent reporting of uncertainties (both systematic and idiosyncratic) will allow the buyers of the associated ESC to add an appropriate risk premium associated with reported uncertainty. If these methods are reliable (even if highly uncertain), the market will quickly price-in the risk with limited additional investigation (Mathew et al. 2004).

A tracking system reduces transaction cost in two ways. First, it provides a single point of data entry with a standard set of data using a standard taxonomy accessible to all market participants. All transactions can take place in a common market viewed from a single computer screen, thus eliminating the costly "double coincidence of wants" inefficiency that adds transaction costs in barter-based markets.[5] Second, a well-designed tracking system will serve as a knowl-

[5] The double coincidence of wants problem is an important category of transaction costs that impose severe limitations on economies lacking money and thus dominated by barter or other in-kind transactions. The problem is caused by the improbability of the wants, needs or events that cause or motivate a transaction occurring at the same time and the same place. The term "double coincidence of wants" is attributed to William Stanley Jevons (Ostroy and Starr 1990, p. 24).

edge base from which best-practices are developed, and the values of various measures and technologies can be transparently compared to identify which measures carry the most risk and the key drivers of that risk. In addition, the systematic or idiosyncratic nature of such risks can be explored with will affect their associated risk premia. Then, those sensitive parameters can be measured or evaluated, resulting in spending evaluation funds only where they will be effective.

Standardization reduces transaction costs because the market is familiar with standard products eligible for trade. In addition, standardization can assist in educating the market, as it is easier to teach standardized measures.

Evaluating additionality on a case-by-case basis is highly inefficient. Standard measures with known uncertainties and in a common database can be evaluated for additionality on a portfolio basis in a manner consistent with the goals of the policy or program.

A market for lemons: relearning the market's lessons[6]

Historically, markets have developed mechanisms for reducing transaction costs and other inefficiencies when the gains from trade are significant to market participants. Economist George Akerlof received the 2001 Nobel Price for his work describing market failures in the market for used cars (Akerlof 1970). Akerlof's example resembles ESC markets in two important ways. Both markets trade products of heterogeneous quality. Also, in both markets, the buyer and seller have asymmetric information because the seller generally has more knowledge about the item being sold than the buyer.

Akerlof argues that these imbalances lead to market failure in the used-car market. We see the same characteristics—and potential for failure—in the ESC market. There are four primary methods of avoiding this failure.

1. *Expert advice*: The buyer can hire a specialist to distinguish between a "lemon" and an item of value. CMVPs could serve as these specialists for the ESC market.
2. *Brand power*: Well-respected brand names give the buyer trust. Buyers will often pay a premium for high-quality brands because of the perceived benefit of avoiding a "lemon." ESCs will also have more value if they are developed by reputable engineering firms, and governed by highly compliant programs or reliable technologies.
3. *Sorting:* Sorting helps buyers avoid "lemons" by highlighting the primary dimensions that define product heterogeneity (e.g. life insurance companies sort prospective clients by age, gender, and smoking history). As the knowledge base contained in the ESC tracking system grows, M&V professionals and program administrators can apply this principle as they learn how to best sort various types of ESCs underwritten by various energy-efficiency projects and technologies.
4. *Pricing*-in: The buyer can compensate for asymmetric information by simply pricing-in a risk premium. If the average person who buys health insurance is 30% sicker than they look, then insurance companies will add a 30% pricing premium to insurance policies. Classes of risky energy-efficiency projects may also develop such premia for asymmetric risks.

Such historic lessons can help identify creative methods of reducing transaction costs associated with the emerging purchases of high-quality ESCs.

Recommendations

In theory, markets for ESCs should add liquidity to energy-efficiency projects by increasing the likelihood that the energy savings asset, having been certified, can quickly and reliably be converted to a tradeable asset. Increasing liquidity both increases market efficiency and desirability, meaning both a reduction in the cost of energy efficiency as well as an increase the amount of energy-saving projects. In short, people are more likely to do things that are easier, less risky and more profitable. However, these benefits entail costs that have not been carefully quantified in any of the existing ESC markets. The ESC markets should include the methods discussed in this paper to reduce transaction costs and increase the

[6] "Lemon," as used here means a defective or unsatisfactory product. In American English it is commonly applied to used cars. George Akerlof's 1990 paper on "The Market for Lemons: Quality Uncertainty and Market Mechanisms" discusses the failure of the used car market.

value of ESCs. For example, without the best practices discussed above, the full benefits of an ESC market may not be realized as it will appear too cumbersome or costly.

To help develop these markets, the authors recommend continued development of, adoption of, and training and certification on the IPMVP methods. Regional, national and international databases of project results should continue to become more available and transparent to jump-start the world's knowledge base on the value and uncertainties associated with various energy-saving projects. Integrating such databases requires a standard taxonomy including standardized ECM definitions and uncertainty parameters.

Many organizations are exploring market-based solutions to achieving energy-efficiency goals and reducing GHG emissions. There continues to be an opportunity for organizations to coordinate their efforts. To further advance these efforts, EVO and the ESC community should continue to collaborate with other market participants such as the Chicago Climate Exchange (CCX), the European Climate Exchange (ECX), the Clinton Global Initiative, the Energy Foundation, the World Bank, the US Department of Energy, the US Environmental Protection Agency and the International Energy Agency.

Changing technology, rising energy prices and new public policies create opportunities for investing in energy efficiency. Profitable energy-efficiency projects abound. Additional market-mechanisms such as ESCs may prove to be effective tools to exploit such markets. An intelligent market design and supporting infrastructure will be critical in the global realization of these benefits.

Acknowledgements The authors would like to thank EVO and its supporters, subscribers and user-community for their continued support.

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