Leveraging the Synergy of Energy Efficiency and Greenhouse Gas Reductions in a Load-Based Cap System

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ABSTRACT

Rules and procedures for quantifying greenhouse gas reductions from energy-efficiency practices are currently being developed in several States. However, energy-efficiency regulatory practices have existed for more than thirty years. This paper explains how existing methodologies for certifying energy savings can be applied to certify greenhouse gas emissions reductions. Topics covered include a more precise method to convert saved electricity into saved greenhouse gas emissions. The paper also discusses the unique issues of integrating energy efficiency into the cap-and-trade system for regulating emissions of a "load serving entity".

Part I - Introduction and Background

A synergy is developing between energy-efficiency delivery systems and regulatory frameworks to eliminate greenhouse gas emissions. Fundamentally, this makes sense for several reasons. Energy-efficiency projects almost always result in the quantifiable reduction of greenhouse gas (GHG) emissions, since the majority of electrical and space heating power in the USA is fired by fossil fuels. Also, there is a large potential resource of available efficiency projects throughout the power utility system, and as new efficiency technologies continually enter the marketplace, this resource will remain present far into the future. Finally, the value of saved energy is very large, and it is in addition to the value of GHG emission reductions. Thus, energy-efficiency projects provide a very cost-effective method to reduce GHG emissions (Prindle, Elliot & Shipley 2006). The designers of load-serving-entity cap and trade systems in Oregon and California are currently considering energy efficiency as a foundational element of the regulatory framework.

In spite of the obvious synergies, in practice the rules and methods for verifying and certifying efficiency resource acquisitions do not work well in coordination with the system for tracking greenhouse gas reductions, and vice versa. To date, only large "mega projects" have been viewed to have enough mutual benefit for the two systems to actively work together. However, it would behoove the key actors and agencies in both markets to develop a standardized working relationship because the stakes are very high. More than half (53%) of GHG Emissions in the United States are emitted by end-use customers of electricity and natural gas that could benefit from efficiency programs (USEPA 2006). This paper will examine the methodology by which a Public Benefits Administrator (PBA) that delivers energy-efficiency programs can rigorously quantify the reductions of GHG emissions from its operations in accordance with standardized GHG accounting methodologies, such as the GHG Protocol for Project Accounting from the World Resources Institute (WRI 2005). This paper will also discuss how energy efficiency can be deployed in combination with a PBA both within and without of a regulated cap and trade framework.

Background on Caps for Load Serving Entities

Worldwide, the development of regulatory frameworks for greenhouse gas emissions is moving toward cap-and-trade systems. In the USA, two main types of GHG caps are currently being developed for application in the power utility sector. California and Oregon are working on the rules for a *Load Serving Entity (LSE) cap-and-trade system*; while the Northeastern States are working on a *generator-based cap-and-trade system*. Regardless of the type, each cap:

1. defines the sectors in which GHG emissions are regulated (e.g., electricity, transportation, land use, etc…);
2. measures and tracks emissions over a defined time period;
3. sets limits on the emissions levels;
4. defines penalties for entities that exceed their allowed emissions limit; and
5. defines a timescale for declining the total emissions under the cap

The two cap systems are distinguished primarily by the type of entity that is regulated. The load-based cap regulates the emissions from "load-serving entities" (LSEs), which include electric and natural gas utilities. The generator-based cap regulates the electric power generator plants, which in deregulated states are often not owned by the LSE. Each type of cap has different issues with respect to integrating energy efficiency effectively. This paper will not examine the issues around integrating efficiency into a generator based cap-and-trade system.

Load Serving Entities can meet their defined cap on emissions in three general ways. The first method is to change their generation mix to be less fossil fuel intensive, either by using less carbon-intensive or more efficient generation technology, fuel switching, or by using renewable generation such as wind. The second method is to obtain GHG offsets or allocations using the *flexibility mechanisms* defined in the cap framework. The third method is to reduce the total "served load" through the development of energy-efficiency projects in the LSE's service territory.

The presence of a cap on the Load Serving Entity creates an interesting dynamic with already existing energy efficiency programs, because the two systems provide parallel regulatory mandates to increase the efficient use of energy in the LSE's territory. *The purpose of this paper is to discuss some of the issues and potential benefits of integrating existing energy-efficiency programs with a LSE cap.*

Background on Public Benefits Administrators

The most common delivery method for energy-efficiency programs is through a Public Benefits Administrator. The PBA usually is funded from a public benefits charge or other rate-based collection mechanism that is funded through the bills of utility ratepayers, and this money is used to provide marketing, technical assistance, information, and incentives to ratepayers to implement more efficient uses of energy. Another name for PBAs is the System Benefits Administrator, or System Benefits Charge Administrator, but this paper shall generally use the term PBA. Three states have a separate non-profit entity that serves as the PBA for multiple utilities (OR, WI, VT), and one implements the PBA through a quasi-governmental organization (NY), although it is more common for individual utilities to have an internal PBA function within their organization. Typically, the Public Utilities Commission in each state provides oversight of the effectiveness of each PBAs activities in reducing the total demand for energy within the utility system. This helps reduce future costs for ratepayers by delaying or eliminating the expansion of the energy infrastructure.

To ensure that ratepayer money is used in the most cost-effective manner, the PBA should use a quantitative evaluation strategy to monitor the efficacy of their programs. Evaluation methodologies for energy efficiency have been steadily improved for more than 30 years, and the best evaluation programs use a combination of engineering studies of energy savings, field monitoring, billing data, post-installation interviews with ratepayers, and statistical analysis. The importance of a rigorous evaluation strategy cannot be understated, because competition for limited PBA funds is strong and an evaluation helps determine the most effective use of the project budget money to serve the public interest. This has the added benefit of satisfying many of the requirements of GHG project development, as discussed in the section below on quantifying GHG reductions.

Some of the more advanced PBAs are actively engaged in quantifying market transformation practices, because the coordinated applications of incentives can have a significant effect on changing the marketplace to be inherently more efficient. By stimulating the market for a more efficient product or service, it is possible to develop a synergy between consumers, manufacturers, and the sales community that has the ultimate transforming effect of either making the more efficient product or service the dominant market choice, or allowing an energy code or appliance standard upgrade to be implemented by government without the resistance of stakeholders. Without this stimulation, the marketplace is significantly slower to adopt new technologies.

The role of the PBA in the GHG market depends on the nature of the GHG regulatory framework or lack thereof. In a framework based on load-serving entities (LSEs), the PBA can certify GHG reductions from efficiency projects within the cap on behalf of the LSE. If the PBA is not operating within a regulatory framework, then it may be able to certify and market GHG offsets from the efficiency projects it helps to develop (Climate Trust 2005). Part II of this paper will describe the methodology that a PBA can use to quantify GHG reductions or offsets in a manner consistent with the expectations of a typical GHG Protocol. Part III will describe how energy efficiency deployed by PBAs within an LSE framework to be can be a key solution for reducing GHG emissions.

Part II - Quantification of GHG Emissions Reductions from Energy Efficiency

There are two issues that must be addressed when quantifying the GHG reductions from energy-efficiency projects: quantification of the energy savings, and the conversion of energy savings into GHG emissions reductions. Quantifying the energy savings from installation of energy efficiency is a fundamental task of the Public Benefits Administrator. The methods and tests to certify actual efficiency projects are equivalent to those recommended in the typical approach for GHG project certification; however, the terminology used in the energy-efficiency community is different and can lead to confusion between the two industries. This section will show how typical PBA operations can result in certifiable GHG emissions reductions.

Table 1. Terminology Relationship Between Efficiency and GHG Certification Methods

Greenhouse Gas World	Energy Efficiency World
Reductions (from a Baseline)	Savings (from a Baseline)
Monitoring and Verification	Measure Life and Evaluation
Additionality (Financial)	Free Riders
Leakage	Interactive Effects
Ownership	Contractual Path
Long Term Reduction Goals	Market Transformation

Quantification of Energy Savings

For the purposes of discussion, energy-efficiency projects can be classified into two categories: large scale "mega" projects, and small scale "bundled" projects. A mega project could be a significant upgrade to a large industrial plant, such as a pulp mill, that uses a huge amount of energy, and thus has potential for a significant amount of energy savings within the project. The assumption is that a mega-project has enough value from the quantity of GHG savings that it is cost-effective to perform an exact analysis with monitoring and verification of savings for the life of the project. In contrast, a bundled project could be the installation of thousands of compact fluorescent light bulbs (CFLs), or a residential home weatherization program. Each weatherized home is still considered an individual project, but the savings are not valuable enough to perform an exact savings analysis for each project. Instead, the PBA must use a suite of analytical tools described below to obtain an estimate of savings for the weatherization program as a whole.

Energy Savings Against a Baseline

It is standard within the utility industry that energy savings for efficiency measures are calculated against a baseline of what would happen in the absence of the PBA program. There are two ways to determine this, either by using a mandated minimum code, or through studies of usage, market conditions, and/or engineering estimates. For example, in the case of building shell measures in new construction, the baseline is typically the code minimum because the PBA shouldn't claim savings for a measure that is already required of the project owner. Unfortunately, baseline determination is rarely so simple. In the case of compact fluorescent light bulbs, savings are determined from a combination of market studies, usage studies, and engineering studies. CFL market studies assess the consumer/retailer dynamics and estimate how many bulbs are sold as a baseline in absence of the PBA program. CFL usage studies show the locations and average daily "burn times" of CFLs inside the residence after purchase. CFL engineering studies determine the early burn-out rates, the average lifetime of the bulbs, and the interactive effects with space conditioning from the light bulb's reduced waste heat production. The Energy Trust of Oregon has determined that in the heating-dominated region of Northwestern Oregon, the interactive effects result in about a 45% penalty on total energy savings from a CFL[1]. In addition, baselines must be constantly adjusted upward as new efficient technologies become standard in the market.

Monitoring and Verification of Energy Savings

Given the vast quantity and diversity of efficiency measures, field monitoring and verification of the actual energy savings can be quite expensive to do in an exact manner. For mega projects, it might be cost-effective to attempt exact measurement, but wide-scale bundled efficiency projects must augment limited field measurement data with statistical techniques. The efficiency community has fine-tuned this approach over 25 years. If energy efficiency is to be a central element of a GHG regulatory framework, then established statistical approaches must be accepted by GHG regulators.

Within the typical PBA structure, an analysis of energy savings is called an *evaluation*. A nationwide industry of energy efficiency evaluations and evaluators has developed over the past 30 years. Evaluation of program savings typically occur on an annual or semi-annual basis, and attempt to verify the actual energy savings over that time period through a statistical model of a large population of sites using pre and post data and often both participant and comparison groups. Other inputs to the evaluation model include analyses of customer billing data, equipment metering and test data, and questionnaires or customer surveys. A synergy within the efficiency program develops as information learned during evaluation is fed into future engineering models and baseline studies.

Another element of the monitoring and verification strategy involves assigning a *measure life* to each efficiency measure. An installed measure is assumed to save energy for a defined physical lifetime. For example, the Energy Trust of Oregon assigns a seven-year lifetime to a CFL bulb, 25 years to a gas furnace, 45 years to attic insulation, etc… However the mechanical lifetime of equipment is not the only deciding factor of measure life. The Energy Trust of Oregon assigns a blanket ten-year measure life to all industrial process efficiency measures within its Production Efficiency program, because the lifetime of a business is often the limiting factor in this sector.

At the Energy Trust, after an evaluation of an efficiency program is completed, the total savings on the books are adjusted to reflect the new data during an annual process called the "True Up". True-up savings should be eligible to be converted into certified GHG reductions because they have passed the GHG accounting tests of baseline, monitoring and verification, and additionality (see below). It can take two years before an evaluation is completed, so regulators must make provisions for performance adjustments within the GHG regulatory requirements as true-up data is acquired. The best way to minimize the size of such adjustments is to use an "anticipated evaluation factor", which is an educated guess of the first evaluation true up factor. Experience has shown that the initial estimates of program savings based on engineering predictions are frequently high. Even for effective programs, prediction errors at the time of installation range from 10% too low to 30% too high. Factors vary based on program delivery effectiveness, but are more predictable by type of program. The anticipated evaluation factor makes true-up changes less dramatic, and increases the credibility of savings as they are booked upon project completion.

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[1] Modeling by Energy Trust has confirmed that the heating penalty for removing incandescent lights is significant in a home that meets Oregon codes for weatherization.

Additionality Tests

The test for additionality is one of the most enigmatic, and often controversial, requirements of a GHG regulatory framework. The essence of additionality is that GHG reductions from a project should happen as a result of the framework, and would not have happened in the absence of the framework. Public Benefits Administrators that have a rigorous evaluation program apply the principles of additionality, although the term additionality is rarely used within the efficiency industry. This is a source of significant misconception on whether and how energy efficiency programs can work within a GHG regulatory framework. The rest of this section will attempt to illuminate the commonality of additionality tests used in both the world of GHG reductions and the world of energy efficiency programs, especially as applied in practice using various different versions of the additionality test (Trexler, Broekhoff, & Kosloff 2006).

Financial Additionality refers to whether the monetary benefits of reductions within the program are necessary to "tip" the project into existence. A GHG reduction project that would happen regardless of the monetary value of the GHG credits fails the additionality test. In the world of the PBA, this test is called the "Free Rider" test. Free riders are project owners that collect on an efficiency incentive even though they would have installed the measure without the incentive. One of the roles of the evaluation program within the PBA is to determine the percentages of free riders for efficiency measures that have already been installed. This information is then used to fine-tune efficiency programs to increase the effectiveness of limited efficiency incentive funds. Efficiency evaluations also measure "spillover", where additional measures are influenced by program activity, would not happen without the program, but do not receive an incentive. This happens when customers decide to install a few more measures on their own, act because they saw how well the measure worked for an acquaintance, bought the measure because it was stocked by a supplier who would not have otherwise stocked it without the program, or forget to apply for rebates. Spillover can be considered "additional" because it would not have happened in the absence of the program.

In order for a PBA to quantify GHG reductions from energy efficiency, and to follow the strictest interpretation of the guidelines for financial additionality, the PBA should remove from its books all energy savings that are the result of free riders, while adding in spillover. This type of adjustment is normally applied during the annual true up process. For example, in 2005, the Energy Trust of Oregon determined that the Building Efficiency Program had a 20% free rider rate, which removed 5.3 million kWh of savings from the 2005 program year during the 2006 true-up (Energy Trust 2005, 3).

Regulatory Additionality refers to the perception that the delivery of energy-efficiency projects is already mandated by an efficiency-based regulatory framework (e.g. PUC rulings or legislation), and thus the value derived from claiming the GHG reductions from these projects is not necessary to tip them into existence. Therefore, the GHG reductions derived exclusively from PBA-funded efficiency projects do not pass regulatory additionality and cannot be claimed as reductions or as offsets. However, this argument may not always apply depending on the context of the relevant GHG regulatory framework.

If the efficiency project is located *within* an LSE regulatory framework, then the concept of regulatory additionality does not necessarily apply, because the GHG regulations are enforced in parallel with any existing efficiency regulations. The LSE is *expected* to meet its GHG emissions cap partly through the application of energy efficiency within its load base. The question becomes an issue of how to accurately track the resulting GHG reductions to prevent double counting, and not one of additionality.

If the efficiency project is located *outside* of an LSE framework, then the project may be eligible to produce GHG offsets that can be sold into a cap and trade system. In practice, whether or not these outlying efficiency projects can be made available will be dictated by the rules defining offsets for any particular GHG regulatory framework. If they are allowed, the funds derived from quantifying and marketing GHG offsets can then be used to develop additional energy-efficiency resources.

Leakage and Tracking Associated With Multiple Fuel Facilities

Given that 53% of the total GHG emissions in the USA come from electricity and natural gas consumption in the residential, commercial, and industrial sectors, it is reasonable to assume that a great many of the available projects in these sectors will fall under the "multiple fuel" scenario. Tracking the impact of the *interactive effects* of efficiency measures that occur within a multiple fuel facility is a critically important issue within a GHG regulatory framework. An interactive effect occurs when increasing the efficiency on the electric side also has an impact on the amount of consumption of a different fuel, such as natural gas, propane, or heating oil. This effect is particularly important to consider when efficiency measures are implemented in a space conditioned facility, because interactive effects are the greatest in these facilities. This consideration also applies to attempts to reduce carbon produced in one fuel (e.g., electric generation) by switching loads to another fuel (e.g., gas).

Unfortunately, data on the interactive effects of various efficiency measures is not generic. It depends heavily on the climate zone of the project's location. For example, there may be a 45% penalty on energy savings from a CFL in heating-dominated northwestern Oregon, but this same CFL would gain an energy bonus in a cooling-dominated environment such as southern California, because the CFL produces less heat than the replaced incandescent light bulb. Calculating the interactive effects requires engineering analysis and modeling in each climate zone for each representative building type, and requires tradeoffs to be made between the cost of analysis vs. magnitude of the interactive effect.

Tracking the impact on GHG reductions of interactive effects is also a very challenging proposition, because it requires coordination between multiple capped entities, such as electric and natural gas utilities. A multiple fuel PBA such as the Energy Trust of Oregon is in a good position to track interactive effects because it delivers efficiency savings for several overlapping electric and natural gas utilities, and has an internal tracking system that has the capability to subtract interactive effects penalties from the savings totals of each fuel. *The design of an LSE framework must have a method to account for the interactive effects of energy-efficiency projects in multiple-fuel and space-conditioned buildings.*

Determining the GHG Value of Electricity Savings

Up to this point, our discussion has focused on how to quantify energy savings in a manner that is consistent with greenhouse gas reductions protocols. This rests on the assumption that energy savings can be directly converted into greenhouse gas savings. In the case of natural gas efficiency, a simple conversion factor provides an accurate accounting of GHG reductions.

Unfortunately, the distributed nature of the electric power infrastructure significantly complicates the conversion of saved electricity to GHG emissions reductions.

The simplest way to convert saved kilowatt-hours into tons of GHG reductions would be to use the annual average GHG emissions factor of the electric utility. Unfortunately, this would tend to be an inaccurate estimate of the actual GHG reductions, because it does not incorporate the seasonal, weekly, and diurnal variations of the electric power generation mix. A saved kWh during a peak load time period will be more likely to displace peak-following generation such as natural gas turbines, while a saved kWh during the night, weekend, or during the spring and fall would be more likely to displace base load generation such as coal. Therefore, this method would tend to overestimate actual GHG reductions, because energy savings tend towards peak loads, and peak-following generation is less carbon intensive than base load.

A better metric for calculating GHG reductions from efficiency is to consider the generation displaced by a single saved kWh, which is called the *marginal resource*. System dispatch models of the electric power system have the capability to calculate the marginal resource at any given hour of the year. However, further complications arise because efficiency measures also tend to have diurnal and annual variations in saved energy, which add together to form an *efficiency load shape*. Calculating the marginal GHG reductions from efficiency requires an analysis of the marginal generation during the hours indicated by the efficiency load shape.

The Energy Trust of Oregon and the Northwest Power and Conservation Council are currently developing a methodology to calculate the marginal GHG reductions from efficiency. The Council uses a system dispatch model to determine the fossil heat rate of the marginal resource for each hour of the year in the Pacific Northwest grid region. Then, another Council model called ProCOST determines the total GHG reduction per saved kWh for each efficiency load shape from the marginal resource data. The Energy Trust uses a database to track the saved energy, measure life, and load shape of each installed efficiency measure, which allows for a multiplication against the ProCOST data to calculate marginal GHG reductions for the life of each measure.

It is important to recognize that the above method for calculating the marginal GHG reductions from energy efficiency combines the *operating marginal reduction* and the *build marginal reduction* (Kartha, Lazarus, & Bosi 2002)[2]. This *combined marginal reduction* more accurately captures the lifetime GHG reduction value of efficiency measures as the power grid evolves in future years according to the expectations of a planning process that includes renewable generation and new fossil generation. The Council currently runs their model according to the 5th Power Plan, which uses energy efficiency and renewable energy to prevent new fossil generation until 2018 (NWPCC 2005). The boundaries of the system dispatch model can be adjusted to model an individual utility to correctly model the total marginal GHG reductions from efficiency operations within the utility's territory.

Part III - The Load-Serving Cap Framework and Energy Efficiency

The previous section of this paper examined issues of attributing GHG reductions to energy efficiency projects and programs. This section will examine three critical design

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[2] Build marginal reductions refer to the ultimate delay or elimination of construction of addition fossil-fired generation plants due to efficiency projects.

elements for achieving significant GHG reductions with efficiency, in an LSE framework with a cap.

Optimizing the Use of Energy Efficiency in a LSE Cap

The first important element is to overcome traditional market barriers that restrain energy efficiency from achieving its cost-effective market penetration levels. It is unlikely that the price of GHG reductions alone will be enough to achieve optimal levels of efficiency in the market place (Prindle et al. 2005). Historically, several mechanisms have been used to support investment in efficiency without valuing GHG reductions, such as Public Benefits Charges for revenues and PBAs for program delivery. A cap-and-trade system can be designed in synergy with existing PBAs to support additional achievement towards carbon reduction goals.

There are several cap-and-trade mechanisms to encourage energy efficiency as identified by Prindle, et al[3], and two of these are likely to work effectively under an LSE cap. The first mechanism is the direct allocation of efficiency-based emission allowances to designated providers, such as PBAs or Energy Service Companies (ESCOs). This mechanism can demonstrate delivery of energy efficiency in accordance with the GHG reduction protocols as described in Part II.[4] The second mechanism is an auction of all or some allowances. Capped entities or others that need allowances can bid for them, and the regulators can then use the proceeds to support energy efficiency actions in the marketplace.

Effective and broad policy to achieve the decoupling of economic prosperity from the emissions of GHG will require the use of several tools. Fortunately, the energy-efficiency mechanisms of the cap-and-trade system should be synergistic with other proven tools to foster energy efficiency, such as performance standards or the decoupling of utility revenue from gross power sales. Also, energy-efficiency policies in parallel with the cap will reduce GHG emissions under the cap and thereby necessarily reduce the competition for scarce allowances. Extensive modeling for the Regional Greenhouse Gas Initiative (RGGI) indicates that the application of these policies will result in lower prices for allowances, and reductions in energy bills (Prindle, Elliot & Shipley 2005).

Ownership of Carbon Reductions and Getting the Signals Right

The second critical element is to define the ownership of the GHG reductions when multiple entities contribute financially to the development of a project. In a large-scale GHG cap-and-trade system, there are multiple parties that could possibly lay claim to the carbon-reduction benefits in a hypothetical energy efficiency project. In practice, incentives from PBAs, or other policy tools such as tax credits, are rarely sufficient to cover 100% of the project cost, and therefore several parties may all contribute in part.

Solutions to the ownership problem depend explicitly upon the nature of the GHG regulatory framework. Within an LSE cap-and-trade system, the LSE by definition derives sole benefit from GHG reductions from efficiency projects within its service territory because emissions accounting applies only to the LSE. Outside of an LSE cap-and-trade, ownership is not explicitly defined. The solution here is a legal issue that requires negotiation between

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[4] An allowance is a right to emit a ton of carbon dioxide equivalent under a cap. Allowances are allocated by the regulatory authority, and can be sold or traded (if permitted).

stakeholders. Clear contractual and financial paths will serve to reduce the conflict over ownership of carbon reductions due to any particular efficiency project that is offered to an LSE cap as an offset.

Inside of an LSE cap, there should be a direct incentive for load serving entities to reduce demand within their territories, although there could be additional flexibility mechanisms for an LSE to meet its cap. Energy-efficiency provides a low cost option for the LSE; however, "The treatment of end user investments resulting in emissions reductions is the weakness of a load-based system." (Burnett 2005). This is because none of the financial benefits of GHG reductions from energy-efficiency projects flow to the project developer. Therefore it is necessary to have explicit policies in an LSE cap framework to convey the carbon reduction price signal to the end-user or its supply chain. This price signal could be manifest as a marginal increase in the existing efficiency incentives for the end-user, or as lowered costs for efficiency products that result from additional supply chain incentives or programs.

Outside of the LSE cap's service territories, ownership is not explicitly defined, and multiple entities can claim a financial link to ownership of the GHG reductions from the project. For the offsets to be certified, it must be proved that ownership is not in dispute. The most likely claimants to ownership are the project owner, the power utility, and the PBA. One potential method to achieve clear ownership is to stipulate that the project owner relinquishes claim to the GHG reductions as a condition of receipt of a financial incentive for installed energy efficiency measures. This method of stipulation parallels the approach frequently followed for claims on renewable energy credits (RECs) used where there are incentives for renewable energy projects. This method is not likely to be a barrier in the case of GHG emissions either, because the value of saved energy is in the range of ten times greater than the value of GHG credits. Mega-projects, on the other hand, may decide to forego the efficiency incentive and develop their own efficiency project while having a third party certify the GHG offsets. In this case, the third party certifier will have to replicate the methods used by the PBA, as described in Part II.

Scalability and Market Transformation

The third critical element is the most difficult: how can energy efficiency be tapped to help achieve those transformative levels of emission reductions scientists say are necessary to stabilize the Earth's climate (IPCC 2001)? The GHG requirements in most proposed load-serving caps are generally described in two phases – narrow reductions in the near-term (e.g. 10% Carbon reductions by 2020) and large, transformative reductions in the longer-term (e.g. 75% Carbon reductions by 2050). In order to achieve both goals, there will likely be two main objectives when selecting delivery mechanisms for energy efficiency under a carbon cap. The first will focus on achieving near-term reductions in a cost-effective and verifiable manner to satisfy the short-term goal. The second will focus on broadening the energy-efficiency effort towards market transformation in order to scale the magnitude of the demand reductions to meet the long term goal of emissions reductions.

A market transformation approach is necessary in energy efficiency because there is a "chicken and egg" problem working against the introduction of more efficient technologies. Manufacturers won't make more efficient products until they know consumers would buy them; but consumers can't buy something that isn't being manufactured. If an incentive is provided for a more efficient product, consumers are more likely to buy the product and manufacturers can feel comfortable producing it. Stakeholder barriers are overcome, and codes and standards eventually can be raised, thus effectively transforming the market to be inherently more efficient (Dethman 2004).

A problem with market transformation comes in trying to actually quantify the savings produced. The Energy Trust of Oregon and the Northwest Energy Efficiency Alliance are currently building models that predict the total savings from the market transformation effort above the "natural" background of efficiency upgrades (Gordon & Robison 2006). If multiple entities contributed financially to the transformation effort, then total savings are apportioned between the entities based on total financial contribution or some other metric. Claiming savings from market transformation can be imprecise and controversial, but the models actually address the most relevant questions regarding savings, and the imprecision can be bounded to produce a "reasonably reliable" answer. Some efficiency measures may not seem very cost-effective on an individual basis, but look much better if the transformative effects of the efficiency program are quantified (Gordon & Robison 2006).

Developing the rules and procedures to achieve the short-term goal of greenhouse gas emissions reductions is an enormous and challenging task in itself. However, the rules should be designed to accommodate the ultimate, longer-term goal of market transformation. Organizations such as the Northwest Energy Efficiency Alliance have shown that a small investment of private or public resources can have a significant transformative effect. A deliberate market transformation approach of incentives, education, and marketing should be applied to increase the efficiency of energy use in our carbon-constrained economy.

Summary

Frameworks for greenhouse gas regulation are under development in several States and will incorporate energy efficiency as part of the mix. Existing energy efficiency practices to quantify energy savings can be readily adapted to quantifying GHG emissions reductions as defined in standard protocols for GHG projects; however, some work still needs to be done on methodologies for calculating the *combined marginal savings* of GHG's from saved electricity.

Integrating energy efficiency into the cap-and-trade framework for a Load Serving Entity requires designing the LSE regulatory systems to work in parallel with systems for delivering energy efficiency, if they exist. Ownership of GHG emissions reductions flows automatically to the LSE, however the LSE may need to provide some method of allocating alternative value to the efficiency project owner, such as an incentive for energy efficiency. Finally, the market transformation practices of energy efficiency should be incorporated into the design of the framework for an LSE cap, as a mechanism to achieve long-term GHG emissions reduction targets. Through the combination of these policies, and the fact the saved energy has a high inherent value even in the absence of valuing GHG reductions, the LSE cap-and-trade system should be able to achieve low-cost, high value emissions reductions by incorporating energy efficiency in the design.

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