An Overview of Guidelines and Issues for the Monitoring, Evaluation, Reporting, Verification and Certification of Energy-Efficiency Projects for Climate Change Mitigation

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1 – SYNOPSIS

We present an overview of guidelines recently developed for the monitoring, evaluation, reporting, verification, and certification (MERVC) of energy-efficiency projects for climate change mitigation.

2 – ABSTRACT

Monitoring and evaluation of energy-efficiency projects is needed to accurately determine their impact on greenhouse gas (GHG) emissions and other attributes, and to ensure that the global climate is protected and that country obligations are met. We present an overview of guidelines recently developed for the monitoring, evaluation, reporting, verification, and certification (MERVC) of energy-efficiency projects for climate change mitigation [1]. These guidelines are targeted to developers, evaluators, verifiers, and certifiers of energy-efficiency projects, and address several key issues, including methods for estimating gross and net energy savings and emission reductions. The next phase of our work will be to develop a procedural handbook providing information on how one can complete monitoring, evaluation and verification forms. We then plan to test the usefulness of these handbooks in the real world.

3 - INTRODUCTION

Because of concerns with the growing threat of global climate change from increasing concentrations of greenhouse gases in the atmosphere, more than 176 countries (as of October 7, 1998) have become Parties to the U.N. Framework Convention on Climate Change (FCCC) (UNEP/WMO 1992). The FCCC was entered into force on March 21, 1994, and the Parties to the FCCC drafted the Kyoto Protocol for continuing the implementation of the FCCC in December 1997 (UNFCCC 1997). The Protocol requires developed countries to reduce their aggregate emissions by at least 5.2% below 1990 levels by the 2008-2012 time period.

The Kyoto Protocol includes two project-based mechanisms for activities across countries. Article 6 of the Protocol allows for joint implementation (JI) projects between developed (Annex I) countries: i.e., project-level trading of emissions reductions («transferable emission reduction units») can occur among countries with GHG emission reduction commitments under the Protocol. Article 12 of the Protocol provides for a «Clean Development Mechanism» (CDM) that allows legal entities in the developed world to enter into cooperative projects to reduce emissions in the developing world for the benefit of both parties. Developed countries will be able to use certified emissions reductions from project activities in developing countries to contribute to their compliance with GHG targets. The key provisions of the Kyoto Protocol remain to be developed in more detail as negotiations clarify the existing text of the Protocol.

Projects that are to be undertaken within the CDM or under JI will involve several tasks: project development and registration; project implementation; and monitoring, evaluation, reporting, verification and certification. There will most likely be different types of arrangements for implementing these projects: e.g., (1) a project developer might implement the project with his/her own money; (2) a developer may borrow money from a financial institution to implement the project; (3) a developer may work with an energy service company who will be responsible for all project activities; etc. While the flow of funds might change as a result of these different arrangements, the guidelines described in this paper should be of relevance for all parties, independent of the arrangement.

3.1. Purpose of MERVC guidelines

Monitoring, evaluating, reporting, verifying, and certifying (MERVC) guidelines are needed for joint implementation and CDM projects in order to accurately determine their impact on GHG and other attributes (see Box 1) (Vine and Sathaye 1997). Implementation of MERVC guidelines is also intended to: (1) increase the reliability of data for estimating GHG impacts; (2) provide real-time data so programs and plans can be revised mid-course; (3) introduce consistency and transparency across project types, sectors, and reporters; (4) enhance the credibility of the projects with stakeholders; (5) reduce costs by providing an international, industry consensus approach and methodologies; and (6) reduce financing costs, allowing project bundling and pooled project financing.

These guidelines are important management tools for all parties involved in carbon mitigation. There will be different approaches («models») in how the monitoring, evaluation, reporting, verification, and certification of energy-efficiency projects will be conducted: e.g., a project developer might decide to conduct monitoring and evaluation, or might decide to contract out one or both of these functions. Verification and certification will most likely be implemented by third parties. Similarly, some projects might include a portfolio of projects. Despite the diversity of responsibilities and project types, the Lawrence Berkeley National Laboratory's (LBNL) MERVC guidelines should be seen as relevant for all models and project approaches.

In the longer term, MERVC guidelines will be a necessary element of any international carbon trading system, as proposed in the Kyoto Protocol. A country could generate carbon credits by implementing projects that result in a net reduction in emissions. The validation of such projects will require MERVC guidelines that are acceptable to all parties. These guidelines will yield verified findings, conducted on an ex-post facto basis (i.e., actual as opposed to predicted project performance).

The Kyoto Protocol contains emissions targets for six major greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). LBNL's MERVC guidelines only examine MERVC issues dealing with CO_2.

4 - MONITORING AND EVALUATION OF GHG EMISSIONS

4.1. Approach to monitoring and evaluation of energy savings and GHG emissions

As an example of the type of monitoring and evaluation that is needed, we present in Fig. 1 an overview of one approach used in evaluating energy savings and GHG emissions. In this approach, gross energy savings are first measured, using one of the options provided in the U.S. Department of Energy's (DOE) International Performance Measurement and Verification Protocol (IPMVP) [2]. Next, the project's baseline is re-estimated, accounting for free riders [3]. The net change in energy use is equal to the gross change in energy use minus the re-estimated baseline. Net emissions are then estimated, using either default emission factors or emissions based on generation data.

4.2. Establishing the monitoring domain

The domain that needs to be monitored (i.e., the monitoring domain) is typically viewed as larger than the geographic and temporal boundaries of the project. In order to compare GHG reductions across projects, a monitoring domain needs to be defined. Consideration of the domain needs to address the following issues: (1) the temporal and geographic extent of a project's direct impacts; and (2) coverage of positive project spillover and market transformation [3].

Box 1

MERVC Definitions

Estimation: refers to making a judgement on the likely or approximate energy use, GHG emissions, and socioeconomic and environmental benefits and costs in the with- and without-project (baseline) scenarios. Estimation can occur throughout the lifetime of the project, but plays a central role during the project design stage when the project proposal is being developed.

Monitoring: refers to the measurement of energy use, GHG emissions, and socioeconomic and environmental benefits and costs that occur as a result of a project. Monitoring does *not* involve the calculation of GHG reductions nor does it involve comparisons with previous baseline measurements. For example, monitoring could involve the number of compact fluorescent lamps installed in a building. The objectives of monitoring are to inform interested parties about the performance of a project, to adjust project development, to identify measures that can improve project quality, to make the project more cost-effective, to improve planning and measuring processes, and to be part of a learning process for all participants (De Jong et al. 1997). Monitoring is often conducted internally, by the project developers.

Evaluation: refers to both impact and process evaluations of a particular project, typically entailing a more in-depth and rigorous analysis of a project compared to monitoring emissions. Project evaluation usually involves comparisons requiring information from outside the project in time, area, or population (De Jong et al. 1997). The calculation of GHG reductions is conducted at this stage. Project evaluation would include GHG impacts and non-GHG impacts (i.e., environmental, economic, and social impacts), and the re-estimation of the baseline, positive project spillover, etc., which were estimated during the project design stage. Evaluation organizes and analyzes the information collected by the monitoring procedures, compares this information with information collected in other ways, and presents the resulting analysis of the overall performance of a project. Project evaluations will be used to determine the official level of GHG emissions reductions that should be assigned to the project. The focus of evaluation is on projects that have been implemented for a period of time, not on proposals (i.e., project development and assessment). While it is true that similar activities may be conducted during the project design stage (e.g., estimating a baseline or positive project spillover), this type of analysis is estimation and not the type of evaluation that is described in this paper and which is based on the collection of data.

Reporting refers to *measured* GHG and non-GHG impacts of a project (in some cases, organizations may report on their *estimated* impacts, prior to project implementation, but this is not the focus of this paper). Reporting occurs throughout the MERVC process (e.g., periodic reporting of monitored results and a final report once the project has ended).

Verification refers to establishing whether the measured GHG reductions actually occurred, similar to an accounting audit performed by an objective, accredited party not directly involved with the project. Verification can occur without certification.

Certification refers to certifying whether the measured GHG reductions actually occurred. Certification is expected to be the outcome of a verification process. The value-added function of certification is in the transfer of liability/responsibility to the certifier.

PANEL 4

The first monitoring domain issue concerns the appropriate geographic boundary for evaluating and reporting impacts. For example, an energy project might have local (project-specific) impacts that are directly related to the project in question, or the project might have more widespread (e.g., regional) impacts (leading to project spillover and market transformation). Also, energy projects may impact energy supply and demand at the point of production, transmission, or end use. The MERVC of such impacts will become more complex and difficult as one attempts to monitor how emission reductions are linked between energy end users and energy producers (e.g., tracking the emissions impact of 1,000 kWh saved by a household in a utility's generation system).

The second issue concerns coverage of positive project spillover, as discussed below. It is important to note that not all secondary impacts can be predicted. In fact, many secondary impacts occur unexpectedly and cannot be foreseen. And when secondary impacts are recognized, a commitment needs to be made to ensure that resources are available to evaluate these impacts.

One could broaden the monitoring domain to include off-site baseline changes (which are normally perceived as occurring outside the monitoring domain). Widening the system boundary, however, will most likely entail greater MERVC costs and could bring in tertiary and even less direct effects that could overwhelm any attempt at project-specific calculations (Trexler and Kosloff 1998).

In the beginning stages of a project, the secondary impacts of a project are likely to be modest as the project gets underway, so that the MERVC of such impacts may not be a priority. These effects are also likely to be insignificant or small for small projects. Under these circumstances, it may be justified to disregard these impacts and simply focus on energy savings from the project. This would help reduce MERVC costs. As the projects become larger or are more targeted to market transformation, these impacts should be evaluated.

4.3. Monitoring and evaluation methods

For energy-efficiency projects, the first step in measuring emission reductions is the measurement of gross energy savings: comparing the observed energy use of project participants with pre-project energy consumption. Several data collection and analysis methods are available which vary in cost, precision, and uncertainty. The <u>data collection</u> methods include engineering calculations, surveys, modeling, end-use metering, on-site audits and inspections, and collection of utility bill data. Most monitoring and evaluation activities focus on the collection of measured data; if measured data are not collected, then one may rely on engineering calculations and «stipulated» (or default) savings (as described in EPA's Conservation Verification Protocols and in DOE's International Performance Measurement and Verification Protocol). <u>Data analysis</u> methods include engineering methods, basic statistical models, multivariate statistical models (including multiple regression models and conditional demand models), and integrative methods. If the focus of the monitoring and evaluation is an individual building, then some methods will not be utilized (e.g., basic statistical models, multivariate statistical models, and some integrative methods), since they are more appropriate for a group of buildings.

There is no one approach that is «best» in all circumstances (either for all project types, evaluation issues, or all stages of a particular project). The costs of alternative approaches will vary and the selection of evaluation methods should take into account project characteristics and the kind of load and schedule for the load before the retrofit. The load can be constant, variable, or variable but predictable, and the schedule can either be known (timed on/off schedule) or unknown/variable. The monitoring approach can be selected according to the type of load and schedule.

In addition to project characteristics, the appropriate approach depends on the type of information sought, the value of information, the cost of the approach, and the stage and circumstances of project implementation. The applications of these methods are not mutually exclusive; each approach has different advantages and disadvantages (see Vine and Sathaye 1999), and there are few instances where an evaluation method is not amenable to most energy-efficiency measures. Using more than one method can be informative. Employing multiple approaches, perhaps even conducting different analyses in parallel, and integrating the results, will lead to a robust evaluation. Such an approach builds upon the strengths and overcomes the weaknesses of individual approaches. Also, each approach may be best used at different stages of the project life cycle and for different measures or projects. An evaluation plan should specify the use of various analytical methods throughout the life of the project and account for the financial constraints, staffing needs, and availability of data sources.

In an earlier report, we reviewed several protocols and guidelines that were developed for the MERVC of GHG emissions in the energy sectors by governments, nongovernmental organizations, and international agencies (Vine and Sathaye 1997). Although not targeted to carbon emissions, we believe that the U.S. Department of Energy's (DOE) International Performance Measurement and Verification Protocol (IPMVP) is the preferred approach for monitoring and evaluating energy-efficiency projects for individual buildings and for groups of buildings, since the IPMVP covers many of the issues discussed in these guidelines as well as offering several measurement and verification methods for user flexibility (USDOE 1997). North America's energy service companies have adopted the IPMVP as the industry standard approach to measurement and verification. States ranging from Texas to New York now require the use of the IPMVP for state-level energy efficiency retrofits. The U.S. Federal Government, through the Department of Energy's Federal Energy Management Program (FEMP), uses the IPMVP approach for energy retrofits in Federal buildings. Finally, countries ranging from Brazil to the Ukraine have adopted the IPMVP, and the Protocol is being translated into Bulgarian, Chinese, Czech, Hungarian, Polish, Portuguese, Russian, Spanish, Ukrainian and other languages.

4.4. Baseline use: re-estimating the baseline

For JI (Article 6) and CDM (Article 12) projects implemented under the Kyoto Protocol, the emissions reductions from each project activity must be «additional to any that would otherwise occur,» also referred to as «additionality criteria» (Articles 6.1b and 12.5c). Determining additionality requires a baseline for the calculation of energy saved, i.e., a description of what would have happened to energy use had the project not been implemented (see Violette et al. 1998). Additionality and baselines are inextricably linked and are a major source of debate (Trexler and Kosloff 1998). Determining additionality is inherently problematic because it requires resolving a counter-factual question: What would have happened in the absence of the specific project?

Because investors and hosts of energy-efficiency projects have the same interest in an energy-efficiency project (i.e., they want to get maximum energy savings from the project), they are likely to overstate and over-report the amount of energy saved by the project (e.g., by overstating business-as-usual energy use). Cheating may be widespread if there is no strong monitoring and verification of the projects. Even if projects are well monitored, it is still possible that the real amount of energy saved is less than estimated values. Hence, there is a critical need for the establishment of realistic and credible baselines.

Future changes in energy use may differ from past levels, even in the absence of the project, due to growth, technological changes, input and product prices, policy or regulatory shifts, social and population pressure, market barriers, and other exogenous factors. Consequently, the calculation of the baseline needs to account for likely changes in relevant regulations and laws, and changes in key variables (e.g., population growth or decline, and economic growth or decline).

Ideally, when first establishing the baseline, energy use should be measured for at least a full year before the date of the initiation of the project. The baseline will be re-estimated based on monitoring and evaluation data collected during project implementation. The re-estimated baseline should describe the existing technology or practices at the facility or site. Some types of projects may not require a full year of monitoring: e.g., in energy-efficiency projects, if the loads and operating conditions are constant over time, one-time spot measurement may be sufficient to estimate equipment performance and efficiency. Finally, in order to be credible, project-specific baselines need to account for free riders

4.4.1. Free riders

In energy-efficiency projects, it is possible that the reductions in energy use are undertaken by participants who would have installed the same measures if there had been no project. These participants are called «free riders.» The savings associated with free riders are not truly «additional» to what would occur otherwise (Vine 1994). Although free riders may be regarded as an unintended consequence of an energy-efficiency project, free ridership should still be estimated, if possible, during the estimation of the baseline. While free riders can also cause positive project spillover, this impact is typically considered to be insignificant compared to the impacts from other participants.

For energy-efficiency projects installing technologies in developing countries where the efficiency of these technologies would be regarded as «conventional» in developed countries, all project participants could be regarded as free riders. As a result, there would be few projects implemented. A possible solution to this problem would be the establishment of performance benchmarks (standards) that would indicate to project developers the type of energy-efficient equipment that would be allowed to be installed and that would pass the «free rider test.»

Free ridership can be evaluated either explicitly or implicitly (Goldberg and Schlegel 1997; Saxonis 1991). The most common method of developing explicit estimates of free ridership is to ask participants what they would have done in the absence of the project (also referred to as «but for the project» discussions). Based on answers to carefully designed survey questions, participants are classified as free riders (yes or no) or assigned a free ridership score. Project free ridership is then estimated as the proportion of participants who are classed as free riders. Two problems arise in using this approach: (1) very inaccurate levels of free ridership may be estimated, due to questionnaire wording; and (2) there is no estimate of the level of inaccuracy, for adjusting confidence levels.

Another method of developing explicit estimates of free ridership is to use discrete choice models to estimate the effect of the program on customers' tendency to implement measures. The discrete choice is the customer's yes/no decision whether to implement a measure. The discrete choice model is estimated to determine the effect of various characteristics, including project participation, on the tendency to implement the measures.

For energy-efficiency projects, a method for calculating implicit estimates of free ridership is to develop an estimate of savings using billing analysis that may capture this effect, but does not isolate it from other impacts. Rather than taking simple differences between participants and a comparison group, however, regression models are used to control for factors that contribute to differences between the two groups (assuming that customers who choose to participate in projects are different from those who do not participate). The savings determined from the regression represent the savings associated with participation, over and above the change that would be expected for these customers due to other factors, including free ridership.

The U.S. Environmental Protection Agency's Conservation Verification Protocols reward more rigorous methods of verifying free riders by allowing a higher share of the savings to qualify for tradable SO_2 allowances. Three options are available for verifying free riders: (1) default «net-to-gross» factors for converting calculated «gross energy savings» to «net energy savings» [4]; (2) project-estimated net-to-gross factors, based on measurement and evaluation activities (e.g., market research, surveys, and inspections of nonparticipants); or (3) if a developer does not do any monitoring nor provide documentation and the default net-to-gross factors are not used, then the net energy savings of a measure will be 50% of the first-year savings (USEPA 1995 and 1996).

4.4.2. Comparison groups

For many projects, comparison groups can be used for evaluating the impacts of energy-efficiency projects. Acting as a baseline, comparison groups can capture time trends that are unrelated to project participation. For example, if the comparison group shows an average reduction in energy use of 5% between the pre- and post-periods, and the participants' bills show a reduction of 15%, then it may be reasonable to assume that the estimated project impacts will be 15% minus the 5% general trend for an estimated 10% reduction in use being attributed to the project.

4.5. Project case: monitoring and evaluation

4.5.1. Positive project spillover

For many programs, the number of eligible nonparticipants is far greater than the number of participants. For example, when measuring energy savings, it is possible that the actual reductions in energy use are greater than measured because of changes in participant behavior not directly related to the project, as well as to changes in the behavior of other individuals not participating in the project (i.e., nonparticipants). These secondary impacts stemming from an energy-efficiency project are commonly referred to as «positive project spillover.» Positive project spillover may be regarded as an unintended consequence of an energy-efficiency project; however, as noted below, increasing positive project spillover may also be perceived as a strategic mechanism for reducing GHG emissions.

Spillover effects can occur through a variety of channels including: (1) project participants that undertake additional, but unaided, actions based on positive experience with the project; (2) manufacturers changing the efficiency of their products, or retailers and wholesalers changing the composition of their inventories to reflect the demand for more efficient goods created through the project; (3) governments adopting new building codes or appliance standards because of improvements to appliances resulting from one or more energy efficiency projects; or, (4) technology transfer efforts by project participants which help reduce market barriers throughout a region or country.

The methods for estimating positive project spillover are similar to those used for free ridership (Goldberg and Schlegel 1997; Weisbrod et al. 1994). Explicit estimates can be obtained by asking participants and nonparticipants survey questions, and discrete choice models can be used (e.g., the effect on implementation of program awareness, rather than program participation, is estimated). Participant and nonparticipant spillover effects can be included in savings estimates in billing analyses, similar to how gross savings are calculated.

4.5.2. Market transformation

Project spillover is related to the more general concept of «market transformation,» defined as: «the reduction in market barriers due to a market intervention, as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced or changed» (Eto et al. 1996). In contrast to project spillover, increasing market transformation is expected to be a strategic mechanism (i.e., an intended consequence) for reducing GHG emissions for the following reasons:

- To increase the effectiveness of energy-efficiency projects: e.g., by examining market structures more closely, looking for ways to intervene in markets more broadly, and investigating alternative points of intervention.
- To reduce reliance on incentive mechanisms: e.g., by strategic interventions in the market place with other market actors.
- To take advantage of regional and national efforts and markets.
- To increase focus on key market barriers other than cost.
- To create permanent changes in the market.

Market transformation has emerged as a central policy objective for future publicly funded energy-efficiency projects in the United States, but the evaluation of such projects is still in its infancy. Furthermore, regulatory authorities have little experience in accepting savings from market transformation. Nevertheless, because of its importance, we encourage project developers to consider savings from market transformation, particularly since other countries are starting to implement market transformation programs (see Vine and Sathaye 1999).

Most evaluations of market transformation projects focus on market effects (e.g., Eto Et al. 1996; Schlegel et al. 1997): the effects of energy-efficiency projects on the structure of the market or the behavior of market actors that lead to increases in the adoption of energy-efficiency products, services, or practices. In order to claim that a market has been transformed, project evaluators need to demonstrate the following (Schlegel et al. 1997):

- There has been a change in the market that resulted in increases in the adoption and penetration of energy-efficiency technologies or practices.
- That this change was due at least partially to a project (or program or initiative), based both on data and a logical explanation of the program’s strategic intervention and influence.
- That this change is lasting, or at least that it will last after the project is scaled back or discontinued.

The first two conditions are needed to demonstrate market effects, while all three are needed to demonstrate market transformation. The third condition is related to persistence: if the changes are not lasting (i.e., they do not persist), then market transformation has not occurred. Because fundamental changes in the structure and functioning of markets may occur only slowly, evaluators should focus their efforts on the first two conditions, rather than waiting to prove that the effects will last. To implement an evaluation system focused on market effects, one needs to carefully describe the scope of the market, the indicators of success, the intended indices of market effects and reductions in market barriers, and the methods used to evaluate market effects and reductions in market barriers (Schlegel et al. 1997).

Evaluation activities will include one or more of the following: (1) measuring the market baseline; (2) tracking attitudes and values; (3) tracking sales; (4) modeling of market processes; and (5) assessing the persistence of market changes (Prahl and Schlegel 1993). As one can see, these evaluation activities will rely on a large and diverse group of data collection and analysis methods, such as: (1) surveys of customers, manufacturers, contractors, vendors, retailers, government organizations, energy providers, etc.; (2) analytical and econometric studies of measure cost data, stocking patterns, sales data, and billing data; and (3) process evaluations.

4.6. Calculation of net GHG emissions

Once the net energy savings have been calculated (i.e., measured energy use minus re-estimated baseline energy use), net GHG emissions reductions can be calculated in one of two ways: (1) if emissions reductions are based on fuel-use or electricity-use data, then default emissions factors can be used, based on utility or nonutility estimates; or (2) emissions factors can be based on generation data specific to the situation of the project (e.g., linking a particular project on an hourly or daily basis to the marginal unit it is affecting). In both methods, emissions factors translate consumption of energy into GHG emission levels (e.g., tons of a particular GHG per kWh saved). In contrast to default emission factors (method #1), the advantage of using the calculated factors (method #2) is that they can be specifically tailored to match the energy-efficiency characteristics of the activities being implemented by time of day or season of the year. For example, if an energy-efficiency project affects energy demand at night, then baseload plants and emissions will probably be affected. Since different fuels are typically used for baseload and peak capacity plants, then emission reductions will also differ.

The calculations, however, become more complex (but more realistic) if one decides to use the emission rate of the marginal generating plant (multiplied by the energy saved) for each hour of the year, rather than the average emission rate for the entire system (i.e., total emissions divided by total sales) (Swisher 1997). For the more detailed analysis, one must analyze the utility’s existing expansion plan to determine the generating resources that would be replaced by saved electricity, and the emissions from these electricity-supply resources. Thus, one would establish a baseline (current power expansion plan, power dispatch, peak load/base load, etc.), select a monitoring domain, conduct monitoring option, measure direct emission reductions (e.g., reductions occurring at the neighboring power plant to lower demand), measure indirect emissions (e.g., modification in the power system due to lower output at the neighboring plant), and calculate net carbon reductions.

One would have to determine if the planned energy-efficiency measures would reduce peak demand sufficiently and with enough reliability to defer or obviate planned capacity expansion. If so, the deferred or replaced source would be the marginal expansion resource to be used as a baseline. This type of analysis may result in more accurate estimates of GHG reductions, but this method will be more costly and require expertise in utility system modeling. In addition, this type of analysis is becoming more difficult in those regions where the utility industry is being restructured: e.g., the supply of energy may come from multiple energy suppliers, either within or outside the utility service area.

The decision on which methodology to use will depend on project size (e.g., kWh, kW, carbon credits requested, project expenditures) or relative project size (e.g., MW/utility service MW). It is up to the evaluator to decide on the best method for the project. Certain thresholds may need to be developed. If a project is of a certain relative magnitude (e.g., a project is 50 MW and the utility’s service area is 400 MW), the evaluator should probably select the second method above.

5 - ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS

The Kyoto Protocol exhorts developed countries, in fulfilling their obligations, to minimize negative social, environmental and economic impacts, particularly on developing countries (Articles 2.3 and 3.14). Furthermore, one of the primary goals of the CDM is sustainable development. At this time, it is unclear on what indicators of sustainable development need to be addressed in the evaluation of energy-efficiency projects. Once there is an understanding of this, then MERVC guidelines for those indicators will need to be designed. At a minimum, energy-efficiency projects should meet current country guidelines for non-CDM projects.

The persistence of GHG reductions and the sustainability of energy-efficiency projects depend on individuals and local organizations that help support a project during its lifetime. Both direct and indirect project benefits will influence the motivation and commitment of project participants. Hence, focusing only on GHG impacts would present a misleading picture of what is needed in making a project successful or making its GHG benefits sustainable. In addition, a diverse group of stakeholders (e.g., government officials, project managers, non-profit organizations, community groups, project participants, and international policymakers) are interested in, or involved in, energy-efficiency projects and are concerned about their multiple impacts.

5.1. Environmental impacts

Energy-efficiency projects have widespread and diverse environmental impacts that go beyond GHG impacts. The environmental benefits associated with energy-efficiency projects can be just as important as the global warming benefits. Direct and indirect project impacts need to be examined, as well as «avoided negative environmental impacts» (e.g., the deferral of the construction of a new power plant). Both gross and net impacts need to be evaluated.

At a minimum, evaluators need to evaluate the environmental impacts associated with the project. Evaluators need to collect some minimal information on potential impacts via surveys or interviews with key stakeholders. The evaluator should also check to see: (1) whether any existing laws require these impacts to be examined, (2) if any proposed mitigation efforts were implemented, and (3) whether expected positive benefits ever materialized. Evaluators may want to conduct some short-term monitoring to provide conservative estimates of environmental impacts. The extent and quality of available data, key data gaps, and uncertainties associated with estimates should be identified and estimated.

5.2. Socioeconomic impacts

In examining socioeconomic impacts, evaluators need to ask the following questions: who the key stakeholders are, what project impacts are likely and upon what groups, what key social issues are likely to affect project performance, what the relevant social boundaries and project delivery mechanisms are, and what social conflicts exist and how they can be resolved. To address these questions, evaluators could conduct informal sessions with representatives of affected groups and relevant non-governmental organizations.

After a project has been implemented, MERVC activities should assess whether the project led to any social and economic impacts and whether any mitigation was done. Direct and indirect project impacts need to be examined, as well as «avoided negative socioeconomic impacts» (e.g., the preservation of an archaeological site as a result of the deferral of the construction of a new power plant). Evaluators should collect some minimal information on potential impacts via surveys or interviews with key stakeholders. The evaluator should also check to see if any proposed mitigation efforts were implemented and whether expected positive benefits ever materialized. The extent and quality of available data, key data gaps, and uncertainties associated with estimates may need to be identified and estimated.

6 - REPORTING

Reporting refers to *measured* GHG and non-GHG impacts of a project (in some cases, organizations may report on their *estimated* impacts, prior to project implementation, but this is not the focus of these guidelines). Reporting occurs throughout the MERVC process (e.g., periodic reporting of monitored results and a final report once the project has ended). LBNL has developed a Monitoring and Evaluation Reporting Form (MERF) that evaluators may follow when reporting energy use and carbon emissions (see Vine and Sathaye 1999).

7 - VERIFICATION AND CERTIFICATION

If carbon credits become an internationally traded commodity, then verifying the amount of carbon reduced or fixed by projects will become a critical component of any trading system. Investors and host countries may have an incentive to overstate the GHG emission reductions from a given project, because it will increase their earnings when excessive credits are granted; as an example, these parties may overstate baseline emissions or understate the project’s emissions. To resolve this problem, there is a need for external (third party) verification.

As part of the verification exercise, an overall assessment of the quality and completeness of each of the GHG impact estimates needs to be made by requesting information in a Verification Reporting Form (VRF), similar to the MERF. For energy-efficiency measures, verifying baseline and post-project conditions may involve inspections, spot measurement tests, or assessments, as well as requesting documentation on key aspects of the project (similar to what is done as part of the IPMVP). In addition, the following general questions need to be asked: (1) have the monitoring and evaluation methods been well documented and reproducible? (2) have the results been checked against other methods? (3) have results (e.g., monitored data and emissions) been compared for reasonableness with outside or independently published estimates? (4) have the sources of emission factors been well documented? and (5) have the sources of emission factors been compared with other sources? At this time, certification is expected to simply be the outcome of a verification process: i.e., no other monitoring and evaluation activities are expected to be conducted.

8 - COSTS

Monitoring and evaluation costs will depend on what information is needed, what information and resources are already available, the size of the project area, the monitoring methods to be used, and frequency of monitoring. Furthermore, some methods require high initial costs: e.g., in metering, start-up costs in terms of equipment and personnel training may make the installation of meters very expensive, while making continuous metering exceedingly cost effective. Based on the experience of U.S. utilities and energy service companies, monitoring and evaluation activities can easily account for 5-10% of an energy-efficiency project's budget.

Due to the availability of funding, we realize that some project developers and evaluators will not be able to conduct the most data intensive methods proposed in this paper; however, we expect each project to undergo some evaluation and verification in order to receive carbon credits (especially, certified emission reduction units). Moreover, we believe that monitored projects will save more carbon and offset the cost of the monitoring because: (1) installations following a monitoring and evaluation protocol should come in near or even above the projected level of energy savings; and (2) installations with some measurement of energy savings should tend to have higher levels of energy savings initially and experience energy savings that remain high during the lifetime of the measure. In the end, the cost of monitoring and evaluation will be partially determined by its value in reducing the uncertainty of carbon credits: e.g., will one be able to receive carbon credits with a value greater than 10% of project costs that are spent on monitoring and evaluation?

Because of concerns about high costs, MERVC activities cannot be too burdensome: in general, the higher the costs, the less likely organizations and countries will try to develop and implement energy-efficiency projects. However, in some cases, due to the enormous cost differential between the carbon reduction options of UNFCCC Parties, fairly high costs can be accommodated before these costs become prohibitive. Nevertheless, MERVC costs should be as low as possible. In sum, actual (as well as perceived) MERVC costs may discourage some transactions from occurring. Tradeoffs are inevitable, and a balance needs to be made between project implementation and the level of detail (and costs) of MERVC reporting guidelines.

Project estimates of impacts could be adjusted, based on the amount of uncertainty associated with the estimates, without conducting project-specific analyses. Projects with less accurate or less precisely quantified benefit estimates would have their estimates adjusted and therefore have their benefits rendered policy-equivalent to credits from projects that can be more accurately quantified. The U.S. Environmental Protection Agency's Conservation Verification Protocol reward more rigorous methods of verifying energy savings by allowing a higher share of the savings to qualify for tradable SO_2 allowances. Three options are available for verifying subsequent-year energy savings: monitoring, inspection and a default option (USEPA 1995 1996). In the <u>monitoring option</u>, a utility can obtain credit for a greater fraction of the savings and for a longer period: biennial verification in subsequent years 1 and 3 (including inspection) is required, and savings for the remainder of physical lifetimes are the average of the last two measurements. The monitoring option requires a 75% confidence in subsequent-year savings (like in the first year). In contrast, the <u>default option</u> greatly restricts the allowable savings: 50% of first-year savings, and limited to one-half of the measure's lifetime. For the <u>inspection option</u> (confirming that the measures are both present and operating): a utility can obtain credit for 75% of first-year savings for units present and operating for half of physical lifetime (with biennial inspections), or 90% of first-year savings for physical lifetimes of measures that do not require active operation or maintenance (e.g., building shell insulation, pipe insulation and window improvements). Thus, utilities could use a simpler evaluation method at a lower cost and receive fewer credits, or they could use a more sophisticated method and receive more credits.

9 - SUMMARY

Monitoring and evaluation of energy-efficiency projects is needed to accurately determine their impact on GHG emissions and other attributes, and to ensure that the global climate is protected and that country obligations are met. Articles 6 and 12 of the Kyoto Protocol require MERVC activities. The challenges to successful monitoring and evaluation will not be insignificant: e.g., the evaluation of positive project spillover, market transformation, and free riders. LBNL has developed MERVC guidelines that address these issues by describing methods, procedures, and forms which can be used in preparing monitoring and evaluation plans and in reporting the results of monitoring, evaluation, and verification (Vine and Sathaye 1999). The next phase of LBNL's work will be to develop a procedural handbook providing information on how one can complete monitoring, evaluation and verification forms. We then plan to test the usefulness of these handbooks in the real world.

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11 - END NOTES

1. This article is based on a more detailed report conducted for the U.S. Environmental Protection Agency (Vine and Sathaye 1999).
2. The IPMVP protocol can be downloaded via the World Wide Web: http://www.ipmvp.org.
3. Free riders are project participants who would have installed the same energy-efficiency measures if there had been no project. Project spillover refers to changes in the behavior of project participants who are not directly related to the project as well as to changes in the behavior of other individuals not participating in the project (i.e., nonparticipants).
4. The «net-to-gross» factor is defined as net savings divided by gross savings. The gross savings are the savings directly attributed to the project and include the savings from all measures and from all participants; net savings are gross savings that are «adjusted» for free riders and positive project spillover. Multiplying the gross savings by the net-to-gross factor yields net savings.

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