



# ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY

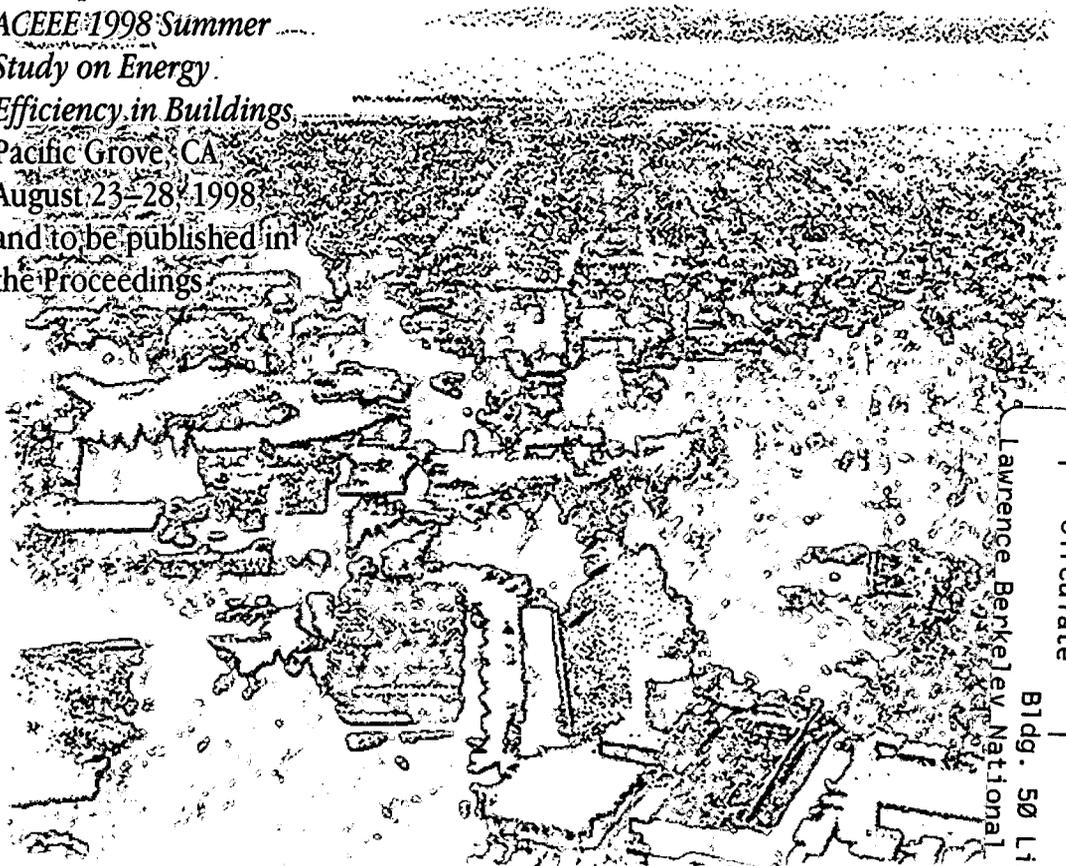
## The Monitoring, Evaluation, Reporting and Verification of Climate Change Mitigation Projects

Edward Vine and Jayant Sathaye

**Environmental Energy  
Technologies Division**

May 1998

To be presented at the  
*ACEEE 1998 Summer  
Study on Energy  
Efficiency in Buildings*  
Pacific Grove, CA  
August 23-28, 1998  
and to be published in  
the Proceedings



Lawrence Berkeley National Laboratory  
Bldg. 50 Library - Ref.  
COPY 1  
REFERENCE COPY  
Does Not Circulate

## **DISCLAIMER**

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

**The Monitoring, Evaluation, Reporting and Verification  
of Climate Change Mitigation Projects**

**Edward Vine and Jayant Sathaye**

**Energy Analysis Department  
Environmental Energy Technologies Division  
Lawrence Berkeley National Laboratory  
Berkeley, CA 94720**

**May 1998**

**Presented at the ACEEE 1998 Summer Study on Energy Efficiency in Buildings  
Pacific Grove, CA, August 1998**

**This work was supported by the U.S. Environmental Protection Agency through the U.S. Department of  
Energy under Contract No. DE-AC03-76SF00098.**

## Abstract

Because of concerns with the growing threat of global climate change from increasing emissions of greenhouse gases, the United States and other countries are implementing, by themselves or in cooperation with one or more other nations, climate change mitigation projects. These projects will reduce greenhouse gas (GHG) emissions or sequester carbon, and will also result in non-GHG benefits (i.e., environmental, economic, and social benefits).

Monitoring, evaluating, reporting, and verifying (MERV) guidelines are needed for these projects to accurately determine their net GHG, and other, benefits. Implementation of MERV guidelines is also intended to: (1) increase the reliability of data for estimating GHG benefits; (2) provide real-time data so that mid-course corrections can be made; (3) introduce consistency and transparency across project types and reporters; and (4) enhance the credibility of the projects with stakeholders.

In this paper, we review the issues involved in MERV activities. We identify several topics that future protocols and guidelines need to address, such as: (1) establishing a credible baseline; (2) accounting for impacts outside project boundaries through leakage; (3) net GHG reductions and other benefits; (4) precision of measurement; (5) MERV frequency; (6) persistence (sustainability) of savings, emissions reduction, and carbon sequestration; (7) reporting by multiple project participants; (8) verification of GHG reduction credits; (9) uncertainty and risk; (10) institutional capacity in conducting MERV; and (11) the cost of MERV.

## Introduction

Because of concerns with the growing threat of global climate change from increasing emissions of greenhouse gases, more than 166 countries (as of May 13, 1997) 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 recently adopted the Kyoto Protocol for continuing the implementation of the FCCC (UNFCCC 1997). Under the FCCC, Annex 1 countries (i.e., developed countries) are required to reduce their emissions in the year 2000 to 1990 levels. Non-Annex 1 countries (i.e., developing countries and countries with economies in transition) do not have this requirement.

The Protocol establishes a framework for addressing the three key topics at the national level: (1) emissions targets; (2) reporting and compliance; and (3) emissions trading. Although there is no mention of project level mechanisms in the Protocol, it is expected that countries obligated to meet emissions targets listed in the Protocol will be implementing policies and projects to reduce emissions. The second topic (reporting and compliance) forms the context for this paper. The Kyoto Protocol establishes procedures to ensure the reporting and measurement of anthropogenic emissions by sources, and removals by sinks, of greenhouse gases at the national level.<sup>1</sup> For example, countries would have to set national systems for measuring emissions accurately, achieving compliance with emissions targets, and ensuring enforcement for meeting emissions targets. Also, annual reports on measurement, compliance and enforcement efforts at the national level would be required and made available to the public. The preparation of such reports involves many complex analytical and institutional issues as they relate to climate change mitigation projects, as discussed in this paper.

The focus of this paper is: (1) at the project level, not at the program level (e.g., utility energy-efficiency programs, or national programs); (2) primarily at the local level with well-defined system boundaries, not at the national level; and (3) on the issues related to the MERV of climate change mitigation projects, not the actual

---

<sup>1</sup> GHG sources include emissions from fossil fuel combustion, industry, deforested biomass, soil carbon loss in deforested areas, methane from agricultural activities, etc. GHG sinks include storage in the atmosphere, ocean uptake, and uptake by forest regrowth and sequestration from carbon accumulation (IPCC 1995; Andrasko et al. 1996). In the Kyoto Protocol, sinks are defined as "direct human-induced land use change and forestry activities, limited to afforestation, reforestation, and deforestation" (Article 3, UNFCCC 1997).

development of guidelines or protocols (the subject of the next phase of our study).<sup>1</sup> The target audience of this paper is primarily government policymakers, but we hope that this paper will also be useful for project developers and investors, nongovernmental organizations, and the research community.

Climate change mitigation projects typically proceed through three phases: (1) project development (e.g., bringing together project investors and hosts, preparing feasibility studies, estimating the GHG reduction, and negotiating contracts); (2) project implementation (e.g., training project staff, implementing the project, managing the project finances, and preparing reports); and (3) project assessment (e.g., monitoring and evaluating the project, calculating the GHG reductions, and verifying the GHG reduction). MERV activities can occur in all project phases.

The focus of this paper is on project assessment (after a project has started implementation) and the following MERV activities:

1. Monitoring: refers to the measurement of GHG reductions<sup>2</sup> and other associated socioeconomic and environmental benefits and activities that actually 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 would involve the measurement of kilowatts produced by a wind generator, or the number of hectares preserved by a forestry project. 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 contribute to a learning process for all participants.

2. Evaluation: refers to both impact and process evaluations of a particular project, typically entailing a more indepth 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. The calculation of GHG reductions is conducted at this stage. Project

---

<sup>1</sup> For more details about the issues covered in this paper, see Vine and Sathaye (1997) which is available on the World Wide Web: <http://eande.lbl.gov/EAP/IES/gcc.html>.

<sup>2</sup> GHG reductions refer to GHG emission reductions or carbon sequestration in this paper. Carbon sequestration refers to the process where carbon is absorbed or taken out of the atmosphere and stored in a terrestrial or oceanic reservoir. This differs from the preservation of existing carbon stocks in a reservoir.

evaluation would include GHG impacts, non-GHG impacts (i.e., environmental, economic, and social impacts), determination of the proper baseline, estimation of leakage and project spillover, etc. 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 and carbon sequestration 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).

3. 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 MERV process (e.g., periodic reporting of monitored results and a final report once the project has ended).

4. Verification refers to establishing whether the measured GHG reductions actually occurred, similar to an accounting audit performed by an objective, certified party.

These activities have different objectives and timing, but they potentially have much overlap and interactions among each other as well as among the institutions that might perform these activities.

## **Carbon Credits and Trading**

The MERV guidelines will be important management tools for all parties involved in carbon mitigation. They will help project participants determine how effective their contributions have been in curbing GHG emissions, and they will help planners and policy makers in determining the potential impacts for different types of projects, and for improvements in project design and implementation. And they will also be needed for ensuring consistency and transparency across project types and sectors.

In the longer term, MERV-type 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 valuation of such projects will require MERV-type guidelines that are acceptable to all parties. These guidelines will yield verifiable findings, conducted on an ex post facto basis (i.e., actual as opposed to predicted project performance).

## **MERV Principles**

Any proposed MERV guidelines should reflect the following principles: they should be consistent, technically sound, readily verifiable, objective, simple, relevant, transparent, and cost-effective. These basic principles should be used to guide the development of the protocols, although tradeoffs may be necessary to include additional information (e.g., simplicity and cost-effectiveness versus obtaining measured data on environmental and socioeconomic impacts). If guidelines are not designed with these principles in mind, then their use and application will be limited and opportunities for providing false and misleading information may go unchecked. In reality, tradeoffs will have to be made for some of these criteria: e.g., simplicity versus the technical soundness of a guideline. Because of concerns about high transaction costs in responding to MERV guidelines the guidelines cannot be too comprehensive and burdensome (e.g., Andrasko et al. 1996; Dudek and Weiner 1996; Embree 1994; Heister 1996).

## **MERV Impacts and Responsibilities**

Based on our review of the literature and discussions with experts in the field, we believe that the MERV guidelines should address the following types of impacts: net reduction in GHG emissions; other environmental impacts; and economic and social impacts. We include a broad array of impacts for three reasons. First, 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, climate change mitigation projects and are concerned about their multiple impacts. Second, the persistence of GHG reductions and the sustainability of climate change mitigation 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. Third, it is premature to peremptorily decide which impacts are more important than others. Each project will need to decide the appropriate allocation of resources for addressing project impacts.

We realize that it will be very difficult and expensive for one organization to conduct MERV activities on all of these impacts. We expect that multiple organizations will be involved in the MERV process and that the financial burden of these activities will be shared by many groups. For example, in the case of projects that are sponsored by Annex 1 countries and implemented in non-Annex 1 countries, we expect both investor and host countries to collaborate and share the costs of MERV activities. In addition, we expect each stakeholder to assess the transaction costs of complying with the MERV guidelines. As a result, not all of the issues proposed for inclusion in the guidelines may be addressed by the organizations responsible for monitoring, evaluation, reporting or verification.

### **GHG Emissions Impacts**

The Kyoto Protocol contains emissions targets for six major greenhouse gases: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), HFCs, perfluorocarbons (PFCs), and sulfur hexafluoride (SF<sub>6</sub>). In climate change mitigation projects, GHG emission reductions may include physical quantities of individual gases involved, tons of carbon equivalent, or total amount of carbon. Project developers could also calculate the various effects of different gases on climate by using a common index, such as the equivalent effect in tons of carbon dioxide. Emission factors can also be used to estimate GHG emission reductions (World Bank 1994a; see also IPCC 1995). The emission factors represent the basic conversion between energy consumption and generation of greenhouse gases. These factors are usually expressed in mass of emitted gas per unit of energy input (g/GJ) or sometimes in mass of gas per mass of fuel (g/kg or g/t).

Forestry projects are more complex, and information should be provided on the amount of carbon accumulated in forest plantations, managed natural forests

and agroforestry land uses. Changes in four main carbon pools (above-ground biomass, below-ground biomass, soils and standing litter crop) need to be described (MacDicken 1996).

### **Other Environmental Impacts**

Climate change mitigation projects have widespread and diverse environmental impacts that go beyond GHG impacts. The environmental benefits associated with climate change mitigation projects can be just as important as the global warming benefits. Accordingly, the MERV guidelines should contain information on environmental impacts in addition to GHG impacts, including changes in emissions of other gases and particulates, biodiversity, soil conservation, watershed management, sustainable land use, water pollution reduction, and indoor air quality. This information will be useful for better describing the stream of environmental services and benefits of a project, in order to attract additional investment and to characterize the project's chances of maintaining reduced GHG emissions over time. This information will, hopefully, also help in mitigating any potentially negative environmental impacts and encouraging positive environmental benefits.

At a minimum, baseline data on key environmental indicators need to be collected. For some projects, a full year of baseline data is desirable to capture the seasonal effects of certain environmental phenomena. Short-term monitoring could be used to provide conservative estimates of environmental impacts, while longer-term data collection is being undertaken. Any negative impacts of the project on local, regional and possibly national air sheds, watersheds, ecosystems and economies should be measured (Andrasko et al. 1996). Opportunities for environmental enhancement should be explored. The extent and quality of available data, key data gaps, and uncertainties associated with estimates should be identified and estimated. The following key issues need to be examined for environmental impacts: what type of monitoring and evaluation is needed, who should do the monitoring and evaluation, how much will monitoring and evaluation cost, and what other inputs (e.g., training) are necessary?

## **Economic and Social Impacts**

A project's survival is dependent on whether it is economically sound: i.e., the benefits outweigh the costs. Different economic indicators can be used for assessing the economics of climate change mitigation projects: e.g., cost-benefit ratio, net present value, payback levels, rate of return, cost in dollars per ton of carbon, carbon sequestered per hectare, etc. Similarly, these indicators should be calculated from different perspectives: e.g., government, investor, consumer, etc. In addition, the distribution of project benefits and costs need to be evaluated to make sure one population group is not being unduly affected.

The types of questions to address in examining the economic and social impacts include: 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 (World Bank 1994b). To address these questions, evaluators could conduct informal sessions with representatives of affected groups and relevant non-governmental organizations.

## **Generic MERV Issues**

Future protocols and guidelines need to address the following generic MERV issues: (1) establishing a credible baseline; (2) accounting for impacts outside project boundaries through leakage; (3) net GHG reductions and other impacts; (4) precision of measurement; (5) MERV frequency; (6) persistence (sustainability) of savings, emissions reduction, and carbon sequestration; (7) reporting by multiple project participants; (8) verification of GHG reduction credits; (9) uncertainty and risk; (10) institutional capacity in conducting MERV; and (11) the cost of MERV.

## **Establishing a Credible Baseline**

One of the critical questions that needs to be addressed by users of the guidelines is how much of an impact can be attributed to a particular project. In order to conduct this type of calculation, one needs to establish a credible baseline

(reference case). Without an appropriate baseline, it is impossible to accurately estimate GHG reductions due to a particular project. The baseline should describe the existing technology or practices at the facility or site and associated sources and sinks of GHG emissions (USIJI 1996). The emissions from sources and sequestration of greenhouse gases by sinks should be estimated for a full year before the date of the initiation of the project and for each year after the initiation of the project over the lifetime of the project without the project. The guidelines should remind the project proposers that future GHG emission levels may differ from past levels, even in the absence of the project, due to growth, technological changes, input prices, product prices, policy or regulatory shifts, social and population pressure, market barriers, and other exogenous factors.

### **Monitoring Domain (Leakage)**

Developing a credible baseline is difficult, but not insurmountable, because of the complexities in delineating the appropriate monitoring domain. The domain that needs to be monitored (i.e., the monitoring domain, see Andrasko 1997 and MacDicken 1997) is typically viewed as larger than the geographic and temporal boundaries of the project. If one of the objectives of the guidelines is to provide the capability to compare GHG reductions across projects, then the guidelines need to be consistent in requesting information at the same monitoring domain and need to address the following issues:

**The temporal and geographic extent of a project's direct impacts.** A climate change mitigation 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.

**Upstream and downstream coverage of indirect energy impacts and pre- and post-harvest coverage of indirect forestry impacts.** For example, energy projects may impact energy supply and demand at the point of production, transmission, or end use. The MERV 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). Similarly, the MERV of emissions of

forestry projects can be conducted at the point of extraction (e.g., when trees are logged) or point of use (e.g., when trees are made into furniture), and when forests are later transformed to other uses (e.g., agriculture, grassland, or range). Thus, one needs to decide whether MERV should focus solely on the emissions from the logging of trees at the project site, monitor the emissions over time from the new land use type, or account for the wood products produced and traded outside project boundaries.

**National and international leakage and off-site (i.e., outside of the project area) baseline changes.** For example, leakage occurs if a natural forest area, previously used to meet local needs for timber and firewood, is closed due to a preservation project and, as a result, fuelwood and timber are harvested elsewhere (MacDicken 1996; Watt et al. 1995). Some projects may involve international leakages: e.g., in 1989, when all commercial logging in Thailand was banned, the logging shifted to neighboring countries such as Burma, Cambodia and Laos as well as to Brazil.

Each applicant should identify potential sources of leakage and describe the steps that will be taken to reduce the risks of potential leakage, or to ensure that the benefits of the proposed project would not be lost or reversed in the future due to leakage. Each project developer should describe all of the situations where leakage might occur, identify which of these situations are most likely to occur and why they are likely to occur, indicate how much of the GHG savings could be lost by leakage, and identify the manner in which the project would act to minimize the likeliest forms of GHG leakage.

One could broaden the monitoring domain to include, for example, leakage and off-site baseline changes. Widening the system boundary, however, will most likely entail greater MERV transaction costs. Transaction costs are the costs incurred by the people responsible for monitoring, reporting, evaluating, and verifying climate change mitigation projects. These costs include not only out-of-pocket expenditures, but also opportunity costs (e.g., the lost time (delay) and resources (e.g., money and managerial attention) that could have been devoted to the next best opportunity for that participant (Dudek and Weiner 1996).

## Net GHG and Other Impacts

Project benefits need to be seen as net benefits (also referred to as “additionality”) to reflect the differences from what most likely would have happened without the project (the baseline, or modified reference case). For example, EPA’s Conservation Verification Protocol permits utilities to use “net-to-gross” factors to convert the calculated “gross energy savings” to “net energy savings.”<sup>1</sup> For measures specified in the Stipulated Savings path, a table of net-to-gross factors is provided, based upon experience with utility conservation programs. If a utility develops its own net-to-gross factor, supporting documentation for the factor must be attached to the verification form (e.g., market research, surveys, and inspections of nonparticipants). If a utility does not do any monitoring nor provide documentation and the measure is not a stipulated measure, then the net energy savings of a measure will be 50% of the first-year savings.

No project should claim emission reductions unless project proponents make a reasonable demonstration that the project’s practices are “additional” to “business as usual” circumstances (the baseline). After establishing a baseline, one needs to determine additionality by evaluating program intent (i.e., was the project initiated with the specific intent of lowering emissions?), emissions additionality (i.e., did specific measures lead to reductions in emissions?), and financial additionality (i.e., did the project rely on new funds or already committed funds?).

## Precision of Measurement

Because of the difficulties and uncertainties in estimating energy savings and carbon sequestration, one needs to know the level of precision and confidence levels associated with the estimated savings or sequestration. The guidelines should recommend the level of precision that is required or should provide options for different levels of precision, so that project developers can decide the level of accuracy based on costs and the needs of policymakers. The guidelines would not necessarily guarantee precision of measurement for individual projects, but they

---

<sup>1</sup> 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 free drivers (see below). Multiplying the gross savings by the net-to-gross factor yields net savings.

could avoid systematic miscalculations. Investors in future projects could decide the appropriate balance between the precision of measurement (or rather the research costs for higher precision) against the risk resulting from larger quantification errors (Heister 1996).

Several options are available for presenting information on precision, keeping in mind that a balance needs to be struck between the costs of assessing GHG reductions and the precision of measurement (Embree 1994; Heister 1996).

First, in EPA's Conservation Verification Protocols (CVP), the objective of the CVP is to award allowances for savings that occur with reasonable certainty (EPA 1995b and 1996). The CVP requires that the savings are expressed in terms of the utility's confidence that the true savings are equal to, or greater than, those for which it applied. The CVP uses a 75% level of confidence using a one-tailed test (no specific precision level is targeted): the reporting entity must be reasonably confident (at the 75% level) that the minimum level of energy savings has been achieved.

Second, project developers could choose one or more options for addressing precision: general level of precision; specific confidence limits (%); optimum precision for fixed-cost; and cost based on precision (MacDicken 1996). If a general level of precision is specified, the sponsor needs to record the detailed specifications for modeling versus field data collection, cost limits from sponsors, and overall desire for precision (e.g., basic, moderate, high).

Third, project developers could include an estimate of variance, confidence intervals or standard error for each mean calculated in the analysis of carbon pools and flows that are measured or considered in the calculation of carbon sequestration benefits (EcoSecurities 1997). While a universally accepted level of precision for estimates of carbon benefits does not currently exist, a reasonable target for the precision of a project's carbon benefit is a standard error of 20-30% of the mean.

Fourth, measurement standards (i.e., the maximum allowable nonsampling error in measurements) could be developed (see MacDicken 1997). Measurements that exceed these standards would be considered unacceptable.

Fifth, carbon claims could be adjusted by discounting the standard error of measurements. One could use the lower range of the standard error of the mean for estimates of reductions of emissions: e.g., if the calculation of emissions is reported

at 100 t carbon/hectare  $\pm$  15%, then one could report 85 t carbon/hectare (personal communication from Pedro Moura Costa, EcoSecurities Ltd., August 17, 1997).

### **MERV Frequency**

At a minimum, MERV frequency will most likely be linked to the schedule of payments for carbon credits. MERV frequency will also depend on the variables being examined. For example, monitoring of litter might be done in the first year of a forestry project and then once every five years, while the monitoring of the end uses of wood might be done annually. Also, within each activity, the duration and frequency might vary by method: e.g., hourly end-use monitoring conducted for a two-week period, or short-term monitoring of lighting energy use for five-minute periods. The monitoring period may also last longer than the project period: for example, a project to install compact fluorescent lamps may last 3 years, but electricity savings from those lamps will continue beyond the project period.

### **Persistence (Sustainability) of Impacts**

The sustainability of climate change mitigation projects is critical if the impacts from these projects are to persist. The issue of persistence is very relevant for the forestry sector where projects are subject to instantaneous loss from fire or shifting cultivators or harvest, and to longer term loss as biomass decays or when harvested forest products are burned or discarded. Information is needed on the institutional capabilities and support for implementing the project over the project's lifetime or on the risks and uncertainties of a project. Because forestry projects may take substantially longer to implement than energy-efficiency projects, the institutional, community, technical and contractual conditions likely to encourage persistence are of utmost concern. Having MERV guidelines to monitor the persistence of GHG impacts will also send a signal to project developers that they should design projects addressing the factors affecting persistence.

Several approaches for monitoring persistence have been proposed. EPA's CVP encourages monitoring over the life of the measure, but gives credit for less

stringent verification. Three options are available for verifying subsequent-year energy savings: monitoring, inspection and a default (Meier and Solomon 1995).

It may be desirable to rank or prioritize projects by their persistence or lack of persistence — this will be reflected in “project lifetime.” For example, if a project area is likely to undergo serious changes in 10 years, then the carbon emission reductions for that project are limited to that 10-year lifetime. The value of those reduced emissions may be less than for emissions from similar projects that are expected to last longer (e.g., 20 years).

### **Multiple Reporting**

Several types of reporting might occur in climate change mitigation projects: (1) impacts of a particular project are reported at the project level and at the program level (where a program consists of two or more projects); (2) impacts of a particular project are reported at the project level and at the entity level (e.g., a utility company reports on the impacts of all of its projects); and (3) impacts of a particular project are reported by two or more organizations as part of a joint venture (partnership) or two or more countries. To mitigate the problem of multiple reporting, project-level reporters should indicate whether other entities might be reporting on the same activity and, if so, who.

### **Verification of GHG Reductions**

As 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. We believe that external (third-party) verification processes need to be put in place and not rely on internal verification or audits.

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 asking the following questions: (1) are the monitoring and evaluation methods well documented and reproducible? (2) have the results been checked against other methods? (3) have results (e.g., monitored data and emission impacts) been compared for reasonableness with outside or independently published estimates? (4) are the sources of emission factors well documented? and (5) have the sources of emission factors been compared with other sources? (IPCC 1995).

Because emission reduction credits will most likely receive detailed scrutiny, it is probably prudent that the credits be differentiated by type of gas (e.g., methane, carbon dioxide, etc.) and by the method used for monitoring and evaluation. Each method will have a specific level of precision and confidence associated with it. Accordingly, when verifying credits, one should take into account the confidence one has in the data and methods used for estimating the reductions.

## **Uncertainty and Risk**

The evaluation of GHG reductions is a risky business, especially with respect to the reliability of the GHG reduction estimates and the credibility of the institutions implementing climate change mitigation projects. Important sources of the first type of uncertainty (i.e., reliability) are: (1) differing interpretations of source and sink categories or other definitions, assumptions, units, etc.; (2) use of simplified representations with averaged values (especially emission factors); (3) inherent uncertainty in the scientific understanding of the basic processes leading to emissions and removals; (4) operation risk (e.g., if the energy-consuming equipment is not used as projected or if the number of trees harvested is increased, then carbon savings will change); and (5) performance risk (IPCC 1995; U.S. AID 1996).

The credibility of the organization is critical to assess, since it affects two types of risk: (1) project development and construction risk, i.e., the project won't be implemented on time or at all, even though funds have been spent on project development; and (2) performance risk. The project developer's experience, warranties, the reputation of equipment manufacturers, the performance history of previous projects, and engineering due diligence are the main methods for

evaluating these risks. Furthermore, one should evaluate the political and social conditions that exist that could potentially affect the credibility of the implementing organizations (e.g., political context, stability of parties involved and their interests, potential barriers, existing land tenure system, and the potential for displacement of land pressure to other areas).

These uncertainties vary widely among different greenhouse gases, source categories for each gas, projects (depending on approach, levels of detail, use of default data or project specific data, etc.), and length of projects (e.g., a short-term project might increase reliability if the management of local forests is known to be poor). It is important to provide as thorough an understanding as possible of the uncertainties involved when monitoring, evaluating, reporting and verifying the impacts of climate change mitigation projects. In addition to qualitative analyses of uncertainties, it is useful to express uncertainty quantitatively and systematically in the form of well-developed confidence intervals (IPCC 1995).

Proposers of climate change mitigation projects should: (1) provide a contingency plan that identifies potential project risks and discusses the contingencies provided within the project estimates to manage the risks; (2) identify and discuss key uncertainties affecting all emission estimates; (3) assess the possibility of local or regional political and economic instability and how this may affect project performance; and (4) provide confidence intervals around their mean estimates.

## **Institutional Issues**

It is unclear at this time which institutions have the authority and capability of conducting MERV activities: government authorities, auditing companies, self-reporting by project developers or host countries, etc. We expect the roles and responsibilities will vary by MERV activity, although some overlap is expected. We expect the division of labor to be a function of available resources and capabilities, the credibility of the person (or organization) in charge of the activity, and the cost of conducting the particular MERV activity.

The capacity of organizations to implement the projects and to conduct MERV activities needs to be addressed by examining whether these organizations

can demonstrate: (1) financial capacity (i.e., the organization must demonstrate that it has sufficient financial resources to implement the project throughout its time frame); (2) management capacity (i.e., the organization must demonstrate its capacity to document and implement the project); and (3) infrastructure and technological capacity (i.e., the organization must demonstrate access to appropriate labor pools, technical skills, technologies and techniques and general infrastructure necessary for the implementation and maintenance of the project throughout its time frame) (EcoSecurities 1997).

**Roles and responsibilities.** Roles and responsibilities need to be clarified as early as possible, so that they are tailored to the appropriate organization; otherwise, delays in the designation will likely lead to delays and disputes later. The guidelines could also recommend that independent verification teams be established (see Watt et al. 1995). The verification teams could either be composed of members from host and investor countries for joint implementation projects, or from an international agency for other projects. Individual verifiers or verification teams would be responsible for conducting the verification activities.

Some resolution of disputes over verification results will also be needed. Recourse in the event of disagreement about the results of a verification could include resolution by the initial verification team, introduction of a second verification team, development of new calculation methodologies, or recourse to a tribunal, depending on the project and the nature of the disagreement. The tribunal might consist of people from the UN, or from a country. If the latter, someone may still be needed at the international level to monitor the activities of individual countries. The tribunal might also be responsible for developing a common set of standardized MERV guidelines.

**Qualifications of MERV personnel and organizations.** Because of the diverse individuals and organizations involved in the MERV of energy savings and carbon sequestration with varying levels of technical expertise, the guidelines may need to recommend qualification criteria for allowing these people to report, monitor, evaluate and verify GHG reductions, so that the findings are perceived as objective and credible. Certification workshops may be needed to ensure that the activities are being conducted in a responsible and credible manner. Training and certification should be sector specific: e.g., a certified evaluator in forestry. The entity(ies) responsible for certification should be identified in the guidelines.

**Staffing, training, instrumentation, and lab facilities.** MERV will entail significant resources, including the potential hiring and training of new staff (or contractors), equipment, and laboratory facilities. The users of the guidelines should be aware of the need for these resources prior to developing their MERV plans.

### **Cost of MERV**

Conducting MERV activities is not inexpensive. For example, based on the experience of U.S. utilities and energy service companies, monitoring and evaluation activities can easily account for 5-10% of a project's budget. Similarly, carbon monitoring efforts require specialized equipment, methods and trained personnel that can be expensive for individual organizations to procure and maintain, and can result in similar percentage expenditures. The cost will vary by size of area, scope of project, variation within and between land use types, type of monitoring, and amount of training required. Early in the process of developing guidelines, the cost of implementing the guidelines will need to be examined, and the costs will need to be disaggregated by institution as well as by activity (MERV).

### **Summary**

Based on our review of the literature and existing guidelines and protocols, we compiled a list of generic issues that need to be addressed in the development of MERV guidelines. In Table 1, we summarize the critical questions for each of these issues and, where possible, provide possible options for addressing these questions. For most of these issues, there is not one simple answer. Several alternatives may be possible for addressing some of the issues, while guidance from policymakers (rather than guidelines) will be needed for addressing other issues.

**Table 1. Generic MERV Issues and Potential Response Options**

Generic issue	Potential Response Options
Credible baseline Monitoring domain Leakage	Identify most likely areas of leakage and possible mitigation measures.
Net GHG and other impacts Free riders, project spillover, and market transformation	Use net-to-gross ratios and comparison groups. Assess market effects and market barriers.
Precision of measurement Confidence levels Sampling	Use a 75% confidence level, or provide options for addressing precision. Estimate variance, confidence intervals, or standard error. Use 20-30% standard error or lower range of standard error. Develop measurement standards .
MERV frequency	Reporting depends on schedule of payments for carbon credits. For monitoring, focus on key parameters for forestry projects. Examine variables and monitoring methods. Consider seasonality. .
Persistence of impacts Institutional capabilities Risks and uncertainties	Use monitoring, default, and inspection options. Annual monitoring for forestry projects. Monitoring every 3 years for energy projects. Rank projects by likelihood of persistence of GHG emissions reductions. Monitor project after termination.
Multiple reporting	Ask project developers to report on multiple reporters.
Verification of GHG reductions Responsible parties Frequency	Use third-party verifiers. Use verification system. Certify verifiers. Use multi-tiered crediting: credits vary by type of verification .
Risks and uncertainties Reliability of estimates Credibility of institutions Controllable risks	Provide a contingency plan. Discuss key uncertainties. Use confidence intervals. Develop MERV protocols and guidelines. Use default estimates where appropriate. Monitor factors affecting risk.
Institutional capabilities Local institutions Administrative burden Political impacts Roles and responsibilities Qualifications & training	Request information on institutional capacities and relationships among project stakeholders. Use different parties for implementation, evaluation, and verification. Use independent verification teams. Develop qualification criteria. Provide training and certification workshops.
Cost of MERV	Disaggregate costs by institution and MERV activity. Balance tradeoffs between cost and other MERV issues. Set cap at 10% of total project budget.

## **Conclusions**

MERV guidelines are needed for climate change projects in order to accurately determine their net GHG, and other, benefits. New protocols and guidelines will be needed for turning GHG reductions into credible, internationally acceptable GHG credits that would trade at a single market price. The MERV issues discussed in this paper need to be worked out before putting a credible emissions trading system in place.

The strictness of MERV guidelines needs to be carefully considered. Strict guidelines may easily lead to burdensome and complex procedures, thereby increasing the transaction costs and reducing the cost-effectiveness of a project. However, if the guidelines for international verification are “loose”, then project sponsors might be more able to manipulate the “measured” emission reductions, e.g., inflating the net emission reductions from the project. Thus, the guidelines should not be overly burdensome but credible. There needs to be a balance between (1) the need to gather sufficient data and information to accurately measure real GHG emissions reductions and build confidence in climate change mitigation projects and (2) the need to promote efficiency by minimizing MERV burdens at all levels (Embree 1994; Heister 1996). Such a balance would limit reporting to what is necessary and reduce costs and the number of transactions among institutions and project participants.

What are the true information needs? In this paper, we have presented our list of key issues that need to be addressed. However, information needs will differ with each organization’s goals with respect to climate change mitigation projects. Based on our review of existing protocols and guidelines, we expect all organizations to support sustainable GHG emissions reductions. However, options should be available for project developers to decide how much effort should be spent in addressing each MERV issue (see Vine and Sathaye 1997).

## **Acknowledgments**

We would like to thank Maurice N. LeFranc, Jr. and Jackie Krieger of the U.S. Environmental Protection Agency, Climate Policy and Program Division, Office of

Economics and Environment, Office of Policy, Planning and Evaluation for their assistance. We would also like to express our appreciation for the following reviewers of an earlier draft of this paper: Chris Busch, Trini Pipi Kroemer, Maurice LeFranc, Joel Swisher, and John Wilson. This work was supported by the U.S. Environmental Protection Agency through the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

## References

- Andrasko, K. 1997. "Forest Management for Greenhouse Gas Benefits: Resolving Monitoring Issues Across Project and National Boundaries," *Mitigation and Adaptation Strategies for Global Change*, 2(2-3):117-132.
- Andrasko, K., L. Carter, and W. van der Gaast. 1996. "Technical Issues in JI/AIJ Projects: A Survey and Potential Responses," a background paper prepared for the Critical Issues Working Group, for the UNEP AIJ Conference, San Jose, Costa Rica.
- Dudek, D. and J. Weiner. 1996. *Joint Implementation, Transaction Costs, and Climate Change*. OCDE/GD(96)173. Paris: Organization for Economic Co-Operation and Development.
- EcoSecurities, Ltd. 1997. *SGS Forestry Carbon Offset Verification Services*. Draft. Oxford, United Kingdom: SGS Forestry.
- Embree, C. (Sid). 1994. "Monitoring, Accounting, Verifying, and Reporting on Joint Implementation Activities: Preliminary Issues and Considerations," presented at the Workshop on Designing Joint Project Mechanisms to Promote Benefits for Developing Countries, Rio de Janeiro, Brazil, Dec. 13-15.
- Heister, J. 1996. "Towards a Methodology for Quantifying Greenhouse Gas Offsets from Joint Implementation Projects and Activities Implemented Jointly," draft working paper, Global Climate Change Unit, Global Environment Division, World Bank, Washington, D.C.
- International Panel on Climate Change (IPCC). 1995. *Greenhouse Gas Inventory Workbook and Reporting Instructions*. Bracknell: IPCC.

- MacDicken, K. 1997. "Project Specific Monitoring and Verification: State of the Art and Challenges," *Mitigation and Adaptation Strategies for Global Change*, 2(2-3):191-202.
- MacDicken, K. 1996. *A Guide to Monitoring Carbon Sequestration in Forestry and Agroforestry Projects*. Working Paper 96/04 (revised 9/96). Arlington, Virginia: Forest Carbon Monitoring Program, Winrock International Institute for Agricultural Development.
- Meier, A. and B. Solomon. 1995. "The EPA's Protocols for Verifying Savings from Utility Energy-Conservation Programs," *Energy: The International Journal* 20(2);105-115 (1995).
- UNEP/WMO Information Unit on Climate Change. 1992. *United Nations Framework Convention on Climate Change*. Geneva, Switzerland: UNEP/WMO Information Unit on Climate Change.
- UNFCCC. 1997. "Kyoto Protocol to the United Nations Framework Convention of Climate Change," FCCC/CP/1997/L.7/Add.1, Dec. 10, 1997.
- U.S. Agency for International Development (AID). 1996. *Strategies for Financing Energy Efficiency*. Business Focus Series. Washington, D.C.: U.S. Agency for International Development.
- U.S. Environmental Protection Agency (EPA). 1995a. *Acid Rain CEMS Program Submission Instructions*. Washington, D.C.: U.S. Environmental Protection Agency.
- U.S. Environmental Protection Agency (EPA). 1995b. *Conservation and Verification Protocols, Version 2.0*. EPA 430/B-95-012. Washington, D.C.: U.S. Environmental Protection Agency.
- U.S. Environmental Protection Agency (EPA). 1996. *The User's Guide to the Conservation and Verification Protocols, Version 2.0*. EPA 430/B-96-002. Washington, D.C.: U.S. Environmental Protection Agency.
- U.S. Initiative on Joint Implementation (USIJI). 1996. *Guidelines for a USIJI Project Proposal*. Washington, D.C.: U.S. Initiative on Joint Implementation.

- Vine, E. and J. Sathaye. 1997. *The Monitoring, Evaluation, Reporting, and Verification of Climate Change Mitigation Projects: Discussion of Issues and Methodologies and Review of Existing Protocols and Guidelines*. LBNL-40316. Berkeley, Calif.: Lawrence Berkeley National Laboratory.
- Watt, E., J. Sathaye, O. de Buen, O. Masera, I. Gelil, N. Ravindranath, D. Zhou, J. Li, and D. Intarapravich. 1995. *The Institutional Needs of Joint Implementation Projects*. LBL-36453, Berkeley, Calif.: Lawrence Berkeley National Laboratory.
- World Bank 1994a. *Greenhouse Gas Abatement Investment Project Monitoring & Evaluation Guidelines*. Washington, D.C.: World Bank.
- World Bank 1994b. *Incorporating Social Assessment and Participation Into Biodiversity Conservation Projects*. Washington, D.C.: World Bank.

**ERNEST ORLANDO LAWRENCE BERKELEY NATIONAL LABORATORY  
ONE CYCLOTRON ROAD | BERKELEY, CALIFORNIA 94720**