Best Practices Guide:

Monitoring, Evaluation, Reporting, Verification, and Certification of Climate Change Mitigation Projects

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Contents

Acronyms

AIJ	Activities Implemented Jointly
AOSIS	Alliance of Small Island States
BAT	Best Available Technology
C	Carbon
CDM	Clean Development Mechanism [Article 12 of Kyoto Protocol]
CERs	Certified Emission Reductions [generated from CDM projects]
CH_4	Methane
CFC	Chloroflourocarbons
CO	Carbon monoxide
CO_2	Carbon dioxide
COP	Conference of Parties (to the UNFCCC)
CTO	Certifiable Tradable Offset
DSM	Demand-side Management
EEM	Energy-efficiency Measure
EIT	Countries with Economies in Transition
ERU	Emission Reduction Unit [generated from JI projects]
FCCC	See UNFCCC
G-77	Group of 77 and China
GEF	Global Environment Facility
GHG	Greenhouse Gases
GIS	Geographic Information System
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
IRP	Integrated Resource Planning
JI	Joint Implementation [Article 6 of Kyoto Protocol]
KP	Kyoto Protocol
kt	thousand tons
LUCF	Land Use Change and Forestry
LULUCF	Land Use, Land Use Change and Forestry
MERVC	Monitoring, Evaluation, Reporting, Verification and Certification
mtC	Metric tons of Carbon
MW	Megawatts
N	Nitrogen
NGO	Nongovernmental Organization
NO	Nitric Oxide
NO_2	Nitrogen Oxide
NOx	the sum of NO and NO_2
N_2O	Nitrous Oxide
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
PM	Particulate Matter
QUELRO	Quantified emission limitation and reduction commitments in the Kyoto Protocol
SBI	Subsidiary Body for Implementation

SBSTA	Subsidiary Body for Scientific and Technological Advice
SO_2	Sulfur Dioxide
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
URF	Uniform Reporting Format
USAID	U.S. Agency for International Development
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
USIJI	U.S. Initiative on Joint Implementation
WB	The World Bank

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Introduction

The United State Agency for International Development's (USAID) Global Center for Environment is sponsoring a series of courses designed to develop technical leadership capacity in energy development and greenhouse gas (GHG) emissions reduction that is both friendly to the environment and beneficial to economic growth. Sponsored by the USAID through a contract with the Energy Group of the Institute of International Education (IIE), Lawrence Berkeley National Laboratory (LBNL) developed the *Best Practices Guide: Monitoring, Evaluation, Reporting, Verification and Certification of Climate Change Mitigation Projects*. This guide is for project developers and evaluators involved with the measurement of GHG emissions from government, non-profit organizations, power companies, financial institutions, consultants and universities. This guide provides an overview of the key issues involved in the monitoring, evaluation, reporting, verification and certification (MERVC) of climate change mitigation projects.

IIE is a non-profit organization whose Energy Group provides technical assistance and training to government and business leaders in developing the skills and knowledge they will need to succeed in meeting their energy management and national development goals.

LBNL, managed by the University of California for the U.S. Department of Energy (DOE), is a multi-program lab where research in advanced materials, biosciences, energy efficiency, detectors and accelerators focuses on national needs in technology and the environment. LBNL's Environmental Energy Technologies Division is one of the pre-eminent organizations in the U.S. and internationally in the areas of energy efficiency improvements, environmental management, training, and institutional strengthening. LBNL has been in the field of energy and environmental management for more than 23 years. Much of the original research, development, and subsequent demonstration and implementation of energy efficiency improvements, energy conservation, and environmental impact assessment and management has been performed by LBNL.

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Chapter 1

Climate Change Overview

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 Oct. 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 adopted 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 requires Annex I (developed) countries to report anthropogenic emissions by sources, and removals by sinks, of greenhouse gases at the national level (Article 5).[1] For example, countries would have to set national systems for estimating emissions accurately, achieving compliance with emissions targets, and ensuring enforcement of meeting emissions targets. Annual reports on measurement, compliance and enforcement efforts at the national level would be required and made available to the public.

The Kyoto Protocol includes two project-based mechanisms for activities across countries. Article 6 of the Protocol allows for joint implementation projects between 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 that 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. Projects undertaken by developed countries will not only reduce greenhouse gas (GHG) emissions or sequester carbon, but may also result in non-GHG benefits and costs (i.e., other environmental and socioeconomic benefits and costs). Further detailed elaboration remains for the key provisions of the Kyoto Protocol as negotiations clarify the existing text of the Protocol.[2]

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[1] GHG sources include emissions from fossil fuel combustion, industry, decomposing and oxidized biomass, soil carbon loss, and methane from agricultural activities, livestock, landfills and anaerobic decomposition of phytomass. GHG sinks include storage in the atmosphere, ocean uptake, and uptake by growing vegetation (IPCC 1996; Andrasko et al. 1996).

[2] While this guide focuses on the Kyoto Protocol, it should also be useful for projects undertaken before the Protocol goes into effect: e.g., in the U.S., the President's Climate Change Proposal contains a program that rewards organizations, by providing credits or incentives (e.g., a credit against a company's emissions or a tax credit), for taking early actions to reduce greenhouse gases before the international agreements from the Kyoto

As countries start to seriously respond to the mandate of the Kyoto Protocol, climate change mitigation project developers will be asked to demonstrate how their project will reduce greenhouse gas (GHG) emissions or sequester carbon. As a result, monitoring, evaluation, reporting, verification, and certification (MERVC) will be the key activities conducted at the project level. MERVC definitions are provided in Box 1. These activities will build upon the work conducted in previous projects, including those of the Activities Implemented Jointly (AIJ) Pilot.

Box 1

Definitions

Estimation: refers to making a judgement on the likely or approximate stock of carbon, 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 carbon stocks, 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 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 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, leakage, positive project spillover, etc., which were estimated during the project design stage. 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, leakage, or 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 chapter). 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, and 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.

Protocol would take effect. The proposal is now commonly referred to as a "credit for early action" program (USGAO 1998).

Under joint implementation, the reduction in emissions by sources, or an enhancement of removals by sinks, must be "additional" to any that would otherwise occur, entailing project evaluation (Article 6). The "emission reduction units" from these projects can be used to meet Annex I Party's commitment under Article 3 of the Kyoto Protocol, necessitating all MERVC activities to be conducted. Similarly, under the Clean Development Mechanism, emission reductions must not only be additional, but also be certified as real, measurable, and deriving from projects that contribute to sustainable development, again requiring the performance of all MERVC activities (Article 12).

Internationally agreed MERVC guidelines to assist project developers and evaluators have not yet been developed by AIJ sponsors. We expect such guidelines to be established for joint implementation and CDM projects under the Kyoto Protocol, since they are needed 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 methodology; and (6) reduce financing costs, allowing project bundling and pooled project financing.

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

The objective of this paper is to provide guidance on how one should go about monitoring, evaluating, reporting, verifying, and certifying climate change mitigation projects.

The MERVC Process

Climate change mitigation projects (not just for the Clean Development Mechanism or under joint implementation) will likely involve several tasks (Fig. 1.). We expect that there will 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 might borrow money from a financial institution to implement the project; (3) a developer might work with a third party who would be responsible for many project activities; etc. While the flow of funds might change as a result of these different arrangements, the guidelines should be relevant to all parties, independent of the arrangement.

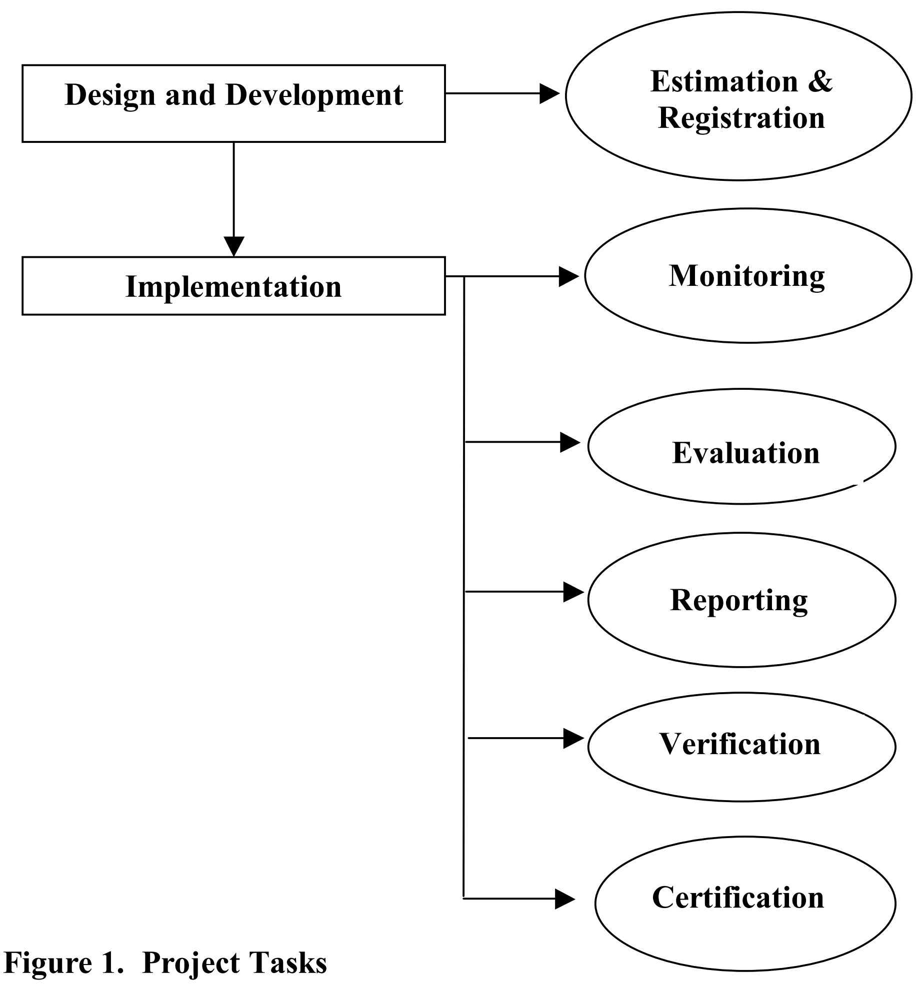


Figure 1. Project Tasks

In Figure 1, we differentiate "registration" from "certification." Certification refers to certifying whether the measured GHG reductions actually occurred. This definition reflects the language in the Kyoto Protocol regarding the Clean Development Mechanism and "certified emission reductions." In contrast, when a host country approves a project for implementation, the project is "registered" (see UNFCCC 1998b). For a project to be approved, each country will rely on project approval criteria that they developed: e.g., (1) the project funding sources must be additional to traditional project development funding sources; (2) the project must be consistent with the host country's national priorities (including sustainable development); (3) confirmation of local stakeholder involvement; (4) confirmation that adequate local capacity exists or will be developed; (5) potential for long-term climate change mitigation; (6) baseline and project scenarios; and (7) the inclusion of a monitoring protocol (see Watt et al. 1995).

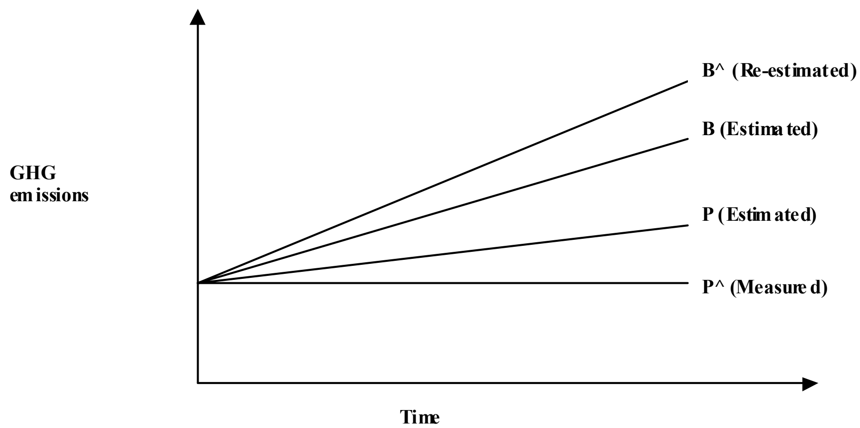
A country may also use different administrative or legal requirements for registering projects. For example, the project proposal (containing construction and operation plans, proposed monitoring and evaluation of changes in carbon stock and energy use and emissions, and estimated changes in carbon stock, energy use and emissions) might have to be reviewed and assessed by independent reviewers. After this initial review, the project participants would have an opportunity to make adjustments to the project design and make appropriate adjustments to the expected changes in energy use, carbon stock, and emissions. The reviewers would then approve the project, and the project would be registered. Individuals or organizations voicing concerns about the project would have an opportunity to appeal the approval of the project, if desired.

Chapter 2

Conceptual Framework

We use an example of a hypothetical climate change mitigation project to show the conceptual framework underlying the monitoring and evaluation that need to be conducted. In this example, the project seeks to reduce GHG emissions rather than sequester carbon. The analysis of GHG emissions occurs when a project is being designed and during the implementation of the project. In the design stage, the first step to estimate the baseline (i.e., what would have happened to GHG emissions if the project had not been implemented) and the project impacts. Once these have been estimated, then the net GHG emissions are simply the difference between the estimated project impacts and the baseline (P-B, in Fig. 2). After a project has begun to be implemented, the baseline can be re-estimated and the project impacts will be calculated based on monitoring and evaluation methods. The net savings will be the difference between the measured project impacts and the re-estimated baseline (P^-B^, in Fig. 2). The example in Fig. 2 illustrates a case where measured GHG emissions are lower than estimated as a result of a climate change mitigation project. On the other hand, GHG emissions in the re-estimated baseline are higher than what had been estimated at the project design stage. In this case, the calculated net GHG emissions (P^-B^) are larger than what was first estimated (P-B).

The conceptual framework is helpful for planning the monitoring and evaluation of a specific project. After a project has been implemented and is about to be evaluated, the key types of data that need to be collected are the following: (1) forecasted GHG emissions without a project (baseline, estimated during the project proposal stage); (2) forecasted GHG emissions with the project (estimated during the project proposal stage); (3) actual GHG emissions; and (4) a revised baseline, based on what has happened since the proposal stage. As discussed later in this paper, some of these data are readily available, while other data will require primary data collection.



B: Estimated GHG emissions without project(baseline)
P: Estimated GHG emissions with project
P-B: Estimated net (additional) GHG emissions

B^: Re-estimated GHG emissions without project (baseline) (after monitoring and evaluation)
P^: Measured GHG emissions with project (after monitoring and evaluation)
P^-B^: Measured net (additional) GHG emissions (after monitoring and evaluation)

Figure 2. Example of GHG Emissions Over Time

Chapter 3

Monitoring and Evaluation

As an example of the type of monitoring and evaluation that is needed, we present in Figure 3 an overview of one approach used in evaluating gross and net changes in GHG emissions in a forestry project (Vine, Sathaye and Makundi 1999); a similar approach has been developed for energy projects (Vine and Sathaye 1999). In this section, we focus on one of the challenges involved in monitoring and evaluation: establishing the monitoring domain. The rest of this paper examines the other issues mentioned in Fig. 3.

Establishing the 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. In order to compare GHG reductions across projects, a monitoring domain must 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 project leakage, positive project spillover and market transformation.

The first monitoring domain issue concerns the appropriate geographic boundary for evaluating and reporting impacts. For example, a forestry 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. Thus, one must decide the appropriate geographic boundary for evaluating and reporting impacts. Similarly, the MERVC of changes in the carbon stock 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, depending on the project developer's claims, one may decide to focus solely on the changes in the carbon stock from the logging of trees at the project site, monitor the changes over time from the new land use type, or account for the wood products produced and traded outside project boundaries.

The same questions about the monitoring domain need to be asked for energy projects. For example, 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 producers and end users (e.g., tracking the emissions impact of 1,000 kWh saved by a household in a utility's generation system).

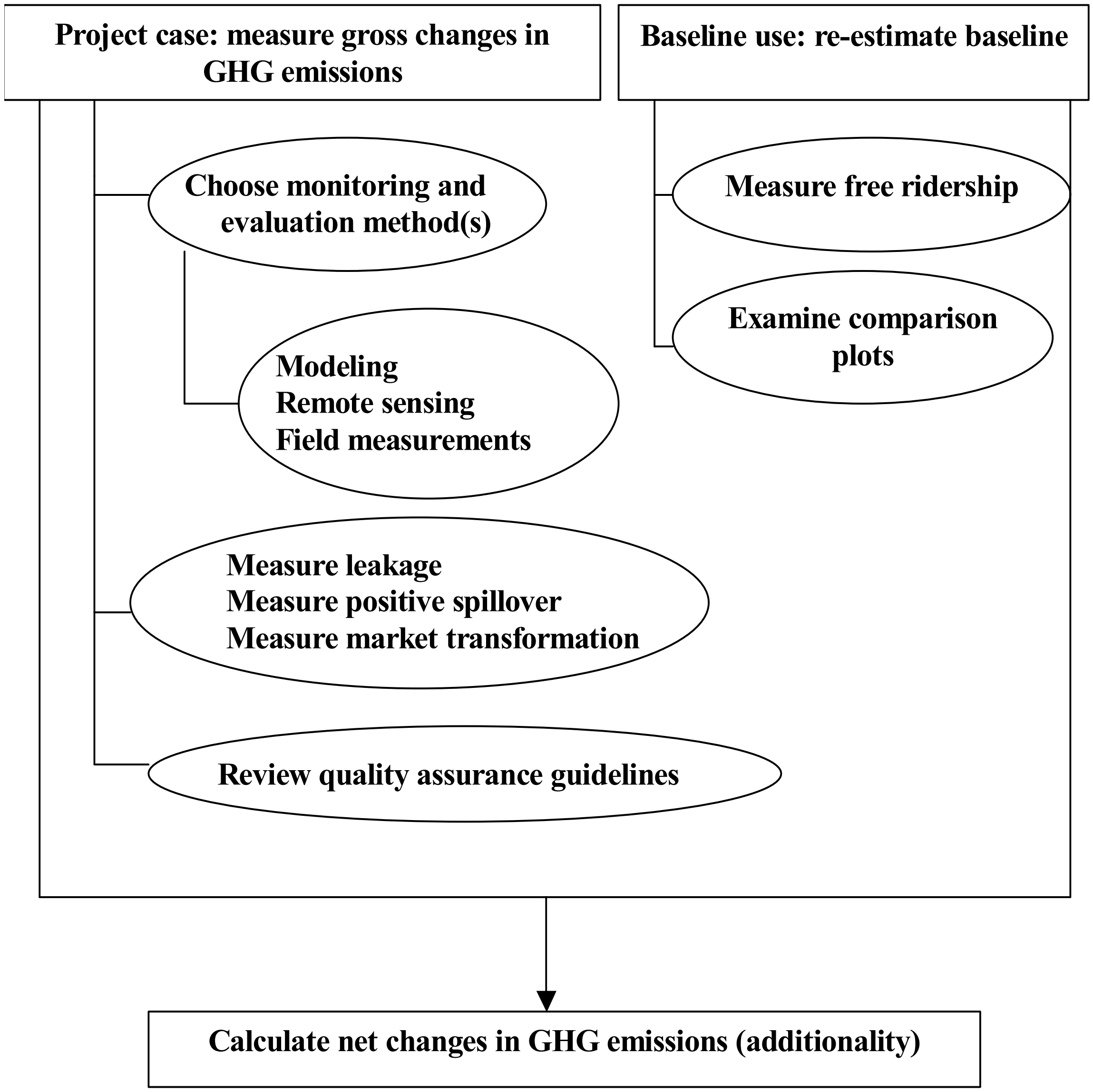


Fig. 3. Evaluation of Forestry Projects

The second issue concerns coverage of project leakage (especially for sequestration projects) and positive project spillover (see 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 should be made to ensure that resources are available to evaluate their effects.

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. For small projects these effects are also likely to be minor or insignificant. Under these circumstances, it may be justified to disregard these impacts and simply focus on energy savings or carbon sequestration from the project. This would help reduce MERVC costs. As the project becomes larger or are more targeted to market transformation, these impacts should be evaluated.
Currently, there are weak linkages in assessing multiple monitoring domains (e.g., local, regional and national) (Andrasko 1997). One potential solution to strengthening these linkages is the use of "nested monitoring systems". In such a system, an individual project's monitoring domain is defined to capture the most significant energy savings and provisions are made for monitoring energy use and GHG emissions outside of the project area by using regional or national monitoring systems (Andrasko 1997).

Chapter 4

Monitoring and Evaluation of Energy Projects

For energy 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 (e.g., Box 3). Several data collection and analysis methods are available which vary in cost, precision, and uncertainty. The data collection 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).[1] Data analysis 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.

Box 3

Monitoring of an Energy AIJ Project: City of Decin's Fuel Switching for District Heating
Natural gas consumption will be monitored annually. Using a fixed carbon content for natural gas, CO_2 emissions and emissions reductions will be calculated for each engine and boiler at the plant. In addition, data on total annual energy produced by the project will be collected, and the resulting GHG emissions reductions will be calculated. The CO_2 emissions will be monitored periodically throughout the year and will be certified by the Czech Ministry of Environment. The Czech Hydrometeorological Institution will develop and implement a monitoring and verification program and will review and assess: (1) the historic CO_2 emissions baseline for the plant, (2) the projected CO_2 emissions under the reference and project scenarios, (3) a report on potential leakage problems and shift of existing load to other sources of heat supply, (4) the Czech government policy on scoring CO_2 emission reductions from the plant relative to the Czech national plan, and the monitoring strategy and techniques proposed.
Source: USIJI (1998)

Engineering methods

Engineering methods are used to develop estimates of energy savings based on manufacturers' technical information on equipment in conjunction with assumed operating characteristics of the equipment. The two basic approaches to developing engineering estimates are engineering

[1] Stipulated savings refer to two different types of stipulated savings methods: (1) algorithms for calculating energy savings for specific measures; and (2) a set of criteria for using best-engineering practices (USEPA 1995). The rationale for the use of stipulated savings is that the performance of some energy-efficiency measures is well understood and may not be cost effective to monitor; stipulated savings should only be used for certain retrofits and conditions.

algorithms and engineering simulation methods (Violette et al. 1991). Engineering analyses need to be "calibrated" with onsite data (e.g., operating hours and occupancy).

Engineering algorithms are typically straightforward equations showing how energy (or peak) is expected to change due to the installation of an energy efficiency measure. The accuracy of the engineering estimate depends upon the accuracy of the inputs, and the quality of that data entering an engineering algorithm can vary dramatically. Engineering building simulations are computer programs that model the performance of energy-using systems in residential and commercial buildings. These models use information on building occupancy patterns, building shell, building orientation, and energy-using equipment. The input data requirements for the more complex simulation models are extensive and require detailed onsite data collection as well as building blueprints. Although engineering approaches are improving and increasing in sophistication, they cannot by themselves produce estimates of net project impacts. The engineering estimates generally produce estimates of gross impacts and do not capture behavioral factors such as free riders and project spillover. It is possible to incorporate free rider and spillover factors from surveys and other evaluation sources in order to calculate net impacts.

Basic statistical models for evaluation

Statistical models that compare energy consumption before and after the installation of energy efficiency measures have been used as evaluation methods for many years (Violette et al. 1991). The most basic statistical models simply look at monthly billing data before and after measure installation using weather normalized consumption data (this is particularly important where weather-dependent measures are involved—e.g., heating and cooling equipment, refrigerators, etc.). If the energy savings are expected to be a reasonably large fraction of the customer's bill (e.g., 10% or more), then this change should be observable in the project's bills. Smaller changes (e.g., 4%) might also be observed in billing data, but more sophisticated billing analysis procedures are often required. This method can be used for comparing changes in energy use for project participants and a comparison group. Statistical models are most useful where many projects (or one project with many participants) are being implemented.

Multivariate statistical models for evaluation

In project evaluation, more detailed statistical models may need to be developed to better isolate the impacts of an energy-efficiency project from other factors that also influence energy use. Typically, these more detailed approaches use multivariate regression analysis as a basic tool (Violette et al. 1991). Regression methods are simply another way of comparing kWh or kW usage across dwelling units or facilities and comparison groups, holding other factors constant. Regression methods can help correct for problems in data collection and sampling. If the sampling procedure over- or under-represents specific types of projects among either project participants or the comparison group, the regression equations can capture these differences through explanatory variables. Two commonly applied regression methods are conditional demand analysis and statistically adjusted engineering models (Violette et al. 1991).

End-use metering

Energy savings can be measured for specific equipment and specific end uses through end-use metering (Violette et al. 1991). This type of metering is conducted before and after a retrofit to characterize the performance of the equipment under a variety of load conditions. The data are often standardized for variations in operations, weather, etc. End-use metering reduces measurement error (assuming the metering equipment is reliable) and reduces the number of control variables required in models. In addition, the meter can calculate the energy change on an individual piece of equipment in isolation from the other end-use loads.

Short-term monitoring

Short-term monitoring refers to data collection conducted to measure specific physical or energy consumption characteristics either instantaneously or over a short time period. This type of monitoring is conducted to support evaluation activities such as engineering studies, building simulation and statistical analyses (Violette et al. 1991). Examples of this type of monitoring that can take place are spot watt measurements of efficiency measures, run-time measurements of lights or motors, temperature measurements, or demand monitoring. Short-term monitoring is gaining increasing attention as evaluators realize that for certain energy-efficiency measures with relatively stable and predictable operating characteristics (e.g., commercial lighting and some motor applications), short-term measurements will produce gains in accuracy nearly equivalent to that of longer-term metering at a fraction of the cost.

Short-term monitoring is a useful tool for estimating energy savings when the efficiency of the equipment is enhanced, but the operating hours remains fixed. Spot metering of the connected load before and after the activity quantifies this change in efficiency with a high degree of accuracy. For activities where the hours of operation are variable, the actual operating (run-time) hours of the activity should be measured before and after the installation using a run-time meter.

Integrative methods

Integrative methods combine one or more of the above methods to create an even stronger analytical tool. These approaches are rapidly becoming standard practice in the evaluation field (Raab and Violette 1994). The most common integrative approach is to combine engineering and statistical models where the outputs of engineering models are used as inputs to statistical models. These methods are often called Statistically Adjusted Engineering (SAE) methods or Engineering Calibration Approaches (ECA). Although they can provide more accurate results, integrative methods typically increase the complexity and expense. To reduce these costs while maintaining a high level of accuracy, a related set of procedures has been developed to leverage high cost data with less expensive data. These leveraging approaches typically utilize a statistical estimation approach termed ratio estimation that allows data sets on different sample sizes to be leveraged to produce estimates of impacts (see Violette and Hanser 1991).

Best methods

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 load type and schedule 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 its 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 (Table 1), 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 methods. 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.

Table 1. Advantages and Disadvantages of Data Collection and Analysis Methods

Methods	Application	Advantages	Disadvantages
Engineering Methods	Individual buildings and groups of buildings	Relatively quick and inexpensive for simple engineering methods. Most useful as a complement to other methods. Methods are improving. Useful for baseline development.	Relatively expensive for more sophisticated engineering models. Need to be calibrated with onsite data. By themselves, not good for evaluation of spillover.
Basic Statistical Models	Primarily for groups of buildings	Relatively inexpensive and easy to explain.	Assumptions need to be confirmed with survey data and other measured data. Limited applicability. Cannot evaluate peak impacts. Large sample sizes needed.
Multivariate Statistical Models	Primarily for groups of buildings	Can isolate project impacts better than basic statistical models.	Same disadvantages as for basic statistical models. Relatively more complex, expensive, and harder to explain than basic statistical models.
End-use Metering	Individual buildings and groups of buildings	Most accurate method for measuring energy use. Most useful for data collection, not analysis.	Can be very costly. Small samples only. Requires specialized equipment and expertise. Possible sample biases. Difficult to generalize to other projects. Does not, by itself, calculate energy savings. Difficult to obtain pre-installation consumption.
Short-term Monitoring	Individual buildings and groups of buildings	Useful for measures with relatively stable and predictable operating characteristics. Relatively accurate method. Most useful for data collection, not analysis.	Limited applicability. Using this method alone, energy savings cannot be calculated.
Integrative Methods	Primarily for groups of buildings	Relatively accurate.	Relatively more complex, expensive, and harder to explain than some of the other models.

International Performance Measurement and Verification Protocol

Although not targeted to GHG 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. The IPMVP covers many of the issues discussed in these guidelines and also offers several measurement and verification methods for user flexibility (Kats et al. 1996 and 1997; Kromer and Schiller 1996; USDOE 1997).[1] 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.

A key element of the IPMVP is the definition of two measurement and verification (M&V) components: (1) verifying proper installation and the equipment/systems's potential to generate savings; and (2) measuring (or estimating) actual savings. The first component involves the following: (a) the baseline conditions were accurately defined and (b) the proper equipment/systems were installed, were performing to specification, and had the potential to generate the predicted savings. The general approach to verifying baseline and post-installation conditions involves inspections, spot measurement tests, or commissioning activities. Commissioning is the process of documenting and verifying the performance of energy systems, so that the systems operate in conformity with the design intent.

The IPMVP was built around a common structure of four M&V options (Options A, B, C, and D) (Table 2). These four options were based on the two components to M&V defined above. The purpose of providing several M&V options is to allow the user flexibility in the cost and method of assessing savings. A particular option is chosen based on the expectations for risk and risk sharing between the buyer and seller, and also on onsite and energy-efficiency project specific features. The options differ in their approach to the level and duration of the verification measurements. None of the options are necessarily more expensive or more accurate than the others. Each has advantages and disadvantages based on site specific factors and the needs and expectations of the customer. Project evaluators should use one of these options for reporting on measured energy savings.

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[1] The IPMVP is primarily targeted to the monitoring and evaluation of an individual building, in contrast to other protocols (e.g., CPUC 1998) that are aimed at the monitoring and evaluation of programs (involving multiple sites). The protocol can be downloaded via the World Wide Web: http://www.ipmvp.org.

Table 2. Overview of IPMVP's Measurement and Verification Options

Measurement & Verification Options[1]	How Savings Are Calculated [reference to LBNL's MERVC methods]	Initial Cost[2, 3]	Annual Operating Cost[4]
Option A: ▪ Focuses on physical inspection of equipment to determine whether installation and operation are to specification. Performance factors are either stipulated (based on standards or nameplate data) or measured. ▪ Key performance factors (e.g., lighting wattage or "motor" efficiency) are measured on a snapshot or short-term basis. ▪ Operational factors (e.g., Lighting operating hours or motor runtime) are stipulated based on analysis of historical data or spot/short-term measurements.	Engineering calculations or computer simulations based on metered data and stipulated operational data. [Engineering methods] [Short-term monitoring]	0.5 to 3%	0.1 to 0.5%
Option B: ▪ Intended for individual energy conservation measures (ECMs) (retrofit isolation) with a variable load profile. ▪ Both performance and operational factors are measured on a short-term continuous basis taken throughout the term of the contract at the equipment or system level.	Engineering calculations after performing a statistical analysis of metered data. [Engineering methods] [End-use metering]	2 to 8%	0.5 to 3%
Option C: ▪ Intended for whole-building M&V where energy systems are interactive (e.g. efficient lighting system reduces cooling loads) rendering measurement of individual ECMs inaccurate. ▪ Performance factors are determined at the whole-building or facility level with continuous measurements. ▪ Operational factors are derived from hourly measurements and/or historical utility meter (electricity or gas) or sub-metered data.	Engineering calculations based on a statistical analysis of whole-building data using techniques from simple comparison to multivariate (hourly or monthly) regression analysis. [Basic statistical models] [Multivariate statistical models]	0.5 to 3% (utility bill analysis) 2 to 8% (hourly data)	0.5 to 3%
Option D: ▪ Typically employed for verification of savings in new construction and in comprehensive retrofits involving multiple measures at a single facility where pre-retrofit data may not exist. ▪ In new construction, performance and operational factors are modeled based on design specification of new, existing and/or code complying components and/or systems. ▪ Measurements should be used to confirm simulation inputs and calibrate the models.	Calibrated energy simulation/ modeling of facility components and/or the whole facility; calibrated with utility bills and/or end-use metering data collected after project completion. [Engineering methods (4.2.2)] [Integrative methods (4.2.7)]	2 to 8%	0.5 to 3%

[1] It is assumed that the cost of minimum M&V, in projects not following IPMVP, involves an initial cost of 0.5%, and an annual operating cost of 0.1% to 0.2%, of the project cost. The costs in this table are uncertain and should be used for general guidance; developers need to estimate costs based on real projects.

[2] The initial M&V cost includes installation and commissioning of meters.

[3] In new construction, this is the % of the difference in cost between baseline equipment and upgraded/more efficient equipment.

[4] Annual operating cost includes reporting, data logger and meter maintenance cost over the period of the contract.

Chapter 5

Monitoring and Evaluation of Forestry Projects

The measurement of a project's carbon fixation necessitates specialized tools and methods drawn largely from experience with forest inventories and ecological research. Monitoring and verifying carbon accumulation in forestry projects must be cost effective and accurate. Monitoring systems should be built upon standard forestry approaches to biomass measurement and analysis, and apply commonly accepted principles of forest inventory, soil science and ecological surveys. Specific methods and procedures should be assembled on a project-specific basis, with the types and extent of monitoring ultimately determined by the relative costs and quantity of carbon return by each measurement type.

Three general monitoring techniques can be used to monitor carbon fixed through forestry projects (based on MacDicken 1997): (1) modeling, (2) remote sensing, and (3) field/site measurements, including biomass surveys (which includes research studies, surveys, the monitoring of wood production and end products, and forest inventories) and destructive sampling. Many of these techniques can be used together (see Box 4).

Box 4

Monitoring of a Carbon Sequestration AIJ Project: Noel Kempff Mercado Climate Action Project (Bolivia)

The monitoring and verification plan includes specifications for: (1) monitoring forest biomass and carbon content of other forest components; (2) monitoring of secondary impact parameters; (3) establishing and maintaining monitoring plots; (4) conducting quality assurance tests and quality control procedures; and (5) developing a summary of the equations that will be used to convert raw data to CO_2 -equivalent units. Monitoring tasks will include: (1) routinely tracking the data elements for C contents, flux rates, and secondary impacts at three locations within the project area; (2) verifying the assumptions made to establish the reference case emissions and secondary impacts projections, and correcting or improving assumptions, as needed; and (3) comparing the documented changes in total C and secondary impacts at the three monitoring locations and making necessary adjustments to the reference case.

Source: USIJI (1998)

Remote sensing needs to be tied to actual ground truthing, since field measurements are, and will continue to be, the best estimate of biomass. Unfortunately, field measurements are costly and are viewed as less practical for large-sized projects. Ground measurement databases will build over time and will eventually make remote sensing and modeling more precise and practical. Until then, project investors will need to incur the cost and the intensity required.

Modeling

Modeling the impacts of certain forestry practices on carbon flows into and out of forest carbon sinks can be used for estimating annual flows of carbon. The models are used to predict future carbon flows, but they do not measure the actual changes. The modeled estimates of carbon storage over time must be checked using one of the techniques described below (i.e., remote sensing with ground truthing or field/site measurement).

Models start from an estimate of a carbon stock for a specific forest type at a specific site. Then, based on information from forest practices, the models develop estimates of annual carbon flows. This approach relies on a series of highly simplified assumptions to estimate total carbon sequestration. For example, assumptions may include: the number of trees planted in either woodlots or agroforestry systems, initial stocking rates, mean annual stemwood volume increments, a biomass multiplier factor, and harvest rates. The assumptions are then entered into a model to estimate the amount of sequestered carbon. The models need to be corrected/ calibrated with measured data periodically as well as with other approaches. For example, approaches that estimate forest productivity by timber volume may be compared with other approaches, such as allometrically derived carbon estimates that incorporate relationships between tree or stand physiological parameters (e.g., diameter, height, weight, tapper (the change in diameter over height) and carbon content (Hamburg et al., 1997; Schroeder et al., 1997; Brown, 1997). The accuracy of these methods will depend on many factors, including the precision of the equations and the homogeneity of the forest (e.g., allometric equations are simpler and more accurate for homogeneous forests and more complex and less accurate for heterogeneous forests).

Some models are already available for simple conditions and standard treatments, such as tree planting on agricultural land. The Land Use and Carbon Sequestration (LUCS) model is a project-based computer model that tracks the changes in carbon density associated with land use changes (e.g., conversion of forested areas to agriculture) (Faeth et al., 1994; MacDicken, 1998). Direct measurements and default assumptions are used to calculate the changes and impacts. The LUCS model has been used in evaluating an agroforestry project on hillsides in Guatemala (Trexler et. al., 1992).

Soil organic matter and ecosystem models play an important role in understanding land management and soil organic carbon sequestration relationships, and also for projecting changes in soil organic carbon through time (Parton et al., 1995; Smith et al., 1997). The rate of soil organic carbon decomposition is usually well represented as a first-order process where the amount converted to CO_2 per unit time depends on the current size of the various soil organic carbon fractions times their rate constants (Smith et al., 1997). Since the amounts present in each carbon fraction depends on management history, these amounts must be accurately accounted if the model estimates of soil organic carbon dynamics are to be realistic. Generally, information on previous management history is less complete than needed to establish adequate initial conditions for models. When management history is well known for a period of at least 20-50 years, many soil organic carbon models do well in simulating management-induced soil organic carbon changes (Smith et al., 1997). Model validation remains an important step for confirming models' assumptions.

The Graz/Oak Ridge Carbon Accounting Model (GORCAM) is another model that can be used to examine the impact of forestry projects on carbon emissions (Schlamadinger and Marland, 1996). GORCAM provides a simplified description of carbon stocks and flows associated with the management of forests. GORCAM calculates carbon accumulation in plants, in short- and long-lived wood products, in fossil fuels not burned but replaced by biofuels, and in fossil fuels not burned because production and use of wood products requires less energy than production and use of alternative materials that provide the same service (Marland et al., 1997). GORCAM has been used to evaluate the impact on carbon emissions by biofuel district heating systems being installed or proposed in Vermont (McLain, 1998), as well as estimating the amount of carbon sequestered by a sustainable forestry management project in Mexico (Bird et al., 1998).

More complex but promising models are being developed. Simple modeling requires relatively little time and effort, however, the gross estimates are probably neither accurate nor precise (MacDicken, 1997). In general, field/site measurements are preferred over standard tables and computer models, because site-specific field studies provide higher quality data and thus higher credibility, although at a higher cost.

Remote sensing

Remote sensing (along with ground-based measurements) can be used to monitor land area changes, map vegetation types, delineate strata for sampling, and assess leakage and base case assumptions. Remote sensing is defined as the acquisition of data about an object or scene by a sensor that is far from the object (Colwell, 1983; see also Slater, 1980; Swain and Davis, 1978; Wilkie and Finn, 1996). Aerial photography, satellite imagery, and radar are all forms of remotely sensed data. Usually, remote sensing refers to the following two types: (1) "high-level" remote sensing that uses satellite imagery, and (2) "low-level" remote sensing that relies on aerial photography.

***High-level remote sensing**:* Many national and international projects and programs have made use of remote sensing with satellites for land cover change research at a national or international level (FAO, 1996; Skole et al., 1997). This type of remote sensing can be done every 5-10 years, in combination with low-level remote sensing. The Face Foundation in the Netherlands and Winrock International have used satellite imagery for evaluating forestry projects (Face Foundation, 1997; MacDicken, 1998). Remote sensing has been used by several researchers in measuring deforestation in tropical forests in Central and South America (e.g., Dale et al., 1994; Sanchez-Azofeifa et al., 1997; Sanchez-Azofeifa and Quesada-Mateo, 1995; Skole and Tucker, 1993; Stone et al., 1991). Attempts to estimate biomass from remote sensors have generally been costly and have had mixed results (MacDicken, 1997). To date, no one has measured carbon using remote sensing (Brown, 1996; MacDicken, 1997).

Skole et al. (1997) have proposed an international system for monitoring land cover change which includes studies in specific locations for field validation and accuracy assessments for the large area analyses. These sites could also be useful for evaluating project impacts, if integrated with the approach described next.

***Low-level remote sensing**:* Using aerial photography, videography, and orthophotographs, photographs of land areas can be taken on an annual basis to see whether the project is proceeding according to design. Field/site measurements and ground truthing will also need to be conducted periodically.

Field/site measurements

Field/site measurements include two types of techniques (biomass surveys and destructive sampling) which can be used together in monitoring carbon in forestry projects.

***Biomass surveys**:* Biomass surveys can include one or more of the following methods: research studies; surveys; the monitoring of wood production and end products; and forest inventories. Research studies use intensive data collection and analysis methodologies to typically test research hypotheses. Surveys of project field activities are conducted to see what was actually implemented in the project. This type of monitoring would provide useful data for the evaluation of GHG reduction and sequestration projects, especially if the surveys were combined with other approaches. The monitoring of wood production and end product data is needed to follow historical and trend data for the development of accurate baselines. An account needs to be made of what happens to the wood once it is felled or trees and branches die. If dead wood is regularly collected, it should be measured and its use recorded.

Carbon inventories can be performed at virtually any level of precision desired by inventory sponsors and provide flexibility in the selection of methods, depending on the costs and benefits of monitoring. Monitoring systems need to assess the net difference in each carbon pool for project and non-project (or pre-project) areas over a period of time. By comparing these changes in the project area to changes in pools unaffected by project activities (i.e. comparison plots), the monitoring effort can assess the impact of the project on carbon storage. Detailed biomass measurement methods can be found in MacDicken (1998).

***Destructive sampling**:* Destructive sampling is the oldest methodology for estimating biomass density at a site. It involves selection of representative sites in the ecosystem (usually a few square meters each, and in a few rare cases as large as one hectare each). All the vegetation is uprooted and the pertinent parameters obtained, e.g., volume, weight at different moisture contents, proportions of various components like branches, stem and roots, and chemical composition of the biomass. Detritus is also collected and similarly analyzed. This is usually accompanied with similar measurements of parameters of interest in the soil profile, including soil layers, structure, texture and cation exchange capacity, organic carbon, inorganic nutrients, etc.

The unique features and diversity of forestry projects, the monitoring domain and socioeconomic issues pertaining to forestry projects, and the variety of carbon pools that might be impacted by forestry projects makes the monitoring and evaluation of forestry projects very challenging. While forestry projects offer the potential for significant carbon sequestration, the verification of carbon credit claims will necessitate significant technical and financial resources. A variety of monitoring techniques are available for forestry projects for determining the amount of carbon sequestered by forestry projects, each having its own advantages and disadvantages. We expect the use of these techniques will vary by the size of the project area, region, type of forest, and the purpose of the project (e.g., to protect forests, supply energy, or provide wood products). One of the key decisions that will need to be made will be to determine the optimal level of costs for implementing these techniques.

Chapter 6

Re-estimating the Baseline

For joint implementation (Article 6) and Clean Development Mechanism (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).[1] Determining additionality requires a baseline for the calculation of GHG emissions, i.e., a description of what would have happened to GHG emissions had the project not been implemented (see Violette, Ragland and Stern 1998). Additionality and baselines are inextricably linked and 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 climate change mitigation projects have the same interest in a climate change mitigation project (i.e., they want to get maximum carbon savings from the project), they may overstate and over-report the amount of carbon saved by the project (e.g., by overstating business-as-usual carbon emissions). This tendency 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 carbon saved is less than estimated values. Hence, there is a critical need for the establishment of realistic and credible baselines. As noted previously, it is difficult to determine the credibility of baselines developed in projects undertaken in the AIJ Pilot because of the lack of available background data on the determination of baselines.

Future changes in GHG emissions 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) (Andrasko, Carter and Gaast 1996; Michaelowa 1998).

Ideally, GHG emissions should be measured for at least a full year before the date of the initiation of the retrofit project and for each year after the initiation of the project during the lifetime of the project. However, some types of projects may not require a full year of monitoring prior to the retrofit: 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. 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. Finally, in order to be credible, project-specific baselines need to account for free riders.

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[1] This section focuses on emissions additionality. Other aspects of additionality (e.g., financial additionality) are not discussed in this section.

Free riders

In climate change mitigation projects, it is possible that reductions in GHG emissions are carried out by participants who would have taken the same actions if there had been no project. These participants are called "free riders." The carbon savings associated with free riders are not truly "additional" to what would occur otherwise (Vine 1994). Hence, this is a test of both financial additionality as well as emissions additionality. Although free riders may be regarded as an unintended consequence of a climate change mitigation 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 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.[1]

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 under the EPA's approach for verifying free riders: (1) default "net-to-gross" factors for converting calculated "gross energy savings" to "net energy savings;"[2] (2) project-estimated net-to-gross factors, based on measurement and evaluation activities (e.g., market research, surveys, and inspections of non-participants); 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 (Meier and Solomon 1995; USEPA 1995 and 1996).

Performance benchmarks

Concerned about an arduous project-by-project review that might impose prohibitive costs, some researchers have proposed an alternate approach, based on a combination of performance benchmarks and procedural guidelines that are tied to appropriate measures of output (e.g., Lashof 1998; Michaelowa 1998; Swisher 1998; Trexler and Kosloff 1998; see also Puhl 1998). In all cases, measurement and verification of the actual performance of the project is required. The performance benchmarks for new projects could be chosen to represent the high performance end of the spectrum of current commercial practice (e.g., representing roughly the top 25^{th} percentile of best performance). In this case, the benchmark serves as a goal to be achieved. In contrast, others might want to use benchmarks as a standard or default baseline which must be improved upon in order to generate valid emission reductions: an extension of existing technology, and not representing the best technology or process.

A panel of experts could determine a baseline for a number of project types, which could serve as a benchmark for the UNFCCC. This project categorization could be expanded to a categorization by regions or countries, resulting in a region-by-project matrix. Project developers could check the relevant element in the matrix to determine the baseline of their project. Most of the costs in this approach relate to the establishment of the matrix and its periodical update. Before moving forward with this approach, analysis is needed to consider the costs in developing the matrix and its update, the potential for projects to qualify, and the potential for free riders. The U.S. EPA is assessing the feasibility and desirability of implementing a benchmark approach for evaluating additionality (e.g., see Hagler Bailly 1998).

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[1] This approach assumes: (1) non-participants would naturally buy the energy efficiency measure as much as participants would, (2) savings from the measures have a significant impact on the bills of non-participants, and (3) a sizeable proportion of non-participants buy/install the measure. These assumptions are not always valid.

[2] 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.

Comparison groups

For many projects, comparison groups can be used for evaluating the impacts of climate change mitigation 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 GHG emissions 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.

Chapter 7

Project Case: Monitoring & Evaluation

Project Leakage

Leakage occurs because the project boundary within which a project's benefits are calculated may not be able to encompass all potential indirect project effects. In this chapter, negative indirect effects are referred to as "project leakage" while positive indirect effects are referred to as "positive project spillover." Leakage is likely more important for carbon sequestration projects than for energy projects. For example, projects affecting the supply of timber products can influence price signals for the rest of the market, potentially counteracting a portion of the calculated benefits of the project: the establishment of forestry plantations could lead to a decrease in timber prices, leading to a higher incentive to convert forests to agricultural purposes. Another example of leakage occurs when a forest preservation project involves protecting land that was previously harvested by the local population for their personal consumption as fuel wood (MacDicken 1998; Watt et al. 1995). Although this area is now protected from harvesting, people from the surrounding communities still require wood for fuel and construction. Preserving this forest area has shifted their demand for fuel wood to a nearby site, leading to increased deforestation. This off-site deforestation will at least partially offset the carbon sequestration at the project site. Furthermore, some projects may involve international leakage: 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 (Watt et al. 1995).

Leakage may occur not only after a project has been completed but also during project development. For example, in the Rio Bravo Carbon Sequestration Pilot Project, a local timber company used the money from the sale of land to project participants for upgrading their equipment, allowing for the possibility of an increase in output of plywood (Programme for Belize 1997). However, this increase in output did not occur. Similarly, the land purchases for the Rio Bravo project could also motivate competitors that had wanted to purchase that land to intensify clearance of the land already in their possession, or intensify production from the land, increasing emissions from agricultural inputs and machinery. However, this also has not occurred (Programme for Belize 1997).

Leakage needs to be accounted for if off-site GHG emissions are to be accounted for, rather than simply those at a particular site. However, leakage can be difficult to identify and even more difficult to estimate and quantify.

Positive Project Spillover

For many programs, the number of eligible non-participants is far greater than the number of participants. For example, when measuring energy savings, it is possible that the actual reductions in GHG emissions are greater than measured because of changes in participant behavior not directly related to the project, as well as changes in the behavior of other individuals not participating in the project (i.e., non-participants). These secondary impacts stemming from a climate change mitigation project are commonly referred to as "positive project spillover." Positive project spillover may be regarded as an unintended consequence of a climate change mitigation 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 or forestry products 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 (see below) (Goldberg and Schlegel 1997; Weisbrod et al. 1994). Explicit estimates can be obtained by asking participants and non-participants 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 non-participant spillover effects can be included in savings estimates in billing analyses, similar to how gross savings are calculated.

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, Prahl and Schlegel. 1996). In contrast to project spillover, increasing market transformation is expected to be a strategic mechanism (i.e., an intended consequence) in reducing GHG emissions for the following reasons:

- To increase the effectiveness of climate change mitigation 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 Box 5).

Box 5

Market Transformation Programs Outside North America

Market transformation programs are being implemented outside of North America, particularly in Sweden, Brazil, Thailand, India, Philippines, Sri Lanka, Poland, and China (Martinot 1998; Meyers 1998). We provide information on market transformation programs for the first three countries.

The ten-year old Swedish program for energy efficiency has produced 25 procurements within the residential, commercial and industrial sectors (Suvilehto and Öfverholm 1998). Examples in the residential sector include refrigerators and freezers, washing machines and dryers; in the commercial sector, lighting and ventilation; and in the industrial sector, factory doors and fans. This program aims to establish market transformation and consists of technology procurement and projects supporting market penetration. There are a wide variety of methods in use; each is designed according to the market barriers, its actors, decision makers, their interplay, and specific market needs, expectations and conditions.

Since 1995, Brazil's national electricity conservation program, PROCEL, has been involved in market transformation, including cooperative efforts with equipment manufacturers (Geller 1997). PROCEL has had considerable success in transforming the efficiency of refrigerators and freezers, lighting, motors, and meters. PROCEL conducts or co-funds several other programs in the areas of research and development, consumer education, training, promotion and ESCO support. These programs are designed to introduce new technologies, increase awareness, change behavior, and stimulate investment in energy efficiency in Brazil.

The Thailand Promotion of Electricity Efficiency project is a comprehensive five-year utility DSM program that created a DSM office within the national electric utility (EGAT) (Martinot 1998). The DSM office is developing and implementing a number of market intervention strategies in the residential, commercial and industrial sectors. The project provides for financing mechanisms, energy-efficiency codes and standards, appliance labeling, testing laboratories, monitoring and evaluation protocols and systems, development and training of energy service companies, integrated supply-side and demand-side planning, and load management programs. EGAT has tried to rely on voluntary agreements, market mechanisms, and intensive publicity and public education campaigns (including appliance energy labels).

Sources: (1) Suvilehto, H. and E. Öfverholm. 1998. "Swedish Procurement and Market Activities — Different Design Solutions on Different Markets," in the *Proceedings of the 1998 ACEEE Summer Study on Energy Efficiency in Buildings*. Vol. 7, pp. 311-322. Washington, D.C.: American Society for an Energy-Efficient Economy. (2) Geller, H. 1997. *Market Transformation through PROCEL: Brazil's National Electricity Conservation Program*. Washington, D.C.: American Council for an Energy-Efficient Economy. (3) Martinot, E. 1998. *Monitoring and Evaluation of Market Development in World Bank-GEF Climate Change Projects*. Washington, D.C.: The World Bank. (4) Meyers, S. 1998. *Improving Energy Efficiency: Strategies for Supporting Sustained Market Evolution in Developing and Transitioning Countries*. LBNL-41460. Berkeley, CA: Lawrence Berkeley National Laboratory.

Market transformation is also relevant for carbon sequestration projects. As a hypothetical example, consider a bioenergy project that grows trees on a rotational basis and harvests the trees as an energy resource for a community hospital. The developer of the project needs to make sure there are no technical, financial, administrative, or policy barriers to the implementation of this project, and to determine if there are other large, energy-intensive end users who could take advantage of this resource (e.g., industrial customers). The project developer could also examine what partnering opportunities exist for promoting the bioenergy project (e.g., developing a voluntary labeling program that identifies customers as "green energy users"). Once the labeling program is in place, additional projects might emerge, creating an expanded market for bioenergy projects. Finally, the developer could try to extend the proposed labeling program to other regions, in order to enlarge the market for the project's trees.

Two examples in the forestry sector show the beginnings of market transformation: (1) the availability of improved biomass cook stoves, an important technology for reducing deforestation, has influenced many non-participants to purchase cook stoves as these programs develop (Bialy 1991); and (2) a reduced impact logging project in Malaysia is being replicated in Brazil and other parts of Indonesia (personal communication from Pedro Moura-Costa, EcoSecurities, Ltd., Sept. 15, 1998; Jepma 1997).

Most evaluations of market transformation projects focus on market effects (e.g., Eto. Prahl and Schlegel 1996; Schlegel, Prahl and Raab 1997): the effects of climate change mitigation projects on the structure of the market, or the behavior of market actors that lead to increases in the adoption of products, services, or practices. In order to claim that a market has been transformed, project evaluators need to demonstrate the following (Schlegel, Prahl and Raab 1997):

- There has been a change in the market that resulted in increased adoption and penetration of technologies or practices.
- That the 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 the 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, Prahl and Raab 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.

Chapter 8

Environmental and Socioeconomic Impacts

The Kyoto Protocol encourages 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 Clean Development Mechanism is sustainable development. At this time, it is unclear on what indicators of sustainable development should be addressed in the evaluation of climate change mitigation projects. Once there is an understanding of this, then MERVC guidelines for those indicators will need to be designed. At a minimum, climate change mitigation projects should meet current country guidelines for non-Clean Development Mechanism projects.

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. 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 or involved in climate change mitigation projects, and are concerned about their multiple impacts. For example, in LBNL's monitoring and verification forms, checklists are provided for developers, evaluators, and verifiers to qualitatively assess the impacts described in this section. These checklists are not exhaustive but are included to indicate areas that need to be assessed. Other existing guidelines are better suited for addressing these impacts: e.g., the World Bank has developed guidance documents for World Bank-supported projects (World Bank 1989). LBNL's checklists should help to improve the credibility of the project (by showing stakeholders that these impacts have, at least, been considered) as well as to facilitate the review of climate change mitigation projects.

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. For example, potential environmental impacts that need to be considered for energy projects are presented in Table 3. 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.

Table 3. Potential Environmental Impacts for Energy Projects

Impact Category	Comments
Dams and reservoirs	Implementation and operation
Effluents from power plants	Air, water and solid effluents from power plants (e.g., City of Decin's fuel switching for district heating project and Honduras' bio-gen biomass power generation project; USIJI 1998)
Hazardous and toxic materials	Manufacture, use, transport, storage and disposal
Indoor air quality	Measures to maintain and/or improve indoor air quality (Community of Guguletu et al. 1998; Chen and Vine 1998)
Industrial hazards	Prevention and management
Insurance claims	Reduced losses in personal and commercial lines of coverage (Vine, Mills and Chen 1998)
Occupational health and safety	Plans
Water quality	Protection and enhancement
Wildlife and habitat protection or enhancement	Protection and management

Source: Adapted from World Bank (1989).

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.

The information collected and analyzed by evaluators will be useful for better describing the stream of environmental services and benefits of a project. Such services and benefits may in turn attract additional investment and characterize the project's chances of maintaining reduced GHG emissions over time. This information will, hopefully, also help to mitigate any potentially negative environmental impacts and encourage positive environmental benefits.

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 (World Bank 1994b). 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 (an example for an energy project is provided in Table 4) 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).

Table 4. Socioeconomic Impacts for Energy Projects

Impacts
Cultural properties (archeological sites, historic monuments, and historic settlements)
Distribution of income and wealth
Employment rights
Gender equity
Induced development and other sociocultural aspects (secondary growth of settlements and infrastructure)
Long-term income opportunities for local populations plants (jobs)
Public participation and capacity building
Quality of life (local and regional)

Source: Adapted from World Bank (1989) and EcoSecurities (1998).

Evaluators need to review the checklist of socioeconomic impacts and 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.

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Chapter 9

Institutional Issues, Roles and Responsibilities

Institutional Issues

It is unclear at this time which institutions have the authority and capability of conducting MERVC activities: government authorities, auditing companies, self-reporting by project developers or host countries, etc. We expect the roles and responsibilities will vary by MERVC 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 MERVC activity.

We believe that local institutions, in particular, should be assessed during the evaluation of climate change mitigation projects. For example, if local community participants are not involved in the design or implementation of a project, then the sustainability of a project becomes problematic. Information on institutional capacity covers the credibility, experience and manpower situation in the executing agency, such as: (1) size of staff (field operations, engineering support, planning, finance/administration, etc.) by function; (2) academic qualifications, area of expertise, and years of experience of agency staff; (3) supporting agencies (e.g., public sector agencies, private consultants, or international organizations); and (4) internal structure of the implementing agency.

Special attention needs to be paid to “capacity issues” as projects have to 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).
In sum, the MERVC guidelines should cover the administrative, institutional and political impacts of the climate change mitigation projects, such as: (1) administrative burden (e.g., institutional capabilities); and (2) political impacts (e.g., sustained political support, consistency with other public policies).

Roles and Responsibilities

Because of the diverse activities involved in the MERVC of GHG reductions, we expect that several organizations will be involved at different levels (local, state, regional, national, and international) (Table 5). It is imperative that the roles and responsibilities are 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.

Table 5. Primary MERVC Actors

	Monitoring	Evaluation	Reporting	Verification	Certification
Project developers	*	*	*		
Consultant organizations [1]	*	*	*	*	*
Non-governmental organizations [1]	*	*	*	*	*
Governmental agencies			*	*	*
International organizations			*	*	*

[1] Consultants and non-governmental organizations (NGOs) must first be accredited by a government organization or industry association to be able to verify a project or to issue a certificate.

One review of pilot AIJ projects suggests that project developers and project parties, who are most closely associated with the project and thus have access to the data and information, should play an instrumental role in the monitoring, evaluation, and reporting of climate change mitigation projects (see Watt et al. 1995). These stakeholders would also rely on the assistance of technical consultants to conduct the monitoring and evaluation tasks; additional participants might include university staff, nongovernmental organizations, and members of governmental agencies. If the evaluation of the project is to be more than calculation of GHG estimates — e.g., a process evaluation designed to improve project implementation — then "outside" consultants who are not involved in the project implementation should conduct the work due to their objective (independent) perspective. This recommendation is based on the assumption that distinctly different evaluation and implementation teams will enhance the credibility and integrity of evaluation. Because the separation of project evaluation and implementation functions is controversial, however, the "pros" and "cons" of such a separation should be examined in more depth. In addition to formal designations to ensure cooperation for conducting the MERVC activities, there will be a need for informal cooperation among all the parties involved: perhaps through workshops and conferences at the regional, national, and international levels.

MERVC will entail significant resources, including the potential hiring and training of new staff (or contractors), equipment, and laboratory facilities. Because of the diverse individuals and organizations involved in the MERVC of energy savings and carbon sequestration, and their varying levels of technical expertise, qualification criteria are needed 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 (see Watt et al. 1995).

Chapter 10

Reporting, Verification and Certification

Reporting

Several types of reporting might occur in climate change mitigation projects: (1) impacts of a particular project could be 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 could be 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 could be 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. If there exists a clearinghouse with an inventory of stakeholders and projects, multiple reporting might not constitute a problem. For example, in their comments on an international emissions trading regime, Canada (on behalf of Australia, Iceland, Japan, New Zealand, Norway, Russian Federation, Ukraine and the United States) proposed a national recording system to record ownership and transfers of assigned amount units (i.e., carbon offsets) at the national level (UNFCCC 1998b). A synthesis report could confirm, at an aggregate level, that bookkeeping was correct, and reduce the possibility of discrepancies among Parties' reports on emissions trading activity.

Verification

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 emissions reductions from a given project, because it will increase their earnings when excessive credits are granted. For 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. Verifiers could be active from the beginning of the project's operations, but in our mind, verification occurs after the project begins regular operations. After the project's first operational interval (e.g., one year), and periodically thereafter (e.g., annually), the verifier would confirm the project's carbon sequestration in the preceding period.

Currently, no rules exist for what kinds of organizations will verify monitoring and evaluation results. Some possibilities include government agencies, private sector firms that specialize in verification, an intergovernmental body such as the FCCC subsidiary bodies, or groups of advisors recognized by the FCCC. 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, such as the United Nations (UN), for other projects.

Some resolution of disputes over verification results will also be needed:

> "Because verification has the potential to be contentious, it should be possible for third parties, as well as the host and investor country parties, to challenge the verification results, in order to encourage watch-dogging between countries. 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." (Watt et al. 1995)

The tribunal might consist of people from the UN, or from an individual 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. This is important not only for reporting GHG reductions internationally, but also for investment purposes: investors would probably welcome a standardized set rather than a diverse set of guidelines across different host countries.

Certification

Certification refers to certifying whether the measured GHG reductions actually occurred. This definition reflects the language in the Kyoto Protocol regarding the CDM and "certified emission reductions." However, some argue that "certification" could be done ex-ante, to certify a proposed offset, assuming that it is carried out as planned. Similarly, some propose CDM projects to be "certified" when they are approved by a host country; however, in this situation, "registered" or "validated" appears to be a more accurate descriptor (see UNFCCC 1998b).

At this time, certification is expected to simply be the outcome of a verification process: i.e., no other measurement and evaluation activities are expected to be conducted. Each of the Kyoto Protocol's flexibility mechanisms (e.g., joint implementation (Article 6), Clean Development Mechanism (Article 12), and emissions trading (Article 17)) requires some form of "government approval" either at the point of transfer, or under Article 3, at the point which the part of the assigned amount or emissions reduction unit is added to or deducted from Annex I Parties' assigned amount. However, only Article 12 provides for a process of auditing and certification that would allow for an objective assessment of whether the transfer was likely to result in net emissions reduction. Hence, part of the discussions in implementing the Kyoto Protocol will focus on the establishment of certification procedures for emissions reduction units generated and traded through these mechanisms.

Certification companies need to be accredited by some higher body: e.g., an international accreditation board, established under the auspices of the UNFCCC. This board would certify companies and make sure they are abiding by certain standards (e.g., via spot auditing). For instance, SGS, Rainforest Alliance, and the Soil Association are certification companies that are accredited by the Forest Stewardship Council to certify that forests meet the standards of the Forest Stewardship Council as set forth in their "Principles and Criteria for Forest Management" (personal communication from Pedro Moura-Costa, EcoSecurities, Ltd., Jan. 28, 1999).

Certification and verification of GHG emissions trading could be achieved by using a system of accreditation and certification, similar to that currently used for quality and environmental management systems certification, i.e. ISO 9000 and ISO 14000 respectively. In this section, accreditation is defined as the recognition, by a responsible authority, that an impartial body is competent to undertake defined activities (Jones 1999). Considerable experience exists throughout the world in operating these systems, and there are lessons that can be learned from that experience (Jones 1999).

For management system certification, there are almost 50 accreditation bodies throughout the world. There are significant differences in the interpretation of international standards and accreditation criteria by the various bodies. With regard to certifying authorities, over 500 have been granted accreditation throughout the world, and this number is growing rapidly. Despite satisfying accreditation criteria, there can be a significant variation in the implementation of certification, not only between certifying authorities in different countries, but between certifying authorities within a country (Jones 1999).

For emissions trading, the following are seen as the principle objectives of the accreditation and certification process, although this is by no means exhaustive (Jones 1999):

- to provide a service which instills, in all participants, confidence that the trading scheme regulations are properly and consistently applied to maintain integrity world-wide;
- to ensure that the trading scheme is regulated in such a way that it is equitable and free from anomalies, and that expanding the scheme does not disadvantage either the incumbents or the new entrants;
- to be cost-effective and not a burden which might discourage trading; and
- to be independent, auditable, rigorous and transparent.

For emissions trading, the certifying authority would: (1) audit emission records of entities participating, or wishing to participate, in trading; (2) validate, through the certification process, the permits participants wish to trade; and (3) provide other certification services as required by domestic arrangements. Other tasks may be added to these for the certifying authority when the rules, modalities and guidelines for emissions trading have been agreed by the Conference of the Parties. Individual countries may also wish to extend these activities to suit national requirements.

The structure of the accreditation and certification scheme is a very important factor in ensuring the integrity of emissions trading. It is in the interests of all parties to ensure that trading and compliance is properly applied in a consistent manner. The concept of an International Accreditation Body (IAB) has been proposed as one model for providing the best opportunity to ensure consistent certification standards throughout the world (Jones 1999). However, some governments may perceive this as an infringement of their sovereignty. Even with an IAB, it is possible that such governments will appoint a national accreditation body, which will be responsible for accrediting certifying authorities within their country.

Chapter 11

MERVC Costs and Concluding Remarks

MERVC Costs

Monitoring and evaluation costs will depend on what information is needed, what information and resources are already available, project type, the size of the project area, the monitoring methods to be used, and monitoring frequency. Furthermore, some methods require high initial costs: e.g., in remote sensing for forestry projects, start-up costs in terms of equipment and personnel training may make a one-time digital image survey prohibitively expensive, while making multiple surveys exceedingly cost effective. The cost for monitoring a forestry project in India has been estimated at 8.5% of the total project cost, and it seems that monitoring similar projects would not exceed 10% of the total cost (Ravindranath and Bhat 1997). In some cases, the monitoring and evaluation costs can be as high as 20% (personal communication from Margo Burnham, The Nature Conservancy, Jan. 28, 1999).[1] Similarly, 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 (see Meier and Solomon 1995; Raab and Violette 1994; see also Kats et al. 1999). However, we expect monitoring and evaluation costs to decrease over time since the cost of measurement is coming down with the costs of communications, chips, computers, etc. (personal communication from Greg Kats, U.S. DOE, April 30, 1999).

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 (see Chapters 4 and 5); 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 carbon savings; and (2) installations with some degree of carbon emissions should tend to have higher levels of saved carbon initially and experience carbon savings that remain high during the lifetime of the measure (e.g., see Kats et al. 1996). 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 be to develop and implement climate change mitigation 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 they become prohibitive. Nevertheless, MERVC costs should be as low as

[1] This percentage is expected to decrease as other project expenditures and costs accumulate over time.

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.

Estimates of project impacts could be adjusted, based on the amount of uncertainty associated with the estimates and potential leakage, without conducting project-specific analyses. Benefit estimates that are less accurate or less precisely quantified would be adjusted. These adjusted project benefits would thus be 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 under this protocol for verifying subsequent-year energy savings: monitoring, inspection and a default option (Meier and Solomon 1995). In the monitoring option, 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 default option greatly restricts the allowable savings: 50% of first-year savings, and limited to one-half of the measure's lifetime. For the inspection option (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. A similar system could be applied to the crediting of forestry projects.

Concluding Remarks

Monitoring and evaluation of climate change mitigation projects is needed to accurately determine the net GHG, and other, benefits and costs, and to ensure that the global climate is protected and that country obligations are met. The five-year pilot phase of "activities implemented jointly" is still in its early stages (most projects were started in 1997-98) and offers little insight into the experience of monitoring and evaluation so far. Evaluation of some of these projects is starting to improve our understanding of key MERVC issues (e.g., how slight changes in the estimates of deforestation can significantly affect the amount of carbon saved by a carbon offset project (Busch et al. 1999)), and we anticipate more evaluations of these projects in the near future.

Nevertheless, we agree with the findings of the second synthesis study on the AIJ Pilot, stating that work needed to be conducted on methodological, technical and institutional issues, including modalities for measurement, reporting and assessment (UNFCCC 1998a). We also agree with the findings from the recent OECD study on emission baselines for AIJ projects which concluded that simple reporting measures were needed for improving the transparency and comparability of different projects (for AIJ, joint implementation and CDM projects), including project-specific emission baselines (OECD 1999). Some MERVC issues have been examined in the AIJ Pilot, but future investments are needed to refine methods and protocols in support of the Kyoto Protocol mechanisms. Some progress has been made in the development of guidance documents for the

MERVC of energy and forestry projects (see Vine and Sathaye 1999, and Vine et al. 1999), but more work needs to be done for developing internationally agreed MERVC guidelines: e.g., evaluation of additionality, free riders, project leakage, positive project spillover, market transformation, environmental impacts, and socioeconomic impacts. A community of MERVC evaluators and verifiers has been developed in response to the UNFCCC AIJ Pilot, and these individuals and organizations are involved in working on the details of implementing the modalities for measurement, reporting and assessment. Institutional and human capacity building is sorely needed to implement future CDM and joint implementation projects, as well as emissions trading regimes.

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