Carbon Offset Accounting and Monitoring of Emission Reductions in Energy Efficiency Projects

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ABSTRACT

The UN Framework Convention on Climate Change (FCCC) allows for the joint implementation (JI) of measures to mitigate the emissions of greenhouse gases. The concept of JI refers to the implementation of such measures in one country with partial or full financial and/or technical support from another country, potentially fulfilling some of the supporting country's emission-reduction commitment under the FCCC. JI projects in developing countries without reduction obligations require a *carbon-offset* mechanism, under which emitters can receive credit toward their country's reduction commitment for investments to reduce CO_2 emissions in other countries.

Energy efficiency projects offer some of the most attractive opportunities for JI projects. Because energy efficiency measures are generally close to commercial viability, they offer the prospect of relatively low-cost carbon offsets. The technical efficiency potential in developing countries is large and offers benefits in terms of technology transfer and pollution prevention. Carbon offsets under a JI regime could become a major source of funding for energy efficiency in developing countries.

This paper addresses key issues related to JI under the FCCC as they relate to the development of energy efficiency projects for carbon offsets in developing countries. Issues include the reference case or baselines, carbon accounting and net carbon savings, monitoring and verification, local agreements and host-country approval. Although the technical issues regarding carbon accounting and monitoring/verification are often treated as barriers to establishing a JI process, we demonstrate that these problems are soluble at reasonable cost using available technologies and methods.

Introduction

Article 4.2 of the United Nations (U.N.) Framework Convention on Climate Change (FCCC) commits the Annex I (industrialized) countries to adopt policies to mitigate global climate change by reducing greenhouse gases (GHG) and enhancing sinks, and to communicate their policies and measures with respect to the aim of returning emissions to 1990 levels (UNEP 1993). This article also allows for the joint implementation (JI) of measures to reduce the emissions of GHGs. The GHGs include CO_2, CH_4, N_2O, certain halocarbons and other gases. The concept of JI refers to the implementation of such measures in one country with partial or full financial and/or technical support from another country, potentially fulfilling some of the supporting country's emission-reduction commitment under the FCCC.

The first meeting of the Conference of the Parties to the FCCC (COP1) was held in Berlin in March-April, 1995. During the meeting, the Parties (i.e., the participating countries) agreed to a pilot phase for JI to be reviewed by the end of the decade. The purpose of the pilot phase, known as "activities implemented jointly" (AIJ), is to gain experience with the concept, to better define methodological and implementation issues, and to identify institutions to manage JI. During the pilot phase, Annex I Parties cannot credit reductions achieved through AIJ against national commitments (COP 1995).

At the third Conference of the Parties (COP3), held in Kyoto in December 1997, the concept of JI was endorsed with credit against emission reduction commitments in the time frame of 2008-2012. In addition, JI involving non-annex I (developing) countries was endorsed and given yet another new label, the "clean development mechanism" (CDM). More specific decisions about the application of these regimes are expected to be made at the fourth COP in November, 1998 (COP 1997).

The broad definition of JI in the FCCC has been a source of confusion, because it could include several different types of transfers based on different sets of obligations under the convention. The Kyoto protocol from COP3 allows countries with reduction commitments to exchange emission reduction measures for payment (COP 1997). This type of JI is clearly consistent with the FCCC and is not problematic at the international level. Such a process could grow into a full-scale emission-permit trading scheme, either on a regional basis or involving all countries with reduction commitments (Swisher et al. 1997).

In the next few decades, however, it is likely that many developing countries will not have emission reduction obligations, for reasons of international equity. Thus, capturing abatement opportunities in developing countries calls for a *carbon-offset* mechanism, under which emitters in (industrialized) countries with existing reduction commitments can receive credit toward their country's commitment for investments to reduce emissions in other (developing) countries with no binding obligation for reductions (Swisher & Masters 1992). This type of *carbon-offset* mechanism appears to be the objective of the CDM that is called for the Kyoto protocol (COP 1997).

Application to Energy Efficiency in Buildings

Reductions in net GHG emissions are possible in several areas, but the two principal categories of carbon emission reduction measures are energy and land-use measures. Energy measures would include, for example, switching from fossil fuel to renewable sources to generate electricity or improving the end-use energy efficiency in buildings, factories and vehicles. Land-use measures would include programs to increase sustainable forest plantation or agroforestry and to develop alternative land-use practices that discourage forest clearing. Both energy and land-use projects are candidates for joint implementation.

Energy efficiency projects offer some of the most attractive opportunities for JI/CDM projects. Because energy efficiency measures are generally close to commercial viability, they offer the prospect of relatively low-cost carbon offsets. For example, several sets of "country studies" of emission abatement potential have identified energy efficiency measures as the largest and most cost-effective category of options (US DoE 1997).

The technical efficiency potential in developing countries is large and offers benefits in terms of technology transfer and pollution prevention. In China, for example, a 15% reduction in energy use and resulting carbon emissions (from the business-as-usual scenario) by 2020 could prevent tens of thousands of premature deaths annually (Wang & Smith 1997).

Carbon offsets under a JI/CDM regime could become a major source of funding for energy efficiency in developing countries. To date, this approach has been applied mostly to land-use measures, most notably in Costa Rica, where carbon offsets are used to finance sustainable forestry and bio-diversity conservation. However, the total potential for carbon offsets from energy efficiency improvements is even greater. This is because, while land-use measures offer one-time carbon sinks, energy-efficiency measures in buildings and industries can supply a continuous stream of carbon emission savings from the projects' annual energy savings (Swisher 1997).

Key Issues for Energy Efficiency Projects as Carbon Offsets

In addition to the technical design, project logistics and financing plan that would be required for any energy investment project, several other elements are needed to evaluate a potential carbon offset project. The minimum additional information needs include the following elements:

1. Reference case or baseline from which energy savings and costs are measured.
2. Carbon accounting and net carbon savings for the project relative to the baseline.
3. Monitoring and verification plan to demonstrate how expected benefits will be measured.
4. Local agreements and host-country approval to demonstrate local acceptance and participation.

Baseline or Reference Case

The potential certification of emission reductions from JI projects will require the assessment of the technical performance of the project compared to the baseline emissions. The baseline emissions are the carbon emissions that are likely to result in the absence of the proposed project. Because carbon offsets represent emission reductions or increases in carbon storage, they can only be measured relative to such a baseline. The definition of the baseline is inherently counter-factual (it will be replaced by the proposed project) and therefore uncertain. The level of uncertainty and credibility of the baseline depends on the type of offset project and the dynamics of the existing energy plan.

In the case of energy projects, the baseline depends on the carbon content of the fossil fuel replaced. The reference condition, of course, is not static, especially for rapidly-growing energy systems, which offer many energy-efficiency opportunities, and the implementation of these options can influence the carbon-intensity of the baseline fuel mix. The simplest approaches to the analysis of baseline emissions are to 1) use the average emission rate for the entire system (i.e., total emissions divided by total sales) or 2) use the emission rate of the marginal generating plant, multiplied by the energy saved, for each hour of the year. Emission rates for common fossil fuels are given in Table 1.

Table 1. Carbon Content of Fossil Fuels

	Carbon content of fuel (Boden & Marland 1995) (mtC/GJ)	**Carbon intensity of electricity* (mtC/MWh)**
Coal	0.024	0.28
Petroleum	0.020	0.23
Natural Gas	0.014	0.16

*Delivered at a net efficiency of 31%. For higher (lower) efficiencies, the carbon intensity would be proportionally less (greater).

As a hypothetical example, suppose a utility system relies on hydroelectric power for its base-load generation, coal-fired plants for intermediate-load and some combustion turbines (CTs) for the peak loads. The hydro potential is exhausted, however, and future base-load plants will be coal-fired. In this case, the average emission rate is low, based on the predominant hydropower. The marginal rate would be higher, based mostly on the coal plants and CTs and partly on hydro for hours where only intermediate and not peak-load plants are run.

A load management program that shifts peak demand in time, with little effect on total energy sales, would simply affect the operating hours of the CTs and perhaps the intermediate-load coal plants. The resulting emission changes, therefore, would closely resemble the marginal hourly emission rates, weighted according to the share of demand reductions (or increases) achieved in each hour.

However, energy-efficiency programs significant enough in scale to change the utility expansion plan would make the marginal emission-rate changes difficult to use for calculating emission changes. In our hypothetical example, the resulting emission change might be savings from a coal-fired plant that would be completely removed from the future generation mix, and its high (coal-based) emission rate would not resemble that of either the low (hydro-based) average or the marginal (CT-based) resource.

One tangible example of a project baseline is the Ilumex project for efficient lighting in Mexico (Blanc & de Buen 1994). The carbon intensity (C_r in equation 1 below) for this project was determined by simulating the dispatch of existing power stations in the cities of Guadalajara and Monterrey. The result was a mix of oil- and coal-fired generation with a combined C_r value of 0.19 mt-C/MWh. This value was applied to the predicted electric energy savings from the project to estimate the resulting emission reduction.

In general, defining a credible baseline case, from which emission reductions resulting from proposed projects will be measured, entails analyzing the existing expansion plan to determine the generating resources that would be replaced by the saved electricity, and the emissions from these electricity-supply resources. It is necessary to determine if planned demand-side management (DSM) measures will reduce peak demand sufficiently and with enough reliability to defer or obviate planned capacity expansion. If so, the deferred or replaced source would represent the marginal expansion resource to be used as a baseline, beginning from the time this generating source is planned to enter service.

Assuming that the baseline carbon intensity has been determined, the principal issue in projects involving energy-efficiency measures (EEMs) is the net energy savings. The approach to determining energy savings involves comparing energy use within a facility, or certain systems in a facility, both with and without the installation of the EEM.

For projects in existing buildings or facilities, the "before" case is the baseline. The project case is the "after," or post-installation case. In new construction projects, the baseline case is counter-factual, in that it cannot be directly observed before installation of the EEM. New construction by definition will not have pre-retrofit information for use in calculating energy savings. Thus, baseline energy use has to be determined by methods other than direct pre-installation inspections or measurements. Where Minimum Energy Performance Standards (MEPS) are in effect, energy savings can be calculated as the difference between the MEPS energy performance level and the actual performance. In other cases, however, comparable performance levels must be determined for the individual end-use that is being assessed.

This does not mean that every carbon-offset project baseline requires a complex agreement on the "business as usual" performance in the host country. Instead, for most energy-sector measures that would be offset candidates, it should be possible for an impartial national institution or multilateral body to propose absolute baseline performance standards, even where no MEPS are in effect by law.

Such standards should be: 1) consistent with sufficiently "good practice" under the status quo that they avoid rewarding performance that would be achieved regardless, and 2) sufficiently less than the state-of-the-art to leave opportunities for investments that move the energy system in the direction of sustainable development. The technical analysis needed to select the proper level for this type of standard could build on existing work and should not involve prohibitive costs.

Carbon Accounting

The relevant unit of measurement for carbon emission reductions is the difference between the emissions in the baseline case and the emissions after implementation of the project. Once the baseline case is clearly defined, the carbon accounting for energy projects is relatively simple. Net emission savings (R_{net}) for renewable energy and energy efficiency projects must be compared on the basis of the carbon content of the fossil fuel replaced or avoided.

$$R_{net} = E_r C_r - E_p C_p \quad (1)$$

where: E_r = Energy produced in baseline or reference case
C_r = Carbon intensity of energy in baseline or reference case (see Table 1)
E_p = Energy produced in project case
C_p = Carbon intensity of energy in project case

For energy efficiency projects, the counter-factual baseline makes both the project's baseline and resulting energy and emissions savings relatively difficult to observe, although a great deal of research has been carried out to measure such savings in the context of utility demand-side management (DSM) programs (Hirst & Reed 1991). Emission reduction measures in the energy sector must be measured relative to baseline values, which are typically uniform annual flows of emissions. An energy-sector measure, and its corresponding baseline process, has a finite technical-economic lifetime, during which the annual emissions and potential reductions apply.

There is a wide range of different types of potential carbon offset projects in both the energy and land-use sectors. Each type of project is different in terms of the net carbon flows that provide emissions reductions or carbon storage potential. Energy projects generally reduce net emissions by reducing energy demand or replacing fossil fuels with cleaner alternatives. Land-use projects can store carbon in standing natural forest, accumulate carbon in new biomass grown in the project, or accumulate carbon in harvested products that enter long-term storage. In addition, biomass energy plantations can store net carbon in new biomass as well as preventing carbon emissions from fossil fuel use. Project types are classified accordingly in Table 2; note the complexity of the carbon stocks involved in land-use projects, compared to energy projects.

Table 2. Parameters for Calculation of Net Carbon Storage by Project Classification ("+" means the carbon stock applies to the project classification, "0" means it does not)

Carbon Stock: / Type of Project:	Standing Biomass	New Biomass	Harvested Biomass	Soil Carbon	Saved Fossil Energy
Forest reserves/reduce deforest.	+	0	0	+	0
Natural forest management	+	0	+	+	0
Timber plantations/wood prods.	0	+	+	+	0
Forest/ecosystem restoration	0	+	0	+	0
Agroforestry/social forestry	+	+	+	+	0
Fuelwood farms (non-commercial)	+	+	0	+	0
Dryland restoration (annual crop)	0	0	+	+	0
Biomass commercial energy farms	0	0	0	+	+
Biomass energy plantations	0	+	0	+	+
Solar energy/energy efficiency	0	0	0	0	+

(Swisher 1991, 1994, 1997)

While energy-sector emission-reduction measures prevent the emission of a quantity of irretrievable carbon emissions, carbon storage by maintaining and enhancing carbon sinks is, by its nature, a different process from reducing an annual flow of emissions from an energy conversion system. Terrestrial carbon sinks do not accumulate carbon indefinitely, but approach a limiting value (Swisher 1991). Thus, the carbon-storage benefit of a carbon sink is a one-time increment in the carbon stock on land.

Monitoring and Verification

Already in the pilot phase of application of the JI/AIJ mechanism, the development of adequate monitoring and verification plans is considered an essential part of a carbon offset project plan. At present, monitoring and verification methods are mostly being left to an *ad hoc* process, as it is not yet realistic to standardize the methods used. As international norms are established for project-level monitoring and verification procedures, compliance with such norms will be required for certification as carbon offsets. In the meantime, technically-credible monitoring and verification plans are being required as part of some national project-certification programs, such as the U.S. Initiative on Joint Implementation (USIJI).

Estimating the emission reductions from carbon offset projects requires the assessment of the performance of the project compared to the baseline emissions. Table 3 characterizes the comparisons that are needed to assess the performance of energy projects and the quantities need to be measured, depending on the type of project (Swisher 1997).

Table 3. Performance comparisons and measurements required for monitoring and verification of carbon offsets in energy projects

Energy Technology	Comparison	Required Measurements
Renewable (solar-wind-hydro-geo) energy supply	Baseline: fossil fuel supply Project: renewable energy system (generally electric)	Baseline: carbon fuel intensity Project: energy supplied
Biomass energy conversion	Baseline: fossil fuel supply Project: biomass production and conversion to fuel/electricity	Baseline: carbon fuel intensity Project: energy supplied and net terrestrial carbon storage
Fuel-switching (supply-side)	Baseline: fossil fuel supply Project: cleaner fuel supply (coal to natural gas, for example)	Baseline: carbon fuel intensity Project: energy supplied and change in carbon intensity
Fuel-switching (demand-side)	Baseline: fuel or electric energy end-use Project: change between fuels or between fuel and electricity	Baseline: carbon fuel intensity Project: energy use, change in efficiency and carbon intensity
Energy-efficiency measures (EEM)	Baseline: fuel or electric energy end-use Project: more efficient end-use technology	Baseline: energy end-use and carbon fuel intensity Project: change in energy use

For the project case, the monitoring needs are highly project-specific, depending on the type of project. For example, energy supply projects can be relatively simple in that they require monitoring only the project emissions (if any) and the energy production (or sales) rates, once the baseline carbon intensity has been determined. For renewable energy projects, one can generally assume the project carbon intensity is zero. Thus, the carbon emission reduction is the product of the baseline carbon intensity and the measured energy supplied (or sold) by the project. This calculation is not always simple, as both values can vary seasonally or even hourly for some projects.

Projects involving fuel-switching or EEMs at the end-use, or demand-side, may require more complex protocols for monitoring and verification. The principal issue in assessing fuel-switching projects is the (decreased) carbon intensity of the energy used in the project, compared to the baseline. Assuming that the baseline carbon intensity has been determined, the principal issue in projects involving EEMs is the net energy savings compared to the baseline energy use.

The actual measurement of baseline energy use (in existing facilities), post-installation energy use, and energy savings can be determined using one or more of the following techniques.

- Engineering calculations
- Utility meter billing analysis
- Computer simulation analysis
- Metering and monitoring

A relatively detailed approach to monitoring will require measuring equipment-usage and energy-service levels to compare baseline and actual energy use in a dynamic way. A great deal of work has been performed in several countries, for example in support of North American utility DSM programs, to develop such protocols, in order to resolve some of the uncertainties about program effects and costs and to improve program design (Hirst & Reed 1991).

One can expect that some of the results of the DSM evaluation work will be adapted for use in carbon offset projects. However, it will be important to select the most robust methods, as a number of issues have appeared that bring reported DSM energy-savings results into question. These include unrealistic estimates of operating hours for lighting and other building-energy systems, substantial discrepancies between calculated and measured values, manipulation of monitoring protocols by parties with an interest in the results, etc. The North American Energy Measurement and Verification Protocol (NEMVP) addresses these issues, which are clearly relevant to offsets (US DoE 1996).

The costs of these procedures are significant, but they are manageable in the context of an overall project budget. Typical building end-use monitoring, based on a statistical sample of similar end-use functions, would tend to cost on the order of $\$1/m^2$, while more the detailed monitoring required for building diagnostics and re-commissioning would tend to cost on the order of $\$2/m^2$ (Swisher & Wang 1997). These values are at the lower end of the ranges given in Table 4.

Performance verification of carbon offset projects is a less technical process than monitoring, but it requires an understanding of the monitoring process, its results, and its applicability to the verification process. To the extent that monitoring results show the results of a project in a comprehensive way, they can serve as the basis of the verification process. Verification can be carried out under the auspices of a public agency or contracted with a private firm experienced in energy and environmental auditing. The latter may be preferable if the firm has good standing and a strong reputation internationally, particularly in countries that are potential carbon offset buyers.

The basic aspects of energy-sector carbon offset performance verification (a similar process can be applied to forestry and land-use projects) include the following:

- Verification of the accuracy of baseline conditions as specified in the agreement between offset buyer and seller,
- Verification of the complete installation and proper operation of new equipment or systems specified in the project,
- Verification of the accuracy of the carbon intensity of the baseline energy source, and
- Verification of the quantity of energy savings or fuel substitution that occur during the life of the measure.

For each site or project, the baseline and project energy use can be estimated using a combination of metering, billing analysis, engineering calculations and/or computer simulations. After a project is completed, the energy savings for the first year should be projected. First year carbon offset credit could be based on these projected savings values. For the subsequent years, the contractor should provide annual (or at some other regular interval) reports that include inspection documentation of the installed equipment and, if necessary, update savings values using data obtained and analyzed during each year of operation. Previous credits would be reconciled as necessary based on results of the periodic report, and future credits would be calculated based on information in the periodic report.

The level of certainty required for verifying performance will vary among projects. The confidence level that is appropriate for establishing energy savings or carbon storage is a function of the value of the project and the cost-effectiveness of increasing or decreasing confidence in the measurement. In Table 4, three verification options are defined by the NEMVP for tracking of energy savings under performance contracts typical of energy-service company (ESCo) projects. The costs of each option vary among applications, and each can be applied to different types of projects, participants and sites.

Definitions of site-specific monitoring and verification plans should include consideration of accuracy requirements and the importance of relating monitoring costs and accuracy to the value of the energy savings or carbon storage. For certain types of projects, a statistical definition of accuracy could be included. For other types of projects, it may be only possible to define a subjective accuracy range or percent of the project budget to be used for monitoring.

Table 4. Measurement and verification options for energy-efficiency projects

Verification Option	Metering	Cost	Accuracy
1: Verifying that EEM has potential to perform & generate savings	None or short-term periodic	Dependent on number of measurement points. Approx. 1-5% of construction cost	Performance accuracy depends on metering. Energy savings accuracy depends on estimated hours
2: Verifying that EEM has potential to perform; verifying actual end-use performance	Continuous in post-installation at system level	Dependent on number of systems measured. Typically 3-10% of construction cost	Performance accuracy depends on metering. Energy savings accuracy depends on baseline assumptions and metering
3: Verifying that EEM has potential to perform; verifying actual (whole bldg.) performance	Continuous in post-installation at whole-facility level	Dependent on number of relative parameters. Typically 1-10% of construction cost	Energy savings accuracy depends on baseline assumptions and selection of relevant variables

(US DoE 1996)

External verification of project performance should be open to qualified private firms and non-profits. Presumably such bodies will be selected to represent the offset buyer and the FCCC Secretariat. This function might be carried out in collaboration with international firms already engaged in other sorts of energy and environmental accounting/auditing activities. At present, no separate institutional structure is being developed for external verification. However, such an institution might eventually be appropriate, in order to bring together both local and external experts on verification issues.

Present USIJI criteria stipulate that an offset project submission must contain "...adequate provisions for tracking the greenhouse gas emissions reduced or sequestered resulting from the project, and on a periodic basis, for modifying such estimates and for comparing actual results with those originally projected." Further, the USIJI Guidelines for Project Proposals require the filing of an annual report that includes "...monitoring data and analysis on emissions reduced or sequestered...significant environmental impacts/benefits...significant economic and other impacts/benefits."

The fundamental principles of the USIJI requirements can be met using, for example, the applicable elements of NEMVP options 2 and 3 listed above. The USIJI guidelines provide the basic design elements of monitoring protocols for energy projects. In addition to the items to be monitored and the schedule, the protocol must identify monitoring methods for the following purposes:

- Trend Monitoring: evenly spaced time series;

- Implementation Monitoring: assessment of whether activities are implemented as planned;
- Effectiveness Monitoring: evaluation of whether specified activities are effective;
- Validation Monitoring: validation of model assumptions;
- Compliance Monitoring: determination of compliance with established criteria

For building energy-efficiency projects in particular, USIJI recommends measuring the performance of all EEMs over their lifetime, and monitoring variables affecting energy demand, such as outdoor/indoor temperatures, conditioned floor space, and changes in production or staffing levels. These exogenous parameters can influence the total facility energy consumption, and therefore they must be accounted for in order to reach an accurate estimate of net EEM savings.

Figure 1 illustrates a hypothetical energy use profile for the first few years of an efficiency project. If all parameters affecting total energy use remained stable during the project life, one would expect a cyclical annual pattern due to seasonal weather variations. Thus the projected efficiency (EE) case and base case might appear as shown. However, occupancy, weather and other non-EEM parameters introduce deviations, which should be corrected in the monitoring process.

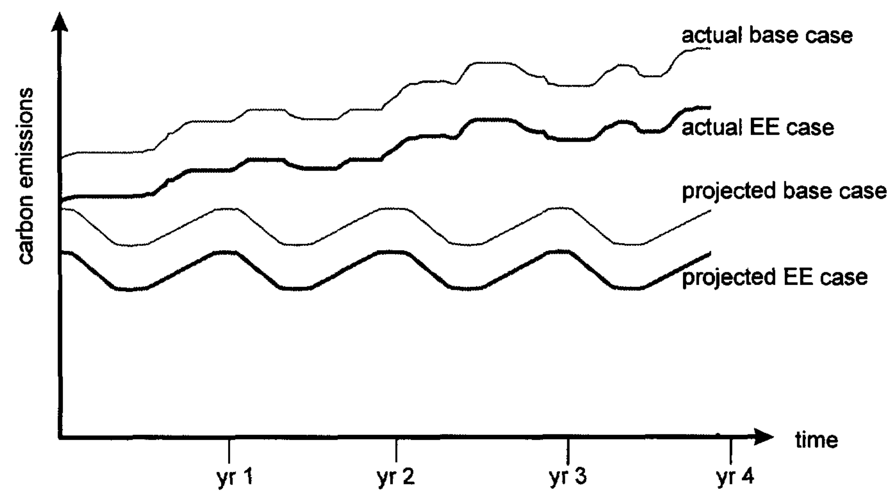

Figure 1. Hypothetical Projected vs. Actual Carbon Emissions

Local Acceptance and Host-Country Approval

The design of a project to provide significant local benefits can be a prerequisite for host-country approval and participation at the local level, especially for forestry projects and to some degree for energy-efficiency projects. In addition, it may be necessary to obtain formal acceptance in order to demonstrate the credibility of the project's long-term performance. At the project level, this means obtaining formal commitments for the needed local participation, including plans to fund the corresponding expenses and incentives. Host-country government approval can be a problem, especially in large countries where national authorities may be several bureaucratic steps removed from the local level. This is one reason why the early rounds of the USIJI process have endorsed more projects in Costa Rica than in India, China and Brazil combined.

To assure that proposed JI projects offer domestic benefits in addition to carbon emission savings, a registry and approval process can be used to elaborate the domestic requirements for JI measures. These requirements might include reductions of local pollution, increased security of energy supplies, improved local income opportunities and local participation in project planning and execution. Not all projects would satisfy all such criteria, but it will be important to at least demonstrate that no domestic laws or regulations would be violated and that a project is consistent with the host country's sustainable development agenda, assuming one exists. Costa Rica is one non-Annex I country with such an agenda, and the Costa Rican Office of Joint Implementation has taken an active role in attracting technical, institutional and financial resources to help realize this agenda via JI.

The objective of a national approval process should not be to add difficult conditions and impede project development, but simply to assure that some domestic benefits are achieved. This is a matter of insurance, as it is much more likely that projects will be successfully operated over the long-term if they are producing local income or other benefits, rather than if they are designed to provide emission reductions or carbon storage alone. Fortunately, it appears that most types of project that would be considered as carbon offsets, including clean energy and sustainable forestry projects, would indeed provide domestic benefits and would therefore be likely to satisfy the approval requirements.

Once the value of the carbon offset of a JI/CDM project is established, the reduction credit must be distributed to the participating parties. It is generally assumed that this allocation can be a matter of negotiation for a given project, and external restrictions on credit allocation could deter investments in offset projects. However, some national or international guidelines might still appear. Usually, the investors, or offset buyers, would receive most of the reduction credit, since this is the primary value motivating their investment, and the sellers would presumably be content with the baseline that the project replaces, which by definition offers no reduction credit. Some cases may be more complex, such as when the buyers would have been investors in the project even without the emission-reducing JI/CDM measures.

Concern about the future value of offsets acquired via JI/CDM also motivates the development of insurance to protect investors against loss of emission reductions achieved via JI/CDM. Insurance can be addressed at the national level or can be built into project portfolios by either the offset buyers or the sellers, if such a diversified funding and pooling arrangement is adopted.

Although it is important from the national perspective to achieve a high rate of successful project implementation, it is unlikely that separate institutions or processes will be needed to handle enforcement. It would be difficult to do so without creating powers that supersede the existing laws and administrative rules. The existing laws and regulations should be sufficient to address possible shortcomings of projects that might be revealed by local or external reviewers.

Conclusion

Although the technical issues regarding carbon accounting and especially monitoring and verification are often treated as barriers to establishing a JI process, these problems are soluble at reasonable cost using available technologies and methods. The necessary monitoring protocols, for example, are in routine use for verifying ESCo-type performance contracts, and these protocols are consistent with the NEMVP and the requirements for carbon offset certification, such as under the USIJI guidelines. The costs of such procedures are significant, but manageable in the context of an overall project budget.

A more uncertain cost burden, however, is imposed by the administrative requirements of securing certification from, for example, USIJI and host country authorities. The latter can entail much time and expense in lobbying government ministries, a cost that is difficult to justify given the small scale of most efficiency projects. The USIJI process can also require hundreds of pages of documents and dozens of person-days of effort. Progress toward reducing this burden via standardized procedures has been slow. Reasons for this lack of progress may stem from the many linkages that have been made between these (mostly) technical issues and other, policy-related, issues such as additionality.

Standardized verification and certification procedures are key to the establishment of a quality standard for carbon offsets based on the emission reductions from energy efficiency projects. Each of the issues described above - baseline analysis, carbon accounting, monitoring and verification, and host-country approvals - require a consistent and comprehensive analytic approach to a diverse range of potential offset projects. Eventually, routine certification of carbon offsets under a JI/CDM regime will require some degree of standardization in carbon-accounting and other analytic procedures.

The goal of creating a carbon-offset market will be to create standard offset products. The standards will have to be met for an offset to be certified. Meeting such a standard represents a singular proxy for offset quality. Thus, for certified offsets, quality may be one-dimensional – an offset either meets the standard for verification or it doesn't – or there may be differentiated degrees of quality. In any case, several criteria will need to be evaluated under a standardized verification-certification process.

References

Blanc, A. and O. de Buen. 1994. “Residential Lighting in Mexico: The Road to Ilumex.” *In Proceedings of the 1994 ACEEE Summer Study on Energy Efficiency in Buildings*, 3:1. Washington, DC: American Council for an Energy Efficient Economy.

Boden, T., and G. Marland. 1995. *Estimates of Global, Regional and National Annual CO_2 Emissions from Fossil Fuel Burning*. ORNL/CDIAC-90. Oak Ridge, Tenn.: Oak Ridge National Laboratory.

Conference of the Parties (COP). 1995. *Decision 5/CP.1 on Activities Implemented Jointly*. 6 April 1995, First Session of the COP, Berlin, Germany.

Conference of the Parties (COP). 1997. *Kyoto Protocol to the UN Framework Convention on Climate Change*. 10 December 1997, Third Session of the COP, Kyoto, Japan.

Hirst, E. and J. Reed. 1991. *Handbook of Evaluation of Utility DSM Programs*. ORNL/CON-336. Oak Ridge, Tenn.: Oak Ridge National Laboratory.

Swisher, J.N. 1991. "Cost and Performance of CO_2 Storage in Forestry Projects." *Biomass and Bioenergy* 1 (6): 317-28.

Swisher, J.N. 1994. "Forestry and Biomass Energy Projects: Bottom-Up Comparisons of CO_2 Storage and Costs." *Biomass and Bioenergy* 6 (5): 359-68.

Swisher, J.N. 1997. "Joint Implementation under the U.N. Framework Convention on Climate Change: Technical and Institutional Challenges." *Mitigation and Adaptation Strategies for Global Change* 2: 57-80.

Swisher, J., E. Haites, C. Zamudio, and S. Embree. 1997. *Analysis of the Potential for a Greenhouse Gas Trading System for North America*. Montreal, Canada: North American Commission for Environmental Co-operation.

Swisher, J.N., and G.M. Masters. 1992. "A Mechanism to Reconcile Equity and Efficiency in Global Climate Protection." *Ambio* 21: 154-59.

Swisher, J.N., and K. Wang. 1997. *Office Complexes Guidebook*. EPRI/TR-109450. Palo Alto, Calif.: Electric Power Research Institute.

UNEP. 1993. *United Nations Framework Convention on Climate Change*. Geneva, Switzerland: UNEP.

U.S. Department of Energy (DoE). 1996. “North American Energy Measurement and Verification Protocol.” Washington, D.C.: U.S. DoE Efficiency and Renewable Energy Network.

U.S. Department of Energy (DoE). 1997. *Summary Report on Climate Change Country Studies, U.S. Country Studies Program*. Washington, D.C.: U.S. Department of Energy.

Wang, X., and K. Smith. 1997. *Health Benefits of Greenhouse Gas Reductions in China*. Geneva, Switzerland: World Health Organization.