CDM Workshop

—Workshop on Baseline for CDM—

PROCEEDINGS

February 25-26, 1999

The New Otani, Tokyo, Japan

New Energy and Industrial Technology Development Organization (NEDO)

Global Industrial and Social Progress Research Institute (GISPRI)

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The Use of Benchmarks to Determine Emissions Additionality in the Clean Development Mechanism
Ms. Shari Friedman, US Environmental Protection Agency

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Dr. Katie Begg, University of Surrey

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Prof. Catrinus J. Jepma, Foundation JIN, the Netherlands

List of Presenter/Commentator

Preface

Technical difficulties in implementing the Clean Development Mechanism, an international mechanism of the Kyoto Protocol is *baseline issue*. To address this issue, an international workshop was held at Tokyo's Hotel New Otani on February 25^{th} and 26^{th}, 1999, inviting globally renowned experts in this field.

Hosting organization was New Energy and Industrial Technology Development Organization (NEDO), with The Ministry of International Trade and Industry (MITI), The Environment Agency (EA), and The Ministry of Foreign Affairs (MOFA) as co-sponsors, and the Global Industrial and Social Progress Research Institute (GISPRI) as the secretariat.

Subjective intention of this Workshop was to clarify the starting point in the coming discussion on the design of Kyoto Mechanisms by accumulating the latest experiences and knowledge of experts.

Thanks to the active participation of many experts, commentators, and policy-makers from all over the world, intensive discussion was conducted at the workshop despite its highly technical theme, providing productive result for participants as well as hosting and co-sponsoring organizations.

Especially, experts making presentations at the Workshop were cooperative in preparation of paper and OHP transparencies, enabling the distribution of these documents at the Workshop in order to enhance the understanding of participants. We hereby express our sincere appreciation for their cooperation. In particular, we would like to appreciate Dr. Robert Dixon of USDOE/IGES for his extensive contribution in identifying appropriate personnel, agreeing to chair the first day sessions, and preparing the presentation.

This report contains these papers presented. Please note that, due to time restriction, all the papers were as distributed at the Workshop, although some experts expressed wishes to edit them.

We sincerely hope that the Workshop discussion will provide useful input into the upcoming negotiation for Kyoto Mechanism designing.

Discussions at the CDM Workshop on Baseline Issue

Purpose and Outline

The Fourth Session of the Conference of the Parties (COP 4) to the United Nations Framework Convention on Climate Change held in 1998 adopted the decision that the details of a concrete scheme for the flexible mechanisms, known as "Kyoto Mechanisms", shall be determined by the end of 2000 (at COP 6). Among these mechanisms, the Clean Development Mechanism (CDM) embraces many issues to be resolved in future. Especially vital is the issue of setting a baseline, that is the amount of greenhouse gas emissions in the absence of the CDM project. Although baseline is essential for determining emission reduction amount, or CDM credits, it can be highly intentional and give a room for gaming. In order to reduce transaction cost, which has been a bottleneck for many AIJ initiatives, some type of *standardization* is anticipated.

Even in researcher level, however, the opinions vary upon the potentials of methodologies to be actuality applicable to broad-ranged and highly diversified CDM projects, and hardly any definitive concept has been established on methodologies. The Workshop, therefore, focuses on the "Baseline Setting Issue" which is a bottleneck for CDM designing, in order for us to deepen our understanding of this issue through intensive discussions among participants of international and national experts, as a kick-off of researches in this field, especially in Japan.

Summary and Thoughts

The Workshop had intensive discussions focusing on technical and methodological issues. The experts from overseas and domestic officials and researchers commented on the fulfillment and success of the Workshop, quite satisfying for hosting organizations.

The theme of the Workshop "the issues of baseline setting" addresses the problem of how to set *emission trajectory in the absence of the project* and the credit amount generated is defined as the difference between the baseline and *actual emission trajectory*. Baseline is essentially *virtual* and principally cannot be observed by definition.

In CDM scheme, an operational entity, an independent institution, will certify the emission reduction amount (CDM credit). If the baseline setting methodology for *similar* projects differ from one operational entity to another, it will reduce the credibility of CDM scheme. Moreover, defining appropriate baseline for each single project will increase (already high) transaction cost, which may hinder the scheme development as a whole. Therefore, "how to *define* the standardized baseline setting method" will be critical for the success of CDM.

This workshop focused on these technical and methodological problems. First Dr. Matsuo (GISPRI/IGES), Dr. Heister (the World Bank), and Ms. Kelly (CCAP) presented the reports on the overall layout of issues, and studies on the solution menu. They were followed by presentation on the case studies of AIJ (Activities Implemented Jointly) pilot experiences by Ms. Ellis, energy project studies by Mr. Takedahara (NEDO) and Dr. Mendis (AED), and forestry project study by Dr. Trexler (TAA).

The second day of workshop introduced the USIJI experiences presented by Dr. Dixon (USDOE/IGES), and the result of EPA baseline studies by Dr. Friedman. Succeeding these, Dr. Begg (Surrey University) and Dr. Jepma (JIQ) pointed out the issue of uncertainties involved in baseline, and summarized the overall issues. The workshop was concluded by panel discussions among presentators and commentators with Mr. Kimura (MITI) acting as a Chair.

Key issues of baseline setting commonly acknowledged at this Workshop were:

- Need to ensure simplicity and transparency, as well as the verification/certification of emission reductions by third party institution(s);
- Need standardization (for consistency, and reduced transaction cost);
- Baseline setting methodologies include benchmarking, technology matrix, and macro-baseline (top-down method). It will be difficult to get consensus on a single method (Among them, benchmark method may have broader acceptance potential);
- Important to incorporate the time-dependent variable and scale economy factor;
- Need to integrate (generalize) terminology;
- Practical to adopt learning-by-doing method;

- Need capacity building.

Conflict of opinions were found in the issues of:

- Interpretation of financial additionality (its relationship with emission additionality, applicability of official funds, and eligibility of profitable private sector projects).

The Participants did not reach consensus either on baseline setting methodologies, addressing of indirect implications such as leakage, or the issue of uncertainties.

In the discussion, it was indicated that one of the possible methods to proceed with international negotiation would be to broaden the standardization framework *step-by-step* (start with case-by-case on the condition of future standardization, and gradually establish standardized method of each project type). Also indicated through the discussion was to *handle* the issue of uncertainties by establishing methodologies including the setting methods for various parameters.

The Workshop successfully clarified how far global discussion on baseline issue has progressed. Major issues on baseline were identified, as well as the methodological (at least conceptual) menu on measures to resolve such issues. We may safely say that we were able to *arrange* the way to *address* such issues in the future process of UNFCCC.

Overall, ongoing AIJ experiences seemed to be useful to some extent, but unsatisfactory in other aspects. The identification of issues and classification of problems were elucidated at this Workshop. It will be necessary to intensify practical discussion in preparation for COP 5.

March 28, 1999

Naoki Matsuo
GISPRI/IGES

CDM Workshop Program

Date/Time:

February 25 and 26, 1999. 10:00 a.m. – 6:00 p.m. (Open for public)

Place:

Hotel New Otani Tokyo (**Suiho** Room; 1st Floor), Kioi-cho 4-1, Chiyoda-ku, Tokyo 102-8578, Japan.

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Agenda

First Day (Feb. 25; Thursday):

REGISTRATION (9:00–10:00)

Morning Session (10:00–12:30) Chair: Dr. Robert Dixon (USIJI/IGES)

Overview of Baseline Issues and General Discussion—Outline of the Workshop

Opening and motivation of the Workshop Mr. Hiroshi Mitsukawa (NEDO)

Baseline as the critical issue of the CDM Dr. Naoki Matsuo (GISPRI/IGES)

Baselines for greenhouse gas reductions: problems, precedents, solutions

Dr. Johannes Heister (World Bank)

Discussions

Options for simplifying baseline setting for JI and CDM projects

Ms. Cathleen M. Kelly (CCAP; US)

Discussions

Lunch (12:30–14:00)

Afternoon Session (14:00–18:00) Chair: Dr. Robert Dixon (USIJI/IGES)

AIJ Experiences and Examples

Emission Baselines for Clean Development Mechanism projects:

lessons from the AIJ pilot phase Ms. Jane Ellis (OECD)

Comments Mr. Kai Uwe-Barani Schmidt (UNFCCC)

General Discussions for morning session and AIJ experiences

Coffee Break

Energy Projects 1 Mr. Shoji Takedahara (NEDO)

Energy Projects 2 Dr. Matthew S. Mendis (AED; Malaysia)

Forestry Projects Dr. Mark C. Trexler (TAA; US)

Comments Mr. Xuedu Lu (Min. of Sci. & Tech., China)

Comments Prof. Mitsutsune Yamaguchi (Keio Univ.)

Comments Dr. Mark R. Stevens

(Dept. of Industry, Sci. & Resources Australia)

General Discussions for afternoon session

Second Day (Feb. 26; Friday):

REGISTRATION (9:30–10:00)

Morning Session (10:00–12:20) Chair: Mr. Kotaro Kimura (MITI, Japan)

AIJ Experiences and Beyond

The U.S. Initiative on Joint Implementation and the U.N. FCCC Activities Implemented Jointly Pilot: Experiences and lessons learned

Dr. Robert Dixon (USIJI/IGES)

Comments Mr. Shigemoto Kajihara (EA, Japan)

Discussions

Benchmarking: The potential applicability of using benchmarks for crediting CDM projects Dr. Shari Friedman (USEPA)

Comments Mr. Kazuhito Sakurai (MITI, Japan)

Discussions

Lunch (12:20–14:00)

Afternoon Session (14:00–18:00) Chair: Mr. Kotaro Kimura (MITI, Japan)

Wrap-Up

Overall issues for accounting for emission reductions

Dr. Katherine Begg (Surrey Univ., UK)

Comments Mr. Duncan Marsh (USDOS)

Discussions

Gap between theory and practice Prof. Catrinus J. Jepma (JIQ, NL)

Comments Mr. Holger Liptow (GTZ/BMZ; Germany)

Discussions

Coffee Break

General Discussions among Participants

Wrap-Up as an Input to Future Development Mr. Kotaro Kimura (MITI, Japan)

Baseline as the Critical Issue of CDM
—Possible Pathway to Standardization—

Global Industrial and Social Progress Research Institute (GISPRI)†
The Institute for Global Environmental Strategies (IGES)‡

Naoki MATSUO

Prepared for presentation at ***Workshop on Baselines for the CDM***
February 25–26, 1999, Tokyo Japan

EXECUTIVE SUMMARY

The issue of baseline setting is a critical issue for designing CDM regime in terms of determining incentives (credit generation) for investors. Despite the clarity of its concept, the methodologies of baseline setting are technically difficult. This issue can be construed rather as the problem of how to *define* the additionality. This paper clarifies the criticality of baseline setting in the whole CDM regime, classifies various methodology concepts, and identifies the cross-cutting issues. Based on these studies, The potential for "standardization" which will be critical for reducing transaction costs is also discussed.

Furthermore, by contemplating on phase-by-phase development for CDM, a menu of potential approaches to overcome technical difficulties stated above is considered in addition to searching for practical resolutions, thereby projecting on possible options for future negotiation process.

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CONTENTS

1. Criticality of Baseline Issue in CDM

1.0. Backgrounds

Clean Development Mechanism (CDM) is a project-based mechanism introduced in the Kyoto Protocol, under its Article 12. This mechanism is the realization of the Joint Implementation concept defined under the United Nations Framework Convention on Climate Change (UNFCCC), and is a critical mechanism as a way for developing countries without obligations in quantitative targets to participate. At the same time, it provides incentives for Annex I countries as an opportunity to earn credits, thus the success of CDM will significantly affect the cohesion and development of a whole framework of the Kyoto Protocol.

However, unlike the emission trading defined under the Article 17 of the Protocol, the CDM requires the identification of reduced amount through the implementation of CDM projects, thus there will be many technical barriers to overcome before the mechanism can be implemented. At the fourth Conference of the Parties in Buenos Aires (COP 4) in November, 1998, it was agreed that the details of regime should be determined at COP 6 to be held by the end of year 2000. Therefore, we expects intensified discussion on the designing of this scheme in coming years.

In this paper, the issue of *baseline setting* which is technically most difficult issue in designing the CDM is focused, and the possibility of *standardizing* the baseline setting methods is considered.

1.1. Purpose of CDM and Baseline Issue

First, let us remember the purpose of CDM in order to determine the criticality of baseline issue in a whole regime of CDM.

According to the Article 12 of the Kyoto Protocol, the purposes of CDM are:

- To assist the sustainable development of non-Annex I countries, and
- To assist the Annex I countries to comply with their emission targets.

The designing of a CDM scheme should be based on these two points. Especially important is the former.

For non-Annex I countries, *i.e.*, developing countries, the CDM should be a “new channel for funds and technologies”, and a framework which enable them to earn *ancillary* benefits in addition to the benefits of climate change mitigation. In order to ensure the fulfillment of these conditions, the most critical issue is the project screening in the CDM approval process. The item 5 (a) of the Article 12 has stipulated that the participation in CDM requires the approval of relevant country’s Government.[1] Therefore, it will be desirable at this stage to

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[1] 5. Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of:

(a) *Voluntary participation approved by each Party involved*;

(b) Real, measurable, and long-term benefits related to the mitigation of climate change; and request each Government concerned to formulate its own guidelines under the general criteria determined by COP, in order to ensure its intrinsic sustainability conditions.[2]

On the other hand, the interests of a investing entity in an Annex I country will be the credit volumes to be earned through the implementation of the project. It will be not only an incentive for the actual implementation of the project, but also a determining factor for the success or failure of this scheme as a whole, depending on how much credits can be generated from this scheme as a whole.

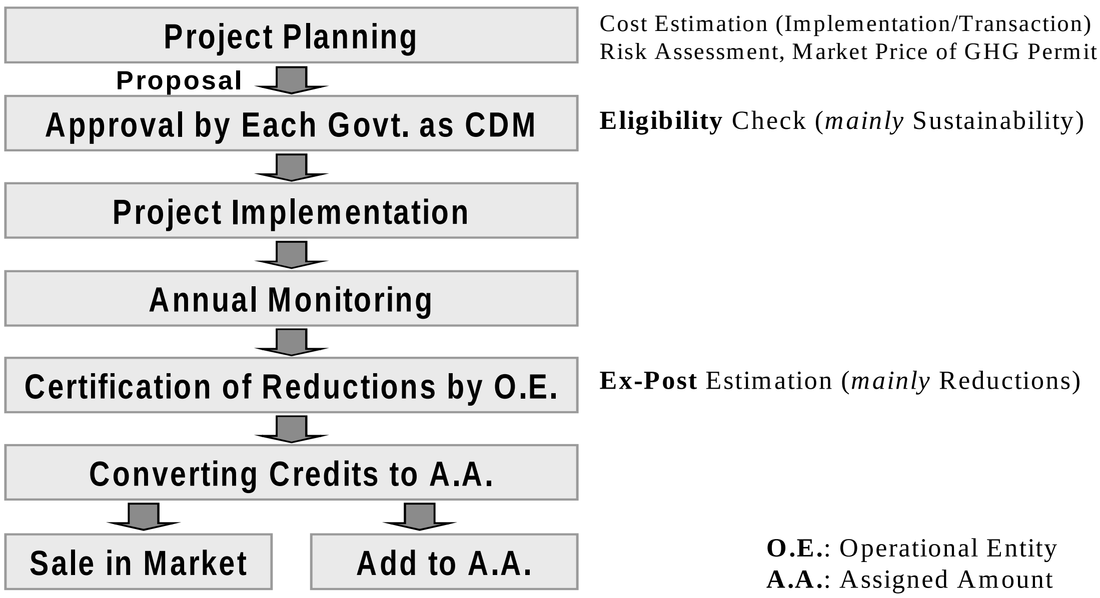
Nonetheless, to determine the amount of the credits, it will be necessary to introduce the scenario of "in the absence of the project (baseline)". By subtracting the actual emissions from that of this base scenario, the credit volume be *defined*. From the experiences of the Activities Implemented Jointly (AIJ) in the pilot phase, projects usually require high transaction costs in addition to implementation costs, which obstruct the promotion of a scheme. In case of ambiguous baseline setting method, there will be a difference between the *actual* reductions and the credits generated. If the credit earned is too small, the incentive to implement projects will be suppressed, and if too large, it will lead to increase of greenhouse gas emissions.

Therefore, the future development of CDM regime itself relies heavily on how a baseline can be determined using simple and less costly methodologies, while attaining these balances.

1.2. Process for Credit Certification

Let us study the actual procedures of CDM project credit certification in order to determine the criticality of baseline issue.

Figure 1: Flow-Chart of CDM Project Procedures



(c) Reductions in emissions that are additional to any that would occur in the absence of the certified project activity. (*Italic* by the author)

[2] Each country may adopt *different* concept of sustainable development, and there will be no need to adopt a common guideline on this. Since the project screening process is before the project implementation, periodical review may be necessary.

As shown in Figure 1, CDM project developer is to formulate a plan for project, by assessing implementation costs, transaction costs, and various risks, while referring to the market price of tradeable emission permits. At this phase, the credit volume is first assessed with the determination of the baseline.

At the next phase, the project is proposed to relevant governments for approval as CDM project. The assessment and confirmation process at this phase will focus on project's benefits on the sustainable development aspects of the host country rather than on the appropriateness of the baseline.

Once approved by relevant governments, the project will be implemented. Monitoring on the effects of the projects shall take place every year, and one of the third party (operational entity) designated by the CDM Executive Board will evaluate the following items on the project:

1. Appropriateness of emission monitoring method (methodology, accuracy, *etc*.)
2. Appropriateness of baseline scenario (methodologies, parameters, *etc*.)
3. Other items (such as sustainability benefits *etc*.), when required.

Depending on the assessment result, the operational entity shall certify the emission reductions of the project.

Therefore, the baseline is a decisive factor at the first phase of an *ex-ante* assessment process conducted by project planners themselves, and at the phase of *ex-post* assessment of emission reduction units. Baseline applied at these two phases of assessment process should utilize the same methodology, but the values of applied parameters will usually differ, since the latter phase uses the actual values.

It is possible to confirm the appropriateness of baseline at the phase of CDM project approval by relevant governments, but only as a reference. The baseline applied for the determination of emission reduction units, *i.e.* the credits certification, should be *ex-post*. Nevertheless, since the assessment of the additionality condition of emission reductions associated with the CDM projects—although they may be overturned by the *ex-post* assessment by operational entity—is to be conducted by relevant Governments at first. Therefore, it will be necessary to clarify the baseline concepts or methodologies applicable for the project at the phase of government approval.

2. View of Baseline Standardization

2.1. Classification of Issues Pertaining Standardization

The above described, the baseline issue is critical in the CDM regime. Here the merits and demerits in *standardizing* the baseline setting methods are discussed.

The standardization on baseline setting is preferable because of the following reasons.

1. Project developers do not need to seek the approval of the Executive Board on baseline setting methodology or to develop their own specific to the project, thus leading to transaction cost reduction, increase in the numbers of projects, and hence, to the development of CDM regime as a whole;

2. By integrating the methodology for the same type of projects, it is possible to secure consistency in mutual assessment of emission reductions and reduce gaming.

On the other hand, the standardization may cause the following difficulties:

3. Technical difficulty to generalize baseline setting which can fully incorporate the specific conditions of each project, leading to the loss of accuracy in determining the emission reductions.

Contemplating further on this issue, the issue can be further divided to:

I. Difficulties *intrinsic* in the baseline setting itself (may exist even for case-by-case methodology);

II. Difficulties specific to *standardization*.

It will be necessary to differentiate these difficulties (though not independent from each other).

In the following, we discuss the possibility of standardizing the baseline setting methodology by examining the requirement risen from the guiding principle for baseline setting, that is the "additionality of emission reductions", and by studying typical baseline setting methodologies.

2.2. Additionality and Baseline-Setting

The Kyoto Protocol requires the emission reductions by project to be *additional*; in other words, the (CDM) project must provide *additional* reductions to any that would occur in the absence of the project (baseline scenario). This means that the difference between the *virtual* baseline emissions and the *real* emissions monitored is the *definition* of reductions to be the origin of credits. It is transparent concept, but difficult to *define* this additionality.

Here we notes that the baseline is *virtual*, and cannot be measured *by definition*. Even with sufficient time and cost spending, *baseline setting will never be exact*. There is no guarantee that the accuracy will improve when specific conditions are addressed case-by-case.

Baseline is, by definition, virtual, and cannot be complete in itself. The uncertainty factors included are

1. Intrinsic difficulty (undetectable and impossible to prove);
2. Technical difficulties (difficulty in assessing indirect impacts, *etc.*).

In this sense, we need to search for *definition* of baseline which is somewhat *easier to attain consent* based on guideline principle of additionality criteria being without project.

The conditions on additionality in the approval process of U.S. Initiative on Joint Implementation (USIJI) are divided into three categories of:

A. (Technological) emissions additionality;

B. Financial additionality; and

C. Program additionality.

The Kyoto Protocol only embraces a broader definition of *emissions additionality*. Therefore, we need to make this emissions additionality, of *additional emission reductions over the "virtual" scenario without project* a guideline principle, while applying both the *financial additionality* and *program additionality* as the operational (interpretation) guideline, as those belonging to broader sense of emissions additionality.

Among the methodologies to assess additionality, the *virtual* status without project which

1. Everyone can agree to, and
2. Practically operational

will be extremely difficult to contemplate. In this sense, we need to seek for methodologies that can balance these two factors. Similar difficulty can be found in the assessment of incremental cost in GEF project assessment.

Program additionality, which is the additionality when *the program is not implemented without CDM scheme*, is difficult to prove. It will be necessary to simulate the decision making process for project implementation. There will be many factors influencing the investors' decision making, many of which are confidential or difficult to quantify (such as risks). Considerable increase in transaction cost is expected (including psychological factors).

Financial additionality interacts with those conditions stipulated above. In case of financial additionality in *government* funded projects, should we include the ODA or other official funded (OOF) projects or not? In case of loans, how much interest rates are acceptable? Since the government funded projects may be utilized to conform to the original purpose of CDM, *i.e.*, to benefit for the sustainable development of host countries, by filling the gaps of private funded projects (such as projects with low profitability) or by enabling the project exclusive to capacity building (less emphasis on credit generation) as an incentive for accumulating experiences at the initial stage of CDM implementation, it can actually contribute to the development of a overall CDM regime, if some kind of a system to clear financial additionality is introduced.[3]

Financial additionality for *private* funded projects will rely heavily on the project's profitability. In terms of above program additionality, the profitability is *not* an only factor for decision making, and the profitability may embrace confidentiality information. In the examples of USIJI, there has been the report on projects which would be profitable but would not be implemented without the USIJI. When determining the profitability, further complication comes in relation to the fossil fuel subsidies in host countries. Thus, it will be difficult to make profitability a sole factor of assessment.

Furthermore, like in the case of DSM program, the entity that receives energy cost reduction benefits through energy saving may not be the same entity that bears the cost of project (investor). The program implemented at net negative cost may not be minus cost at the investor side. In such case, it may be possible to coordinate benefits by sharing credits among stakeholders. We need to determine how much we can differentiate the cost and benefits.

Focusing on the benefits in host country's sustainable development, some projects may be approved even with some doubts on the additionality. In case of multi-purpose projects such as the project to reduce SO_2 emissions and to simultaneously generate credits by energy saving, it may be difficult to differentiate the SO_2 emission reduction benefits from energy saving benefits, in other words, difficult to separate the costs and benefits.

A method of *standardization* to resolve the problems relating to the investor side decision making will be to set a specific format based on the designated procedure, and to prepare a *menu-type spreadsheet* that incorporates various profitability concepts and financial situation information. If the spreadsheet is designed in a way to enable to draw conclusion automatically when each item is filled, it will significantly reduce the difficulties pertaining in such decision-making process. In this way, it will be possible to elucidate the barriers of project

[3] Opening a new and separate account, formulating a formula to *define* financial additionality, *etc*.

implementation, and to facilitate the statistical treatment of issues. Furthermore, the different types of assessment items can be introduced depending on the types and scales of projects.[4] However, such spreadsheet will only allow to determine whether the investment decision making will be *marginal* or not, and will not determine the baseline itself.

2.3. Methodologies for Identification of Reductions

Classifying Issues

This section is devoted to the discussion of methodologies for the identification of reductions when the aforementioned conditions of program additionality and financial additionality are cleared, and determine how to standardize the methodology for emission reductions.[5]

This is the problem of which baseline or reference scenario to select. From various studies, the outstanding issues for review are;

1. Which baseline concept and methodology to apply (what set of parameters)?
2. Generally, these parameters are the functions of time and space. How are we to standardize them?
3. Methodologies of standardization (statistical processing (averaging) by region/ development phase/time; past records; (non-)extrapolation; technology specific values; virtual/real reference project, *etc*.)
4. Setting of lifetime (reduction throughout the lifetime of a project?)[6]
5. How to make a portfolio of various methodologies (single methodology, combined methodologies, menu-selection type, *etc.*)
6. Study of indirect effects and their assessment (depending on project scale, positive or negative leakage, *etc*.)
7. Timing to review the baseline.

These are the problems concerning the baseline setting as a whole. These should be addressed both for case-by-case approach and for standardization. Not only the item 3 but also every item can be standardized.

Categorizing the Assessment Concepts

The original idea of baseline is to assume the virtual emission pathway where project is not implemented, thus the issue is how to *define* the alternative pathway setting. What kind of concepts (views) are for alternative pathway setting?

First, there is the ***micro-baseline setting*** method which incorporates the characteristics of each project. In this concept the project specific characteristics are addressed to some extent, and the alternative scenario of similar or different type can be set. The key for standardization is how far project specific situation is to be addressed. Whatever the degree of specific

[4] Acceptable are “direct inquiry” method and others.

[5] *Emissions* additionality is not independent from other additionalities. *Definitions* on *program* additionality and *financial* additionally will influence the emission additionality, *i.e.*, may alter the baseline setting concept.

[6] Especially, forestry-related projects require coverage beyond the project’s lifetime. (For example, to introduce an agreement on no deforestation after the completion of the project.)

condition being addressing, however, baselines will differ significantly in terms of parameters' chronological dependency, system's boundary, the adoption of virtual or real reference projects, and whether to average statistically, or adopt own records in the past. Also the degree (accuracy) of incorporating indirect effects may increase the risk of perpetual rise in transaction costs for fixing the reductions.

Second concept is ***technology matrix*** method specific to applied technologies.[7] This is the method to prepare the default technology matrix. Technology matrix is not necessarily being two-dimensional, but can have various suffixes depending on the background considered. Whether to make the matrix elements the fixed numbers, or to incorporate time and space dependence will determine the degree of standardization. In such case, a problem is what kind of technological level to use.[8] Also there is a case where it will be difficult to make proper comparison between technologies. Also difficulty is how to incorporate indirect effects.

Thirdly, there is the methodology of ***macro-baseline setting***, a ***top-down*** methodology. It is a way to set baseline from macro-economic indicators such as economic growth rate. In this case, the keys for standardization also depend on the selection of macro parameters. By incorporating regional and chronological dependencies, however, it may be possible to set more cross-cutting baselines independent of the type of project. In some cases this method will make a similar result from the first method, but may raise psychological resistance in terms of pursuance in precision.

Common problems for these methods include how broad a range to consider in the parameter settings, and how to incorporate chronological changes. Profitability also, will influence these methodologies. For example, in case of the project of new thermal power plant construction, it may be possible to give CDM project approval only for the part of efficiency improvement equipment whose high cost will hinder its installment without CDM scheme.

Addressing Chronological Changes

Generally, the external factors changes over time. Therefore, it will be appropriate to incorporate chronological changes into the parameters of the baseline. However, *unique* determination of parameters is difficult. The forecasted values in chronological change of parameters at the proposing phase to relevant Governments should be modified to actual values at the phase of emission reduction certification.

Addressing Indirect Effects

The suggestion was made that the projects may induce possible indirect effects on greenhouse gas emissions elsewhere. However, it is extremely difficult to evaluate this effect accurately. In general, it can be positively correlating to the scale of projects. Therefore, to induce the indirect effect assumption only for the projects with significant scale (in terms of emission reductions) will be practical. In such case, the assumption on indirect effects will require costs, and at the same time increase in administration costs for approval process to be paid to the CDM Executive Board.

Indirect effects represented by *leakage*, may not necessarily be *negative* in emission reductions but be *positive* in some cases. For example, there may be technology penetration

[7] Possible two-dimensional matrix with fuel input and applied technology as suffixes.

[8] Possibilities include: some type of averaging (per region), available (average) technologies in developed countries, economically feasible technologies, best available technologies, *etc.*

effects, correcting of market imperfection, and demonstration effects, which are considered positive impacts and called *spillover* effects.[9] Such beneficial side of indirect effects may be difficult to quantify, but it is preferable to be assessed fully as review items in project approval process.

Addressing Gaming Issue

Generally, incentives to set higher baseline will act on both investor side and host country side.[10] The concerns for such game theory activities may be addressed by letting third party (operational entity) to approve the project. For greater stringency in approval process, especially at the initial stage, it may be possible to introduce plural operational entities to certify the emissions reductions of each project. Suitable standardization contributes to suppress this phenomenon as well.[11]

Addressing Uncertainties

Uncertainties in CDM will include those associated with the *monitoring* of net emissions and those related to the *baseline* setting. These two should be discussed separately.

To reduce the overestimation of emission reductions due to uncertainties, it will be possible to introduce discounts within the range of uncertainties, and *partial crediting* in which only a part of credits is allowed to generate. However, depending on the estimated range of uncertainties and in concern of possible underestimation, it may be possible to limit its application to clear-origin tolerance.

In case of baseline uncertainties, the definition of uncertainties itself is ambiguous. *Proper* baseline itself may be a rather arbitrary existence. To qualify such uncertainties is possible, in a sense, but quantitative estimation is rather difficult. Only after defining the baseline formulation method, it may be possible to quantify the uncertainties in applicable parameters and other factors.

In Case of Projects in Series

Though not discussed much, if the project is comprised of multiple processes in series of projects, the issues of additionality requires closer attention. If one of such process in series is to become the CDM project, *the additionality without the process* means that the whole series of projects including the processes before and after the CDM process will not function. Example is the case of a pipeline construction from a dock to a power station as a part of natural gas thermal power plant construction is designated as a CDM project.

In spirit of the Protocol, it will not be appropriate to certify the effects of whole series of projects to a part (a process) of projects (in this case pipeline setting). Possibility is to utilize some methods such as the weighed distribution of project series implementation cost. However, in case of projects, such as capacity building, that requires less cost but *essential* for host countries in terms of CDM's purposes, it will be preferable to apply weighed distribution

[9] Spillover effects are extremely important merit for the existing pure *technological cooperation* and *technology transfer*.

[10] At the initial stage of CDM, misunderstanding between developed and developing countries may induce a host developing country tends to underestimate the credits (lowering baseline), especially where investor side is the sole beneficiary of credits.

[11] It is possible to divide the functions of monitoring review and credit certification, and to authorize each to separate operational entities.

of benefits including not only cost benefits but also other factors.

In Case of Negative Reductions

The implementation of approved CDM project may result in *negative* emission reductions. In such cases, should the investor give out credits in forms of emission permit or credit?

Generally speaking, it is hardly plausible for a project with anticipated emission increase to receive an approval as CDM project. In this sense, one option is for the project executor not giving out credits (of course they cannot earn credits). There can be the condition that projects provide benefits other than global warming mitigation. Anyhow it will require political judgement.

Other Considerations

The CDM's purposes of *assisting the sustainable development of a host country* stated at the first section and others can be incorporated into baseline formulation.

To implement the projects of mini-hydropower or PV power generation in an isolated island, for example, what will be the applicable type of baselines? Even with the absence of fossil fueled power supply plan as an alternative to the project, it may be possible to set the baseline using the case of diesel fueled power generation.

It is possible to explicate the appropriateness of this project's baseline by:

1. Emphasizing the economic and social benefits for island residents due to the electrification of the isolated island;
2. Emphasizing the *positive* indirect effects for disseminating technologies and providing the resources for indigenous clean energy sources such as renewable energies.

This case also requires some political judgement.

2.4. Options for Policy Implementation

Importance of Early Implementation

Overlooking the whole CDM scheme and more broadly the framework for conforming to the Kyoto Protocol, it is essential to have early implementation and penetration of CDM scheme as well as the introduction of incentives for early implementation of many projects. In terms of baseline issue, this need for early implementation is a trade-off with the stringency of a scheme. How to balance will be a political issue judging merits and demerits. Let us consider baseline issue in this view.

Focus should be on the momentum to launching and promoting a scheme. Demanding stringency from the initial stage of a scheme and causing higher cost and more delays will not be desirable. Especially important is to formulate something *definite* at the earliest stage, and to indicating them to private sector entities, thus reducing concerns of private entities in investment risks, so that we can encourage and hasten the vigorous launching of the CDM scheme.

Chronological Development

The Protocol prescribes that the CDM project shall be able to start from the year 2000. At the COP 4, the Parties agreed to determine the details of a concrete scheme for CDM and other Kyoto mechanisms by the COP 6 at the end of year 2000. Furthermore, among three flexible mechanisms, the CDM has received the highest priority. The issue now is to prioritize the formulation of baseline within the limited time-frame. The baseline issue presents considerable technical difficulties, and long hours of discussion may not complete the resolution of difficulties unless there is a sufficient political momentum. It may be possible, however, to start the scheme case-by-case and to standardize within the designated time-frame.

Standardization of baseline itself requires periodical or sporadic review of its methodologies and parameter values. The chronological development of a CDM scheme may vary as stated herein, and will require the full reviewing of scheme's reality.

Selective Options for Standardization

Standardization method can be one of various methodologies discussed before, or can be a menu-selection method. In case of a menu-selection, the selection may be among standardization methodologies based on different concepts, or between the given standardization method and self-developed case-by-case method. For instance, the selection between relatively stringent standardization method and flexible case-by-case method may be preferable in reducing the uncertainties. Case-by-case method may require additional costs, but, if additional credit generation exceeds additional costs, it can be adopted (if merits are sufficient to persuade the Executive Board).

Another method in introducing standardization will be to standardize from those areas where obtaining agreements of relevant parties is relatively easy, and, to modify such standardized type in response to special conditions, case by case.

In any cases, it is impossible to prepare standardization methods for all possible CDM projects from the beginning. Therefore, we must incorporate case-by-case approach in any cases. In this case, it may take some time to set up the baseline method for new type of project,[12] however, standardization can be possible using this experience for the following similar type of projects as precedent.

For a case of projects such as highway construction where the judgement of additionality is extremely difficult, it is possible to remove such cases from the types of applicable projects (may need to identify which types of projects). Then, as the experiences and knowledge in other project types accumulate, such types of projects can gradually be introduced as the applicable projects.

Ad-Hoc Executive Board and Operational Entities

In any case, it is necessary to determine which institutional body of FCCC shall be responsible for the review and tentative operation of a CDM scheme (before the Protocol entering into force). Among exiting subsidiary bodies, SBSTA will be the most appropriate,

[12] Problem is which entity shall bear the cost to set up the baseline methodology at this initial stage. Also, the responsibility of baseline methodology development is optional for either the Executive Board (or its designated institutes) or the project applicants.

but to establish a subsidiary body exclusive to CDM scheme can be an option.

3. Toward the Realistic Solutions

At stated in the above sections, there are several options for future negotiations. Here a policy package process for a credible direction is suggested:

1. Establish a Ad-Hoc CDM Executive Board under the SBSTA, providing certain degree of authorities (such as the authority to determine baseline methodologies *etc.*);
2. This Ad-Hoc Executive Board is to determine the most preferable baseline setting and standardization methods for each type of CDM projects plausible from the experiences in AIJ, and based on several consigned studies and the works of expert committees;
3. The standardization methods shall be reviewed every five years;
4. Upon the receipt of application for a new type of project (request from each Government), the Ad-Hoc Executive Board shall determine the applicable baseline setting methods within a year of application submission;
5. Any additional administrative cost shall be born by the payment of administrative fee for CDM project certification. The fee shall not be set to add excessive cost burden for a new type project applicant (averaging in a whole system).

Above is an example for developing the CDM scheme. There could be other and better methods. Nonetheless, we must proceed to design and implement the CDM scheme. Unfortunately, our experiences may not be sufficient to do so. Therefore, it will be essential to maintain flexibility such as *learning-by-doing* or *step-by-step* in adopting whatever the methodologies we are to apply for the CDM and its baseline.

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BASELINES FOR GREENHOUSE GAS REDUCTIONS: PROBLEMS, PRECEDENTS, SOLUTIONS

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<u>Draft for discussion:</u> rev.1.4, 16 July 1998
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Acknowledgements: Much of section 7 on lessons from demand-side-management is based on a background paper by Daniel Violette and Shannon Ragland of Hagler-Bailly Consulting. The discussion of the US emissions reductions credits draws on a background paper by Byron Swift of the Environmental Law Institute. The menu-choice method for baseline revelation was proposed in background material by Tracy Lewis. I am grateful to Johannes Heister and Charles Feinstein for helpful discussions and comments. However, all interpretations, conclusions, and errors are mine.

SUMMARY

Rigor in baselines
It's important to establish the right degree of rigor in baselining. Overly lax baselines will threaten the system's credibility and usefulness, and shift rents from high quality providers to low quality providers of offsets. Overly stringent baselines will discourage valid projects and drive up project costs.

The only 'magic bullet' for baselining is to set up a national or sectoral baseline, and define offsets against this baseline. A variant is to use facility-level prior output as a baseline, in a context where sectoral emissions are capped, and the caps are binding. (The US market for NOx and VOC offsets provides a precedent.) This will be difficult in most cases; in fact, joint implementation is a device for avoiding the difficulties of setting the sectoral or national caps. However, it is worth thinking about: a) in EITs; b) where project-level interventions have sector-wide implications, as in the power sector and land-use sector. In these cases, calculations of sectoral-level baselines have to be performed anyway.

Keeping baselines honest
Failing that, baseline determination unavoidably has a judgmental component. This means that baseline determination depends not just on methodology, but on a set of institutions that keep the methodology's application reasonable and honest.

Third party certification may not by itself yield unbiased results. In any situation where there are reasonable doubts, incentives will encourage practitioners to rule in favor of higher baselines. This has been true, for instance, in evaluations of public transit systems in the US, where ridership projections have consistently been biased upwards and cost projections consistently biased downwards, resulting in biases in favor of heavily-subsidized capital-intensive rail systems. In contrast, the US system of DSM incentives successfully uses panels of public interest representatives to review evaluations of net energy savings (ie. the equivalent of offset measurement) by third party evaluators. This is noteworthy because DSM incentive programs constitute a large scale (approximately $3 billion/year) analog to the carbon offsets market, facing very similar baseline problems.

Three methodological issues
The methodological issues in baseline-setting, broadly are:

1. *additionality:* the determination of which technology would have been adopted in the absence of offset sales
2. *direct emissions:* determination of direct emissions conditional on technology,
3. *leakage:* determination of indirect impacts on emissions.

Of these issues, the second is the most straightforward, though not necessarily simple. It is largely a question of measurement and sampling techniques. Detailed protocols for this exist in the energy and forestry sectors.

Additionality
Issue 1, the additionality issue, is perhaps the most difficult and subjective. There are two basic ways of making this determination:

a) using comparison groups – this may be appropriate for projects, such as DSM, which can be thought of as 'bundles' of smaller activities and for which adequate populations of control units exist.
b) simulating the project investment decision – this is an unavoidable approach for large projects without obvious comparison groups, and will probably be a feature of most PCF project evaluations. The question is 'simply': what project, if any, would the project sponsor have undertaken in the absence of offsets funding? The approach is to apply behavioral and/or financial models to predict, in a structured way, whether the proposed project would have been spontaneously undertaken in preference to the baseline or reference project. In many cases this will be equivalent to the incremental cost approach of the GEF, though with a more transparent treatment of incremental benefits.

Behavioral/financial models
The behavioral/financial modeling approach to additionality subsumes the 'barriers' approach to JI. The latter simply nominates a qualitative list of problems which raise project costs and risks. The behavioral/financial modeling approach imposes some rigor by requiring the systematic quantification of those costs and risks.

In order to apply the behavioral/financial approach we need three components:

- an *engineering or cash flow model* showing expenses and revenues under different assumptions; this could be anything from a simple spreadsheet to a complex engineering model of a facility,
- a *normative decision model* which chooses among projects based on the output of a). This decision model could be a simple spreadsheet-based comparison of NPV's or IRR's, or it could be a more sophisticated model incorporating multiple goals and constraints. At the sectoral level, a integrated resources planning model of electrical generation capacity expansion might be applicable.
- A *set of key parameters* to input into a) and b), including capital costs, expected future fuel prices, and pollution charges.

Most of these key parameters are either known only to the project sponsor, are subject to deliberate manipulation by government policy, or are subject to change over time. Default specification of these parameters, probably on a country-by-country basis, reduces the danger of moral hazard and minimizes 'gaming'. Some of these decisions, while crucial to baseline determination, cannot easily be made on empirical grounds – e.g., whether or not to accept policy-based distortions in energy prices, or how to assess future levels of enforcement effort of pollution and forestry laws. Pending any official ruling on these issues, the PCF management will have to make provisional decisions.

Partial crediting strategies
Partial crediting strategies can be used to account for uncertainty and asymmetric information in additionality or baseline determination. For instance, where the investment decision model suggests that the low-carbon project adoption is possible but marginal, partial credit could be requested. Menu-choice revelation mechanisms could possibly be applied in conjunction with the independent stakeholder review process mentioned above. These mechanisms involve letting the project sponsor choose between a high baseline with partial credit for measured reductions or a low baseline with full credit for measured reductions.

Dynamic baselines
Dynamic baselines (that is, adjustable over time) are feasible, and have been used successfully in establishing net energy savings for DSM incentives. They are desirable:

- in replacement/retrofit projects, when retirement of the existing facility is sensitive to unpredictable changes in prices or interest rates. A static baseline would require predicting a precise date when the retirement decision would have taken place in the absence of the project. A dynamic baseline is advantageous if there is a good chance that economic conditions would militate against the retirement decision for a longer-than-expected period.
- when emissions are volatile because of variable and unpredictable facility loads. A static prediction of loads would lead to greater variance in offset production – eliminating them, for instance, if loads were greater than anticipated.

The potential benefits of dynamic baselines have to be weighed against the greater costs.

Leakage
Leakages -- often discussed in connection with forestry projects -- are potentially worrisome also for fuel-switching and efficiency-increasing projects. Project-level reductions in the demand for fuels can have a 'snapback' effect as other consumers react to slightly depressed prices by slightly increasing consumption. On the other hand, positive spillover effects can amplify emissions reductions if project-sponsored technologies diffuse to nonproject facilities. General adjustment or discounting parameters for this purpose should be developed.

Duration of abatement/sequestration and forestry projects
Forestry projects have different durations of impact than do industrial emissions abatement projects. Abating a ton keeps it out of the atmosphere for the average residency time of the GHG in question. Sequestration, or deforestation prevention, is always potentially reversible. The difference needs to be explicitly accounted for when assessing baselines and calculating offsets. One solution is a "pay-as-you-sequester" scheme, in which sequestration services are reckoned on a ton-year basis (keeping a ton out of the atmosphere for a year), and credited at regular intervals. A conversion factor would relate ton-year credits to 'perpetual' tons, using a discounting formula. This facilitates setting up sequestration projects in situations where political and implementation risks discourage long term (20 or 30 year) contracts.

1. INTRODUCTION: BASELINES AND WHY THEY MATTER

AN AWKWARD BUT POTENTIALLY FEASIBLE INSTRUMENT

The Kyoto Protocol to the Framework Convention on Climate Change allows developed countries to sponsor greenhouse gas (GHG) reduction projects in host countries. The difference between the project's actual emissions, and the hypothetical emissions had the project not been implemented, constitute a savings or offset, typically measured in tons of CO2 or carbon equivalent. This quantity can be sold as an emissions reduction[1] (ER) to developed-country buyers, who use it to offset their own GHG emissions. The credit has value because the buyers face either a tax or a limit on net GHG emissions.

This device, also known as Joint Implementation (JI), is an awkward but potentially feasible solution to an otherwise intractable problem. The problem is to reduce the world social costs of GHG reduction by taking advantage of the perceived large supply of low-cost reduction options in the developing world. An international system of tradable emissions permits could accomplish this without the troublesome mechanics of defining and agreeing on hypothetical baselines. The disadvantage of such a system is the perceived current political impossibility of agreeing on emissions budgets for developing countries – in part because of the serious distributional issues involved, in part because of resistance to the concept of emissions permit trading. ER trading substitutes a large number of small and ostensibly technical determinations about project-level baselines for a small number of large, overtly political negotiations about country-level emissions budgets.

THE PROBLEM WITH BASELINES

The distinguishing feature of an ER system is that it is based on an unobservable commodity: the difference between observed GHG emissions by a project host and those which hypothetically would have occurred, had there been no project. The Protocol makes clear that reductions must be "additional to any that would otherwise occur". To define an ER, it is necessary to specify the hypothetical, unobservable baseline level of emissions.

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[1] This term potentially encompasses both the emissions reductions units of the Protocol's article 6, and certified emissions reductions of article 12.

Agreed-on baselines will always be problematic for three reasons. First, it is inherently difficult to predict what would have happened in the 'but-for' world. Second, both buyers and sellers of ERs have strong incentives to overstate the baseline level of emissions, since this increases revenues for the seller and in aggregate may reduce the price of offsets for buyers. Third, baseline setting requires some assumptions about national policies. The project-level approach to emissions reductions obscures, but does not really eliminate, the political issues associated with setting national emissions budgets.

OVERVIEW OF THE PAPER

The next section reviews the consequences of inaccurate baselines and discusses the tradeoffs associated with different levels of baseline rigor. Section 3 focuses on how asymmetric or uncertain information about key behavioral parameters leads to baseline uncertainty. Section 4 discusses four general methodological approaches to overcoming these problems and establishing baselines. The fifth section discusses the use of partial crediting and information revelation strategies to correct for asymmetric information problems. Next there is a discussion of spatial and temporal boundary issues. Section 7 discusses the lessons learned from demand-side-management incentive programs in the US, an interesting large-scale analog to GHG offsets. The concluding section offers recommendations for baseline practitioners.

2. CONSEQUENCES OF INACCURATE BASELINES

Does it matter if baselines are overstated? Some argue that a concern with baseline accuracy reflects only a desire of developed countries to reduce transfers to developing countries. But baseline inaccuracy has wider-ranging impacts on world welfare and on income distribution among developing countries. As a benchmark, consider Figure 1. This shows the now-familiar diagram of the benefits of ER trading when baselines are accurately known. The demand curve represents the developed country marginal abatement cost curve. The supply curve represents the supplying countries' marginal abatement cost curve. The shaded area represents the abatement cost reduction realized by permitting trade in ER's. With the curves shown in the diagram, most of these gains accrue as rents to the supplying countries.

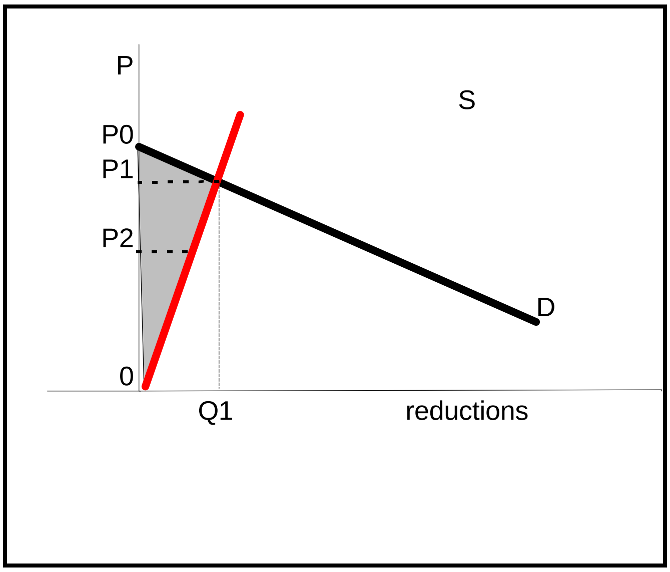

Figure 1

Figure 2 shows the outcome if some non-additional projects are presented -- and accepted -- as additional. These are likely to be economically and environmentally desirable. But because these projects, by definition, would have occurred anyway, their supply price for (non-genuine) ER's is zero. Their inclusion pushes the supply curve outward. As a result, world GHG emissions increase by Qn, because buying countries are allowed to increase their emissions by this amount. Presumably the damages from these emissions exceed the savings in buying-country abatement costs (the area under the demand curve from 0 to Qn). The gains from ER trade, shown again by the shaded triangle, are reduced. Some relatively-high cost suppliers of genuine ERs are now crowded out of the market. Remaining suppliers of genuine ERs see their rent per ton reduced by P_1-P_2. *In sum, overstated baselines result in increased GHG emissions, reduce the gains from ER trading, and divert rents away from projects with more accurate baselines.*

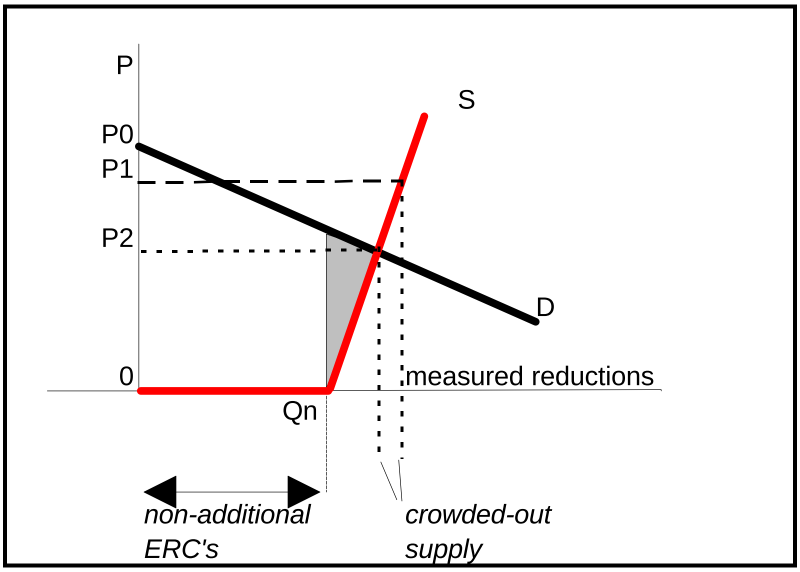

Figure 2

ERRORS IN BASELINE DETERMINATION AND THEIR COSTS

It's not possible to determine baselines with perfect precision. In the important case of determining additionality, there are two types of mistakes: certifying non-additional projects (a type II error), and denying certification to genuinely additional projects (a type I error). Each kind of mistake carries a cost. The former increases world GHG emissions; the latter denies funding to a worthwhile project and increases world abatement expenditures.

Any system for certifying ERs is bound to make one or both of these types of errors. There's likely to be a tradeoff between the errors. For instance, it's been suggested that ER eligibility could be limited to a class of projects deemed obviously additional– say, solar generation of electric power. This reduces type II errors, at the cost of massive type I errors. On the other hand, lax enforcement of eligibility requirements eliminates type I errors, but introduces serious type II errors.

Note that the errors do not, in general, cancel out. That is, we cannot apply the standard statistical argument that, if our baseline estimates are unbiased, the mean *estimated* baseline over all projects will be very close to the mean *actual* baseline. This is clear in the case of additionality determination: each type I error screens out a useful project (but does not affect net GHG emissions), and each type II error increases global GHG emissions. More generally, projects with underestimated baselines will be less financially viable and may as a result be withdrawn, or fail. Hence even if baseline estimates for project candidates are unbiased, the baselines for successful projects will tend to be biased upwards.

The magnitude of these problems depends on the relative supply of projects whose additionality is in question, and on the costs of accurately distinguishing between additional and non-additional projects.

RETROFIT/REPLACEMENT TYPE PROJECTS

Additionality determination is a particularly acute problem for energy-related projects which involve the retrofitting or replacement of inefficient apparatus. This class of projects probably includes some of the lowest-cost supply of GHG reductions. The existence of these opportunities is one of the reasons that there are perceived strong gains to ER trade between developed and developing countries. The problem is that it may be difficult to distinguish between low-cost ER projects, and "no-regret", non-additional projects. A screening system may be prone to making both type I and type II errors in this case – and the type I errors (exclusion of valid projects) may be particularly costly.

SUMMARY AND CONCLUSIONS

Strong forces will tend to favor upwardly-biased baselines, and proposal for ERs from nonadditional projects. If not screened, the result is increased world GHG emissions, reduced revenues to valid ER projects, and undermined confidence in the FCCC.

However, screening is neither costless nor perfect. Screening will result in exclusion of valid projects, as well as inclusion of invalid ones. Error rates can be reduced, but at a cost. The following sections examine the sources of inaccuracy and uncertainty in baselines and additionality, and discuss the applicability of actual and theoretical methods for estimating baselines.

3. ADDITIONALITY ISSUES

THE KEY ADDITIONALITY QUESTION: WHEN WOULD TECHNOLOGIES SHIFT?

Consider a JI project which substitutes a new, highly efficient gas boiler for a inefficient old coal boiler, and takes as its baseline the continued operation of the coal boiler for 20 years. Baseline determination has two elements:

1) What would be the emissions of the coal boiler, if it continued in operation?

This is largely, though not entirely, a monitoring or engineering issue. Engineering methods can be used either to directly measure emissions, or to relate emissions to more easily measurable proxies such as fuel consumption. This paper will largely sidestep this measurement issue. It can be solved in principle with equipment and statistics – though some systems may simply be too expensive to monitor with acceptable accuracy. Large measurement errors would result in very uncertain measurements of offsets from projects offering small emissions reductions.

2) Would the coal boiler in fact have continued in operation – and how long? Twenty years? Five years? Three months?

I will argue that this is the more important and difficult question. The short history of AIJ/JI projects provides examples of projects which appear, in retrospect, not to be additional. For instance, in Pyrzyce, Poland, a bilateral AIJ investment sponsored the replacement of 68 coal-fired boilers with a central geothermal heating plant. (Nordic Council of Ministers 1996) The baseline assumed the indefinite continued use of the individual coal-fired boilers. A review team subsequently found that the local authorities had two backup plans in the event that AIJ funding did not materialize: installation of a central, modern coal-fired plant, or installation of the geothermal plant with a lag of a couple of years.

Many types of proposed or actual JI/ER projects share the same characteristic: they sponsor a discrete technology switch which arguably might have occurred spontaneously, in the near to intermediate future. This is particularly true for retrofit/replacement type projects, but also applies to technology choices for new facilities. Some examples are as follows:

Project type	*Factors affecting spontaneous adoption of new technology*
Fuel-switching projects, especially away from coal	value of fuel savings and air pollution reductions; maintenance cost of old plant
New generator choices: low or high efficiency?	valuation of fuel savings and air pollution reduction; maintenance of fuel subsidies or price controls on electricity
Demand side management: installation of energy-saving equipment	valuation of energy savings
Install coal processing and washing improvements	price differential for processed coal
Methane capture from landfills for electric generation	Standards for landfill construction: *Landfills with minimal standards*: installation of methane capture has costs greater than benefits; therefore project is additional and abates methane. *Landfill with high standards*: much infrastructure needed for power generation is already in place, power generated from methane more than defrays investment costs, therefore project is <u>not</u> additional
Adopt reduced impact vs. standard logging techniques	Do loggers save money or satisfy regulatory requirements with low impact techniques? How strictly will the government enforce logging regulations?

TECHNOLOGY SHIFTS DEPEND ON HARD-TO-OBSERVE PARAMETERS

Reviewing this list, additionality questions arise when technology adoption decisions depend on parameters which are *hard to observe, subject to misrepresentation, subject to strategic manipulation, and subject to change.* Crucial parameters of this type are:

- cost of capital/risk premia: in many economies in transition, capital costs are very high and hard to gauge precisely. The problem is compounded for risky investments. This may be the single most important parameter affecting additionality in energy-related projects. These projects almost always involve an up-front investment which yields a stream of benefits in terms of fuel cost savings. For additionality, what matters is whether the return from this investment is sufficient to induce self- or external financing of the project.

- environmental charges and enforcement levels for SO2, NOx, and particulate emissions: Efficiency-enhancing, carbon-saving energy investments generally reduce standard air pollutants such as particulates and SO2, which impose considerable local health and economic costs. These implicit costs vary from place to place. In many cases there are explicit regulations or charges associated with air pollution; the official level is observable, but the effective enforcement levels vary considerably from place to place and over time (see Wang and Wheeler 1996 for a discussion of geographic variation in effective pollution levies in China). It is these enforcement levels which will determine the degree to which environmental benefits are weighed in the host's decision about technology changes.

- maintenance and downtime costs: where the reference project is continued use of an old facility – for instance, a half-century-old boiler – maintenance costs will increase over time, at a rate that is hard to predict.

- transactions costs – Even in well-functioning developed economies, highly profitable opportunities for energy savings are overlooked. The failure to take advantage of these opportunities is often attributed to ill-defined (but possibly real) transactions costs, though it is clear that poor incentives also play a role.

- energy prices – These of course are currently observable, but their unpredictable future changes will be a major determinant of incentives to switch technologies.

- opportunity costs of land. The profitability of switching to a carbon-friendly form of land use (such as plantations or agroforestry) depends on the profits from alternative uses, such as pasture. Average returns to these activities may be observable, but there may be a good deal of variation based on land quality, distance to market, and management skills.

- commodity and timber prices – again, these are subject to unpredictable future change and will have a large bearing on technology switches. For instance, as cattle prices decline, some areas of pasture will be spontaneously abandoned to secondary regrowth of forest.

- public policies affecting energy prices: trade, fiscal, and regulatory policies affect fuel prices and electricity tariffs and thereby influence technology choice. It is difficult to predict whether or when these policies will be modified or changed.

- public policies affecting agricultural and forest products prices – import restrictions, credit subsidies, and price supports affect decisions on the conversion of forests to agriculture.

- enforcement levels for forestry and land use regulations – many countries have laws prohibiting unauthorized forest clearance and placing strong restrictions on forest exploitation. As in the case of pollution regulations, these laws are often imperfectly enforced – but they are enforced to some degree. Over the decades-long horizon of a potential forest protection project, what assumptions should be made about enforcement levels?

In order to verify additionality and construct a reference scenario for a JI project, we need to be able to impute or predict these difficult-to-observe parameters[2]. We run into three problems:

1. *Actors have an incentive to hide or misrepresent these parameters.* It is to the advantage of project sponsors to be able to claim that their capital costs, risks, training and setup costs are high. These then constitute barriers to the adoption of the JI/ER project.

2. *The parameters are subject to change over time.* This is a problem for retrofit/replacement type projects, where the baseline scenario involves continued operation of an old facility. While it may not be advantageous to shut down that facility today, it may become advantageous in the future, depending on how prices, capital costs, and pollution regulations evolve. In many cases the direction of change may be somewhat predictable. For instance, in economies in transition, there may be a trend towards lower capital costs, higher pollution charges, higher fuel charges, and higher electricity tariffs, all of which would promote switching from an old, inefficient energy technology to a new, more efficient one.

3. *The parameters may be distorted.* This is a problem of equity across countries, and possibly of moral hazard. It occurs when countries or other actors increase (or threaten to increase) emissions, or maintain undesirable policies, that establish artificially high baselines. Possibilities include:

   - energy subsidies: subsidized fuel prices encourages the adoption or retention of low-efficiency generators, boilers, and energy distribution systems. Subsidized electricity artificially encourages low-efficiency and low-productivity end-uses.

   - deforestation subsidies: including subsidized agricultural credit and technology.

   - neglecting conservation: By restricting the size of its national system of protected areas, a country increases the area of forest available for agricultural conversion or timber exploitation and therefore available for generating ER's via protection.

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[2] See section 4 for a discussion of how this approach relates to the idea of "barriers".

- retarding development of market infrastructure: offsets markets may retard the development of mechanisms to finance energy conservation measures, such as energy service companies, regulatory reform, and financial sector innovations.

- reducing efforts to enforce pollution and forestry laws: lax enforcement establishes a baseline of inefficient energy use and rapid deforestation against which offsets can be claimed.

It's worth stressing that this is a genuine dilemma which does not necessarily ascribe base motives to would-be host countries; the term 'moral hazard' doesn't do justice to the problem. Many countries, for instance, have strict forestry laws on the books. Enforcing them creates conflicts with powerful vested interests and often gains little public support. Officials who believe that maintenance of forest cover is socially beneficial now find that, by *not* enforcing the laws they can gain enough resources to maintain the forests while keeping both the public and the vested interests happy. On the other hand, this kind of strategic behavior may be seen as inequitable by other countries that have taken greater steps to enforce similar laws and therefore find themselves unable to claim offsets.

SOME EXAMPLES

Hidden parameters: Pyrzyce district heating

Nordic Council of Ministers (1996) presents a detailed financial and economic analysis of the Pyrzyce coal-to-geothermal project mentioned above. The project involves an investment of $15.31 million over two years. After this start-up period, it delivers estimated annual savings of $890,000 in fuel costs, $130,000 in maintenance costs, $1.97 million in value of SO_2 and NO_x reductions, and 68,618 tons of CO_2 reductions. Could this project be undertaken on a commercial basis? Drawing on the data presented in Nordic Council of Ministers (1996), the table below recalculates the net present value of costs (in millions of dollars) under different assumptions about two key parameters: the opportunity cost of capital, and the value of SO_2 and NO_x reductions (expressed as a multiple of the original assumed values). Positive numbers mean that costs exceed benefits, and suggest that under these conditions the project is truly additional. Negative

		Discount rate		
		0.05	*0.15*	*0.25*
Pollutant cost factor	*0*	$2.83	$7.51	$8.53
	0.5	($8.51)	$2.18	$5.38
	1	($19.84)	($3.15)	$2.23
	2	($42.51)	($13.82)	($4.07)

numbers, shaded and in brackets, mean that benefits exceed costs, suggesting that the project is not additional.

According to this table, if this project were located in an area which placed no value on SO_2 and NO_x reductions (cost factor=0), it would not be undertaken; even with a very low discount rate, the fuel and maintenance savings are not sufficient to compensate for the investment costs. On the other hand, a similar project located in an area with very high sensitivity to air pollution (cost factor=2) would be undertaken even under very high discount rates. At the actual pollution sensitivity (cost factor=1), additionality is very sensitive to the cost of capital; below about 19.5% the project is worthwhile, above that threshold it is not.

In most economies in transition, these two parameters – capital costs and effective pollution charges – can be estimated, but only with some uncertainty. For instance, there may be official pollution charges, but enforcement may vary systematically between regions and between types of plants. This means that outside observers might find it difficult to determine whether a Pryzyce-type investment is additional in a particular setting – say one in which the investor applied for JI finance, claiming a capital cost of 17% and a pollution cost factor of 0.8. It is for this reason that simple rules of thumb (e.g.: geothermal is always additional) are likely to be unreliable.

This analysis is consistent with the finding noted earlier that the town planned to abandon the old heating system even in the absence of AIJ funding.

Uncertain parameters: reforestation of pastures in Costa Rica

Faris *et al.* (1997) analyze the financial and economic returns of a reforestation JI project in Costa Rica. (This is a stylized version of a current project). The project involves converting pasture to timber plantations. In addition to the sale of carbon offsets, project owners benefit from a small harvest of wood at year 12 after plantation establishment, and a large one at year 20. The assumed baseline is indefinite maintenance of pasture, with a revenue of $20/year.

The additionality or baseline question in this case is whether the investors would have found it profitable to invest in the timber plantations in the absence of carbon offset sales. We reanalyze Faris *et al.*'s spreadsheet to examine the sensitivity of additionality to assumptions about the opportunity cost of capital, and to variations in wood revenues 20 years hence. Future wood revenues are subject not only to price risk, but also to risks of damage or expropriation.

The net present value of costs/hectare are shown below as a function of capital cost, and of year 20 revenue expressed as a multiple of the original assumption. Again negative costs (shaded) indicate a profitable project. On this analysis, risk appears to be an important determinant of additionality. Assuming that the wood revenue factor has an expected value of 1, the project is fairly attractive at 6%. At an 8% discount rate, the project begins to look unattractive to a risk-averse investor. As the discount rate rises above 10%, the project is unattractive to a risk-neutral investor, suggesting that it is additional.

	NPV of COSTS under different scenarios *discount rate or cost of capital*

		0.06	0.08	0.10	0.12	0.14
Wood revenue factor (year 20)	0.25	496.73	618.67	688.66	724.97	739.49
	0.50	26.81	301.32	472.79	577.11	637.52
	0.75	(443.10)	(16.03)	256.92	429.24	535.56
	1.00	(913.01)	(333.38)	41.04	281.38	433.60
	1.25	(1,382.93)	(650.74)	(174.83)	133.52	331.64
	1.50	(1,852.84)	(968.09)	(390.70)	(14.35)	229.68

Distorted parameters: policies and emissions in Indian coal plants

Khanna (1997) models emissions and electricity production at 63 coal-based power plants in India, accounting for 86 percent of coal-based generating capacity in 1990-91. About half these plants are operated at energy efficiencies of less than 25%, against design efficiencies of 32%. Several policy-related factors keep efficiencies low and CO2 emission high. Most plants use low-quality coal, because imports of washed coal are prohibited. Subsidies for electricity production, and fixed electricity tariffs, keep low-efficiency plants in operation.

Khanna shows that removal of trade restrictions, subsidies, and price caps results in an annual welfare gain of $600 million, a reduction in government subsidies of $3 billion, and a reduction in CO2 emissions of 11.7 million tons.

If JI projects were proposed in this sector, what would be the appropriate baseline? It depends whether policies are taken to be mutable. One could argue that it is politically impossible, in the short to medium run, to remove the large subsidies. In this case, the current situation would be accepted as the baseline, and ER sales could be used to finance CO2 reductions. Alternatively, one could argue that the country has the power unilaterally to reduce emissions, and should not be rewarded for maintaining socially inefficient policies. In that case, the baseline would be drawn 11.7 million tons under current emissions. It's worth noting, though, that in this case the volume of ER sales could not possibly finance the generation subsidies, so the ER market does not provide a perverse incentive (to the government) to maintain them.

SUMMARY AND CONCLUSION

The hard part of baseline setting is determining whether, or when, the project sponsor would have spontaneously switched from a high carbon to a low carbon activity. The switching decision depends on hard-to-observe parameters. To construct a baseline, we can either impute those parameters and predict the sponsor's behavior, or look for a control group which represents the baseline conditions. The next section examines both approaches.

4. METHODS FOR DETERMINING ADDITIONALITY AND BASELINES

INTRODUCTION

This section describes four approaches to baseline determination, focusing particularly on determining whether or not the proposed low-GHG project would have been spontaneously adopted:

1. *Direct questioning:* Ask the project participant what would have been done absent the project.

2. *Control group methods:* Observe the behavior of a comparison group not offered opportunities to sell ER's.

3. *Behavioral/financial models:* Build a model that predicts how a facility or sector would respond to the incentives posed by an ER project. A powerful methodology for building such a model is to assume that the actors maximize profits, subject to some constraints: "should have" as a means of forecasting "would have".

4. *Sectoral or regional cap:* This redefines a JI project as the establishment of an allowance-like system, where unused allowances are equivalent to offsets.

Of these, the control group and behavioral/financial models are likely to be the most useful.

DIRECT QUESTIONING

The most straightforward approach to baseline determination is to ask the project sponsor what would be done in the absence of the project. To a skeptic, this approach will seem hopelessly naive and open to manipulation, but is widely used. Interestingly, it is the main way that US utilities estimate 'free ridership' when assessing the impact of demand-side management programs. (See section 7).

DSM programs offer incentives to households or firms that install energy saving measures. Utilities are rewarded for energy savings after correcting for 'free riders' - those who would have installed the measures anyway. To determine the free ridership rate, evaluators often use survey instruments such as that shown in Box 1. Potential drawbacks of this approach include respondents' inability to deal with hypothetical questions (Ozog and Waldman, 1992), their incentive to answer strategically, and their reluctance to admit to 'free riding'. Remarkably, a significant proportion of the respondents acknowledge that they would have adopted the measures without any incentives.

More sophisticated surveys aimed at large commercial customers use a wider range of questions to establish decision processes and rules. These are similar to the behavioral models discussed later in this section. For instance, Goldberg and Scheuerman (1997) describe evaluation of a program in which commercial customers were provided with incentives to adopt high-efficiency lighting. An evaluation survey found that lighting technology decisions were often determined by formal corporate policies established at distant headquarters, rather than by local incentives; on this basis, free ridership was estimated at 49%.

These methods are now being applied to DSM projects in developing countries. It is worthwhile to monitor these efforts and assess the potential applicability to JI/ER projects that similarly consist of 'bundles' of household or firm-level interventions.

The following questions appear in a survey of residential participants in a utility-sponsored energy audit program. These two questions are repeated for each of five types of installation which might have been recommended to the customer in the course of the audit.

Q. **39. On a scale of 1-10 with 1 being "definitely would not have installed" and 10 being "definitely would have installed", how likely would you have been to install this measure on your own if it had not been recommended to you through the Audit**?

1	2	3	4	5	6	7	8	9	10
Definitely would not have (*skip next question)*									Definitely would have

98 DON'T KNOW... *skip next question*

Q. **40. When would you have installed this measure?**

1. Within one month of scheduling audit
2. Within six months of scheduling audit
3. Within one year of scheduling audit
4. Over one year from time of scheduling audit
8. DON'T KNOW

Source: Hagler-Bailly

Box 1

CONTROL GROUPS

A valid control group is the gold standard of baseline determination. For instance, if high-efficiency light bulbs were subsidized through a JI/ER project in one city, but not in an otherwise completely comparable control city, monitoring the latter would provide baseline information about the spontaneous rate of adoption of the bulbs in the absence of incentives.

Valid control groups are also the holy grail of baseline determination, because they are difficult to find. This section begins by reviewing the pitfalls associated with a control group approach, then discusses some potential solutions, and concludes with a discussion of the applicability of the control group approach to baselining for various ER project types.

Why valid control groups are hard to find

Ideally, we would like to compare the behavior of a 'treatment' group or individual offered the opportunity to participate in a class of ER projects, with a control group not eligible to participate. After controlling for compositional differences between the groups, and differences between groups in exposure to exogenous factors (such as weather), the control group provides a baseline against which emissions reductions can be reckoned.

Two practical problems stand in the way of this straightforward approach:

Idiosyncrasy: Valid statistical comparisons require a decent sample size to detect modest changes in emissions; much will depend, of course, on the degree of noise and confounding variation in the data. In many cases, the project facility may be unusual or idiosyncratic, and it may be difficult to find a large enough or similar enough control group to permit these comparisons. This will particularly be the case for fuel-switching projects involving large industrial or municipal facilities.

It will also, in general, be the case for evaluating projects affecting national electrical generating capacity. This is because any such project has *sector-wide* impacts. This point is made by Swaminthan and Fankhauser (1997), who illustrate how the alternative to installing a small renewable-energy plant is to accelerate the phase-in of large conventional plants. The unit of analysis for project-vs.-control comparisons is therefore not the plant or utility, but the entire national generating sector, so there can be no domestic comparison group.

Selection effects: The immediate problem for ER applications is that all potential ER suppliers within a participating country are potentially eligible to participate in the offsets markets. Would-be project sponsors will systematically recruit potential offset suppliers with the interest and capability of cost-effectively reducing emissions. As more and more suppliers are recruited into projects, remaining nonparticipants constitute an increasingly less appropriate control group, since they are likely to be systematically different from their counterparts who were recruited into a project. In the limit, there may be no nonparticipants left at all.

Before and after comparisons

The simplest possible control group approach is a before-and-after comparison: emissions of the entire eligible population (of facilities, forest plots, etc.) are compared before and after the advent of the ER project. Given a long enough time series, and sufficient variation, the before-and-after comparison can be adjusted for possibly confounding exogenous factors such as weather.

There are several drawbacks associated with before-and-after comparisons:

- *Moral hazard* is a danger. For instance, if pre-program deforestation rates serve as a baseline, there is a danger of inducing higher deforestation in any area which might later seek to produce offsets through deforestation prevention. A standard corrective in this situation is to use older data – say, before 1995 – to establish the baseline, but this raises the second problem: failure to control for contemporary trends.
- *Changing incentives or conditions* make historical data a poor guide to the current baseline. For instance, in the economies in transition, rapid changes in prices, management structure, regulations make historical comparisons of limited use. Similarly, past deforestation rates may be of little use if subsidies for forest conversion or prices of agricultural products have changed substantially, and may change in the future.
- *Recently-introduced technologies* may still be in the process of natural diffusion; typically adoption rates follow a logistic curve in the period after an innovation is introduced. A simple before-and-after comparison would overstate the baseline if it failed to account for natural diffusion rates. If it were possible carefully to model the diffusion process, however, before-and-after comparisons could in principle detect 'spillover' effects of ER projects on inducing technology adoption by nonparticipants.

Comparing project participants and nonparticipants over time: self-selection and other problems

The alternative to before-and-after comparisons is concurrent, post-project comparisons of 'treatment' (project) and control groups. Concurrent control groups account for ongoing changes in the economic environment, but present their own problems. First, the use of concurrent control groups implies the use of dynamic baselines – baselines that are not prespecified, but 'observed' in the course of project execution. While often regarded as infeasible, this kind of dynamic baseline has been used routinely for the determination of DSM incentives for net energy savings (see section 7).

Concurrent treatment-vs.-control comparisons are straightforward when the control group is ineligible for, and likely to be unaffected by, the project. In many, perhaps most, cases these conditions will not be satisfied. The 'control' group will consist of units (households, firms, etc.) which could have participated in the project, but chose not to, or were purposefully not offered the opportunity. If project participants constitute a significant fraction of the universe of possible participants, then they will tend to differ systematically from nonparticipants. It's generally reasonable to suppose that participants may have been more willing to reduce emissions even in the absence of a project, meaning that the baseline is overstated.

For instance, consider a program which offers incentives for industrial firms to adopt high-efficiency lighting. Acceptors of the incentives will tend to have lower discount rates, greater internal incentives for cost-minimization, and higher maintenance costs than nonacceptors. These characteristics would be conducive to energy conservation and emissions reductions even in the absence of incentives. But, as emphasized in section 0, these characteristics are difficult to observe. Therefore non-acceptors are a biased control group – they don't really represent how the *acceptors* would have behaved, absent the incentive.

This problem has long been recognized in DSM applications (EPRI, 1991) and indeed is the canonical problem of the program evaluation literature: comparisons between control and program groups need to control for observed and unobserved confounding variables. Train (1994) presents a detailed description of the econometric issues and a critique of the state of practice.

A simplified version of the approach is as follows. Assume that an ER project offers units (firms or households) an opportunity to participate in a program – perhaps one which involves incentive payments. The program promote measures which reduce emissions. It is quite possible, however, for nonparticipants to adopt these measures, and this leads to a free-rider or additionality problem in determining the baseline.

Behavior of the units can be described through a system of equations:

$$P^* = X\beta + u \qquad (1)$$

$$P = 1 \text{ if } P^*>0,\ P=0 \text{ if } P^*<0$$

$$\Delta E = Z\gamma + \delta P + e \qquad (2)$$

where P^* is the unobserved propensity to join the program

P is a dummy variable indicating participation in the program

X and Z are vectors of variables affecting participation and emissions reduction

ΔE is the observed change in emissions after the project was initiated.

Program participation is based in part on the unit's predisposition to adopt the measure and save energy. Therefore the observed determinants of emissions reduction, Z, overlap substantially with the determinants of participation, X; and likewise for the effects of the unobserved determinants u and e. This means that the observed participation indicator P is highly correlated with the unobserved propensity to reduce emissions e; in the limit, if everyone who was going to reduce emissions anyway volunteers to participate in the program, then the true value of δ is 0, but an OLS estimate of equation (2) yields a spurious positive value.

The well-known econometric solutions to this problem are:

a) to estimate the pair of equations jointly via maximum likelihood methods, allowing for the correlation of e and u; or

b) to estimate the participation equation first, use it to derive E(u|X) (the expected unobserved propensity to participate, given observed variables X), and then to plug this value into equation (2) as a control for the self-selection bias.

This cookbook procedure faces some difficulties in implementation. Train (1994) notes that this procedure is often erroneously applied to the determination of the *level* of energy consumption (or emissions) E, rather than the *change* ΔE. In addition, the econometric identification of equation (2) is tenuous. Intuitively, to be sure that we are capturing the exogenous effect of project participation on emissions reductions, we need to find a variable which affects participation, but which does *not* affect emissions reductions. Again, intuitively, just about the only conceivable candidates for this role are variables which describe bureaucratically-determined eligibility requirements or recruitment/advertising efforts which vary between units.

International comparison groups

When should international control groups be used? In principle, the use of international comparisons provides a means of providing true, uncontaminated control groups not subject to self-selection bias. However, it may often be the case that international comparison groups differ too much in composition, behavior, or ambient price levels to make satisfactory controls. This will be particularly true for situation involving retrofits of old energy facilities, or for forestry applications. International comparisons may be more reasonable with respect to the adoption of new technologies -- such as electric generation equipment – where the menu of possibilities is indeed fairly standard throughout the world. Even here, though, differences in capital costs may complicate the comparisons.

There are two situations in which the use of international comparison groups is advantageous, even if the result is to demonstrate the lack of opportunity to generate ERs. The first is where domestic prices are distorted. Here international comparison is an important means of determining the baseline in an undistorted environment. The second is in the case of footloose industries selling to a world market. Some fear that firms in these industries could claim offsets without actually reducing emissions, merely by relocating their facilities from the developed to the developing world and then using local firms to define the baseline. Use of international comparators for this class of projects would reduce this risk.

Summary: applicability of control group approaches

In sum, control group approaches are most useful when:

- the number of project and nonproject observation units (e.g., firms, households) is large
- the units are reasonably homogenous, or their emissions behavior is easily related to well-observed characteristics

- the project is of limited geographical scope or otherwise does not recruit most of the pool of potential participants (this criterion can at best be satisfied only temporarily, since there is no obvious restriction on participation in ER markets)
- there are no large domestic policy distortions such as subsidized energy prices
- spillover effects are not large, or can be separately modeled.

Preproject data can serve as a useful comparison basis when factors affecting emissions don't change much over time. However, the routine use of pre-project data as a baseline could lead to moral hazard for subsequent projects, as would-be participants seek to establish a higher baseline.

Concurrent control vs. project comparisons are potentially useful in controlling for unpredictable factors such as weather, capacity utilization due to business vagaries, and prices. However, use of concurrent data implies a dynamic baseline.

These characteristics make the control group approach to baselining applicable to many DSM projects. As section 7 discusses at length, control group techniques of varying rigor have been extensively used in the evaluation of net energy savings from these projects in the US. Similarly, control groups may be an effective way of establishing baselines for fuel-switching projects involving large collections of small or medium-sized facilities. They may be effective also for projects involving the adoption of reduced-impact logging or other agricultural/silvicultural technologies among small and medium operators.

In general, control group techniques will be less satisfactory for certain important classes of projects:

- *large retrofit or replacement projects in transition economies*. Here the baseline question is when the original equipment would have been replaced, absent the project. Historical data will provide no guide, and the universe of contemporaneous control facilities may be too small.
- *large electrical generation projects.* As noted above, the need to look at sector-wide impacts makes these projects awkward for control group analysis.
- *deforestation prevention or reforestation projects.* The baseline, without-project rates of deforestation or regrowth depend strongly on prevailing prices for wood and agricultural goods and on the state of enforcement of forestry laws. These parameter may well vary over the 20 or 30 year period that might be typical for such projects. It may also be impractical to set up a control area which is both excluded from participation in the project and insulated from the project's indirect effects (such as a geographical displacement of the demand for land conversion).
- *projects in host countries with energy subsidies or other policy distortions.* If it is determined that baselines should be based on economic prices rather than prevailing, subsidized prices, local control groups are not helpful.

These shortcomings motivate the next approach to baseline determination.

BEHAVIORAL MODELS BASED ON FINANCIAL/ENGINEERING ANALYSES

In the absence of a real control group, it is necessary to create a virtual control group. This means constructing a model describing how the unit in question would behave over time in the absence of offset sales. The focus would be on predicting whether the unit would adopt the project or the reference (baseline) technology, in the absence of a market for GHG offsets.

Such a model would have both normative and positive elements. It would be normative to the extent that it corrects for policy distortions – for instance, by shadow pricing energy at world prices. It would be positive to the extent that it attempts to predict how the unit would actually behave, contingent on those corrected market signals. Such a model would not, for instance, assume that firms face no transactions costs, no risks, and can borrow at the social discount rate. It would recognize that there is extensive evidence that firms do not invest in *apparently* high return energy measures (see DeCanio and Watkins 1998 for an empirical study and citations to the literature) – but explicitly model this as a consequence of high transactions costs and high capital costs.

The approach

One approach would employ financial (cost/benefit) analysis of engineering (or agronomic) models. This approach would use the same model, and level of sophistication, as would be employed to make an investment decision in the project. It would in fact simulate the investment decision. The proposed procedure is as follows:

1) Construct a cash flow model which predicts project costs and benefits over time, as a function of output prices, input prices, and important contingencies.

2) Use the model to evaluate potential possible projects, including the JI/ ER project (evaluated without possibility of ER sales), and one or more reference projects.

3) On the basis of (2), predict which project would be chosen in the absence of ER sales opportunities, using a normative investment decision rule. (A positive rule might be better but would be harder to derive.) For instance, in a retrofit/replacement project, the rule might be: invest in the ER if it offers a greater net present value than continued operation (with optimal maintenance) of the current equipment. More complex, heuristic models of the investment process are possible.

The emphasis on financial analysis subsumes and makes more rigorous an alternative approach, which is to identify "barriers" to adoption of the project technology. (IEA 1997; Carter 1997) There are many plausible barriers, including poorly functioning financial markets, risks associated with installing and operating locally unknown technology, and internal organizational structures that discourage investments in energy efficiency. (See for instance Golove and Eto, 1996). However, the critical assumption behind JI or ER projects is that these barriers can be overcome, given enough money. Money overcomes barriers either by covering unusually high transactions or set-up costs, or by boosting returns high enough to compensate investors or lenders for the project's risk. A financial or behavioral analysis provides a framework for quantifying the effect of these barriers on costs, risks, and returns. It therefore provides a systematic framework for assessing additionality claims.

This approach is similar to the incremental cost analysis required by the GEF. The GEF finances incremental costs of a project relative to a baseline scenario. However, the GEF incremental cost analysis is made awkward by the explicit exclusion of incremental benefits. Analysts are urged to find some way of describing incremental benefits as avoided incremental costs (GEF 1996, para 25). For the purposes of analyzing JI/ER projects, there need be no embarrassment at explicitly factoring incremental benefits into the investment decision framework.

The need for default parameters

Section 3 argued that behavior depends on some hard-to-observe parameters – in particular, the firm's capital cost or target rate of return, and the penalties attached to air pollution. To calibrate any behavioral model, we have to specify those parameters.

To facilitate baseline determination, baseline certifiers could agree on standard, country-specific default values for these crucial but unobservable parameters, including cost of capital (or target rate of return), and effective pollution charges. Standard values could also be used for current and anticipated energy prices. For instance, analyses of fuel-switching projects would be required to use common values for energy prices, actual or shadow prices for pollution, and target rate of return. These values would necessarily be country-specific. Different rates of return would likely be set for new versus established technologies.

The use of standard values for these parameters has two advantages. It simplifies project preparation by obviating the need for researching and justifying these contentious values. It also removes one of the chief levers for 'gaming' the system.

The use of standard values would, of course, introduce type I and II errors, as described in section 2. For instance, if the risk-adjusted target rate of return is set as 22%, firms with lower capital costs will tend to have nonadditional projects approved; firms with higher capital costs will tend to have valid projects rejected. Error rates could possibly be reduced by tying the default values to firm size, type, or location, but this makes the process more complex.

A major policy decision is whether to use these default parameters to correct for policy distortions. Should, for instance, the calculations be done at world energy prices or at prevailing local prices? Where there are no effective pollution charges, should a shadow price of pollution be imposed? Should official pollution charges be used if they are not actively enforced? These questions boil down to the decision: should a country's policies be taken as mutable or given? (See section 3). Ultimately there may be a clarification of the Kyoto Protocol which decides this issue. Until then, practitioners will have to decide on their own. It would however be possible for an ER project to calculate offsets against two baselines (corrected and uncorrected for policy distortions), pending a formal decision under the UNFCCC. It is worth noting that the GEF methodology for computing incremental costs requires that the calculations be done at world prices if there are local distortions. (GEF 1996).

New technologies, risk, and diffusion

Technologies new to a country would be expected to have higher start-up costs and higher risks of failure. In the evaluation procedure, this might be reflected as a higher target rate of return. It will be hard to set this hurdle with precision. Setting the hurdle very high (i.e., favoring a presumption of additionality) may be relatively harmless in this case because of the high likelihood of positive spillovers. As the technology diffuses, relative risks and start-up costs will decline and it will be possible to model the adoption decision with greater accuracy.

Incentives for accurate reporting

Couldn't a project sponsor manipulate financial or engineering records to support an additionality claim? Of course. The advantage of the proposed financial analysis, as with any auditing system, is that it makes manipulation more difficult.

It's possible to structure incentives to promote accurate reporting. One way to do so is to employ a partial-crediting system (see section 0) for ERs as a Bayesian crediting mechanism: we credit the *expected* number of genuine ER's. The rationale here is that there is genuine uncertainty, for the host as well as the certifier, about the costs and benefits of both the project and reference scenarios. Again consider a typical retrofit/replacement project. A Bayesian approach to additionality might compute the internal rate of return of adopting the ER project, relative to maintaining the status quo. If the IRR falls below some minimum threshold, the project is presumed to be additional with 100% probability. If the IRR falls above some maximum threshold, it is presumed nonadditional with 100% probability. Between the thresholds, the presumed probability of the project's non-adoption is interpolated. The gross amount of reductions produced by the project is scaled by this probability. This sliding-scale approach reduces the strong incentive to manipulate data that would result from an all-or-nothing determination of additionality.

Proper incentives could be further reinforced in this case if there were a mechanism for funding high-return energy-efficiency projects. Suppose, for instance, that a funding mechanism, or energy service companies, were prepared to invest in energy conservation measures with payback periods of two years or less. We might then credit ER projects on a sliding scale, with full crediting for projects with estimated paybacks of four years or more, and no crediting for those with projected paybacks of two years or less. Companies with profitable energy conservation opportunities might find it more expedient directly to finance conservation measures than to go through an ER certification process which might yield relatively few credits.

Example: Poland Coal-to-gas AIJ evaluation

Incremental cost analysis was used in the appraisal of the Poland Coal-to-Gas AIJ project (GEF 1994), which sponsored the conversion of numerous small coal boilers to gas. The approach serves as a model for the investment-decision approach proposed here. (The procedure was embodied in a "user-friendly, menu-driven spreadsheet model"). In appraisal, it was assumed that the target rate of return (cost of capital) is 25%, and used official pollution charges of $73/ton for SO2 and NOx and $36/ton for particulates. A simple spreadsheet-type cost-benefit analysis of the profitability of gas conversion for a pilot facility showed that it was more profitable for the facility owners to retain the existing coal boilers than to replace them with gas. The analysis recognized that this decision might be sensitive to future price changes. Sensitivity analysis showed that if the pollution charges were increased severalfold to reflect actual damages, if real labor costs were assumed to increase at 5% annually, and if energy prices were set at world level, the project would have an IRR of 22%, still below the threshold. This then justified the assumption of additionality.

Since I am proposing that this modeling approach is a crude but serviceable description of actual behavior, it is of interest to know how well it predicts fuel-switching by district heating plants. In fact, since the project was appraised in 1993, a spurt of similar conversions has spontaneously been undertaken in Poland[3]. Many of these conversions are funded by grants or concessional loans through the National Environmental Fund, the Ecofund, and the Bank for Environmental Protection. In addition, some district heating companies are undertaking conversions with self-financing or conversion loans. The Krakow district heating company, for instance, is converting or eliminating about 80-100 coal boilers per year[4].

Does this trend invalidate the use of the simple investment model? Probably not. It is likely that these conversions are explicable by an unexpectedly rapid decline in the risk-adjusted cost of capital, and by an increase in the availability of concessional funds from national sources[5]. It may however indicate that the model is too simple and requires the refinement.

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[3] Eric Martinot, personal communication, Oct. 27, 1997.

[4] *Ibid.*

[5] The latter raises very profound baselining questions. If Poland was willing to subsidize such projects on the basis of their local environmental benefits, that might well be taken to show that such a project could not possibly be addtional, and qualify as a source of emissions reductions. But if we agree to assess projects at world, rather than local, fuel prices, should we do the same thing for pollution charges?

Since district heating projects have been, and are likely to continue to be, a prominent class of JI/ER projects, it would be worthwhile to test the accuracy of alternative financial/behavioral models of fuel-switching. This can be done by analyzing the actual conversion experience of district heating plants in Poland and other countries over the past five years. A particularly strong hypothesis would be that concessional financing was directed towards facilities with strong local environmental impacts.

Dynamic or static baselines?

The financial/behavioral approach to modeling makes it possible to construct dynamic baselines. Consider, for instance, an old district heating plant. Based on today's fuel prices, labor costs, and capital costs, it may not be profitable for the plant to switch fuels. This would justify the creation of ER's by switching to a more efficient fuel. But how long should we imagine that the old plant continues, in the reference (baseline) scenario? It depends on how those prices are anticipated to change.

A conservative approach would presume that all those factors are systematically changing so as to favor fuel-switching. Static baseline determination would therefore:

1. predict prices, interest rates, and pollution charges over the project lifetime
2. apply the financial model to determine at what date the plant would switch fuels, in the absence of ER revenues.

The result might be, for instance, an *a priori* prediction that the plant would be retired after five years in the baseline case, so that ERs could only be generated during that period. Suppose, however, that there was some chance that prices might not change. In that event, the reference plant might continue in operation for many years. A static determination of a five year baseline would squelch the creation of many ER's.

To prevent this, a dynamic baseline could be used. The baseline would not be determined in advance. Instead, the behavioral/financial model would be exercised each year. If it predicted that the old technology would still be in place, ER's could be reckoned against this high baseline. If it predicted that incentives now favored a shift to a new technology, the baseline would be appropriately ratcheted down. This approach is more complicated than the static approach. Bear in mind, though, that actual emissions have to be measured and certified at a regular basis, so that the trouble of recomputing the baseline is not as great as might be thought.

Dynamic baselines have often been viewed as a needless, risk-increasing complication. But this need not be the case. Dynamic baselines could be tied to easily observable variables such as load factors, exchange rates, central bank interest rates, or fuel prices. They can actually reduce risk or increase the attractiveness of a project. For instance, imagine a heating/cooling project which reliably reduces emissions by 20% in a context where emissions depend on the weather. A static baseline, based on expected temperature would yield a volatile stream of offsets: lots or none, depending on how actual temperature compared to assumed temperature. Dynamic baselines can be viewed as an element of the methodological toolkit to be used when appropriate.

Summary: project types appropriate for investment decision analysis.

The financial/behavioral model approach is appropriate for use at three different scales:

1. At the *sectoral* scale, simulation models are available to determine investment in and dispatching of electric generation capacity. (See e.g. Swisher *et al.* 1997) These models could be used to determine baseline investment decisions in the absence of JI/ER projects. (Again see Swaminathan and Fankhauser 1997). Similarly, landscape-level land use models, integrated with agricultural/silvicultural supply and demand models, could be used to project emissions from land use change in the absence of JI/ER interventions. The cost of these models would be moderate to high, but would be reasonable in light of the volume of ER's produced by a sectoral project.

2. For *large projects*, the approach would mimic the investment decision methodology which would be used even in the absence of JI/ER opportunities. Examples include:

- fuel-switching retrofit/replacement projects
- choice of generator, or manufacturing technology, from among a set of "off-the-shelf" models, given a predetermined load or capacity
- decision on whether or not to build a privately-owned generating facility using renewable energy sources
- decisions by large logging companies on whether or not to adopt reduced-impact logging techniques

3. For *projects which induce changes among households or small firms*, and where control group methods are not possible, hybrid statistical/financial approaches would be used to predict behavior in the absence of the project. Examples include:

- adoption of longer-payback energy conservation measures by small households and firms
- pasture abandonment by small farmers

This proposed approach – financial-engineering models with prespecified parameters – is hardly free from ambiguity or opportunities for manipulation. However, there will be many circumstances for which there is no feasible alternative to this approach. Provision of guidelines on standard parameters and application of standard investment-decision methodologies, together with provisions to safeguard the integrity of the certification process, will go a long way towards maintaining its credibility.

SECTORAL CAPS AS BASELINES

A conceptually simple, politically difficult solution to the baseline problem is to establish sectoral or national caps and measure offsets against these. (see e.g. Carter 1997). This is particularly appealing when facility-level projects have significant sectoral effects. For instance, as noted in a couple of contexts in this paper, a decision to build a generating plant can affect grid-wide expansion and generation plans. Similarly, project-based efforts to protect a forest plot from subsistence-oriented conversion may merely divert the convertors to another location. For both energy and forestry projects, it is therefore desirable if not essential to compute sectoral level baselines and look at sectoral level effects.

There are two severe difficulties in pursuing this approach. The first is setting the overall cap. This could be done through the use of a complex model of the energy sector or of land use. It could be done on the basis prior emissions levels, adjusted for population or economic growth. In general, agreement on such a cap might be very difficult. For Annex I countries, though, the cap is already defined on a national basis and it might therefore be possible to define a sectoral subcap.

The second difficulty is allocating the rights to create offsets against this cap. The economist's natural tendency is to recommend the creation of a tradable domestic allowance system. Unused allowances would automatically count as offsets. Palmisano (n.d.) discusses the severe political problems involved in coming up with an acceptable means for allocation. ELI (1997a) acknowledges those problems, but suggests that solving them in the political rather than bureaucratic arena, and placing a legislative deadline for achieving an allocation, can advance the process.

A 'back-door' route to this system is to establish a sectoral cap, and then allow firms within the sector to generate offsets against their historically-established emissions level. This has been done in several US states in the form of Emission Reduction Credit (ERC) trading programs for NOx and VOC (volatile organic compounds)[6]. These programs allow sources to sell, for credit, reductions in emissions against a baseline. The sources already face individual limits on emissions. ERC's can be used as offsets to help satisfy these limits. Because the ERC programs take place in areas with regional limits on emissions, they strongly resemble Article 6 emissions reduction regimes in an Annex I country with a binding national emissions cap.

By and large, the methodology for baseline determination has not been contentious in these programs: baselines are specified to be the lower of permitted and actual emissions. (In some cases, plant shutdowns are excluded as a source of ERC's, for fear of leakage). The sources are already subject to regulation and monitoring, generating the information needed for baseline definition.

[6] The following discussion draws on the background paper, ELI (1997b).

However, the ERC systems have been criticized as requiring higher transactions costs than the cap-and-trade systems they so closely resemble. Most new ERC systems (discrete emissions reductions or DERs) require year-by-year crediting of achieved reductions against pre-established baselines. To ensure the integrity of the system, the states require three to five separate, public reports, including: a notice of DER generation, a notice of intent to use DERs for compliance purposes, a notice and certification of DER use, a notice of transfer (if the DER is sold) and a notice of DER certification. Some systems require precertification of the credits, which introduces high transactions costs; others place liability for credit validity on the buyer, which raises risks. One state uses private third-party certification. The need to verify physical output in order to trade ERCs contrasts sharply with the need only to verify the validity of an allowance certificate in a cap and trade system. (ELI 1997b; Dudeck 1995).

Can ERC/DERC systems evolve into cap-and-trade systems? Typically, ERC systems already have much of the necessary market infrastructure in place, including regional emissions caps and firm-level monitoring of output. Because of this, there are pressures for the US ERC systems to evolve into cap-and-trade systems similar to the existing SO2 system; the EPA is drafting a cap-and-trade program for NOx to cover 22 states and the District of Columbia. Palmisano (n.d.) is nonetheless pessimistic that ERC systems can evolve into allowance systems, though granting it as a long-term possibility.

It is possible that ERC systems may be suitable for EIT's faced with binding caps, especially where there is already some regulatory infrastructure in place. It would be essential to control against leakages into uncovered or unregulated sectors (such as small firms.) Over the medium run, ERC systems might facilitate a transition from JI to a pure emissions-allowance trading system for these countries

5. PARTIAL-CREDITING AND MENU CHOICE STRATEGIES

Uniform partial crediting of offsets

Suppose that we believe that there is a 50% error rate in the certification process, so that 50% of approved reductions are not in fact additional. Our problem is that we cannot identify which is the offending 50%. One response to upwardly-biased baselines is to grant only partial credits for reported reductions. For instance, we could offer 50% credit for each reported reduction, in the hope that, in aggregate, credited reductions will be about the same magnitude as actual reductions.

This partial crediting strategy has a drawback, however. Consider the situation shown in Figure 3, which shows aggregate demand and supply for ER's. The initial demand for ER's, D_0, is shown as highly elastic; think of it as being demand as seen by a price-taking small country. One half of the measured reductions (Qn) are not additional, and thus have a supply price of zero. A proposed solution is to impose a 50% in-kind tax on the ER's: buyers are required to retire, or donate to the common good, 50% of the measured reductions that they buy. This shifts the demand curve for pre-discount reductions down by 50% to D_1, because the buyers need to buy twice as many credits to accomplish a reduction which they could accomplish by other means at a cost of D_0. The partial-crediting strategy is successful in reducing both the number of non-additional credits, and the rents received by their producers: both fall by half. However, the strategy has the disadvantage of pricing out of the market some genuine, but higher-cost suppliers of ER's, those between Q_0 and Q_1. This illustrates the error trade-off discussed earlier: type II errors decrease, but type I errors increase. Moreover, the result is a kind of adverse selection: the proportion of realized credits which are not additional increases from half to two-thirds!

The partial crediting strategy can be improved if there is a means of discriminating among suppliers and reducing the rents received by suppliers with overstated baselines. We turn to two general techniques for doing this.

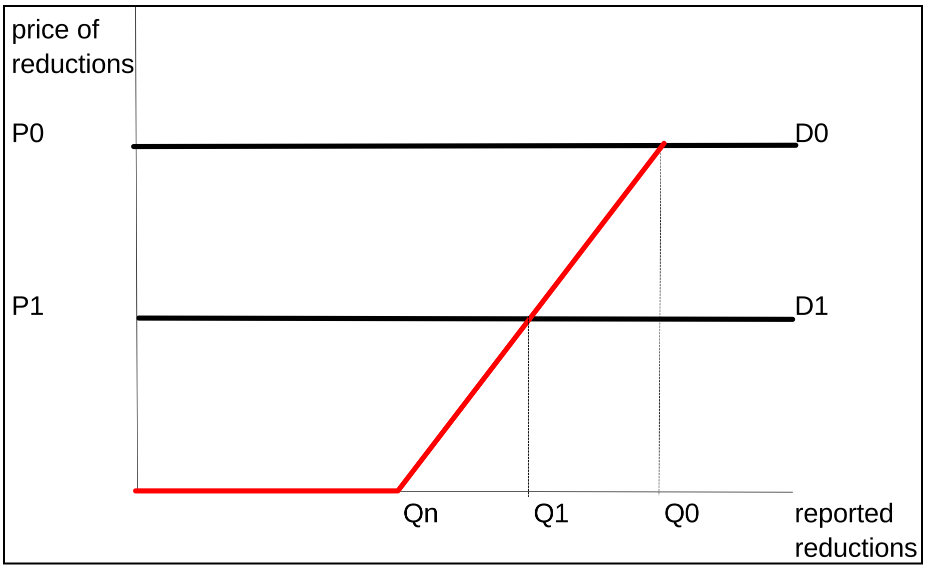

Figure 3

Relating partial crediting to rigor of baseline determination

Preparing detailed baseline analyses can be expensive, and involves some fixed costs. Small suppliers of ER's may find that the costs associated with preparing a rigorous baseline are high enough to undercut the viability of the project. But relaxation of baseline standards might invite overstatement of baselines by suppliers.

An obvious response is to offer full credit for reductions from projects presenting rigorous baseline calculations, and partial credits for reductions from projects with less-rigorous baselines meeting a minimum standard. The standards for full crediting, and the rate of crediting, will determine once again a tradeoff between type I and type II errors. Ultimately the determination has to be made partially through guesswork.

This strategy has been used in the EPA Conservation and Verification Protocols (EPA 1995; see discussions in Hagler-Bailly 1998 and Vine and Sathaye 1997). The Protocols are used for allocating SO2 allowances to utilities that encourage their customers to install conservation measures. They allow the utilities a choice among methods for establishing net energy savings. The *monitored* method requires the utilities to use comparison group methods to establish net energy savings in the first and third years after measure installation. These savings may then be applied throughout the measure's estimated lifetime, which ranges from five years for water faucet aerators to 25 years for wall insulation. An *inspection* method requires only that the utility verify that the measure remains in place. This permits 75% credit of stipulated savings rates, for 75% of the estimated lifetime. A *default* method requires no inspection and grants 50% credit for 50% of the estimated lifetime.

Revelation mechanisms[7]

Background

Regulatory economics has long faced a problem similar to baseline determination and related to the 'hidden parameters' problem of section 3. Regulators want to allow a regulated monopoly to achieve a set rate of return, but they are hampered by ignorance of the firm's technical efficiency in producing output. Under certain conditions, regulators can draw up a menu of different payment schemes corresponding to different reported efficiency levels, in such a way that the firm is induced to truthfully report its efficiency level. (Baron 1989) It is important to note that these mechanisms are not 'free'. Firms still receive information rents – payments that are larger than would be necessary in a world where their efficiency was perfectly observable.

Lewis (1997) describes how such a mechanism applied by regulators in California and other states to set payment schedules related to demand side management activities. Here the baseline was taken as given. The problem was how much the PUC should pay for net energy reductions, acting as a discriminating monopsonist on behalf of public ratepayers.

[7] This section is based on background material from Tracy Lewis, who proposed the menu-choice mechanism described here.

At issue was the extent and cost of potential reductions which could be achieved. Some utilities, for instance, argued that undertaking DSM programs, as mandated, would require large fixed costs and yield modest results.

The solution to the problem was the design of a menu of alternative payment options. One option offered a high fixed payment for undertaking the program, and a low marginal payment per unit of energy conserved. A second option offered the converse: a low fixed payment and a high marginal payment for energy conservation. The third option was intermediate. The options were designed so as to induce truthful revelation of type. That is, a company with cheap options for conservation should prefer to choose the high-marginal-payment option, and a company with few conservation prospects should prefer the high-fixed-payment option. Further, the schemes were designed with the intention that the utilities should not make extraordinary profits, and that cost-effective DSM measures should be supported. The spirit of the approach is similar to that used by insurance companies in offering customers different combinations of deductibles and premiums.

Designing the menu options is not a completely scientific, objective process. The idea is to roughly guess the range of situations faced by different utilities, and put parameters on them in a way which seemed likely to satisfy the truthful revelation principle. In practice, the menu was designed through a collaborative stakeholder process as described in section 0. Lewis (1997) describes it as follows:

> To create these options, regulators solicited data and information on all aspects of the conservation program, including the utilities' projected baseline, levels of energy production, the costs of managing and marketing DSM measures, the energy savings resulting from conservation investments, and the demand for DSM measures by utility consumers. The process for collecting and analyzing data was a collaborative one. Input from all stakeholders including the utilities, residential and industrial customers, and conservation and environmental interest parties, as well as regulatory staff, was solicited.

What is significant for present purposes is that it was possible for a diverse group of stakeholders to design a politically-acceptable menu choice scheme.

Application to GHG ER's: the principle

Here is an example of how a revelation mechanisms might be applied to baseline determination. Suppose that some class of projects – for instance, fuel-switching projects in a particular countries – includes two groups of participants. Group L has low baselines, group H has high baselines, and it is difficult for an outside observer to distinguish between them. There are two broad sets of explanation for the difference between L and H:

1. *Differences in capital cost and pollution valuation* As we have discussed, one reason for sites to differ in baselines is that they face different capital costs and pollution costs. Facilities with higher capital costs and lower valuation of pollution damages will

tend to have higher baselines. They will also tend to have higher marginal cost of emissions reductions, since a facility of this type reckons less gains from fuel savings and reduction of local pollutants such as SOx and particulates.

2. *X-inefficiency*. Alternatively, group H might, for internal organizational reasons, have a higher level of x-inefficiency and thus have a larger supply of relatively low-costs GHG abatement options. In this case, the marginal cost of reductions would be lower for group H.

Figure 4 shows the dilemma of uniform crediting strategies. The 'true' baselines are bH (high baseline group) and bL (low baseline group). Marginal costs of emission reduction, as a function of total emissions, are MCH and MCL for the two groups. The market price of ER's is P. At this price, if baselines were observed by the certifying agency, the facilities would reduce emissions to cH and cL respectively. Group L facilities receive revenues of P*(bL-cL) and incur total costs equivalent to the area under MCL between bL and cL [which we will designate TCL(cL)], and similarly for group H. Since baselines are not observed, however, a group L facility is tempted to claim that it really belongs to group H. This gains it additional revenues of P*(bH-bL), and results in the crediting of bH-bL invalid reductions.

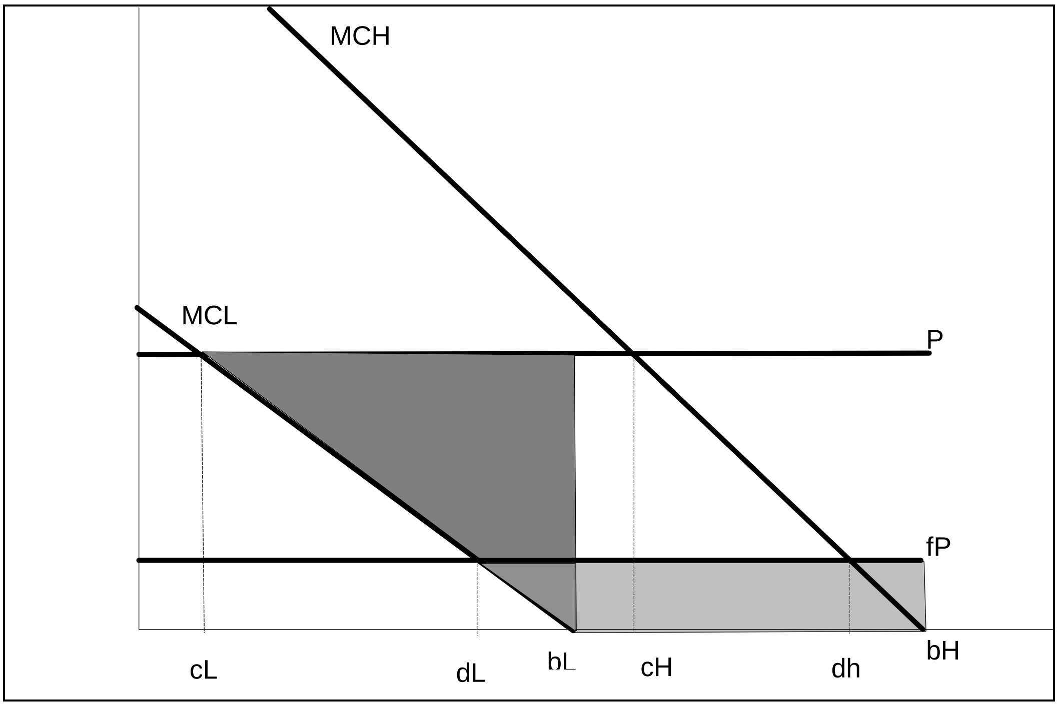

Figure 4

A partial crediting strategy is also unsatisfactory. Suppose that reported emissions reductions are credited at a fraction rate f<1, so that the effective price per reported emission reduction is fP. L's rents are reduced, and invalid reductions are reduced to f*(bH-dL). However, actual emissions are also reduced to (bL-dL) + (bH-dH), and H's rents are also reduced.

An alternative is to offer applicants for ER's a choice between two options:

- *option A:* receive full credit for emissions reductions below the stringent baseline bL
- *option B:* receive partial credit, at some rate f, for reductions below the generous baseline bH.

The revelation mechanism is successful in revealing truth if group L facilities choose option A and group H facilities choose option B. This in turn requires that:

- L's profits are higher under option A than under option B, so that:

$$P^*(bL-cL)-TCL(cL) > fP^*(bH-dL)-TCL(dL)$$

(the vertical striped area is greater than the horizontal striped area)

- H's profits are higher under option B;

(clear in the case illustrated because under this option H must spend TCH(bL) before earning any credits, and the face a marginal cost of reductions in excess of the price.

If an appropriate crediting fraction can be found, the revelation mechanism eliminates invalid ER's and reduces L's rents. Unlike the fixed-fraction partial crediting approach, it allows L to produce the efficient amount of ER's. However, relative to uniform full crediting, it screens out or reduces in scope some valid projects: once again, the type I vs type II error tradeoff. In this case, it denies H some credits.

Whether an appropriate menu can be found depends on the shape of marginal abatement curves and the degree to which they can be elucidated. An interesting real-world example of something akin to a menu mechanism was used in baseline definition for Costa Rica's Protected Areas Project (SGS 1997, Chomitz *et al.* 1998), the basis for an offering of CTO's (certified, tradable carbon offsets). The project defines what it regards as a defensible baseline, based on available information. It recognizes, however, that future information (such as improved studies of land cover change) may yield retrospective refinements in baseline definition. For that reason, it places about 20% of offsets from first-year activities in a 'permanent buffer'. In effect, the project only begins claiming offsets for sale after reductions exceed this buffered amount. This looks something like the outcome of a choice between partial crediting from a high baseline and full crediting from a low one, where the latter option has been chosen.

Application to GHG ER's: another example

A natural application of a partial crediting strategy of this sort occurs when there is agreement that additionality is uncertain. For instance, suppose that a firm has a number of possibilities for energy conservation, with payback periods ranging from six months to four years. The additionality of the six-month-payback measures is open to some question. Perhaps there are true barriers to adoption, perhaps the firm is inefficient and has set up its own, surmountable stumbling blocks. A Bayesian approach might suggest that partial credit be awarded to the six-month-payback measures, with increasing credit as the payback period lengthens.

Institutional aspects of menu-choice mechanisms

The process of determining the menu choices is involved, time-consuming and unavoidably political in nature; it cannot be reduced to an algorithm. For this reason, applications in regulatory economics typically involve direct negotiation between the regulatory principal and the entity being regulated. In the context of the UNFCCC, it might be difficult to delegate responsibility for these negotiations to a third-party certifying organization. The use of this mechanism might therefore be reserved for very large projects (or classes of homogenous projects), with negotiations undertaken directly with a designated supervisory body (such as that associated with the Clean Development Mechanism). For instance, it might be applied to the determination of baselines for national-level carbon sequestration projects, or national-level emissions related to electricity generation.

On the other hand, we should not entirely rule out the possibility that menu-choice schemes could be designed in a decentralized system. A collaborative process among stakeholders, described in more detail in section 0, might be empowered with designing menu-choice schemes.

The political acceptability of this kind of mechanism might be related to the explanation of the differences between high and low baseline scenarios. The menu-choice mechanism is more appealing when baseline differentials are thought of as being related to x-inefficiency, as in the example of differing payback periods for energy conservation schemes. Here the high baseline is somewhat questionable, justifying the application of partial credit. A firm claiming a low baseline, on the other hand, is one that has already undertaken extensive efficiency-increasing measures, and therefore deserve full credit for further reductions.

6. SYSTEMS BOUNDARY ISSUES

SYSTEMS BOUNDARIES: SPATIAL

Emission-reduction projects may have a variety of indirect effects, both positive and negative, on emissions elsewhere. Consider, for instance, a project which reduces the demand for coal by an industrial consumer. In a competitive market for coal, the result will be an infinitesimal decline in the overall market price, as the demand curve shifts slightly to the left. This infinitesimal decline, however, affects a very large number of other consumers, who compensate by increasing their consumption. Individually this response is negligible, but the collective response of many thousands of consumers will be a "snapback" increase in energy consumption and emissions which substantially dilutes the initial reduction.

A simple algebraic illustration: suppose that emissions are proportional to the consumption of an energy commodity, whose demand and supply curves are:

$\ln Q_D = \ln d_0 + d_1 \ln P$

$\ln Q_S = \ln s_0 + s_1 P$

$d_1 < 0,\ s_1 > 0$

A demand side management project reduces d_0 by an very small fraction. If there were no "snapback" effect, the proportional change in Q would be the same, that is the elasticity of Q with respect to d_0 would be 1. In fact, the elasticity is:

$\partial \ln Q / \partial \ln d_0 = s_1/(s_1 - d_1)$

where s_1 and d_1 are the price elasticities of supply and demand. Thus, quite intuitively, "snapback" disappears only where demand is completely price-inelastic, or where supply is perfectly elastic. As overall demand becomes more and more elastic, a larger proportion of the direct, observed emissions savings are vitiated by induced increases elsewhere in the economy.

In the case of exhaustible fossil fuel resources, changes in expected demand should lead to changes in the entire future time-path of depletion.[8] While it is difficult to predict how much of the rebound is contemporaneous, IEA (1995) describes the world coal market as being responsive in output and price to short-term demand pressures. It cites Australian econometric studies showing a short-run price elasticity of supply of about 0.4 and a long run elasticity of 1.9.

Market spillovers such as this abound in JI/ER projects. Consider the following examples:

1. *New private powerplants.* As electricity markets become deregulated, it becomes more difficult to predict the impact on emissions of a new, marginal plant. A new geothermal powerplant, for instance, may end up expanding the supply of electricity relative to the reference case, rather than displacing existing production, kilowatt-hour for kilowatt-hour. Net impacts then depend on how the plant's installation affects

[8] I am grateful to Sam Fankhauser and Luis Constantino for making this point. See also Fearnside (1997).

either the market price of electricity, or, if prices are fixed, how people are rationed into the system. These impacts also depend on the daily and annual timing of the new output.

2. *Forestry projects* A project which protects a plot of forest from conversion to agriculture may simply raise the demand for forest conversion elsewhere, by slightly raising the price of cattle, maize, or timber, and slightly reducing the reservation price of labor for forest clearance. In the limit, if demand for timber or for agricultural conversion is inelastic, protecting a plot of forest simply diverts conversion elsewhere, possibly even outside the national boundaries of the host country. (Brown *et al* 1997). On the other hand, establishment of new plantations may absorb labor and reduce the price of wood products, reducing pressures for deforestation.

3. *Coal efficiency projects.* Martin (1998), discussing within-facility reactions to changes in effective energy prices, emphasizes that increases in coal efficiency have the perverse effect of inducing switches from gas to coal, vitiating the direct emissions reductions. Michaelowa (1997) makes the same point. At the market scale, this may be a particular problem for projects which support coal-washing, which reduces coal transport costs and increases combustion efficiency. If successful, these may induce consumers to switch into coal from less emissions-intensive fuels.

4. *Industrial efficiency*. Any improvement in industrial efficiency may result in a decrease in price and increase in production for the good in question, along with a concomitant increase in emissions.

5. *Demonstration effects.* On the other hand, positive spillovers are also possible. A demand-side management project may have a demonstration effect, spurring the adoption of emissions-reducing technologies at other sites.

In all these cases, site-specific assessments of carbon emissions are inadequate to capture the scope of project impacts. It is necessary to take a wider, sectoral view of both baseline and project-related emissions. This can be done with varying degrees of sophistication.

The simplest approach is to use crude estimates of sector-wide supply and demand elasticities to estimate leakage effects. Martin (1998) provides simple examples of how this might be done. This approach ignores general equilibrium effects, which will be difficult to model in a practical fashion. In other cases, such as the electricity sector, relevant sector-wide models may be available "off the shelf".

Brown *et al.* (1997) stress that proper project design can reduce or eliminate these market-based leakages. For instance, a pasture abandonment project might arrange for the intensification of beef production in existing pastures so as to neutralize any market-mediated rise in the demand for pasture conversion. Since pastures to be abandoned will have very low stocking rates, this need not be expensive or difficult.

More generally, proper accounting for leakages will shift project selection efforts towards projects without these problems. For instance, a reduced-impact logging projects that maintains log output (relative to the baseline), but reduces collateral damage to non-harvested trees will not have any market-based leakages.

PERMANENCE AND CARBON SEQUESTRATION

ER projects have value because they affect the time-path of atmospheric GHG concentrations. Emissions abatement projects have different durations of impact than do sequestration or forestry projects. The difference needs to be explicitly accounted for when assessing baselines and calculating offsets.

It is easiest to illustrate the importance of *duration* in ER baselines through a parable. A buyer of carbon offsets is willing to pay $20/ton, the going price. His first purchase is from the owner of an abandoned coal mine. There is a ton of carbon on fire in the mine; if nothing is done, it will all burn instantly. For $20, the mine owner offers to put the fire out and ensure that it will never restart. This keeps the ton of carbon out of the atmosphere forever, and there are no market-mediated spillover effects. The buyer thinks that this certainly constitutes a one-ton offset, and buys it for $20. The buyer now walks down a road populated by farmers. Each farmer owns a tree containing one ton of carbon, and wants to slash and burn it in order to plant some crops. The first farmer is just about to chop down her tree and burn it when the buyer arrives. For $20, she offers to postpone cutting the tree for twenty years. She makes no promise about what will happen thereafter; since the tree is already worth cutting, and crop prices are rising, we presume that it will be cut as soon as the 20-year contract expires. The buyer agrees to the terms, and purchases a 20-year offset for $20. The second farmer will postpone cutting for only 10 years, but still demands $20. The buyer assents. The third farmer agrees only to postpone cutting for a single day, but the buyer, with some misgivings, agrees to this, too, and pays $20 for the third offset. A ton is a ton, isn't it?

This example is by no means artificial. Imagine a project that sells offsets that arise from secondary regrowth on abandoned pasture. Each ton of biomass accumulation is offered as a homogenous commodity, irrespective of when that ton is removed from the atmosphere and embodied as biomass. Suppose the commitment to the offset buyer is for a fixed period of twenty years. Thus the first ton of growth is guaranteed to be out of the atmosphere for nearly twenty years. The last ton is guaranteed to be sequestered for only days. The argument is the same for a fixed-duration deforestation prevention project. If the baseline is a constantly decreasing biomass over time, the last averted ton has a very short guarantee attached to it.

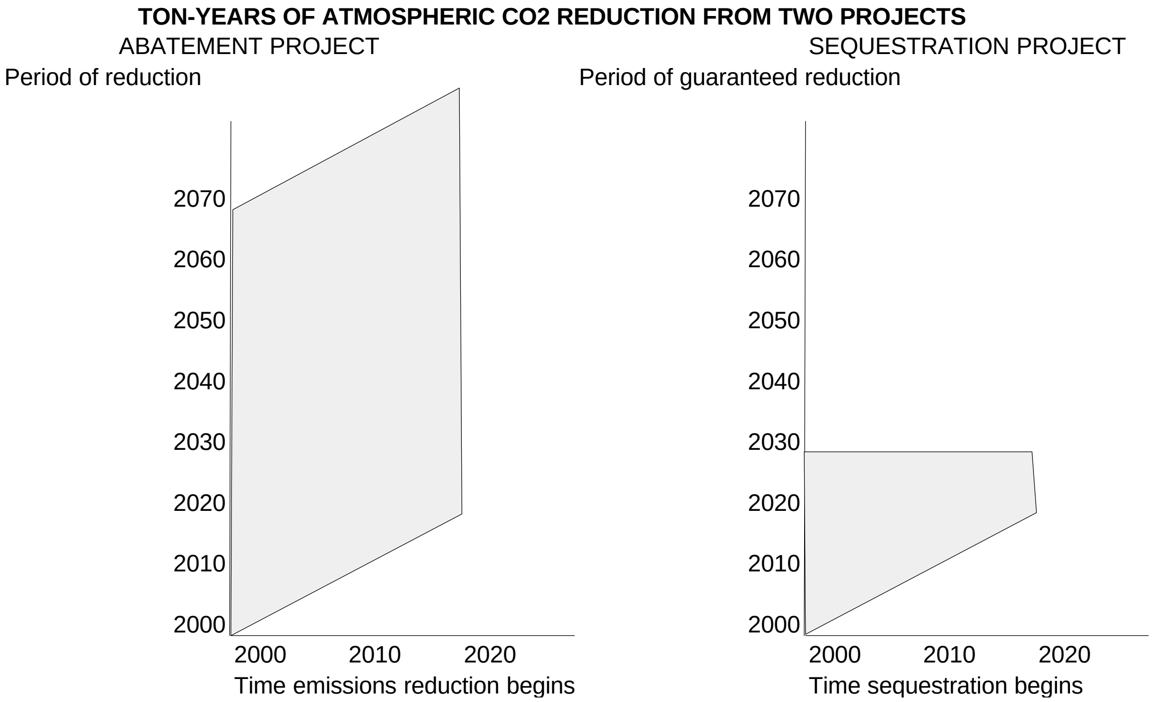

Figure 5

The issue is shown graphically in Figure 5. ER projects reduce atmospheric GHG relative to a baseline. This reduction in atmospheric carbon has both a start date and a notional end date. The horizontal axis plots the time at which an emissions reduction starts. For each ton reduced, the vertical axis shows the period during which this reduction affects atmospheric concentration of GHGs. In the case of an abatement project (left panel), the reference scenario envisions a flow of carbon being combusted at a constant rate from 2000 to 2020. Each ton of carbon is resident in the atmosphere for 70 years[9]. The first ton would have been combusted in 2000 and resided in the atmosphere until 2070. The last ton would have been combusted in 2020 and resided until 2090. The ER project completely abates these emissions. The shaded area shows both the quantity of resulting carbon offsets and their duration.

The right panel shows a project which sequesters carbon through forest regeneration. In 2000, biomass begins accumulating as secondary growth. The project contract concludes in 2030, after which landowners are free to burn the accumulated growth. To be entirely parallel to the abatement project, the sequestration project would have to provide a longer guarantee.

It would be possible to make sequestration and abatement projects commensurable by computing the number of discounted ton-years of atmospheric GHG reduction due to the project. This has been suggested by Fearnside (1997). A justification for this can be derived from Rosebrock's (1994) account of an optimal control model by Richards (1993).

[9] This assumption is for expository purposes only. The half life of CO2 is probably closer to 100 years, so that a substantial amount of CO2 is resident for centuries.

The optimal control model maximizes social welfare allowing for changes in atmospheric GHG concentrations and their effects on the economy. If economic damages are linear in gas concentrations, then the present value of a marginal reduction in gas concentration in year t is given by:

$$\lambda = \exp(-rt)*\gamma/(r+\delta)$$

where γ is a gas-specific constant, r is the social discount rate, and δ is the dispersion rate of the gas. By integrating this shadow value over time, we obtain the relative value of fixed-duration sequestration services relative to abatement or perpetual-duration services. (See table below)

	Years			
r	*1*	*10*	*20*	*40*
0.03	0.030	0.259	0.451	0.699
0.06	0.058	0.451	0.699	0.909
0.10	0.095	0.632	0.865	0.982

At a discount rate of 6%, a single ton-year of sequestration services is worth about 5.8% of the value of a perpetually sequestered ton; a twenty-year guarantee is worth 70%. Reckoning sequestration services in ton-years, rather than tons, solves an important problem hindering the development of markets for sequestration offsets: the credibility of long-term contracts. These pose an even more severe problem for sequestration projects than for abatement projects. For abatement projects, this year's and previous years' reductions are for all practical purposes perpetual. While there is some risk that next year's abatements may not be accomplished, the past year's achievements are secure and can be credited. For sequestration projects measured in undifferentiated tons, there is always the risk of reversal of achievements. If crediting depends on maintenance of a forest for a specified long period – say twenty years – there is always a risk that natural disaster or political upheavals towards the end of the period could undo the previous decades' accomplishments.

In a pay-as-you-go sequestration service scheme, a certifying authority would periodically check sequestered biomass against the baseline, and certify the accomplished number of ton-years of credit; ton-years could be aggregated into 'perpetual' tons at an established, fixed conversion rate. This device greatly reduces the risk to ER investors, and particularly facilitates agreements which involve ongoing payments for forest maintenance. It would allow the participation of countries or landowners with perceived high risks of nonperformance. These suppliers may have low costs of supply, but might be shut out of the market if only long-term sequestration contracts were valid.

Another advantage of ton-year crediting is alleviating concerns about loss of sovereignty. Some nations object to permanent or very long-term sequestration commitments, viewing them as equivalent to loss of sovereignty over their territory. But forestry investments for limited-term production of ton-years of emissions reductions are no more a loss of sovereignty than are investments in palm-oil plantations. Ton-year crediting allows host countries to determine a period of commitment with which they feel comfortable, and allows them to reclaim the stream of emissions reductions thereafter. This might smooth the long-term transition to an era when the host countries assume emissions limitations.

Ton-year crediting has already been applied, implicitly, to the analysis of reduced-impact logging projects. Sustained logging activities generate sawtooth-shaped graphs of carbon storage over time. (See figure) Carbon storage dips sharply when the stand is harvested, recovers with regrowth, and then dips at the next harvest. Reduced impact logging projects generate offsets by reducing the amount of collateral damage that loggers do as they extract marketable timber. For instance, reduced impact logging techniques minimize the area cleared for skid paths, roads, and landing pads, and use vine-cutting and directional felling techniques to reduce the number of trees unintentionally damaged in felling. This shifts the jagged time-profile of carbon upward. Boscolo *et al.* (1997) evaluate the GHG impact by computing the *discounted* carbon accumulation, which is equivalent to the discounted integral over time of the shaded area in the figure.

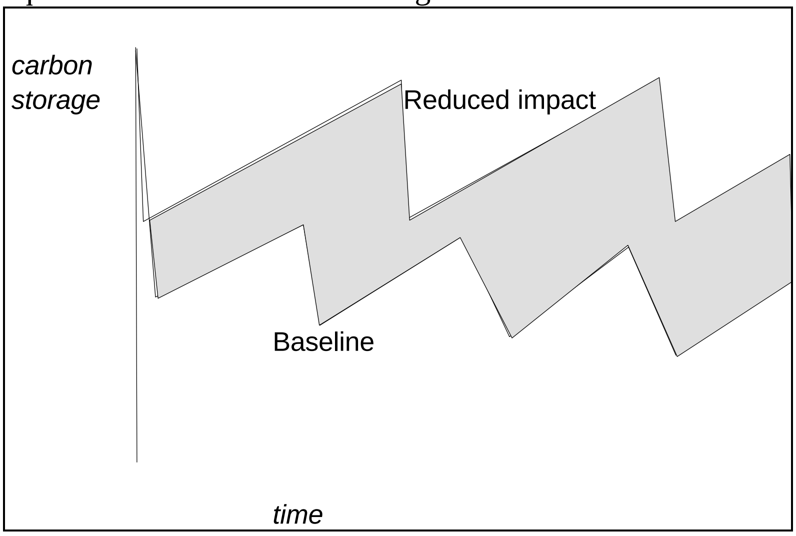

Figure 6 (adapted from Boscolo et al 1997)

7. DEMAND-SIDE-MANAGEMENT INCENTIVE SYSTEMS: LESSONS FOR GHG BASELINE METHODOLOGIES[10]

Demand-side management (DSM) incentive systems in US utilities constitute an existing, large-scale analog to the prospective GHG emissions reductions credit system. These programs reward utilities for saving energy (and as a byproduct, reducing GHG emissions) against a hypothetical baseline. A typical incentive payment is roughly equivalent to \$20/ton of carbon[11]. What is interesting for our purposes is that these large-scale programs have had to grapple with all of the methodological problems involving baselines discussed above and have come up with practical, politically acceptable solutions.

This section describes DSM incentive systems, explains how they are analogous to GHG ER systems, and describes their methodological approach to establishing baselines.

DSM INCENTIVE SYSTEMS AS AN ANALOG TO GHG EMISSIONS REDUCTION CREDIT SYSTEMS

For about the past fifteen years, state regulators have charged utilities with providing energy services to customers at the lowest cost. There are two ways of doing this: through increased generation, and through DSM activities which increase efficiency of energy use. Typically, DSM programs involved providing incentives for customers to adopt higher-efficiency technologies for lighting, air conditioning, electric motors, and so forth. Thus the regulators had to find ways of rewarding the utilities both for producing and conserving electricity (Hagler-Bailly 1998). In order to reconcile these opposing objectives, it became necessary to specify a baseline against which energy savings are reckoned. Incentive payments to the utilities are then tied to these savings – sometimes in a simple linear fashion, sometimes through a complex formula.

The resulting analogy with GHG offsets is very close: the commodity, energy savings, is a kind of offset; the baseline is the energy consumption level against which savings are calculated and incentives credited; the state Public Utilities Commission is the analog of the UNFCCC, setting the rules of the market, including the definition and certification of baselines; the utility is the equivalent of the carbon credit buyer, and the customer is the seller. In fact, most DSM programs result in CO2 emissions reductions and therefore could potentially qualify as producers of GHG offsets.

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[10] This section draws heavily from a background paper prepared by Hagler-Bailly Consulting, Inc.: "Evaluating Greenhouse Gas Mitigation through DSM Projects: Lessons Learned from DSM Evaluation in the United States". Verbatim quotes are double-indented.

[11] Eto (1995) reports mean shareholder incentives, weighted by program size, of 4 cents/kWh in a sample of 40 large commercial DSM programs; we apply a rough estimate of an emissions rate of 200 tons C/gWh.

In setting up these programs, the state Public Utilities Commissions have had to grapple with virtually all of the baseline issues discussed earlier. A key issue in energy conservation incentives is the extent of free-riders; i.e., whether the recipient of a conservation incentive would have undertaken the required conservation actions even in the absence of an incentive. Policy and implementation debates have also focused on "snapback" or "takeback" – the degree to which increased efficiency induces increased usage of energy, and spillovers, or the extent to which DSM activities have a demonstration effect and result in more rapid technological diffusion. Table 2 summarizes some of the parallels between DSM and GHG program issues and terminology.

Table 2 Related GHG Emissions Reductions and DSM Terminology

GHG Emissions Reduction Terminology	Related DSM Terminology
GHG emissions reduction credits or offsets	***Net program impacts.*** Energy use reductions that are attributable to the program, i.e., they would not have occurred had the DSM program not been offered.
UNFCCC Conference of Parties or subsidiary body such as the Clean Development Mechanism: regulator of credit creation and trade	***State Public Utility Commissions*** which set the incentive terms for utilities
host countries: producers of offsets	***utility customers:*** ultimate producers of energy reductions via use of energy-saving technologies
investors, Annex I countries**:** finance activities in host countries which lead to production and acquisition of offsets	**utilities** provide incentives for customers to reduce demand, and receive credit
Additionality. Projects must provide for a reduction in emissions that is additional to any that would otherwise occur. (FCCC/CP/1997/L.7/Add.1)	***Free riders.*** Net impacts are often calculated by subtracting out free riders, i.e., those customers who would have installed the energy efficiency measure on their own without the DSM program.
Positive leakages. Degree to which project activities result in decreased emissions outside the project site or boundaries	***Spillover; Market Transformation; free drivers.*** Program spillover occurs when the program influences the program participants, and customers who do not participate in the program to invest in energy efficient technologies. Market transformation refers to spillover that permanently affects demand and supply of efficient technologies.
Negative leakages. Degree to which project activities result in compensating increases in emissions outside project site or boundaries	***Takeback.*** Takeback (also called snapback or rebound) is an economic response increased energy efficiency or lower effective energy prices.. For example, a homeowner may leave lights on longer after installing efficient light bulbs.
Static vs. dynamic baselines In the absence of the project, should emissions be assumed to have remained constant over time?	***Persistence*** of benefits: the extent to which net impacts should be adjusted over time due to changes in baseline or reference technology, as well as for actual performance of installed efficiency measures. ***Statistical adjustment*** of gross (before vs. after) energy consumption for nonprogram factors such as weather.

Source: modified from Hagler-Bailly 1998

SCALE OF DSM PROGRAMS

DSM programs are large and enjoy widespread support. Hagler-Bailly (1998) reports:

> From 1989 to 1996 about $16 billion was spent on these programs by regulated utilities. (EIA, 1996, 1997). In 1996, 1,003 utilities in the United States reported having a DSM program; these utilities represent almost one-third of all U.S. electric utilities, and include 97% of large utilities with generation levels of 120,000 MWh or higher (EIA, 1997).
>
> According to the EIA (1997), energy savings for the 573 large utilities totaled almost 62 billion kWh for 1996, which represents 2% of annual electric sales, at a mean cost of less than 3.0 cents per kWh saved. Commercial programs accounted for 47% of these energy savings (29 billion kWh), residential programs for 33% (21 billion kWh), and industrial programs for 17% (10 billion kWh).

HOW DSM PROGRAMS EVALUATE BASELINES AND ADDITIONALITY

Baselines are an implicit rather than explicit part of DSM program evaluation. Typically, net program impact is computed in two steps. *Gross impacts* are the difference between observed energy consumption by program participants (technology adopters), and imputed consumption, had the participants not adopted the technology in question:

$$\text{gross impact for adopters} = \text{predicted consumption assuming nonadoption} - \text{observed consumption with adoption}$$

Net impacts are gross impacts, adjusted for free ridership:

$$\text{net impact for adopters} = \text{gross impact} * [1 - \text{probability of spontaneous adoption}]$$

In principle, net impacts should also credit program-induced adoption by *nonparticipants* (spillover effects), though this is rarely done in practice.

Baseline determination enters the evaluation in both steps: in the adjustment of predicted consumption for extraneous factors, and the prediction of spontaneous adoption.

Gross impact evaluation

Methodologies for gross impact evaluation differ greatly in sophistication (Hagler Bailly 1988):

- *engineering methods* typically apply standard energy consumption factors to with and without-project technologies. They may for instance, use default or spot-metered energy consumption rates for old versus new appliances, multiplying by reported or assumed hours of operation. In some cases, however, sophisticated process models are constructed – for instance, to allow for the cross-effects of lighting choices on energy used for heating.

- *statistical methods* include a wide range of analyses of billing or other actual consumption data. They derive the baseline from observed utilization rates – either from pre-program data for participants, or from data on a comparison group. More sophisticated approaches statistically adjust the observed data for compositional differences in program and comparison groups, or for extraneous factors such as weather. At the limit, the distinction between gross and net impact evaluation disappears as econometric approaches are be used to model the program participation decision.

- *integrated methods* combine parameters derived from both statistical and engineering methods.

Table 3 shows the range of methodologies applied to different project types. Hagler-Bailly (1998) reports on choice of methodology:

> Method selection has depended on a number of factors including precision requirements, evaluation budget, and evaluator preferences or skills. CADMAC (1994a) provides detailed comparisons across impact evaluation methods of data demands, errors, cost, and robustness.
>
> Engineering methods alone can be inexpensive and simple to implement, and are appropriate for small programs or programs such as industrial motors or new construction that lack comparison groups or pre-program data. They also allow analysis of interactions between measures (e.g., efficient lighting can reduce demand for air conditioning in commercial buildings), and analysis of load profiles and time differentiated impacts (e.g., peak versus off-peak impacts[12]) (RCG/Hagler Bailly, 1991).
>
> However, engineering methods as a stand-alone approach are now rarely used. Most engineering approaches take advantage of the power of sampling and statistics to generate a new set of engineering-based methods such as CEM or SAE methods. A more complete discussion of these methods is found in CADMAC (1994a).
>
> ...As an example of the variety of methods used in practice to estimate energy savings, a study of 40 of the largest commercial lighting programs (Eto et al., 1995) found a wide variety of evaluation methods, including instances of

[12]. This characteristic is important for estimating GHG reductions because generation fuel and emissions rates often differ between peak and nonpeak power sources.

> programs using multiple evaluation methods.... Thirty five utilities... verified measure installation through on-site inspections, and 20 verified hours of operation through on-site inspections. Nineteen utilities, or almost 50%, also conducted billing analyses: one used a simple pre- and post-program comparison for participants; three used simple billing comparisons including nonparticipants; three used regression methods; and 12 used SAE regression methods.

In general, significant progress has been made in gross impact evaluation, with increasingly well-defined protocols for measurement and analysis of energy consumption data. Much of this work would be directly applicable to JI/ER projects.

Net impacts

The methodology for assessing net impacts is less well developed than that for gross impacts. DSM evaluations use all three methods described in section 3: direct questioning of participants, control groups, and behavioral models. Marbek Resource Consultants and RCG/Hagler Bailly (MRC and RCG 1994) provides a concise summary of baseline and free-ridership methodologies as applied to standard types of programs (see Table 4).

In general, the *direct survey* approach has been the most widely used. It is usually directed towards measurement of free ridership, though occasionally used to assess spillover effects. *Comparison groups* are often used to adjust for weather and other factors affecting energy consumption. Sometimes informal, rather than statistical comparisons are made of building practices or appliances. (Hagler Bailly 1998). More rarely, *behavioral models* are constructed along the lines sketched in section 4. These can be important, for instance, in industrial motor replacement programs where the reference scenario can be continued use of the old motor, rewinding, or replacement.

Of these techniques, the comparison group approach seems the most transferable to GHG ER programs. Direct survey approaches may not be reliable. Baseline scenario definition for new construction is extremely problematic, since buildings are idiosyncratic systems of energy-using components. It is possible to use engineering methods to simulate the energy consumption of a candidate reference scenario (see DOE 1997) but justifying that scenario is difficult.

Table 3. Summary of Impact Evaluation Techniques

Technique		Appropriate Program Types	Relative Cost Requirements**	Relative Precision	Comments
Engineering	Algorithms	Lighting (residential and commercial), water heating, refrigeration, motors, some processes	Low	Low/medium	Precision can be increased through surveys to establish nonprogram impacts and calibration.
	Building simulation models	HVAC,* daylighting	Low/medium	Low/medium	Precision can be increased through surveys to establish nonprogram impacts and calibration.
	Detailed process/application-specific models	Thermal cool storage, industrial processes	Medium	Medium/high	Models often rely on end-use metering, which can be expensive and is used when savings are expected to be large.
Statistical	Simple comparison	Residential HVAC, water heating, small commercial HVAC, lighting	Low	Low	Comparison groups must be closely matched, and weather variation is not addressed.
	Augmented comparison	Residential HVAC, small commercial HVAC, some industrial processes	Low/medium	Medium	Comparison groups must be closely matched; time-series comparison may be useful for industrial processes.
	Multivariate regression	Residential HVAC, water heating, commercial HVAC, lighting	Medium/high	Medium/high	Typically requires data on both participants and nonparticipants along with a survey of each to develop explanatory variables for the model.
	Multivariate regression with participation model	Residential HVAC, water heating, commercial HVAC, lighting	Medium/high	Medium/high	Requirements are similar to multivariate regression except sample size must be larger to accommodate discrete choice participation model.
Integrated Engineering and Statistical	Statistical audit procedures	Residential HVAC, water heating, commercial HVAC, lighting	Medium	Medium	Generally uses small samples of end-use metered sites to verify the engineering estimates.
	Statistically adjusted engineering models	Residential HVAC, water heating, commercial HVAC, lighting	High	High	Precision will increase and costs will decrease if engineering estimates are completed before participation.

* HVAC is heating, ventilation, and air conditioning.
** Although costs depend on several factors such as program size, the approximate categories indicated are low (<$100,000), medium ($100,000 to $500,000), and high (>$500,000).

Source: Hagler Bailly (1998) based on Marbek Resource Consultants and RCG/Hagler, Bailly (1994).

Table 4. Summary of Baseline Issues for Selected Energy Efficiency Measures

Measure	Baseline Approach	Free Rider	Spillover	Takeback	Persistence
Residential New Construction	Statistical analysis (comparison area), builder survey inputs for engineering model	Builder survey, sales data, or survey in comparison area	Time series comparison of building practices, builder survey, survey in comparison area	Statistical bill comparisons or home-buyer survey	Persistence not a significant issue compared to other DSM measures
Comments: Engineering analysis for small/informational programs; multivariate regression or SAE recommended for most incentive programs; SAE with end-use metering recommended for large programs.					
Residential Envelope	Statistical analysis (pre/post or comparison groups), engineering analysis with on-site surveys	Survey (participants or both participants and nonparticipants)	Similar to residential new construction	Survey questions could address takeback issues	Not important for relatively permanent measures (insulation and window improvements), important for caulking and weatherstripping
Comments: Building simulations would be appropriate for small or informational programs, and statistical or integration methods are more appropriate for direct installation and incentive programs. Load programs, which require participants to complete much paperwork, are more susceptible than low-income weatherization programs.					
Residential Hot Water	Engineering estimates	Survey (participants or both participants and nonparticipants)	Survey (participants or both participants and nonparticipants)	Survey (studies do not show large takeback incidence)	Water heater wrap and low-flow showerheads are less persistent (particularly with customer installation) than efficient heaters and pipe insulation
Comment: Engineering analyses with surveys are recommended for small or informational programs. Statistical methods may not be able to effectively measure showerhead and aerator impacts, but can identify impacts of hot water packages.					
Residential Refrigerators	Time series billing and metering data can be used for buy-back programs, but not new dwelling installations; engineering analyses can use standard efficiency levels as baselines	Pre-program sales (e.g., dealer survey) or participant surveys for incentive programs, participant surveys for buy-back programs that purchase second refrigerators	Survey (dealers, participants, or both participants and nonparticipants)	Participant surveys can ask about whether incentive led to different purchase, or if new refrigerator was purchased earlier than planned and old refrigerator kept as secondary refrigerator	Persistence is likely for efficient units, but uncertain for buy-back programs
Comments: Statistical analysis for incentive program will lack pre-participation data on alternative refrigerator purchase, but engineering methods can use labeled usage data for comparable, nonqualifying models. Buy-back programs are amenable to statistical methods because savings are potentially large and pre-program data exist. Source: Hagler-Bailly 1998					

Table 4 (cont.)
Summary of Baseline Issues for Selected Energy Efficiency Measures

Measure	Baseline Approach	Free Rider	Spillover	Takeback	Persistence
Commercial New Construction	Engineering methods combined with surveys of nonparticipants/trade allies (efficiency levels), and participants (hours of use); comparison group selection is difficult because of structural heterogeneity	Participant surveys	Surveys of nonparticipating builders and designers	Not likely to be a significant factor	Relatively persistent unless turnover rates/remodel rates are high
Comments: Larger programs may be able to eventually use statistical or integration methods (e.g., SAE) to estimate baselines because the range of building types will be greater. Engineering methods are more common, e.g., building simulations (HVAC and daylight measures) or algorithms (e.g., lighting), and estimates can be improved by on-site monitoring or metering and statistical sample selection..					
Commercial Lighting	Engineering methods with survey or site-based data on baseline technologies and usage levels; statistical or combination methods may be justified by large expected savings	Can be large for lighting programs, use participant surveys; comparison groups can be difficult to identify	Survey (participant, or participant and nonparticipant) and equipment dealer surveys	Not likely to be a significant factor	Malfunctioning systems, tenant turnover, and remodeling affect persistence
Comments: Engineering methods are commonly used for lighting programs, with SAE methods used for larger programs.					
Industrial Motors	Engineering methods or time series comparisons are commonly used	Can be large, especially among large participants, use participant and dealer surveys	Can be large, survey nonparticipants or estimate market saturation levels	Not likely to be a significant factor	Generally persistent over motor lifetime
Comments: If greater precision is required, time-series comparison approaches of end-use metered data are most appropriate. Identifying baseline activity (new motor, rewind existing motor, continued use of existing motor) is important.					
Sources: Hagler Bailly (1998) based on Marbek Resource Consultants and RCG/Hagler, Bailly (1994).					

Incidence of "free ridership"

Hagler Bailly (1998) summarizes metaanalyses of free ridership as follows:

> Saxonis (1995) reviewed the treatment of free ridership behavior in about 100 program evaluations. ...the diversity of approaches to estimating free ridership behavior (e.g., self-reported, or based on billing analysis or life-cycle analysis methods) continues to generate a wide range of free ridership incidence, e.g., 0% to 42% in a sample of 25 program evaluations of residential compact fluorescent bulb (CFB) programs, and 0-73% for a sample of 20 commercial lighting programs. However, when outliers were excluded from the sample, free ridership levels were less than 20% (and a majority less than 10%) for residential CFB programs, and less than 25% for commercial and industrial lighting programs.
>
> Comparable results are found in Eto et al. (1995), which analyzed a cross section of 40 commercial-sector DSM programs. Reported incidences of free ridership among the programs ranged from 0% to 50%, with a simple average of 12.2% and a standard deviation of 11.4%.
>
> Both utilities and the regulators have been interested in increasing net program benefits by reducing free ridership. One approach has been to analyze the correlates of free ridership, and then more aggressively market those customer segments least likely to adopt DSM in the absence of the program. A second approach has been to shift away from financial rebates towards information diffusion programs. While free ridership has never been eliminated (except perhaps for low income programs), it is possible to keep free ridership in programs such as lighting and motors to less than 30%.

Variations in free ridership measures are driven by variations both in programs and in the reliability of measurement methods. Practitioners in the evaluation industry believe that any underestimates of free-ridership are counterbalanced by the lack of credit for positive spillover effects.

Persistence and dynamic issues

DSM incentive programs routinely employ baselines that are adjusted after the start of the project. As the preceding discussion makes clear, baselines are often determined from control group data collected during the course of the DSM program. These data allow implicit or explicit adjustment for weather or other unpredictable factors affecting energy consumption. In addition, estimates of free ridership are often based on surveys conducted well after program initiation. This is an interesting counterpoint to the standard JI or GHG practice of pre-establishing a baseline.

DSM practitioners have been concerned with assessing the "persistence" of DSM actions: for how long after installation should a technology be credited with providing energy savings? This is primarily viewed as a monitoring, rather than a baseline issue. Energy savings from a high-efficiency light or motor may accrue over many years, but cease if the device is removed, unutilized, or broken. To ensure accurate reckoning of savings over time, it is necessary to check that the installed device (such as a high-efficiency light or motor) is still in place and functioning correctly.

In practice, DSM programs often employ periodic inspections to ensure that past installations are still functioning. Hagler Bailly (1998) report:

> The California protocols specify periodic persistence evaluations and full load impact evaluations, and the schedules differ across program types because expected measure lifetimes differ (CPUC, 1993). Retention studies, which determine whether efficient measures are in place, are usually required biennially after the installation year, and load impact studies are required three or four years after the installation year. These inspections need not continue indefinitely, however. (*see the discussion of the EPA Verification Protocols in section 6).*

a) In principle, the baseline can also change over time, as technologies, regulations, prices, or capacity utilization change. In practice, baselines are sometimes retrospectively adjusted to reflect changes over time in equipment utilization rates. This information is generated on an ongoing basis as utilities determine baselines for new participants. However, it is rare to retrospectively revise a baseline assumption about technology choice for prior-year participants (e.g. to have a dynamic baseline for the retirement date of existing equipment).

Evaluation costs

NARUC (1994) surveyed twelve states and found that utilities spent from 3% to 10% of their DSM program costs on evaluation, with a mean of 6%. The reviewers suggested that 4% to 8% was a reasonable guideline. EIA (1995) surveyed the 50 utilities reporting the largest amount of energy savings. Among 20 respondents, the mean proportion of DSM program costs devoted to evaluation was about 3%, with the maximum under 7%. Eto *et al.* (1995) also find mean evaluation costs of about 3% in a sample of 37 reporting large utilities in 1992.

There are almost certainly significant economies of scale in program evaluation. This is particularly true for statistically based estimates, since the sample size necessary for a given level of accuracy is more or less independent of the size of the population from which it is drawn.

Guidelines and protocols

To what extent can baseline procedures be standardized? Interestingly, there is no industry-wide standard for baseline determination. Although most states have some form of DSM incentive program, official protocols for energy savings evaluation have been established only by California and New Jersey. (Hagler Bailly 1998). Protocols for energy monitoring and verification have also been published by the EPA (1995) and by the US Department of Energy (the International Performance Measurement and Verification Protocol, USDOE 1997). State-of-practice reviews include EPRI (1995), EPRI (1996) and CADMAC (1996).

These guides and protocols contain, in many cases, quite detailed specifications for the metering and sampling of realized energy consumption. They may for instance specify minimum sample sizes, frequency of inspections, and metering methods. They are much less prescriptive with regard to the determination of net, rather than gross impacts – i.e., the determination of additionality. The California Protocols (CPUC 1992) merely suggest that net impacts can be assessed by comparing before-and-after consumption by participants with before-and-after consumption by a comparison group. The IPMVP simply takes pre-installation consumption as the baseline for retrofit/replacement programs (DOE 1997).

DO DSM PROGRAMS YIELD GENUINE SAVINGS?

As we have seen, DSM incentive programs face the same problems of offset definition, monitoring, and verification as GHG ER programs. The DSM programs have faced this challenge with increasingly sophisticated evaluation programs. Particular progress has been made in the area of monitoring actual energy usage and adjusting it for exogenous determinants such as weather. However, adjustments for free ridership (additionality) have been criticized by some as naive, crude, or methodologically flawed (Joskow and Marron 1992; Train 1994). On the other hand, spillover benefits are rarely measured. On net, are these programs actually generating additional energy savings?

Parfomak and Lave (1996) use a clever approach to test the aggregate accuracy of reported savings from energy conservation programs. Using panel data on 39 utilities for the period 1970-1993, they regress the annual change in electric sales on changes in electricity price, fuel prices, manufacturing employment, non-manufacturing employment, heating degree days, cooling degree days, and the reported net addition to conservation. They argue that a coefficient of -1 on the conservation report would show it to be accurate; a coefficient of 0 would show it to be spurious. Their estimated coefficient is -0.994, with a standard error of .281, strongly supporting the hypothesis that reported energy savings are meaningful. There is however a slight qualification: this result is obtained with the inclusion of a separate variable representing reported conservation by Southern California Edison, the largest utility in the sample and the reporter of the largest level of conservation. The SCE coefficient was estimated at -0.261, with a large standard error of 0.452 – not significantly different from either 0 or -1. They note that savings from SCE's purely informational programs (as opposed to those offering customer incentives) are widely regarded as overreported. However, this class of savings does not earn the utility itself an incentive award from the Public Utilities Commission and so is not regarded with concern.

While more meta-evaluation data of this kind would be useful, it appears that DSM incentive schemes, for all their potential shortcomings, have been successful. They have been widely adopted, indicating broad political support. The next section examines the institutions that support the integrity and credibility of these systems.

WHAT KEEPS BASELINES HONEST?

As the preceding discussion makes clear, program evaluation is not a pure science: a variety of methodologies are used, and adjustments for additionality (free ridership) are sometimes crude. We would expect that both financial incentives and evaluators' professional enthusiasm for DSM would tend to result in overstated energy savings. (This doesn't necessarily presuppose unethical behavior, just a persistent tendency to err in favor of higher energy savings when there is legitimate uncertainty.) Yet the results cited above suggest that on average, baselining is reasonable accurate. Does reliance on third-party evaluation suffice to keep baselines honest?

A cautionary example: transit forecasting

In "A Desire Named Streetcar" Pickrell (1992) presents a cautionary lesson from another interesting analog to baseline determination: the financial analysis of large public transit projects. Over the past three decades, large US cities have chosen among competing plans for public transportation. Because of the magnitude of the federal subsidies involved – over $60 billion – the federal government required cities to justify their choices among alternative projects on the basis of ridership and cost projections. As in the case of GHG baselines, these projections of hypothetical futures were the basis for the award of external funds to the cities. Generally these projections were undertaken by third-party consultants presumably concerned about their reputations.

Pickrell retrospectively analyzes the validity of ridership and cost projections in eight cities which chose to invest in rail transit, the most expensive and heavily subsidized of the transit options. He makes the following case for pervasive bias in the system:

- the decision in favor of a rail transit project was generally made on the basis of narrow projected advantages in ridership and cost
- transport demand modelling and cost projection can draw on well-established, increasingly sophisticated, methodologies; nonetheless
- in seven out of eight cases, projected ridership was less than half of actual ridership; in the eighth case, projected ridership was 28% below actual ridership;
- actual construction costs exceed projected costs by 17% to 150%;

- most of the projection errors are not traceable to errors in assumptions such as population growth rates, fares, and travel speeds.

Pickrell concludes that:

> ...By tolerating pervasive errors of the consistent direction and extreme magnitude documented here, the transit planning process has been reduced to a forum in which local officials use exaggerated forecasts to compete against their counterparts from other cities...Such competition increasingly leads officials to encourage their planning staffs and consultants to underestimate rail transit projects' costs and overestimate their prospective benefits. (Pickrell 1992, p 169)

DSM incentive systems and "collaborative process'

In contrast to the case of public transit, we have cited evidence from Parfomak and Lave (1996) suggesting that utilities' estimates of energy savings are reasonably accurate on average. Since utilities are rewarded for energy savings, and since the quantification of energy savings is usually performed by utility-hired consultants, this is striking. What maintains the system's accuracy?

Part of the answer is an active network of professional associations and meetings. (Hagler-Bailly 1998) A biennial conference series sponsored by the American Council for and Energy-Efficient Economy, the Department of Energy, and several utilities has produced reference literature and promoted networking. The Electric Power Research Institute has sponsored research and dissemination in evaluation methodology. And the Association of Energy Service Professionals' largest standing sub-committee is the one concerned with evaluation. These groups, publications, and activities promote consensus in evaluation standards.

Public oversight of the process is probably a crucial factor promoting accuracy in assessment. Although utilities generally prepare their own evaluations of energy savings, these evaluations must be reviewed and approved by the Public Utilities Commission (PUC). Hagler Bailly (1998) reports:

> This review process often includes outside parties as advisors and many states have established a formal "collaborative process" that includes environmental interest groups, ratepayer groups, industrial representatives, and others who might have an interest in the outcome of these DSM programs. A key component of this review is consideration of the evaluation plan....
>
> [The collaborative] process uses a review committee of interested parties established by the state PUC that reviews all DSM ... activities on a regular basis, e.g., quarterly or every six months. The utility files a report that presents the current status of each program in terms of its implementation

> in the field as well as on-going evaluation efforts. This regular communication between an oversight organization and the utility proved valuable to both parties. This allowed the utility to make real-time changes in their programs if problems were found, or to revise their evaluation methods if circumstances dictated that a different approach be used. These were presented to the collaborative committee and feedback was given to the utility.

In other words, ***baseline methodologies are subject to review not just by a hired consultant, but by an independent board of stakeholders.*** In some cases, this board reviews evaluations commissioned by the PUC. In the cases of Michigan, however, the evaluator reports not to the utility but to the committee itself, which consists of two representatives from ratepayer groups, and one each from the PUC, the utility, and the attorney general's office (NARUC 1994).

Conclusions on keeping baselines honest

The ER baseline determination process should not rely only on self-regulation by certifiers or consultants. Development of professional bodies can help to establish standards of practice. Development of an accreditation mechanism for certifiers is probably desirable, but may not be sufficient to ensure unbiased baseline setting.

Emulation of the DSM's "collaborative process" is an interesting complement to accreditation-of-certifiers. In the GHG context, it would involve inviting representatives of the public interest, probably from NGOs, to sit in on the baseline determination process. It is probably not even necessary to give these stakeholders a formal veto; rather, failure to achieve consensus might be noted in the course of the certification process, and might be expected to increase the likelihood that the certifier is audited by the accreditation board. The process need not, however be confrontational, and it is quite conceivable that stakeholders might decide that a proposed baseline was unreasonably strict. An advantage to the collaborative process is that it could be adopted voluntarily by project hosts and investors.

8. CONCLUSIONS AND RECOMMENDATIONS

To set up a baselining system, two levels of decision are necessary. First, some general guidelines need to be established for the determination of baselines and additionality. Arguably some of these guidelines need to be established at the level of the UNFCCC, but until binding rules are established, offsets producers and traders will need to make some provisional decisions. I outline the main issues and choices in setting guidelines. Second, task managers or project sponsors need guidance on selecting and applying appropriate baseline methodologies. A preliminary procedural sketch is provided.

SETTING GUIDELINES

Ground rules

a) *Should baselines be evaluated under prevailing prices and policies, or in a hypothetical distortion-free policy environment?*

Some, perhaps many, projects make sense only if policy distortions are taken as given. Alternatives include:
i) always compute baselines under distortion-free assumptions.
ii) decide, on a country-by-country and policy-by-policy basis, which policies are immutable in the short to medium run, for practical purposes. For instance, current energy subsidies could be accepted for baseline purposes if the host country has adopted a plan for their gradual phase-out.
iii) accept prevailing policies and prices for baseline purposes.

The most conservative option, given an emphasis on producing high-quality offsets, would be to invest only in projects which generated offsets under distortion-free assumptions. This is consistent with GEF guidelines.

There may eventually be a UNFCCC ruling on this issue. In the interim, project sponsors may wish to maintain two baselines, with and without policy distortions. They could reckon offsets against the more stringent baseline, but retain the option to use the higher baseline if officially permitted.

b) *(Relatedly) What assumptions should be made about the level and enforcement of regulations on air pollution (or alternatively, of the effective level of pollution charges or local environmental damages). Similarly, what assumptions should be made about the effective level of enforcement of forestry and land use regulations.*

Choices include:

i) Using charges or practices established under official regulations (even if unreasonably strict or lax).
ii) Adopting default values.
iii) Quantifying and adopting current effective practice.

Choice i) is the most straightforward to apply, but problematic for several reasons. Where standard are very low, there could be questions about moral hazard and fairness. Where standards are unrealistically high, and not enforced, their use would scuttle potentially valuable projects. Choice iii) is the closest to a true measure of additionality, if practice could be perfectly observed, but there are problems with measurement and again with moral hazard. Choice ii) is inevitably somewhat arbitrary, but could be based on either 'best practice' among comparable countries, or on a damage function estimate.

c) *What assumptions should be made about the effective cost or availability of capital for projects similar to those under consideration?*

Possibilities include periodic surveys of banks or businesses outside potential JI/ER sectors. It may be possible to come up with rough rules of thumb based on central bank lending rates plus a differential.

Independent baseline review

I have argued that it would be useful to have disinterested reviewers examine proposed baseline calculations, in addition to third-party certifiers. This has the potential advantage of significantly boosting the credibility of the baseline, but also introduces potential extra costs and delays. One way to proceed would be to incorporate the examiners into the baseline design process, rather than adding a final, time-consuming review step. This has the potential advantage of early identification of projects that may not be perceived as additional.

It may be worth experimenting on a trial basis to see whether this feature is worthwhile. Selection of neutral reviewers will be a key to success.

Project selection

It has sometimes been argued that baseline, additionality, leakage, and measurement problems are greater for DSM and forestry projects than for other classes, such as fuel-switching projects. This conventional wisdom could bear some reexamination:

- The clarity of fuel-switching baselines is illusory if there is a chance that the host would spontaneously switch from the reference technology to the proposed project.
- As in the case of DSM projects, some fuel-switching projects appear economically rational to adopt without external support. The existence of barriers to the adoption of profitable technologies, and of failure to account for local environmental benefits, is often less plausible in the case of large projects than for the assemblages of smaller activities which constitute DSM projects.
- Unlike DSM projects, there is generally no way to construct a credible control groups.
- Any project which reduces the demand for energy in general, and coal in particular, should be presumed to have significant leakage effects through market 'snapback', as reduced demand depresses prices, prompting nonproject consumers to increase their consumption.

This is not to argue against the fuel-switching projects, many of which are doubtless valuable, but rather to argue that other classes of projects deserve a closer look. There are for instance forestry projects which may have little or no leakage. These include:

- reductions in collateral damage by loggers to nonmarketed timber
- reductions in anthropogenic fires affecting nonmarketable timber
- projects which neutralize leakage. For instance, a pasture abandonment project might slightly decrease the supply of beef; but since stocking ratios on affected lands would likely be low, it would be possible to sponsor a compensating increase in beef supply from areas of intensive production so as to neutralize any tendency for pasture to expand elsewhere. (See Brown *et al* 1997 for other examples).

BASELINE DETERMINATION AT THE PROJECT LEVEL

Here is an outline of a step-by-step guide.

1. *First determine whether there is a natural comparison group for this project.* This may be the case if the project consists of a large set of small-scale industrial, residential, or farm interventions, and if there are similar 'control' units for observation outside of the project area. In some cases, it may be possible to construct comparison groups for individual large projects if they are suitably generic. If it is possible to construct a comparison group, the practitioner can draw on a broad set of methodologies developed for DSM and program evaluation.

2. *If comparison groups are infeasible, set up the baseline problem as an investment decision among several potential reference projects and the proposed ERC project.*

a. Describe the potential project choices. Use observed data or engineering/agronomic models to establish emissions rates, conditional on those choices.
b. Establish the values of key parameters: current and expected future fuel and electricity prices; pollution charges, shadow-prices, or regulations; capital costs or target rates of return. Ideally these should be set by default. In practice, early projects will establish precedents. This should be recognized in budgeting for project appraisals.
c. Propose an investment-choice decision procedure: how would the sponsor choose among these alternatives in the absence of PCF funding. Where the baseline is a Bank or IFC-financed project, apply standard evaluation tools: why would alternative A be financed and not proposed project B, in the absence of PCF funding? This reduces to incremental cost analysis in many cases. A very simple, spreadsheet-based model of NPV or IRR could be used at the pre-screening stage, with a more sophisticated model used for project appraisal.
d. Use this procedure to determine which alternative would be chosen in the absence of offsets funding. Confirm where possible by reference to current practice. (That is, even where a statistically valid control group cannot be constructed, it is important to know whether similar fuel-switching projects, new construction practices, etc. are being undertaken without subsidies.) If the predicted choice is ambiguous, consider a partial crediting strategy.

3. *Devise a protocol for measuring the actual emissions of the project technology, and the predicted emissions of the baseline or reference technology*. The former can be accomplished through monitoring and sampling procedures, and protocols for this purpose exist. The latter could be based on pre-project data, on a survey of comparison facilities, or on engineering models.

4. *Decide whether or not to use a dynamic baseline – one that is flexible over time*. Dynamic baselines will be worthwhile:

i) in replacement/retrofit projects, when retirement of the existing facility is sensitive to unpredictable changes in prices or interest rates

ii) when emissions are volatile because of variable and unpredictable facility loads

In the absence of control groups, dynamic baselines are constructed by i) modeling the retirement decision as in 2d) above, but with annually updated parameters; ii) using an engineering model to represent the response of the reference technology to alternative loads.

5. *Assess market and/or leakage impacts.* Market impacts are necessary to compute emissions reductions from projects that affect electricity supply or demand. Leakage impacts must be computed for most projects. For projects with marginal sectoral impacts, use default assumptions about market responses (such as 'snapback' responses to reductions in coal demand, or world timber market responses to project-sponsored reductions in log harvesting). For projects with nonmarginal sectoral impacts (such as the construction of large generating facilities), use sectoral models such as integrated resource planning models.

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Options for Simplifying Baseline Setting for Joint Implementation and Clean Development Mechanism Projects

Tim Hargrave, Ned Helme and Ingo Puhl, November 1998

I. Introduction

Article 6 of the Kyoto Protocol created Joint Implementation (JI), which provides for the transfer or acquisition of emission reduction units (ERUs) from project activities among Annex I Parties, while Article 12 of the Protocol established the Clean Development Mechanism (CDM), which allows for the transfer of certified emissions reductions (CERs) from non-Annex I nations to Annex I Parties. Central to the success of JI and the CDM will be the satisfactory resolution of the issues of how to set project emissions baselines and how to determine whether or not project activities are additional to what would have happened otherwise. Complicated rules for baseline setting and determining additionality would increase project transaction costs and decrease the number of executed transactions, which would reduce the effectiveness of the two mechanisms both in reducing the compliance costs of buying countries and in providing capital flows and other economic and environmental benefits to developing country Parties and countries with economies in transition.

To date, project baseline setting and additionality determination has taken place on an *ad hoc*, case-by-case basis because formal rules do not yet exist. This "bottom-up" approach has required project developers to expend significant time and resources in preparing projects, and both host countries and importing countries to devote substantial resources to reviewing project applications. Two fundamental problems have been encountered that have slowed the development and approval of new projects:

- First, project sponsors must develop *emissions baselines* that are highly specific to the local context, with assumptions about an array of variables. This process requires a great deal of information and leaves room for sponsors to engage in gaming -- overstating baseline emissions and therefore projected emissions reductions. For this reason regulators must carefully check the underlying data and assumptions.
- Second, project developers must devote considerable time and effort to explaining why the emissions reductions benefits of their projects are *additional* to what would have happened otherwise, and regulators must review these explanations. This requires regulators to try to understand the motivations of project sponsors to determine the precise reasons they have undertaken projects. This review process is very subjective and not transparent.

Alternative approaches are now being examined that would simplify baseline setting and additionality determination. Under these methods governments would develop simple rules for setting baselines. Projects that produced emissions below these baseline levels would be able to generate CERs and ERUs and would automatically be considered to be additional. These approaches would result in reduced transaction costs for project developers, host country governments and nations importing emissions reductions, which in turn would mean increased project throughput. There are three main benefits to an increased number of projects:

- host countries would attract more new investment and would receive greater and more immediate local benefits of projects, such as improvements in air quality and public health;
- a greater number of transactions would mean the generation of more ERUs and CERs, which in turn would translate into lower costs and improved compliance by Annex I countries; and
- greater CDM activity likely would mean an increased pool of funds for climate change adaptation activities, as Article 12 paragraph 8 of the Protocol calls for a portion of the proceeds of CDM activities to be used to assist developing countries that are particularly vulnerable to climate change impacts.

Several issues must be addressed regarding the development and use of simplified approaches. First, the use of simplifying methods would require an upfront investment of time and resources on the part of host countries. Parties must weigh these costs against the benefits of increased project flow. It is important to note that smaller countries might be able to mitigate their set-up costs by working together to develop regional approaches to simplifying baseline setting and the determination of additionality. Second, it is imperative that the benefits of simplifying project preparation not come at the expense of the environmental integrity of the CDM.

The purposes of this paper are first, to describe some of the new methods for baseline setting and additionality determination; and second, to briefly call attention to some of the major policy considerations surrounding the use of these new methods. The simplifying methods described here include the technology matrix, emissions benchmarks and top-down baselines.

II. The technology matrix approach

Introduction

Under this approach, a number of pre-defined default technologies would be identified as the baseline technologies for a defined region and for a specified time. The emissions baseline for a project would equal the emissions rate for the specified technology. Projects that introduced technologies with GHG emissions lower than the specified baseline technology would be considered to meet the additionality requirements. Periodically, the matrix would be updated so that technologies that represented a certain threshold share in a country or region's technology inventory were added to the matrix and therefore were no longer considered additional.

Establishment and use of a technology matrix would involve the following steps:

1. Specification of default technologies for different sector/project types based on current technologies and practices in the host country or region.
2. Creation of a matrix to be approved by the Conference of Parties (COP) that specified the emission performance level for each technology included in the matrix. Countries probably would want to start with a limited list of technologies, and expand it as more was learned.
3. Calculation of project emissions against the default emissions baseline. If the developer preferred to use another method he would have to prove that his emission estimates were more accurate than the default estimate.
4. Evaluation and updating of the technology matrix regularly, and application of the revised matrix to new projects. As noted, the matrix should be revised so that technologies already in widespread use no longer qualified as additional. Default technology baselines should be reviewed every five to ten years, because behavior/technology will realistically change within that time frame. The matrix should not be used retroactively to affect existing project baselines.

This simple default approach offers some advantages over a case-by-case approach:

- It would reduce project developers' transaction costs, because developers would no longer have to spend money on developing project-specific baselines.
- It would reduce gaming, because project developers would have to select their baseline technologies from the predetermined technology matrix.
- It would increase certainty and transparency, because the performance benchmark would be clear and predictable.
- It would eliminate the confidentiality issues that are often encountered in commercial projects because it would not require sharing of sensitive financial or technical information.
- It would eliminate uncertainty about assumptions about future energy prices and economic growth, because these factors would not be central to the establishment of the matrix.

Issues

A number of issues arise in implementing a technology matrix approach:

- ***Simplicity vs. rigor***: Simplicity should not give rise to a significant decrease in the quality of emissions benefit estimates. One issue of particular importance is the fact that the development of a technology matrix would involve the identification of current technologies and practices without regard to expected future trends. More investigation is needed of the accuracy of the technology matrix approach.
- ***Gaming***: Technology-specific baselines would eliminate opportunities for gaming on a project basis, but it could create a large opportunity for gaming at the system level. Establishing default technologies would have a political dimension and

forging agreement between host countries and the COP or CDM Executive Board might be difficult.

- ***Large projects***: The costs of establishing baselines for large projects are relatively low per dollar of investment, so it is possible that little would be gained by simplifying the rules for establishing baselines for these projects.
- ***Proper matching of baseline technology and project investment***: Considering the possible range of investment options, it might be difficult to match a baseline technology to a specific project context.

III. Benchmarking

Introduction

Under this approach, project emission baselines would be set based on emission performance "benchmark" rates that were determined with reference to criteria such as historic or projected sector-specific emission intensity trends. Like the technology matrix approach, benchmarking would simplify project characterization, in that all projects that reduced emissions to below benchmark levels would generate CERs and ERUs and would automatically qualify as additional. Benchmarking differs from the technology matrix approach, however, in that emissions baselines can be set in reference to a mix of technologies rather than a specific technology. For instance, the baseline emissions rate for new power projects in a region might be set at the weighted-average emissions rate for new clean coal and combined cycle natural gas plants (rather than in reference to one or the other). This is especially important for projects that may offset emissions from a range of facilities using different technologies. Also, unlike with the technology matrix approach, benchmarks may be "forward-looking", or set based on projected technologies rather than the current capital stock. Countries would seek COP or CDM Executive Board approval for the benchmarks they had developed.

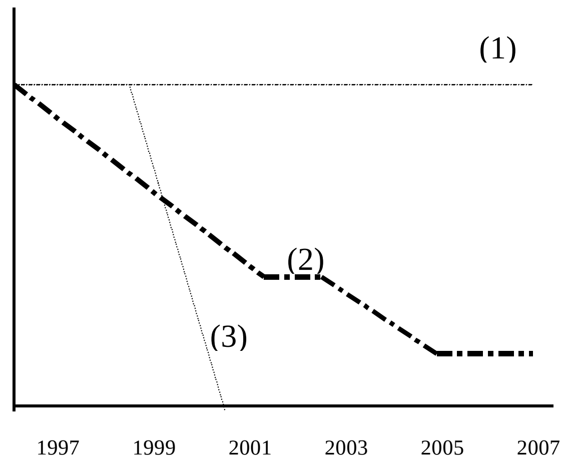
Four different types of benchmarks could be set:

- **static and historic**: This method would create a constant benchmark over the life of the project based on historical emission levels of the emitting source(s) being replaced;
- **static and forward-looking**: This approach would result in a constant benchmark over the life of the project based on the carbon emissions profile of the planned energy mix within the sector or subsector during the life of the project;
- **dynamic and historic**: Here the benchmark would change periodically over the life of the project based on historical changes in carbon intensity rates; and
- **dynamic and forward looking**: This method would create a changing benchmark based on emissions rates of projected new capacity.

It is likely that the choice of the proper benchmarking approach will be specific to the local context; however, a detailed assessment of the suitability of different benchmarking methods for different types of GHG mitigation activities and in different regions has not yet been conducted. Clearly, the choice of benchmarks will have a strong impact on the amount of CERs generated. This is demonstrated in Figure 1, which displays alternative benchmarking scenarios for a wind project in Costa Rica replacing a diesel generator. The figure illustrates three baseline emission scenarios:

1. a static and historic baseline using the emissions profile of the existing diesel plant over the lifetime of the project;
2. a static and forward-looking benchmark based on the emission profiles of a new wind plant for the baseload and of a diesel plant for the peak; and
3. a static and forward-looking baseline using the emissions profile of the diesel plant and the emissions profile of the planned conversion of the national grid to 100% renewable power in 2001.

Figure 1: Benchmark Options for Wind Power Plant



Issues

The implementation of the benchmarking approach raises a number of issues:

- ***Geographical scope of benchmarks***: Should benchmarks be established on a project, regional or country-specific basis? In larger countries, standard technologies may vary regionally based on the proximity of fuel and other factors.
- ***Sectoral specificity***: Establishing benchmarks for each different sector and project type probably would increase the environmental accuracy of the benchmarks but also would require more resources to develop. Further, the cost-effectiveness of the benchmark approach under particular circumstances will depend on the availability and accuracy of data for the sector. More concrete experience is necessary to obtain a better understanding of this issue.
- ***Planning certainty***: The use of dynamic baselines would mean that at project inception investors would not know the number of emission reduction credits that

they would earn each year. It appears that private sector companies, because they like planning certainty, would prefer benchmarks based on conservative estimates of emissions-related performance, even though this would lead to generation of a small number of CERs. This trade-off needs to be better understood.

IV. Top-down baselines

Introduction

Top-down baselines are project baselines derived by the host government from a more aggregate baseline. This would be the national assigned amount in the case of JI; in the CDM context, it could be a national or sectoral emissions baseline. Baselines could be set either in terms of absolute emissions or based on GHG emissions per unit of output (e.g., carbon emissions per unit of GDP). The latter approach might be preferred because it would not restrict economic growth, allowing emissions to grow in absolute terms as long as the carbon efficiency of economic activity was improving.

In the CDM context, the aggregate top-down baseline set by a developing country would not be binding in the same way as an obligation made by an Annex I country under the Kyoto Protocol; however, because the level at which baselines were set would determine the number of CERs created and impact the compliance activities of Annex I countries, baselines would have to be established through a consultative process with the Conference of the Parties or the Executive Board of the CDM. The aggregate baseline would have to be set tightly enough so that it was acceptable to other Parties from a climate change perspective, but loose enough to ensure 1) that the country adopting the baseline was fairly rewarded for new activities and initiatives; and 2) that local development needs and national circumstances were taken into account.

In both the JI and CDM context, national regulators would establish project baselines by allocating the aggregate baseline to individual project activities. This would be done so that the sacrifices and benefits from engaging in GHG emission mitigation activities were distributed to sources under the baseline in a way that was consistent with broader sectoral policies and development objectives. Once baselines had been assigned to them, projects would not be required to undergo further additionality tests. Further, government decisions on how to allocate baselines to project activities could occur without further international review. In essence, top-down baselines would give national governments greater flexibility in setting baselines for JI and CDM projects; the price of this flexibility would be a non-binding agreement to control all emissions sources covered under the baseline.

In Annex I countries, which will have to adopt national policies to meet their Kyoto emissions obligations, top-down baselines could be imposed as regulatory requirements on emissions sources. In developing countries, the sponsors of project activities covered under the aggregate baseline would have a choice as to whether or not they participated in the CDM. Those who believed that they could reduce project emissions to below their assigned baselines would be able to generate CERs, while those who thought that they could not would opt not to participate.

Top-down baselines are particularly sensible for Annex I Parties, because these countries probably will want to monitor emissions from all major sources and impose ceilings on the emissions of major sectors anyway. Non-Annex I countries might also want to adopt top-down baselines for a number of reasons:

- They could avoid the administrative burden and transaction costs of negotiating and approving baselines on a case-by-case basis;
- By reducing transaction costs, they potentially could increase the level of investment activity;
- In establishing national/sectoral baseline strategies and project baselines, they could account for emissions reductions that cannot be attributed to particular projects -- for example, those from activities such as pricing reforms -- and then monetize these reductions through the CDM. The additional revenues gained through this strategy could be used to finance adjustments to the new sector policy framework (e.g., demand-side energy efficiency improvements to offset higher electricity prices);
- By expanding the coverage of baselines to include entire sectors, they could decrease emissions leakage, as well as the costs of monitoring leakage; and
- They could gain access to a flexible energy policy and planning tool that enabled them to operationalize their climate change priorities.

Issues Regarding the Use of Top-Down Baselines in the CDM

The use of top-down baselines in the CDM could significantly increase the number of projects undertaken by a country, but a number of issues must be resolved. The first of these is the cost of building the capacity needed to establish and implement top-down baselines. To use a top-down approach, countries would need to engage in national or sectoral baseline planning and would have to set up comprehensive systems for monitoring and verifying emissions. Neither of these steps would be required if the country were to take a project-by-project approach to the CDM. Thus the use of a top-down approach would impose some additional upfront costs on participating nations. It is not clear whether these costs would be greater or less than the cost reductions that a top-down approach would provide by eliminating the need for project-by-project baseline setting. This issue will need to be examined separately by each country.

A second issue associated with top-down baseline setting is what may be referred to as the “carrots with no sticks” problem. This issue derives from the fact that even if non-Annex I countries were to establish aggregate baselines, they still would not be subject to binding emissions obligations. Thus projects would have a financial incentive to reduce emissions below baseline levels so that they could sell CERs, but they would not necessarily face sanctions if they exceeded their baselines. Some projects would sell CERs while others increased their emissions, with the net result possibly being that the country exported

CERs even though the sources covered under the aggregate baseline as a whole had exceeded that baseline. This would be an unacceptable result from an environmental standpoint, because the use of top-down baselines is predicated on the idea that CERs sold by a project are supported by corresponding emissions reductions from some emissions source covered under the aggregate baseline.

A number of options is available for addressing this problem. One is to establish a rule that Parties buying CERs would not be able to count the CERs for compliance purposes unless all of the sources under the aggregate baseline had met their project baselines or that in aggregate all covered sources had met the aggregate baseline. Application of this type of rule in the context of the CDM would ensure that the emissions reductions supporting exported CERs had not actually been offset by emissions increases by other sources covered under the cap.

This approach raises two difficulties. First, enforcement of this rule likely would require countries to impose domestic penalties on sources that produced emissions above baseline levels. This in effect would convert the project baselines into binding targets and the CDM program into a mandatory domestic regulatory program. This step would probably be unpopular in most developing countries, where binding GHG regulation is for the most part not now contemplated.

Second, the rule would pose a risk for project investors, because the delivery of CERs by a particular project would depend on the performance of all projects covered under the aggregate baseline. Investors would not know until the end of the commitment period whether or not their projects would be able to deliver CERs. They would respond to this uncertainty by increasing their discount rates, which would make the projects less competitive. This problem does not exist in Annex I JI because the existence of the national emissions cap gives investors confidence that leakage effects will be addressed and that ERUs are backed by real reductions.

Another way of approaching the "carrots with no sticks" problem would be to establish the aggregate baseline as an internationally binding emissions target. This target would be like those agreed to by Annex B countries, except that they likely would be set as "growth baselines" (measured in carbon emissions per unit of output) rather than in terms of absolute emissions levels.[1] If countries were to accept binding obligations of this sort, then the CDM really would be no different than Annex I JI. Thus, as in Annex I JI a top-down approach would be sensible because there would be no chance that emissions would leak to other sources covered under the baseline. It is worth noting that if they adopted targets, countries also would have the option of engaging in emissions trading under Article 17.

[1] The concept of growth baselines was first proposed by the Center for Clean Air Policy several months prior to the Kyoto negotiations in 1997. The idea was then adopted by the US delegation and proposed in Kyoto.

This approach to setting CDM project baselines obviously has serious implications, in that countries would be bound by international law to meet their emissions targets. Countries would have to decide whether this extra commitment was justified by the additional capital and technology that could be attracted through Annex I JI or emissions trading.

A final means of addressing the "carrots with no sticks" issue would be to require countries using the top-down approach to establish very strict baselines, and then allocate these baselines evenly among covered sources. These sources thus would be able to generate CERs for export only if they had very low emissions. This approach would not eliminate the "carrots with no sticks" problem, in that it would still be possible for some firms to export CERs even as the covered sector as a whole failed to achieve the aggregate baseline; however, requiring a country exporting CERs to install some very clean facilities would ensure that that country had taken some steps to control average emissions rates. The obvious problem with this approach is that it would make the generation of CERs more difficult, restricting the level of project activity.

V. Policy Considerations

Simplifying methods for baseline setting will be effective and credible only if they do not impair the environmental integrity of JI and the CDM and they are not too costly to develop and administer.

Environmental Integrity

Under a technology matrix or benchmarking approach, a project's baseline would be determined through consideration of the key factors that determine the choice of technology and practice. All factors affecting the decision would not be considered, however, as they theoretically would be under a case-by-case approach. This means that simplifying methods could result in the establishment of an incorrect baseline.

The magnitude of the estimation error associated with the use of these methods is not obvious *a priori*, nor is the direction of the error. It is also not clear that the level of error associated with simplifying methods is greater than that associated with the case-by-case approach, given many of the problems (such as quantifying project leakage) that can exist in establishing case-by-case project baselines. Further, more research and discussion is needed regarding the level of error that is tolerable in exchange for the increase in projects that could come through the use of simplifying methods. A key component of the COP's future research agenda should be to investigate the environmental tradeoffs (if any) associated with the use of simplifying methods.

The use of top-down baselines presents a slightly different set of environmental issues. The use of this approach in the context of Article 6 joint implementation poses very little environmental risk, because the fact that the host country is operating under an emissions ceiling provides confidence that emissions reductions corresponding to the AAUs sold will be made somewhere in the host country. As already noted, though, the use of top-down baselines in the CDM context does pose an environmental risk, however, because the host country is not subject to an emissions cap. This "carrots without sticks" issue has been addressed above.

Set-up Costs

The main purpose of using any of the simplifying methods described above is to reduce transaction costs for project developers and reduce the costs to government of reviewing and approving projects; however, the implementation of these methods will require a commitment of resources initially. In the case of the technology matrix and benchmarking, resources also would be needed on an ongoing basis to update the metrics.

Each baseline-setting method comes with different implications for government set-up costs. At one end of the spectrum is the current bottom-up project-by-project approach, which requires host countries to do little more than dedicate staff to approving projects that are submitted. At the other end is the top-down baseline approach, which would require countries to develop sectoral baselines, allocate baselines to individual projects, and then monitor emissions at each project covered under the sectoral baseline. The technology matrix and benchmarking approaches would fall somewhere in between, requiring host nations to define emissions reference cases for the major GHG-emitting sectors in their countries. This would demand the collection and analysis of energy and emissions data for these sectors.

In assessing the advantages and disadvantages of various baseline-setting methods, countries will need to weigh the administrative costs associated with implementing a particular method against the projected increase in the number of projects resulting from use of the method. At first glance it might seem that for smaller countries the set-up costs associated with simplified baseline-setting methods would outweigh the benefits; however, at the same time, it is probably true that the development of benchmarks, technology matrices and top-down baselines would be easier to do in smaller countries than in large. In addition, it is worth noting that smaller countries that have similar energy and GHG profiles could defray the set up costs of developing simplifying baseline-setting methods by working together to develop a common set of baseline-setting rules. This idea deserves further discussion.

VI. Conclusion

To date, project emissions baselines have been set on a case-by-case basis. This process has been very time- and resource-intensive, has not been consistent across projects, and has not been transparent.

This paper has described three approaches to simplifying project baseline setting – the technology matrix method, benchmarking, and top-down baselines. The use of these methods would facilitate project preparation, review and approval, leading to a greater number of projects. More projects would in turn mean increased investment, greater and more immediate local benefits, improved Annex I Party compliance, and greater funding for adaptation projects.

Two issues must be addressed regarding the use of the baseline setting methods described here. First, these methods must not harm the quality of project emission benefit estimates. While it is not clear that they would, more research here is necessary. Second, the costs of establishing and administering simplifying methods must not outweigh the benefits of using the methods. On this point, the paper has noted that neighboring countries of like circumstances could consider working together to develop regional approaches to baseline setting. Examining the advantages and disadvantages of simplifying baseline setting methods should be at the top of the COP's JI and CDM research agenda.

Emission baselines for Clean Development Mechanism projects: lessons from the AIJ pilot phase

Jane Ellis, OECD[1]

Prepared for presentation at: Workshop on baselines for the CDM
February 25-26 1999, Tokyo, Japan

Introduction

The Clean Development Mechanism (CDM) was first set out in the Kyoto Protocol at the third Conference of the Parties (COP) in 1997. The wording in the Kyoto Protocol (KP) on how the CDM will work is vague, although more substantive than for the other Kyoto mechanisms. Indeed, the Buenos Aires Plan of Action, agreed at COP4 in 1998 (UNFCCC 1998a, decision 7/CP.4), sets out 50 separate items that need to be addressed in order to set up the principles, modalities, rules and guidelines for the operation of the CDM. These range from the basic "purpose of CDM projects" to more specific criteria on methodological and technical issues. Two of these refer explicitly to baselines, i.e. "criteria for project baseline" and "environmental additionality and baselines".

CDM projects will have some similarities with Activities Implemented Jointly (AIJ) projects[2]. Both CDM and AIJ are project-based activities whose aims include greenhouse gas mitigation or removals by sinks. Both are open to Annex I and non-Annex I country participation. Both have projects that would be sited in one Party although financed wholly or in part by another Party, or an entity from another Party. Examining the way in which emission baselines were set for AIJ projects could allow some useful lessons to be drawn when determining how to set up emission baselines for CDM (and JI) projects. This paper explores these lessons, and also outlines an alternative way of setting emissions credits for CDM projects.

Emission baselines in AIJ projects

The FCCC secretariat listed 95 AIJ projects (UNFCCC 1998b) in its second compilation and synthesis of project information submitted by Parties. All 95 projects are reported to the UNFCCC in a uniform reporting format. This format requests the emissions baseline scenario with and without the AIJ project, as well as other information. However, there is at present no agreed method by which an emissions baseline should be calculated.

Emission baselines are important for CDM projects as they will form the basis for determining certified emission reductions (CERs) from these projects. However, AIJ projects do not accrue emissions credits as they are part of a pilot phase. AIJ emissions baselines are therefore used as an indication of the real and measurable greenhouse gas mitigation effect of the project. In this context, they are relevant to potential CDM projects.

Information on AIJ emission baselines is sparse. Many AIJ project reports outline a quantified emissions baseline (and some projects present <u>more</u> than one possible baseline scenario). However, descriptions of the

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[2] AIJ was set up as the pilot phase of Joint Implementation at COP1 in 1995 (UNFCCC 1995).

methodology used to calculate the emissions baseline in different project reports is often short, and it is rarely possible to reconstruct the emissions baseline presented from the data and descriptions given.

The shape of the emissions baseline used in different AIJ projects can vary significantly. This can be illustrated by examining the emissions baseline used in a common project type: lowering the carbon-intensity of heat production via fuel switching at heating plants. These projects make up more than half of all AIJ projects, and typically involve replacing a boiler and installing or upgrading ancillary equipment at existing heat-producing installations.

Actual emission baselines reported for different AIJ projects of this type are illustrated in Figure 1 and explained in Table 1. The most striking aspect of this figure is the diversity of emission baselines in the different projects. These differences are due to site-specific variations (such as location), and to different assumptions in:

- the length of time over which an emissions baseline is valid;
- the relative energy output before and during the AIJ project;
- whether fuel switching would have occurred in the absence of the AIJ project, and if so, when; and
- the timing and effectiveness of any demand or supply-side energy-efficiency measures.

Despite the importance of these different assumptions, not all AIJ project reports outlined the reasons behind the assumptions presented.

Figure 1
Emission baselines reported in different fuel-switch AIJ projects (not to scale)

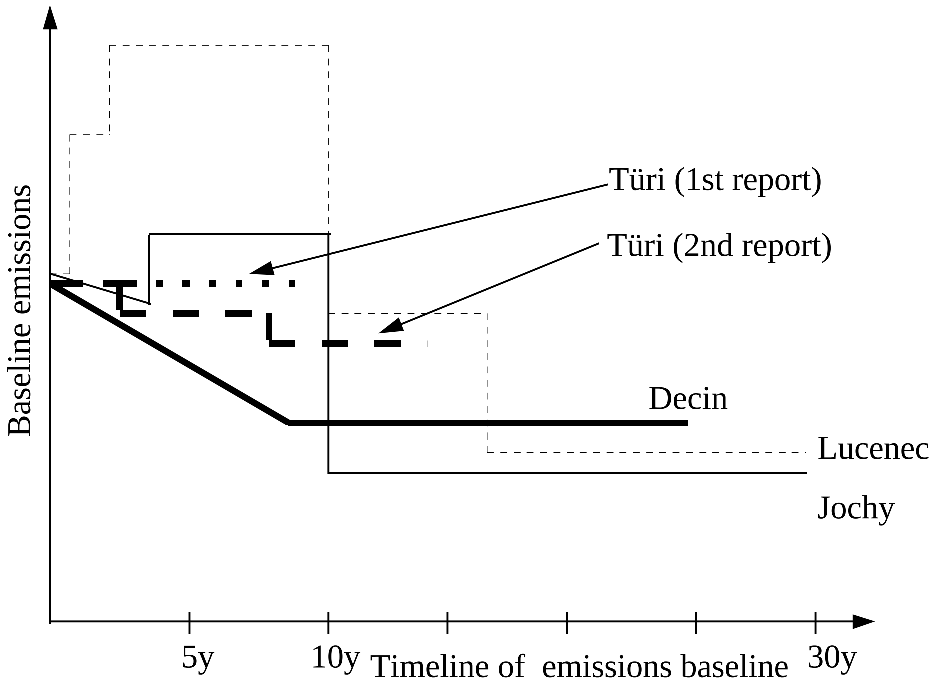


Table 1
Assumptions made in different fuel-switch AIJ projects

Project name	Timeline chosen		Fuel switch in baseline?	Baseline energy output assumptions	Other assumptions
	Length (y)	Comment			
Türi (1st report)	10y	Length of loan repayments	No	Same as pre-project	None
Türi (2nd report)	15y	Estimation based on life of new equipment and life of equipment not replaced	No	Same as pre-project	Stepped energy efficiency improvements
Decin	26y 8m	No reason given in report submitted to the UNFCCC.	No	Energy output from plant decreasing and then plateauing from year 8.	None
Jochy	30y	Estimated life of <u>new</u> equipment (equipment replaced by AIJ project was old, with a short remaining lifetime).	Yes: to gas	Assumes energy demand will increase 25% in 2003.	Assumes old boilers will be rehabilitated to improve their efficiency slightly.
Lucenec	30y	Estimated life of new equipment, although equipment replaced was old.	Yes: partial switch to biomass	Assumes energy demand will increase 25% in 2001.	None

Source: UNFCCC project reports and Yager and Mydske, 1998

Examining other AIJ projects, such as those aiming to increase energy efficiency of existing equipment, highlights other reasons why emission baselines differ from project to project. Major reasons include:

- different assumptions in the carbon-intensity of displaced electricity;
- whether learning effects would affect the technology's performance in the early years of the project;
- the relative production of goods before and during the AIJ project; and
- whether or not the mid or low-point of possible values have been taken (e.g. to ensure environmental conservatism).

These examples illustrate the importance that assumptions have on the shape of the emissions baseline, even when the AIJ project involves upgrading or renewing an existing installation. The relative importance of different assumptions will change according to the project type, although the time over which a project generates emission benefits is perhaps the most important overall. The examples also show that assumptions are highly site-specific, and that the reported baseline for each project may represent a choice from a number of feasible emission pathways (Yager and Mydske 1998).

However, not all AIJ projects involve upgrading existing equipment. Some AIJ projects involve installing new energy-producing equipment at a "greenfield" (new) site. The discussion above has shown that determining the emissions baseline for a project already underway is not simple. Difficulties are compounded for totally new projects where there are no direct pre-project comparisons available for the major factors that determine that project's emissions, i.e. which fuel and technology are used, and what the system output was.

CDM project sites are limited to non-Annex I countries. Areas in which CDM projects may be promising, such as the energy sector, are growing rapidly in many of these countries. Therefore, a relatively high proportion of CDM projects are likely to be at greenfield sites. Determining project-specific emission baselines for these CDM projects is thus likely to be subject to many uncertainties.

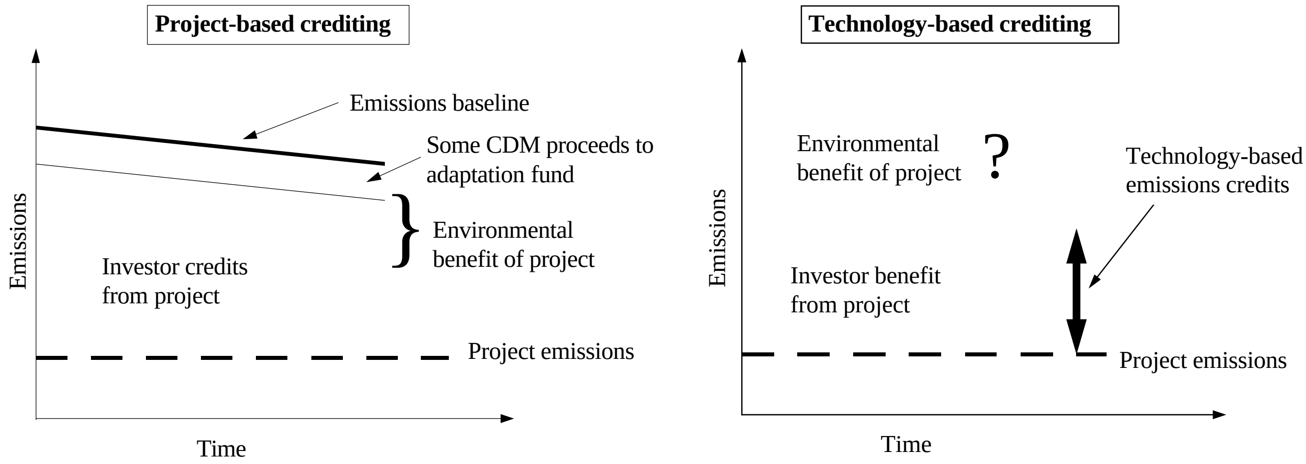
Technology-based crediting

The Kyoto Protocol states that CDM projects have to result in emissions that are real, measurable and that *are additional to any that would occur in the absence of the certified project activity.* However, this does not necessarily mean that project-specific emission baselines have to be drawn up for each CDM project.

A system could be envisaged in which a project-specific emissions baseline is not needed for CDM projects, but that CERs are allocated on the basis of technology installed[3]. For example, installing a heat-producing plant based on fuel F and technology type T would result in X_{FT} CERs per energy output (or per year of operation). Technology-based emissions crediting has a number of advantages and disadvantages with respect to allocating emission credits on the basis of a project's actual and baseline emissions. The difference between this and the system described above are outlined in Figure 2.

[3] Other potential ways of determining emission credits from projects, such as via sectoral baselines, are not examined in this paper.

Figure 2
Schematic representation of different crediting mechanisms



The main advantages of a technology-based crediting system are that it would be cheap and simple to use for investors. Such a system would save time and money otherwise spent analysing and monitoring the pre-project situation and projecting how this would develop. It would therefore reduce the transaction costs and lead times required to set up a CDM project compared to a system in which a project-specific emissions baseline was required. These lower transaction costs means that smaller projects would face a lower cost barrier than under a system of project-based crediting. Technology-based emissions credits could also be varied by country, region or other level to take into account differing levels of fossil fuel use and energy efficiency. In this way, energy-efficient technology installed in an area where current efficiencies are low could obtain higher credits than installing the same technology in an area where average efficiencies are higher.

A technology-based emissions crediting system could also result in relatively predictable emissions benefits. This reduces the uncertainty of a project's benefits and may increase the number of CDM projects initiated. Such a system would also mean that CDM projects could be initiated and generate credits even if there is not enough underlying data on a project or sectoral level to set up a meaningful project-specific emissions baseline.

There are two main disadvantages of a technology-based emissions system. The first is that the environmental effectiveness of a project is more difficult to determine if there is no reference scenario against which to compare its performance. Because of this, some analysts (e.g. Carter 1997) suggest that only a few technologies, such as those based on renewable energy, should be eligible for technology-based emissions credits. Allowing other, more GHG-intensive, technologies to become eligible to generate investor credits under a technology-based system is possible. However, it is also problematic (see later discussion and figure 3). If GHG-intensive systems were to be allowed to benefit from technology-based emissions credits, the environmental integrity of the system could perhaps be best ensured if the technology credits were limited, either in per unit technology terms, or in terms of the emission timelines for such projects.

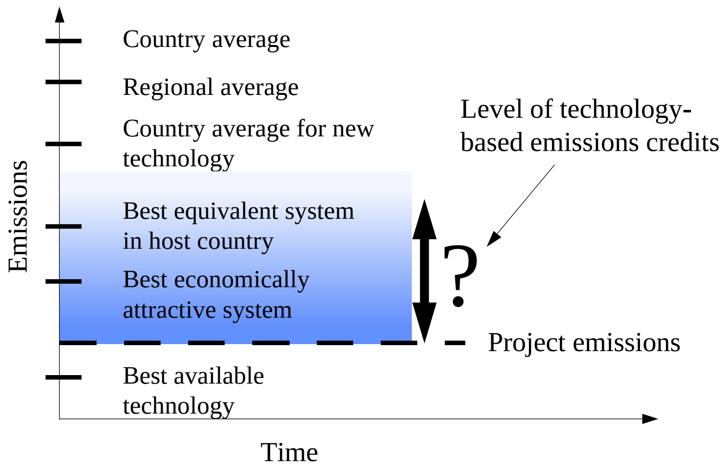
The second major disadvantage of technology-based credits is that they could be costly to set up at the international level. The system would be internally consistent only if agreement was reached on the technology-specific level of credits. However, agreement between Parties on this and on whether or how any regional modifications are taken into account is likely to be long, difficult and therefore costly. Moreover, a centralised credit matrix may prove difficult and lengthy to update (although periodic updates would be needed in order to take technology improvements into account).

In addition, if technology-based credits were set up, this should be done such a way so that "idle technology" is not encouraged. This would occur if the installed technologies under a CDM project were not subsequently used to their full extent and/or economic lifetime and investors nonetheless benefited from emissions credits from these projects. (Underuse of new technology is not uncommon when inadequate user support or training is given.)

Even if there was agreement that some or all CDM projects could accrue technology-based emissions credits, determining the level of these credits would not be easy. Like determining the level of project-based emission baselines, there are several feasible options available for technology-based credits (figure 3).

Figure 3

Possible variations in crediting levels for a technology



Should the "reference" that sets the level of credits be the host country average; the regional average; the country or regional average for recently installed technology; the best equivalent system already installed in the host country, or the best economically attractive system? Should the level of technology credits be modified if the project technology emits significantly more than the best available comparable technology? How could the level of credits be set for competing energy supply technologies based on different fuels?

In addition to setting the level of credits, many other issues may have to be resolved before a technology-based crediting system could be agreed. Some of these issues are the same or similar to those that would also need to be resolved a project-based emissions baseline system. For example, how long should those credits last and should this be subject to revision? How could the system deal with uncertainties and learning effects? And should there be any distinction between crediting levels for replacement and greenfield projects?

The level at which technology-based emissions credits are set could vary widely for a particular technology type (figure 3). If technology-based emissions crediting is allowed, the level at which credits are set is extremely important. This level will influence the uptake of CDM projects and consequent emissions "leakage"[4]. The level of credits will also affect the mitigation cost of proposed CDM projects. The relative mitigation cost of different CDM project types will, in turn, affect the relative attractiveness of different project types and thus send wider signals leading to built-in incentives for certain fuels and/or technologies.

[4] Since CDM projects take place in countries that have no emission commitments, allowing Annex I countries to offset CERs from CDM projects against their domestic emissions effectively increases the Annex I emission cap agreed to at Kyoto. This increase is the emissions "leakage".

Conclusions

Emission baselines are highly project and site-specific. The manner in which AIJ emission baselines have been drawn up under the AIJ pilot phase is, to a large degree, dependent on input assumptions. Project emission levels and project-based emission baselines are uncertain, and a quantitative assessment of a project's environmental benefit is subject to considerable uncertainty. Variations in the input assumptions used in different AIJ projects means that emission baselines are often not consistent between projects, even when these projects are similar. In addition, the rationale behind the assumptions used, and any underlying data or supporting documents, is rarely presented in detail, which means that these emission baselines are also not transparent.

Calculating and reporting project-specific emission baselines for AIJ projects, and for JI and CDM projects and activities, could be made more transparent and consistent if internationally-agreed guidelines set more specific guidance on the methodology and format for such reporting. Some improvements, e.g. on reporting format, could be made relatively simply and would not be very contentious. Other potential modifications, such as an agreement on how to set the length of time over which a project could generate emission benefits, will be less easily resolved.

Technology-based emissions crediting could be one option used instead of project-based emissions crediting for some CDM projects. This system is subject to some similar uncertainties and unresolved issues as project-specific emissions credits. But, with its highly simplified crediting structure, it would have a number of advantages such as being quick, simple and cheap at the point of use, and leading to predictable stream of emissions credits that could also be differentiable by project site. However, great care would be needed in such a system to ensure that credits were neither too small, which would inhibit the uptake of CDM projects, nor too generous, which could result in countries receiving emissions credits for projects whose economic and environmental additionality are questionable.

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These reports are available at http://www.unfccc.de/fccc/ccinfo/aijact/

A Study of Project Baselines
by Shoji Takedahara

1. Basic Understanding

With regard to the Clean Development Mechanism (CDM) stipulated in the Kyoto Protocol, baseline setting methods will be the key issue to be addressed in the coming years. Baselines will be the basis for calculating greenhouse gas (GHG) emission reductions (or absorbed amount). For promoting implementation of CDM, it is necessary to minimize transaction costs and simplify preparations for project implementation. At the same time, it is important to check calculated values against actual reduction values in order to be as accurate as possible.
Viewed in this light, standardization of baseline setting methods for different project types and standardization of calculation methods for GHG emission reductions will be proposed as follows.

2. Some Project Types and Baselines

(Hereafter, a typical project of a project type will be described as the "Project.")

2.-1 Scrapping of Old Existing Power Stations and Construction of New Ones (with the amount of power generation being the same)

(1) Baseline Determination

- GHG emissions in the absence of the Project, that is, in the case of existing power stations continuing operation, will be the Baseline.

(2) GHG Baseline Emissions [BE] = GHG Emissions of Existing Power Stations

- In this case, concerning GHG emissions of existing power stations, the issue is whether to set the Baseline at the present level (static), or to anticipate a decline in emissions through improvement of facilities, etc. and higher emissions due to aging of facilities (forward dynamic).

(3) Actual GHG Emissions with the Project [PE] = GHG Emissions of New Power Stations

(4) GHG Emission Reductions (Annual) = BE-PE

2.-2 Construction of New Power Stations by Renewable Energy to Meet Increased Demand (eg. Photovoltaic Power Generation)

(1) Baseline Determination

- Even in the absence of the Project, it is necessary to meet expanding electricity demand. It is reasonable to assume that this will be supplied through expansion of existing power stations of the country (or region) concerned.
- In this case, the following Baseline options could be considered:

(a) Simple average of GHG emissions from all power stations of the country (or region) concerned
(b) Average GHG emissions of the most common-type power stations of the country (or region) concerned
(c) Average of 25% of power stations with the lowest GHG emissions

(to compare with new stations as much as possible)

(d) Average of 25% of power stations with the highest GHG emissions
(older stations will be scrapped in turn)

- Regarding (a) to (d) given above: should they be static or forward dynamic?

(2) GHG Baseline Emissions (BE) = (Annual power generation of new power stations)×(GHG emissions per unit amount of power generation of the Baseline)

(3) Due to power generation through renewable energy, GHG emissions with the Project will be zero.

(4) GHG Emission Reductions (Annual) = BE

2.-3 Waste Heat Recovery and Utilization

This type of projects aim to recover waste heat as energy such as steam, electricity, etc., which used to be disposed in existing production processes, and to effectively utilize it.

If energy is recovered as electricity:

(1) Baseline Determination

- If existing private electric generators are no longer needed because of use of the electricity recovered by the Project, the Baseline will be determined as in 2.-1 above.
- If the electricity recovered by the Project is to be used to meet increasing demand, the Baseline will be basically determined as in 2.-2 above. However, there also may be a method to consider only private electric generators of the country (or region) concerned in 2.-2.
- The issue is whether the Baseline should be static or forward dynamic.

(2) GHG Baseline Emissions (BE) = (Annual power generation through waste heat recovery) × (GHG emissions per unit amount of power generation of the Baseline)

(3) Due to power generation through waste heat recovery, GHG emissions with the Project will be zero.

(4) GHG Emission Reductions (Annual) = BE

2.-4 Recovery of Waste Heat From Incineration of Waste Derived From Biomass Raw Materials

This type of projects aim to recover waste heat from incineration of waste derived from biomass raw materials, including paper sludge, municipal waste, etc., and to effectively utilize it as energy such as steam, electricity, etc. There are two aspects to this type of projects: (1) production of energy from waste; and (2) reduction of methane emissions from landfilling waste through implementation of this type of projects.

The Baseline related to energy production from waste heat and GHG emissions reductions is determined as in 2.-3 above.

Methane Emissions Reduction

(1) Baseline Determination

- In the absence of the Project, waste that was supposed to be incinerated will be landfilled and produce methane emissions through anaerobic fermetation.
- In this case, should methane emissions per unit waste be calculated from waste composition of the Project implementation site or should it be the average level of the country (or region) concerned?
- The issue is whether the Baseline should be static or forward dynamic.

(2) Methane Baseline Emissions (BE) = (Amount of waste to be incinerated) ×(Methane emissions per unit waste of the Baseline)

(3) Due to incineration, methane emissions with the Project will be zero.

(4) Methane Emission Reductions (Annual) = BE

2.-5 Energy Conservation Through Change of Production Processes, Etc.

This type of projects aim to reduce consumption of fossil fuel per unit production by improving and modifying production facilities and processes, and switching raw materials.

(1) Baseline Determination

- GHG emissions from production processes before modification or improvement will be the Baseline. GHG emissions will be calculated based on consumption of fossil fuel per unit production.
- The issue is whether the Baseline should be static or forward dynamic.

(2) GHG Baseline Emissions (BE) = (Annual production after modification or improvement) × (GHG emissions per unit production of the Baseline)

(3) Actual GHG Emissions with the Project [PE] = Annual GHG emissions from new processes

(4) GHG Emission Reductions (Annual) = BE-PE

DEFINING BASELINES FOR CDM ENERGY SECTOR PROJECTS

BY

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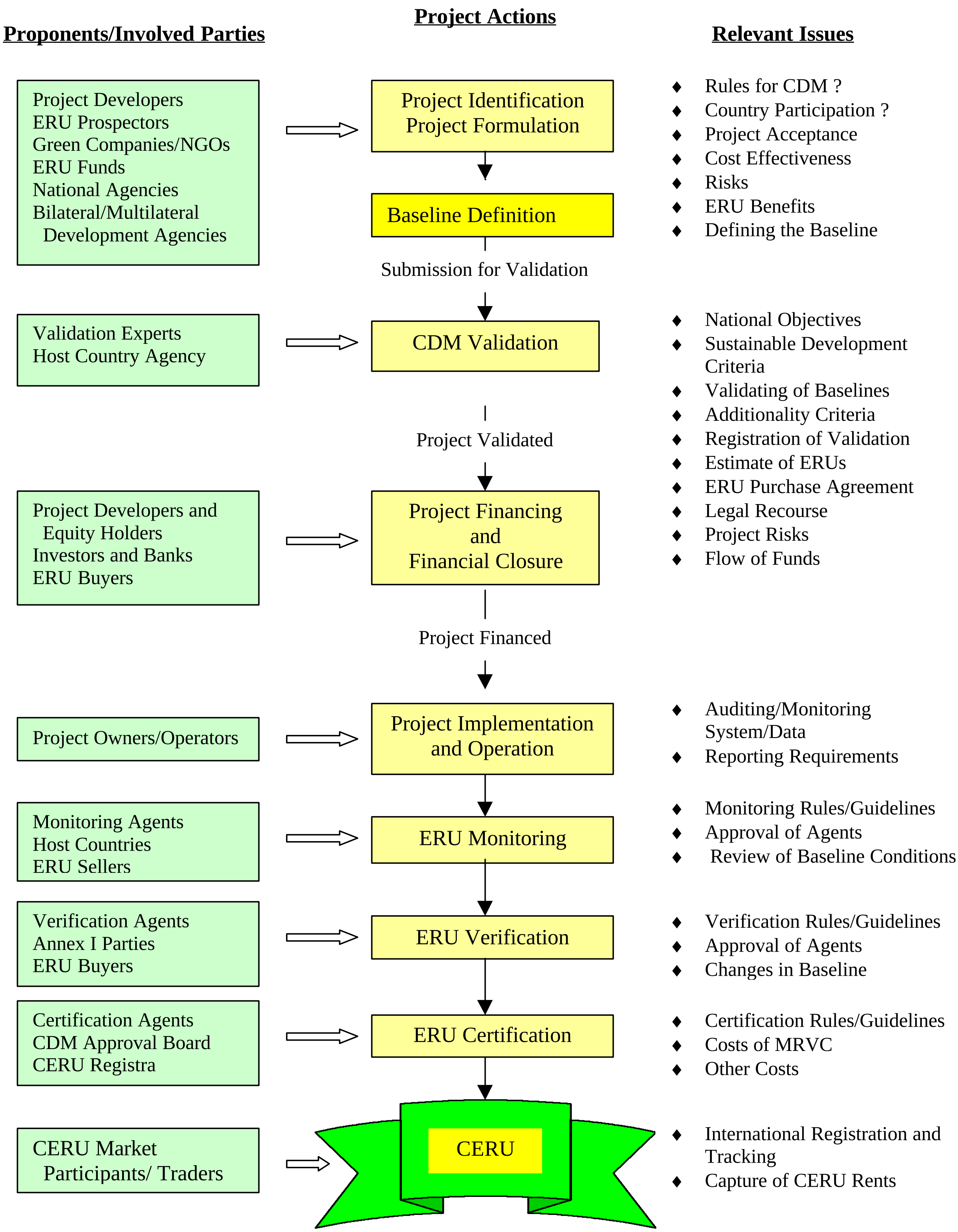
25 FEBRUARY, 1999
TOKYO, JAPAN

OVERVIEW OF PRESENTATION

- Steps in the CDM Project Cycle.
- Approach, options and steps for defining energy project baselines.
- Issues relating to energy project baselines.
- Validation and verification of energy project baselines.
- Conclusions and recommendations.

Steps in the CDM Project Development Cycle



APPROACH FOR DEFINING ENERGY PROJECT BASELINES

- Who has the responsibility for defining the baseline?
  - The ultimate responsibility must be with the host country.
  - The actual responsibility will fall to the project developer / investor.
  - Validation and certification will discourage inflating of baselines.

- What factors should be considered in defining the baseline?
  - Current trends in technology and practice.
  - Financial optimums.
  - Economic optimums.
  - Projections / simulations of future expectations.

- When should the baseline be defined?
  - In association with the definition of the CDM project.
  - In advance to attract CDM investments.

OPTIONS FOR ENERGY PROJECT BASELINES

- National Baselines – not very practical for determining the additionality of specific energy projects. More useful for assessing the additionality of macro policy and institutional measures.

- Sectoral Baselines – also not practical for assessing the additionality of specific energy projects. Useful for assessing the additionality of sectoral policy and institutional measures.

- Sub-sectoral Baselines – potentially useful for establishing additionality benchmarks that can be periodically updated and used in lieu of more specific baselines.

- Technology Baselines – useful in establishing the additionality of technology efficiency improvements.

- Project Baselines – necessary for defining the additionality of specific CDM projects.

STEPS FOR DEFINING ENERGY PROJECT BASELINES

1. Clearly define the proposed CDM project and identify the “normal” economic benefits / outputs of the project (e.g., kWh, lumens, tons of steam, passenger kilometers, etc.). Define these benefits as: $\mathbf{B_{cdm}}$

2. Define the baseline project that will result in similar economic benefits /outputs. Define these benefits as: $\mathbf{B_b}$

3. Ensure that the “normal” economic benefits / outputs of both the CDM project and Baseline project are equal so that we are not comparing “apples against oranges”. $\mathbf{B_{cdm} = B_b}$

(Steps for Defining Energy Project Baselines - continued)

4. **Financial Additionality** - define the financial present value (FPV) of all capital and O&M costs for the CDM project and the baseline project. Determine if the financial present value of the costs for the CDM project is greater than the present value of the costs for the baseline project. That is: $\mathbf{FPV_{cdm} > FPV_{b}}$. If not, the CDM project is not financially additional to the baseline and should not be considered for CDM.

5. Economic Additionality - define the economic present value (EPV) of all capital and O&M costs for the CDM project and the baseline project. Determine if the economic present value of the costs for the CDM project is greater than the present value of the costs for the baseline project. That is: $\mathbf{EPV_{cdm} > EPV_{b}}$. If not, the CDM project is not economically additional to the baseline. However, the project may be considered by the CDM to help remove barriers or change national policies.

(Steps for Defining Energy Project Baselines - continued)

6. **GHG Additionality** – define the net greenhouse gas (GHG) emissions for the CDM and the baseline project. Determine if the GHG emissions for the CDM project are less than the GHG emissions for the baseline project. That is: $\mathbf{GHG_{cdm} < GHG_b}$. If not, the CDM project is not environmentally additional to the baseline project.

7. **ERUs of the CDM Project** – the emission reduction units (ERUs) of the CDM project can simply be represented as:
   $\mathbf{ERU_{cdm} = GHG_b – GHG_{cdm}}$.

ISSUES RELATING TO ENERGY PROJECT BASELINES

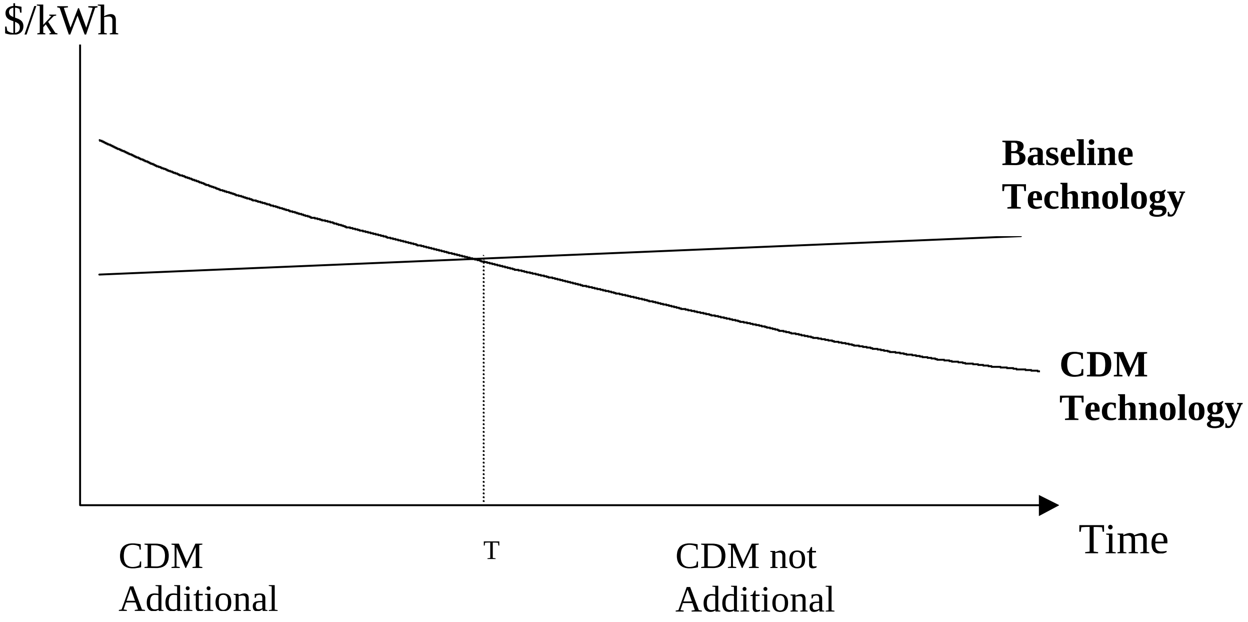
- **Measurability of baseline GHG emissions** – the baseline project is counterfactual and does not exist if the CDM project is selected. Thus the emission profile of the baseline project is hypothetical. However, the emission profile of similar baseline projects may be substituted.

- **Changes in expected baseline project emissions** may occur due to political, economic, technical and institutional uncertainties. Dealing with these uncertainties in the baseline definition phase is not practical. They should be evaluated during the verification processes for emissions from CDM projects.

- **Validity period for baseline emissions** – the period for which baseline emissions are valid should be equivalent to the period for which the baseline project is in fact replaced by the CDM project. However, it should not exceed the economic life of the baseline project.

(Issues Relating to Energy Project Baselines – continued)

- **Static versus dynamic baselines** – the problem of fixed baselines can be addressed by considering periodic adjustments to the validity of a baseline based on economic criteria. The figure below illustrates an example where the CDM option becomes less costly in time "T" than the baseline option and is therefor no longer financially additional.



VALIDATION AND VERIFICATION OF PROJECT BASELINES

- Validation of project baselines should be the responsibility of host country national CDM authorities and should be part of the overall process of validating a CDM project.

- The validation process should confirm the estimated ERU potential of a proposed CDM project.

- Verification of project baselines should be undertaken by independent CDM project verification agents and should be part of the overall process of verifying the ERUs from a CDM project.

- The verification process should confirm the actual ERU production of an implemented CDM project.

- Upon verification, the ERUs of a CDM project can be certified by the CDM Executive Board.

CONCLUSIONS AND RECOMMENDATIONS

- The process of defining energy project baselines should be simple and transparent.

- Project baselines are preferable to national and sectoral baselines as they provide a basis for a more direct evaluation of resulting CDM ERUs.

- Project baselines should allow for the determination of the financial, economic and environmental additionality of proposed CDM projects.

- Validation of CDM project baselines should be the responsibility of host countries in recognition of national sovereignty.

- Verification of CDM project baselines should the responsibility of designated independent verification agents to ensure environmental integrity.

Advancing the Development of Forestry and Land-Use Based Project Baseline Methodologies for the Developing CDM Regime

Presented at:

Global Industrial and Social Progress Research Institute's
Workshop on Baselines for CDM
Hotel New Otani Tokyo, Japan
February 25th and 26th, 1999

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Over the last decade, a significant number of climate change mitigation projects in a range of land-use change and forestry (LUCF) sectors have been pursued under the aegis of the Activities Implemented Jointly pilot phase or through other mechanisms. As development under the Kyoto Protocol proceeds, it is still unclear what the role of LUCF projects will be in achieving the objectives of the Protocol. To the extent that LUCF projects can be pursued, particularly through the Protocol's flexibility mechanisms, there is a fear among important interest groups to the policymaking process that forestry projects will overwhelm the nascent climate change mitigation marketplace. At worst, this outcome is seen as having the potential to undercut the environmental impact of the Kyoto Protocol; at best, it is viewed as undercutting the Protocol's technology transfer and other objectives.

One proposed approach to solving this potential problem is to simply eliminate the opportunity of LUCF projects to participate under the Protocol's flexibility mechanisms, including Joint Implementation under Article 6 and the Clean Development Mechanism under Article 12. An alternative approach would be to set project-level standards by which interest groups with concerns about the forestry sector can be assured that only "legitimate" projects are being granted mitigation status under the Protocol. The project-level additionality criterion stated in the Protocol is one of the standards being looked to for this purpose.

Although sometimes defined in different ways, additionality was required under the "activities implemented jointly" (AIJ) pilot phase and is required under Articles 6 and 12 of the Kyoto

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Protocol. Additionality is particularly important in the context of projects pursued under the Clean Development Mechanism (CDM) because the certified emissions reductions generated through the CDM will be used to help meet emissions reduction targets of Annex B Parties. If project activities are not additional, then global emissions will likely be higher than they would have been without the CDM project. Additionality is less of a policy concern for mitigation projects occurring within Annex B countries, assuming that those countries ultimately comply with their obligations under the Protocol, because additionality largely disappears as a concern in a capped emissions system. It does remain a practical issue for Annex B countries, however, since credits issued to non-additional JI or other projects will raise the future compliance hurdle for those countries.

Project-by-project additionality determinations through the creation of a variety of baseline cases have proven a particularly difficult concept to operationalize in the AIJ pilot phase. This is because of the unavoidable subjectiveness of estimating what would have happened “but for” any specific project, often referred to as the “baseline” or the “reference case.” It is against this reference case that a project’s greenhouse gas (GHG) benefits must be calculated. As many observers have pointed out, the difficulty of project-specific “additionality proofs” is compounded by the fact that parties to a CDM or other transaction may have an incentive to overstate a project’s additionality and emission reduction benefits.

The Treatment of LUCF Mitigation Obligations and Options Under the FCCC and the Kyoto Protocol

Numerous studies, including those of the Intergovernmental Panel on Climate Change, have concluded that forestry-based and other biotic climate change mitigation measures have an important role to play in national and international climate change mitigation efforts. Estimates of the cost-effective global potential of forestry offsets often exceed one billion tons of carbon per year.

Reducing land use-related sources and enhancing land-use and forestry-related sinks are important

UNFCCC Article 4(2)(a): Parties shall adopt national policies and take corresponding measures on the mitigation of climate change by . . . protecting and enhancing its greenhouse gas sinks and reservoirs.

Kyoto Protocol, Article 2.1(a)(ii): Annex I Parties shall implement policies relating to protection and enhancement of sinks and reservoirs, and promotion of sustainable forest management practices, afforestation, and reforestation.

Kyoto Protocol, Article 3.3: Industrialized Parties shall net out forestry sources and sinks in calculating their emissions.

Kyoto Protocol, Article 6.1: Any Annex I Party may transfer or acquire emission reduction units from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks.

Kyoto Protocol, Article 12.3(b): Annex I Parties may use the certified emission reductions accruing from project activities to contribute to compliance with part of their quantified emissions reduction commitments.

components of the U.N. Framework Convention on Climate Change and of the Kyoto Protocol. The Kyoto Protocol mandates industrialized countries to account for forestry-related sources and sinks in demonstrating Protocol compliance.

Often overlooked in the debate over forestry under the CDM is the tremendous role that forestry-sector projects, appropriately designed and implemented, can play in biodiversity conservation, sustainable development activities, watershed protection, food production, and other areas that are high societal priorities.

There Are Many Different Kinds of LUCF and Forestry Projects, Each Presenting a Very Different Profile from the Perspective of the Technical Issues At Issue, Including Baseline Development.

In the political environment that surrounds today's carbon offset and joint implementation debates, biotic mitigation measures are often addressed as a monolithic block. What quickly becomes clear in any serious discussion of LUCF projects, however, is the variety of biotic mitigation technologies, and the diversity of their ability to compete in the developing mitigation marketplace. In considering forestry technical issues, it is important to recognize that the LUCF sector is made up of many sub-sectors, and it makes not sense to talk about LUCF potentials or issues in a generic way. These subsectors include:

- Forest conservation (potentially including park reserve establishment/expansion; agroforestry; commercial plantations; and forest management)
- Reforestation (potentially including forest restoration, afforestation, long-term rotations, and short-term rotations)
- Bioenergy (substituting for fossil fuels, or mined firewood)
- Forest management including (sustainable forest management and plantations)
- Harvesting Method (including reduced impact logging)
- Conservation tillage practices

Each of these LUCF technologies has very different technical and policy characteristics.

Relatively Little Technical Thought Has Gone into How to Address LUCF Technical Mitigation Issues; Even less than in the Energy Sector

Notwithstanding the cost-effectiveness and multiple benefits of forestry and other biotic offsets, their future as an accepted mitigation option remain uncertain. Individuals and organizations concerned about relying on forestry and land-use change projects for climate change mitigation have raised various policy and technical concerns:

- Can forestry and land use change projects be reliably quantified, monitored, and verified?

- Will pursuit of forestry and land-use change mitigation efforts impede basic economic development or result in negative environmental impacts in developing countries?

- Will pursuit of forestry and land-use change mitigation efforts impede progress on achieving actual emissions reductions and technology transfer objectives in the energy sector?

- Will land use-based mitigation measures be lost prematurely, leading to reversal of their mitigation benefits?

Dealing with these questions is often an exercise in speculation, primarily because there are still no commonly accepted standards for evaluating GHG offset projects, and existing offset projects vary widely in quality. Hence, most observers evaluate climate change mitigation projects through their ability to address several key questions:

- Are they supplemental to what would have happened but for the project?

- Are the project's benefits reliable and long-term?

- Can the project's benefits be accurately quantified, monitored, and verified?

- Do the projects provide significant co-benefits?

These questions apply to all categories of project-based mitigation measures, forestry-based and otherwise. What differs in some cases is how forestry and land-use projects are perceived to perform against some of these criteria. Thus, as projects have developed through the AIJ pilot phase, numerous studies have been conducted to measure and analyze important aspects of offset methodology. The most important issues identified in these studies are almost certainly to become important CDM methodological issues. Key issues are additionality, baselines, leakage, and monitoring and verification. LUCF projects are often singled out for particular attention in these areas, even if their being singled out is undeserved.

Technically and politically credible answers to these issues are clearly needed if forestry is to play a significant role in future climate change mitigation efforts. If this work is not accomplished, the result could be major societal losses in foregone cost-effective climate change mitigation opportunities, as well as foregone opportunities to simultaneously advance other important social objectives.

Additionality and Baselines for LUCF Projects

Although sometimes defined in different ways, additionality was required under the "activities implemented jointly" (AIJ) pilot phase and is required under Articles 6 and 12 of the Kyoto Protocol. Additionality is particularly important in the context of projects pursued under the Clean Development Mechanism (CDM) because the certified emissions reductions generated through the CDM will be used to help meet emissions reduction targets of Annex B Parties. If project activities are not additional, then global emissions will likely be higher than they would have been without the CDM project. Additionality is less of a policy concern for mitigation projects occurring within Annex B countries, assuming that those countries ultimately comply with their obligations under the Protocol, because additionality largely disappears as a concern in a capped emissions system.

Because determining what is additional is a significant challenge for both the forestry and energy sectors, an important first step involves addressing the concept of additionality as it is commonly discussed: 1) *Environmental additionality*, which refers to whether some or all of the CO_2 benefits would have occurred in the absence of the project; and 2) *Financial additionality*, which refers in some sense to whether the project would have happened anyway, and to whether the project's development and financing is truly motivated by CO_2 mitigation concerns. The principal motivation behind these additionality components is to avoid crediting investments that will not reduce the amount of carbon dioxide in the atmosphere under business-as-usual circumstances.

For some of the LUCF sectors mentioned above both financial and environmental additionality are clearly an issue, for others, however, the case is much less clear. Commercial plantations and forest management, for instance, can generate strong financial additionality concerns. Like the majority of energy-sector projects, these projects usually have an economic rationale motivating investment, therefore justifying the CO_2 benefit beyond standard business-as-usual circumstances can become important to meeting the additionality requirement. In contrast, forestry conservation projects, for example, generally have no economic rationale, and are far more rarely challenged on additionality grounds that energy-sector or commercially-oriented LUCF projects. The question then becomes one of environmental additionality, e.g. whether the land involved was truly threatened with destruction, and whether the proposed project would change that outcome.

The most widely accepted approach to demonstrating CO_2 additionality is by developing baseline emissions estimates, and comparing them to a "with project" case or cases. Baseline case and "with project" case establishment is widely recognized as being among the most difficult issues in creating an accepted carbon offset.

How are Baselines and "With Project" Cases Determined?

In estimating total carbon benefits of an offset project, a baseline of emissions or sequestration-related activity must be established against which to measure change. A project cannot claim emissions reductions unless a case is made that demonstrates that the proposed project practices are “additional” to baseline circumstances. “The baseline is broadly defined as the collective set of economic, financial, regulatory and political circumstances within which a particular project operates.”(Costa, P.M., *et al.*, *SGS Forestry: Carbon Offset Verification Services - Introduction*, SGS Forestry, Oxford, England (1997)). With forestry, the baseline is the level of carbon storage that would have existed in the absence of the offset.

Establishing the baseline scenario requires concrete knowledge of future trends including economic, sociological, and political practices. SGS Forestry has recently outlined a basic process by which it asserts this can be done: "[t]he project baseline should ultimately combine the evidence of the historical baseline together with potential future constraints, as appropriate to the situation" (Costa, *et al.*, 1997). SGS argues that project sponsors should identify potential future developments (political or economic) that might dramatically impact the project baselines and should define guidelines for adjusting the project baseline if or when the dramatic event occurs (Costa, *et al.,* 1997).

Baseline establishment for forestry projects is susceptible to being divided into two pieces:

* *First, the biophysical baseline projecting the vegetative "but for" case on the land-base in question.* It can be argued that the science exists to easily measure this aspect of the baseline on a project level.

* *Second, what has been defined as the socioeconomic baseline.* This baseline is more difficult to measure. First, it is difficult to identify human behavior in alternative policy or economic scenarios and the effects of those behaviors on the forestry project in question (Fearnside, 1997). Second it is difficult to identify the appropriate economic boundaries within which baseline assessments should be made. An overly narrow boundary could lead to severe leakage effects. Too broad a boundary might make it impossible to define and implement any offset project, including energy-sector projects. As the IEA has stated, "[s]ystem boundaries have to be drawn in a way which limit the relevance of effects outside of that system on the outcome of the assessment to a tolerable minimum” (International Energy Agency, 1997).

The History of Baseline Development in Forestry Projects

As it stands now, the Kyoto Protocol’s additionality standard appears stricter than that which was established for the AIJ pilot phase, which was interpreted by many observers to mean that the reclassification of overseas development assistance funding as joint implementation should be avoided. General approaches being suggested for additionality are displayed in Table 1. The Table is not limited to forestry projects.

Table 1
Summary of Methods for Evaluating Additionality

Method	Example
Quantitative Methods	
Establish a reference project	Projects already planned/approved; projects that satisfy return on investment criteria (Heister, 1996)
Develop sector-specific baselines	Host country would need to establish baseline emissions for sectors supporting JI projects before project approval (Carter, 1997; Wirl et al., 1996)
Qualitative Methods	
Establish guidelines	USIJI Program Criteria (USIJI, 1994); AIJ Japan Program (Environment Agency of Japan, 1997)
Demonstrate implementation barriers	Projects qualify if parties can show that a technological, financial, or institutional barrier is overcome (Martinot, 1997; Carter, 1997; IEA, 1997)
Narrow project categories that automatically qualify	Some projects such as wind and solar generation are generally unlikely and, therefore, most likely additional (Carter, 1997)

As already noted, financial additionality has not been a significant consideration in the evaluation of forest protection projects. Therefore few examples of such additionality "proofs" exist.

Several of the baseline definition approaches used in forest protection projects are provided below:

- *The Ecoland project in Costa Rica*. Baseline Case: It was argued that private inholdings within the Piedras Blancas National Park were under imminent threat of loss if not somehow protected. Logging permits were already being issued for some of the parcels, and agriculture already had a foothold within the Park. Landowners, who had been waiting for government buyouts for several years, were threatening to accelerate the pace of land use change if such buyouts were not accomplished. It was assumed for the Baseline Case that lands would be cleared over a 15 year period without a project intervention. "With Project" Case: Carbon offset funding was made available to purchase a portion of the private inholdings, which would then be turned over to the National Park service.

- *The Face Foundation project in Uganda*. Baseline Case: Although there is no private land within the Park, there are clear warnings that the park will be threatened by human-induced changes to the land and water ecosystems by the expansion of the neighboring communities. Most significant threats arise from traditional income generating activities rely on forest products (small-scale plantations, grazing livestock, and timber harvesting) and difficulties associated with rising populations in the region and potentially questionable land tenure patterns. "With Project" Case: The Ugandan government has not shown the capability to reforest and restore these national parks. The funding for this project is additional.

- *The Rio Bravo project in Belize*. Baseline Case: Multiple baselines were employed for different parts of the Rio Bravo project. In the case of Parcel A, it was argued that the land would be essentially clearcut for new agricultural development in the absence of project intervention. This would lead to the loss of existing biomass, and to foregone growth in standing biomass on the same parcel. In the case of Parcel B, it was argued that a status quo situation would have prevailed in the case of carbon levels. "With Project" Case: In the case of Parcel A, carbon offset funding was made available to purchase the parcel for the Programme for Belize, preventing its conversion to agriculture. In the case of Parcel B, carbon offset funding was made available to develop a sustainable forestry management program designed to increase the total pool of sequestered carbon.

- *Reduced Impact Logging in Malaysia*. Baseline Case: The forestry industry in Indonesia controls over 320 million ha of production forest. Current logging practices in Kiani Lestari involve felling trees in random directions, due in part to the trees being literally tied together by vines, and extraction by bulldozers, which results in damage to both the residual stand and the soil. Studies in neighboring Malaysia indicate that these conventional logging practices break and uproot as many as 50% of the remaining trees and disturb soils on up to 40% of the land area. The Malaysian studies found that harvesting as few as 10 to 15 trees per ha released as much as 300 - 350 t CO_2. In the absence of the project, uncontrolled and destructive logging practices are expected to continue in Kiani Lestari. "With Project" Case: Data developed in Malaysia show that there will be reduced carbon dioxide emissions and enhanced sequestration in RIL-harvested areas for decades. In addition to carbon benefits, there are social and economic benefits that would not be generated without the project. It is relatively certain, that RIL would not have occurred if not for the offset funding, but RIL's place in future regulatory regimes is far from certain.

- *The Noel Kempff Mercado project in Bolivia*. Baseline Case: Although there is no private land within the Park, there are clear warnings that the park will be threatened by human-induced changes to the land and water ecosystems by the expansion of the neighboring communities. Most significantly, recent colonization at the park's borders has

> resulted in continued illegal extraction of mahogany and cedar, as well as hunting and trading of endangered species, in addition to agricultural and cattle ranching expansion on park lands. All of these activities have been made easier by the lack of Park authorities or infrastructure necessary to enforce protection along with increased road building and international demand for live animals and their products. The inaccessibility of sustainable livelihoods and increasing demands brought about by new communities in the area represent an imminent threat to this biological diverse area. "With Project" Case: Under the three tiered scope of the project, carbon offset funding was made available to avert imminent land-use changes through the buy out of concessionaires and the establishment of income-generating activities for local populations.

One conclusion of this brief review is that, as with energy sector projects, baseline approaches are basically customized to the circumstances of each project.

Thinking About Alternatives to Project-by-project Baseline Assessments for the LUCF Sector

One way to think about the importance of LUCF additionality is in the context of determining the relative magnitude of the two errors associated with additionality policy: 1) the emissions resulting from overly strict additionality policies that effectively prevent the crediting of legitimate and additional LUCF projects; and 2) the credits that might be inappropriately issued based on overly lax additionality criteria. It is possible, for example, to predict a scenario for tropical forest cover over the next several decades under a business as usual scenario. Food and Agriculture Organization (FAO) statistics on forest cover suggest that nearly 50% of global forest cover is threatened. If this the case, the emissions associated with a failure to credit legitimate forest conservation projects is very large. The credits that might be inappropriately issues through a failure to apply additionality criteria, however, is of roughly the same magnitude. Clearly, some approach to addressing additionality at the project level is important to minimize both errors.

As already noted, project-by-project additionality has proven a particularly difficult concept to operationalize in the AIJ pilot phase. This is because of the unavoidable subjectiveness of estimating what would have happened "but for" any specific project. The current project-by-project approach to baseline determination and additionality assessment for LUCF projects will almost certainly prove as unacceptable for forestry-sector mitigation efforts over the longer term as it is already proving for energy-sector mitigation efforts. This makes credible investigation of the application of alternative additionality screens a high priority.

Although there are many facets to the additionality issue, two primary approaches to the issue can be broken out:

Conducting project-by-project additionality determinations. As mentioned above, this approach has prevailed to date; it involves the construction of "best guess" reference cases at the project level. The difficulty with this approach is that "best guesses" can legitimately vary widely, allowing analysts to come to completely different conclusions with respect to both financial and emissions additionality of a project. It also creates an incentive for project developers to creatively overstate project benefits, and carries with it inordinately high transaction costs.

Apply sectoral or geographical additionality "benchmarks" in lieu of project-by-project additionality determinations. Such benchmarks have been discussed primarily in the context of energy-sector projects. Based on some projection of business-as-usual performance at the sectoral or country level, these benchmarks would establish the "standard-to-beat" for projects seeking CO_2 credits. Once established, projects meeting or going beyond the benchmarks would receive CO_2 credits for doing so. Although less site-specific than a project-level additionality review, and hence capable of missing important nuances specific to an individual project, the standardized benchmarking approach would presumably be less susceptible to project-level gaming, would be more conducive to guiding mitigation projects and activities in particular policy and project directions, and would presumably entail much lower transaction costs than true project-level analyses.

As with energy-sector interventions, LUCF benchmarks would be applied to all projects within a given sector, looking at historical and sectoral information to develop some sort of benchmark by which project developers and evaluators could assess the additionality of the projects without having to develop a project-specific methodology and assessment. As with energy-sector benchmarking, this approach applied to the LUCF sector implicitly assumes that the inaccuracy of the resulting benchmarks at the individual project level is statistically unimportant when averaged over many projects, or at least that the systematic error associated with the sectoral approach is less than the random or systematic error associated with project by project additionality assessments. Consolidating baseline-setting efforts across an entire class of projects should also offer the opportunity to achieve increased credibility and fewer transaction costs.

As in other benchmarking efforts, a number of analytical issues need to be addressed in considering LUCF benchmarks:

- What are the possible bases, strategies, and methodologies for constructing benchmarks?
  - Historical land use trends
  - LUCF related projections
  - Normative values

- How does LUCF benchmarking systematically differ, if at all, from energy-sector benchmarking? For example, is historical data more or less relevant to benchmark creation, and are LUCF trend projections more or less reliable?

- How aggregated can the benchmarks be made, whether sectorally or geographically?

- How often should LUCF benchmarks be updated?

- Which LUCF subsectors are most conducive to benchmarks, and which are simply not conducive?

In considering the development of LUCF benchmarks, it is important to be careful in defining what we are talking about. In many benchmarking discussions, several issues often get interchangeably discussed in ways that confuse rather than clarifies the issues. For example:

- *The feasibility of designing benchmarks:* Can a reasonable benchmarking approach be defined that plausibly reduces both the Type 1 and Type 2 errors referred to above to acceptable levels.

- *Benefit quantification*: Can the carbon benefit associated with meeting or exceeding the benchmark be quantified in a sufficiently robust manner? The issues of data availability, data accuracy, and data precision are very important to this determination, but are qualitatively different from the issues associated with whether a plausible benchmark can be designed in the first place.

- *Monitoring and verification*: Can the quantified benefits be sufficiently monitored and verified?

- *Policy relevance:* Even if benchmark can be designed, and the benefits sufficiently quantified, is the magnitude of the potential benefit (regionally or globally) sufficient to justify the effort to going through the benchmarking process. It may well be that the answer to this question varies considerably from LUCF subsector to subsector.

Overview of LUCF-Based Benchmarking

The conceptual basis for thinking about benchmarking in the LUCF sector is similar to that for the energy sector. Many issues that need to be addressed in assembling benchmarks can be the same, or at least similar, to those encountered in the energy sector. There is no inherent reason to suspect that LUCF-based benchmarks at the sectoral level are inherently more difficult or easier to arrive at than benchmarks for individual energy sectors. Sub-sector by sub-sector, however, some LUCF benchmarks are likely to be considerably more important, plausible, and cost-effective than others. Indeed, it may turn out that some categories of LUCF projects are simply not susceptible to the development of effective benchmarks. Even where a benchmark may be achievable, it may be that the climate change mitigation benefit of the benchmark in question may not justify the effort required to develop the benchmark.

Because so little attention has been given to the issue of LUCF benchmarking, any tentative conclusions need to be treated with caution. A "from the ground up" assessment of forestry benchmarking is clearly needed.

Conclusions

Over the last decade, land use change and forestry (LUCF) projects have been subject to the same additionality reviews as have other types of mitigation projects. Several conclusions are evident:

1) *There is nothing qualitatively different in the issues to be addressed in assessing financial or emissions additionality for LUCF projects as compared to other project types.* The analytical steps are the same, and the subjectiveness tends to be parallel. Many of the socioeconomic variables that must be projected are different for LUCF projects, however, requiring different data and technical expertise, and potentially different techniques for evaluating additionality claims.

2) *In practice, LUCF projects have been easier to evaluate on financial additionality grounds than most other types of mitigation projects.* Many energy-sector projects pursued under the AIJ phase have been charged with being non-additional; relatively few LUCF projects have faced a similar challenge. This is because LUCF projects to date are generally not as commercially oriented as energy-sector projects. Few LUCF projects, particularly those involving forest conservation efforts, have offered any rate of return (or even repayment) to project funders. As such, the CO_2 mitigation motivation of the projects has been undisputed.

3) *As more potentially commercial LUCF projects are proposed for pursuit under Articles 6 and 12 of the Kyoto Protocol, the challenges facing financial additionality determinations in the LUCF and other sectors will become more similar.* It is hard to envision circumstances, however, in which LUCF projects pose more difficult additionality issues than those associated with projects in other sectors.

4) *Alternatives to project-specific additionality determinations, including technology and performance-standard benchmarking, should prove as applicable to LUCF projects as to other kind of mitigation projects.* For the same reasons that apply to other sectors, it is important to identify and develop alternatives to the current subjective approach to determining project-level additionality for LUCF projects.

Clearly, developing baseline methodologies to evaluate additionality will be an important component of implementing the CDM. Although experience with the AIJ pilot phase indicates that the additionality of LUCF projects is no more difficult to evaluate than that of other project types, it is important to ensure that credible but implementable methodologies are developed for dealing with the additionality issue in general.

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I. Introduction

Initiated in 1993 as part of the U.S. Climate Change Action Plan, the U.S. Initiative on Joint Implementation (USIJI) supports the development and implementation of voluntary projects between U.S. and non-U.S. partners that reduce, avoid, or sequester greenhouse gas (GHG) emissions. Final groundrules for the USIJI Program,[1] published in 1994, describe the purpose of the pilot program, outline the time line for evaluation and reassessment of the program, define eligibility criteria for domestic and non-U.S. participants, establish an Evaluation Panel to review potential USIJI projects, and define criteria for acceptance of projects into the USIJI portfolio.

Projects accepted into the USIJI Program are evaluated against nine criteria and four other areas of consideration. The criteria require that each project accepted into the USIJI Program demonstrate that it:

- has the acceptance of the host country government;
- will reduce or sequester net GHG emissions;
- was developed or realized because of the USIJI Program;
- provides data and methodological information sufficient to measure emissions with and without the project;
- provides for tracking and verifying the emissions reduced or sequestered by the project;
- identifies associated environmental and developmental benefits;
- and provides assurance that benefits gained will not be lost over time.

These criteria are intended to identify those projects that support the development goals of the host country while providing GHG benefits beyond those that would occur in the absence of the joint implementation activity. The criteria have been formulated to ensure that projects accepted into the program will produce real, measurable net emissions reductions. Net emission reductions achieved as a result of USIJI projects will be measured, monitored, verified, and reported.

The USIJI Program is directed by an Interagency Working Group, chaired by the Department of State, which has the primary responsibility for policy development. The USIJI Evaluation Panel is co-chaired by the Environmental Protection Agency and the Department of Energy, and includes representatives from the

Agency for International Development and the Departments of Agriculture, Commerce, Interior, State, and Treasury. The USIJI Secretariat, an interagency staff, supports the day-to-day operation of the USIJI Program. Technical experts are drawn from a variety of organizations to assist the Secretariat in the proposal review process and to provide technical assistance to project developers.

The USIJI Secretariat offers a variety of technical services to support both the development and the implementation of USIJI projects. These technical services include:
(1) technical assistance to aid project developers in calculating emission reduction benefits, developing monitoring and verification plans, and identifying sources of project financing;
(2) capacity building to support human and institutional capacity building for joint implementation in select countries around the world; (3) information resources including technical guidance documents, databases, a fax-on-demand service, an information hotline, and an Internet site; and (4) public recognition to help project participants increase the visibility of their participation in the program.

The USIJI Secretariat accepts project proposals at any time, and will provide limited technical assistance to project developers to help address USIJI project evaluation criteria and other considerations as specified in the USIJI Groundrules. A formal proposal evaluation and acceptance process is conducted approximately three times per year.

The first four years of the USIJI Pilot Program have provided valuable experience in testing and refining methodologies for designing, implementing, and evaluating GHG mitigation projects. A great deal has been learned in working with multiple international partners in the public and private sectors in a number of countries and across several project sectors. For example, host country acceptance is a good proxy for whether a particular project is compatible with that nation's development goals. There is a basis for preliminary criteria for determining whether a project is “additional," for guidelines for assessing non-GHG impacts associated with projects and for a measurement and verification protocol, and for tools to evaluate whether GHG benefits may be lost or reversed over time. Analysis of project cost data indicates that it is not yet meaningful to compare totals across projects in an effort to assess their relative cost-effectiveness. There are simply too many differences in presentation and substance, and project developers have indicated that certain cost data are confidential.

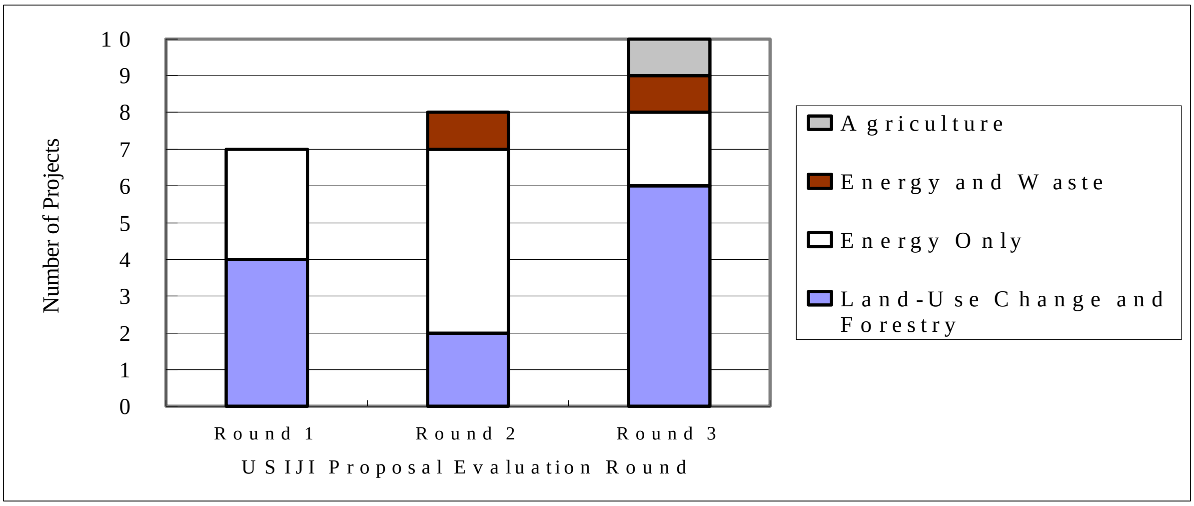
While the USIJI Program is pleased with the progress of USIJI and the AIJ pilot phase, it is clear that in the absence of credits, investments in JI projects will not reach the level necessary to fully realize the potential of this concept. Although the experience gained from the 25 USIJI projects accepted to date provides a useful foundation for developing criteria for crediting GHG reductions achieved by JI projects, additional work will be needed to develop standard criteria that can be applied successfully to a broad range of projects. However, this should not prevent making a decision to adopt credited JI in the near future.

II. Summary of USIJI Projects

As of June 30, 1997, the USIJI Program had conducted three rounds of proposal evaluations and accepted 25 projects from 11 countries. Seven proposals were accepted in Round 1 (announced in February 1995), eight in Round 2 (announced in December 1995), and ten in Round 3 (announced in December 1996). The following countries are currently hosting USIJI projects: Belize (2), Bolivia (1), Costa Rica (8), Czech Republic (1), Ecuador (1), Honduras (3), Indonesia (1), Mexico (2), Nicaragua (1), Panama (1), and the Russian Federation (4).

As the USIJI Program has grown, it has continued to diversify in terms of both the number of participating host countries and the type of project activities. The third round of proposal evaluations resulted in the addition of projects in five new countries-Bolivia, Ecuador, Indonesia, Mexico, and Panama-to the USIJI program. The 25 USIJI projects accepted to date span four principal sectors: twelve projects are classified as land-use change and forestry projects, ten are classified as energy projects, two are classified as both energy and waste projects, and one is classified as an agriculture project. Figure 1 presents the types of USIJI projects according to the evaluation round in which they were accepted.

Figure 1. USIJI Projects by Sector and Proposal Evaluation Round



Within each sector, many types of project activities are used to achieve GHG emission benefits. In the land-use change and forestry sector, project activities range from forest preservation, forest regeneration, afforestation, and silviculture to agroforestry, sustainable timber harvesting and the manufacture of durable wood products. In the energy sector, project activities include fuel switching, energy efficiency improvements, cogeneration, capture of fugitive emissions, and alternative energy generation. The two multi-sector projects involve the conversion of biomass waste to energy. The agriculture project involves crop management for the accumulation of soil carbon.

Although carbon dioxide ($C0_2$) is the primary greenhouse gas addressed in most USIJI projects, one project exclusively targets methane (CH_4) emissions and another reports both $C0_2$ and nitrogen oxides (NO_x) emission benefits. Over a 60-year period, the 25 USIJI projects are anticipated to generate GHG benefits totaling at least 136 million metric tonnes of $C0_2$,[2] 1.3 million tonnes of CH_4, and 4,900 tonnes of NO_x. Individual project benefits are expected to accrue over project lifetimes that vary from 12 to 60 years.

The USIJI projects involve a broad range of participants and are funded through a variety of mechanisms. The project participants include government ministries and agencies, non-governmental organizations, private-sector companies, universities, research institutes, and financing organizations. The sources of project funding include the sale of carbon offsets; revenues generated directly by project activities, such as the sale of timber, other biomass resources, and energy; investment capital from private-sector companies; loans provided by commercial banks and multilateral organizations such as the International Finance Corporation; government incentives; endowments; and grants.

All 25 USIJI projects have been formally accepted by the government of their host country, a requirement for their acceptance into the USHI Program. In each case, host country acceptance has been documented in a letter from the designated national authority of the host country. Of the 25 projects, 15 are classified as “in progress," indicating that activities associated with project implementation have begun on site. This could mean, for example, that although project implementation activities (e.g., construction and planting) have begun, GHG benefits have not yet necessarily begun to accrue. The remaining projects have not yet initiated on-site activities, and are classified as “mutually agreed." In several cases, difficulties in obtaining funding and/or overcoming logistical or technical obstacles have delayed project implementation.

A summary of the 25 USIJI projects is presented in Table 1 .

[2] *The total GHG benefits will be determined by the level of project funding received.*

Table 1. Summary of USIJI Projects

Tile of Project	Type of Activity	Stage of Activity(1)	Remarks Project life(2)	GHG Benefits(tonnes)(3)			
				CO_2	CH_4	N_2O	Other
Belize							
BEL/Maya Biomass Power Generation Project	Energy: alternative energy generation (biomass)	Mutually agreed	31 years	3,418,444			4,860(Nox)
Rio Bravo Carbon Sequestration Pilot Project	Land-use change and forestry : forest preservation, sustainable harvesting, reduced impact logging, silviculture, fire management, manufacture of durable wood products	In progress	40 years	6,023,992			
Bolivia							
Noel Kempff Mercado Climate Action Project	Land-use change and forestry : forest preservation, reforestation, park expansion, and sustainable forest product enterprise development	In progress	30 years	53,190,152			
Costa Rica							
Aeroenergia S.A. Wind Facility(4)	Energy: alternative energy generation (wind)	In progress	21 years + 1 month(with possible extension)	36,194			
Dona Julia Hydroelectric Project(4)	Energy: alternative energy generation (hydroelectric)	In progress	15 years (with possible 5 year extensions)	210,566			
ECOLAND: Piedras Blancas National Park	Land-use change and forestry : forest preservation and natural regeneration	In progress	16 years	1,342,733			
Klinki Forestry Project	Land-use change and forestry : afforestration, reforestation, silviculture	In progress	46 years	7,216,000			
Plantas Eolicas S.A. Wind Facility	Energy: alternative energy generation (wind)	In progress	21 years + 5 months	397,173			

Tile of Project	Type of Activity	Stage of Activity[1]	Remarks Project life[2]	GHG Benefits(tonnes)[3]			
				CO_2	CH_4	N_2O	Other
Project BIODIVERSIFIX	Land-use change and forestry : reforestation, fire management, anti-poaching operations	Mutually agreed	51 years	18,480,000			
Project CARFIX: Sustainable Forest Management[4]	Land-use change and forestry : forest preservation, forest regeneration, reforestation, silviculture, sustainable harvesting, reduced impact logging	In progress	25 years	21,776,749			
Tierras Morenas Windfarm Project	Energy: alternative energy generation (wind)	Mutually agreed	13 years + 11 months(with possible 5 year extensions)	296,761			
Czech Republic							
City of Decin: Fuel-Switching for District Heating	Energy: fuel-switching, energy efficiency improvements, cogeneration	In progress	26 years + 8 months	607,150			
Ecuador							
Bilsa Biological Reserve	Land-use change and forestry : forest preservation	Mutually agreed	30 years	1,170,108			
Honduras							
Bio-Gen Biomass Power Generation Project, Phase 1	Energy, waste: alterative energy generation (wood waste)	In progress	21 years	2,373,940			
Bio-Gen Biomass Power Generation Project, Phase 2	Energy, waste: alterative energy generation (wood waste)	In progress	21 years	2,373,940			
Solar-Based Rural Electrification in Honduras	Energy: alternative energy generation (solar)	Mutually agreed	24 years	17,192			
Indonesia							
Reduced Impact Logging for Carbon Sequestration in East Kalimantan	Land-use change and forestry :reduced impact logging	Mutually agreed	40 years	134,379			

Tile of Project	Type of Activity	Stage of Activity[1]	Remarks Project life[2]	GHG Benefits(tonnes)[3]			
				CO2	CH4	N2O	Other
Mexico							
Project Salicornia: Halophyte Cultivation in Sonora	Agriculture: Salicornia cultivation and crop management, technical analysis of soil carbon accumulation and commercial feasibilty of Salicornia cultivation	In progress	59 years + 7 months	1,080			
Scolel Te: Carbon Sequestration and Sustainable Forest Management in Chiapas	Land-use change and forestry : agroforestry, reforestation, sustainable harvesting, silviculture	In progress	30 years	55,000-1,210,000			
Nicaragua							
El Hoyo-Monte Galan Geothermal Project	Energy: alternative energy generation (geothermal)	Mutually agreed	37 years + 6 months	14,119,469			
Panama							
Commercial Reforestation in the Chiriqui Province	Land-use change and forestry : reforestation	Mutually agreed	25 years	57,640			
Russian Federation							
Reforastation in Vologda	Land-use change and forestry :assisted natural regeneration	Mutually agreed	60 years	858,000			
RUSAFOR-Saratov Afforestation Project	Land-use change and forestry : afforestation and reforestation	In progress	40 years (Sites 1 & 2); 60 years (Sites 3 & 4)	292,727			
RUSAGAS: Fugitive Gas Capture Project	Energy: capture of fugative methane emmissions	In progress	27 years + 7 months		1,263,500		
Zelenograd District Heating System Improvements[4]	Energy: energy efficiency improvements	Mutually agreed	30 years	1,575,840			
TOTAL				136,025,229-137,180,229[5]	1,263,500		4,860(Nox)

(1) The following definitions are used for these categories:

Mutually agreed = accepted USIJI proposal; activity is agreed between all Parties involved (designated national authorities), but project activities have not begun on site.

In Progress = any stage of activity between “mutually agreed” and “completed”

Completed = Project is finished/terminated

(2) Project life refers to the estimated functional lifetime of the project, not necessarily the period over which GHG reductions are estimated to occur.

(3) Reduction estimates are made by project developers. Estimates are in metric tonnes, full molecular weight basis. The USIJI Program does not accept these estimates per se, but will be monitoring and verifying emissions reductions as they are attained.

(4) Although the information on this project that is contained in this report is based on the project proposal and other material provided by the project developer, the developer has not yet reviewed this report.

(5) Actual reductions achieved will depend upon the amount of funding received.

III. Discussion of Key Issues

One of the primary goals of the ongoing Activities Implemented Jointly (AIJ) pilot phase of Joint Implementation (JI) is to test and evaluate methodologies for the design, implementation, monitoring, and verification of GHG mitigation projects involving multiple international partners in the public and private sectors. The practical experience gained by developing 25 pilot AIJ/JI projects involving the United States and 11 other countries offers valuable insight into the potential benefits offered by AIJ/JI and the challenges that must be addressed in order to achieve those benefits. The following issues have been identified as particularly critical to designing and implementing successful AIJ/JI projects; (1) determining the compatibility of the project with host country development goals; (2) determining the additionality of project benefits; (3) quantifying project costs; (4) measuring GHG emission benefits; (5) identifying non-GHG project impacts; (6) monitoring and verifying project results; (7) preventing the loss or reversal of project benefits; and (8) crediting emission reductions.

Although the USIJI Program requires that project proposals address most of these issues, the program does not mandate the approaches that must be taken. Therefore, different strategies are currently being used, even by projects with similar activities in the same sector. The comparative effectiveness of these strategies will become clearer as the projects reach maturity and as the program, consultants, academics, and others continue to conduct research on these issues. The following discussion highlights some of the questions raised, strategies applied, and lessons learned to date.

1. Determining the Compatibility of the Project with Host Country Development Goals

The developers of all 25 projects have demonstrated that their projects are compatible with the development goals of the host country. A broad range of development goals may be relevant to, and affected by, USIJI projects; these goals can include national targets for GHG emission reductions, improvements in energy efficiency, forest conservation, biodiversity and watershed protection, and sustainable economic development. The foremost method for documenting the compatibility of USIJI projects with host country development goals is obtaining a letter of host country acceptance of the project. As discussed above, this letter is a requirement for acceptance of the project by the USIJI Program. In addition, some project developers have further demonstrated how their project is consistent with host country regulations, laws, and policies, as well as with any bilateral agreements between the host country and the United States to cooperatively promote GHG emission reductions and sustainable development. This is a pivotal requirement for a successful project and data on existing projects indicate that assuring this criterion is met can be accomplished using existing procedures.

2. Determining the Additionality of Project Benefits

Several of the USIJI project criteria are intended to ensure that the GHG benefits associated with USIJI projects are additional to what would have occurred otherwise. This concept, known as “additionality", is critical to determining whether commitments to achieve net emission reductions have been met specifically through the implementation of USIJI projects. As with the determination of a credible reference scenario, the determination of additionality involves analysis of past and current trends that are extremely complex and difficult to identify and document. For the purpose of analysis, the USIJI Program has divided the concept of additionality into three components: emissions additionality, financial additionality, and program additionality. The technical issues surrounding additionality and its components are also areas where the USIJI program is currently conducting and sponsoring research. The primary goal of this research is to develop widely applicable methods for the determination of additionality.

Emissions Additionauty

In order to demonstrate emissions additionality, project developers are requested to develop emissions estimates for the reference and project scenarios. To be credible, the reference scenario projections should be consistent with (1) prevailing standards of environmental protection in the country involved; (2) existing business practices within the particular sector of industry; and (3) trends and changes in these standards and practices. Project developers must clearly demonstrate that the project will generate GHG benefits above and beyond those in the reference scenario. Some of the challenges associated with developing credible emissions estimates for the reference and project scenarios are discussed in the section “Measuring GHG Emission Benefits" below.

Financial Additionality

USIJI projects should not represent the simple repackaging of federal or multilateral funds that would have been available in the absence of the USIJI Program. Therefore, project developers are requested to demonstrate that their project funding is independent of, or in addition to, funding from the financial instrument of the FCCC (i.e., the Global Environment Facility), Official Development Assistance (ODA), U.S. government funding available in fiscal year 1993, and funding from multilateral development banks.

In some cases, the process of demonstrating financial additionality has been complicated by the use of ODA, GEF, or other non-USIJI-related funding sources either for components of the USIJI project or for a broader initiative from which the USIJI project was developed. For example:

- Several USIJI projects, particularly in the land-use change and forestry sector, are components of larger regional projects funded by ODA, multilateral sources, or grants for activities such as biodiversity or forest conservation. In these cases, the project developers were asked to distinguish clearly between funding used for USIJI and non-USIJI activities. The project developers can claim GHG benefits only for those activities supported by funding that meets the criterion for additionality. In some cases, projects that had used funding from multilateral development banks or ODA in the past were able to satisfy the additionality criterion because that funding had been discontinued and USIJI project activities were to be supported by additional funding from other sources.

- The project developers for one land-use change and forestry project used non-U.S.ODA-funded research to aid in project design, but did not use any of this funding directly for project implementation. Because the research element was separate from project implementation in terms of both the funding source and the funding management, this project was found to meet the USIJI criterion for financial additionality.

- Two related projects funded by loans from the International Finance Corporation were determined to meet the criterion of financial additionality because these loans are provided at or near market rates and are not considered ODA by the U.S. Government or under the standard international definition of ODA adopted by the OECD' s Development Assistance Committee.

Program Additionality

Project developers are asked to demonstrate that their project “was initiated as a result of, or in reasonable anticipation of, USIJI.” Therefore, project developers must demonstrate that, given prevailing regulations, policies, technologies, practices, and trends, their project would not have been introduced in the absence of USIJI.

This criterion required careful consideration in those projects that were a continuation, extension, or component of an existing program that was not initiated as a result of USIJI. In these cases, the project developers had to clearly demonstrate that the particular activities being proposed as USIJI projects had been initiated in response to USIJI, or that participation in the USIJI Program would uniquely enable the project developers to overcome barriers to implementation, such as a lack of funding, lack of government support, need for technical assistance, or difficulty identifying project partners.

The element of additionality is critical to ascertaining the environmental benefits of a JI project. From projects initiated to date, preliminary criteria may be established, although these will clearly not apply to all projects. A dual scheme, with general standardized additionality criteria and a separate process for individual assessment of promising projects that do not readily meet the standard guidelines, may ultimately be needed.

3. Quantifying Project Costs

The USIJI project criteria do not set any specifications for calculating and reporting project costs. In proposal materials. project developers are requested to provide information on project budgets and actual and potential funding sources only to the extent necessary to determine the additionality of project funding and to demonstrate the viability of the project. The FCCC Secretariat however, is now requesting cost information for JI projects. Ideally, this type of information would enable potential developers and investors, policy analysts, and other interested parties to evaluate the cost effectiveness of GHG mitigation projects, possibly in terms of the cost per ton of CO_2 equivalent emission benefits generated by the project. Although the USIJI Program has encouraged project developers to provide cost information for project development and implementation and has reported this information to the extent it is available, a number of challenging issues need to be resolved before this information can be used to evaluate the cost effectiveness of different JI projects on a consistent basis. These issues include the following:

- Further discussion is needed to define the types of relevant project costs and revenues and to differentiate between the costs and revenues associated with project development and those associated with project implementation.

- Further discussion is needed to develop a uniform cost reporting method that addresses such issues as how to account for variable interest, exchange, and depreciation rates and what discount rate should be applied.

- Some project developers wish to maintain the confidentiality of some or all of their cost data. The provision of partial cost information could complicate project comparisons on the basis of cost.

Because these issues have not yet been resolved, the USIJI Program has not attempted to validate the cost information presented to date on USIJI projects. Therefore, this information should not be used to compare the cost-effectiveness of these projects. The USIJI Program questions whether this may be a private-sector issue, with project costs being irrelevant for JI determination, and cost determination ultimately established by the market.

4. Measuring GHG Emission Benefits

The USIJI project criteria require that project developers provide sufficient data and methodological information to establish estimates of current and future GHG emissions in the absence and presence of project activities (i.e., emission estimates for the reference and project scenarios). This process is often challenging. For example, many projects lack site-specific data and the methods for determining the reference and project scenarios and calculating associated emission benefits vary widely. The USIJI Program is currently conducting research on the technical issues surrounding the measurement of GHG emission benefits. The primary goals of this research include the development of credible, transparent GHG emission benefit estimates for the 25 accepted USIJI projects and the development of widely applicable methods for the measurement of these benefits. Some of the technical issues referenced above are discussed more specifically below.

Data

In many cases, project- or site-specific data on GHG emission sources and sinks were not available to project developers during the proposal preparation process. In these cases, project developers had to rely upon default data obtained from regional, national, or international sources. To correct for inaccuracies resulting from the use of default data, many developers included in their proposal the collection of site-specific emissions and sequestration data as an anticipated USIJI project activity. In some cases, the GHG benefits projected by the developers in the project proposals have been, or will be, revised following the collection of site-specific data

A lack of site-specific data regarding GHG sources and sinks can lead project developers to exclude from their assessment the sources and sinks for which data are not available or which the developers assume to be relatively insignificant. Excluding GHG sources and sinks from project assessments can reduce the accuracy and credibility of the GHG emission benefits attributed to USIJI projects. On the other hand, focusing project assessments on the most significant and most accurately quantifiable GHG sources and sinks reduces both the reporting burden placed on project developers and, in some cases, the amount of uncertainty and error in the emission calculations. The determination of criteria for identifying “significant" GHG sources and sinks on a project-by-project basis is an important area for further development.

Methodological Information

In order to establish credible reference and project scenarios, project developers must identify the factors likely to influence emissions and sequestration in both scenarios and predict how these factors will evolve during the lifetime of the proposed project. In land-use change and forestry projects, these factors can include the variable demand for land and land-based resources (e.g., timber, food crops, and grazing pasture) due to population growth or migration, changes in the local and national economy, and changes in government land-use policies. In energy projects, these factors can include changes in the demand for, and the supply and cost of, various fuel sources as well as the development of new technologies and government energy policies.

The reference scenario is particularly difficult to formulate and verify because it represents the prediction of future activities that will not take place if the project is implemented. Project developers have generally selected one of three approaches to defining the reference scenario: (1) analyzing past trends and making a credible case that these trends are likely to continue in the future if the project is not implemented; (2) identifying the factors likely to influence future emissions and modeling their effects; and (3) selecting a control area outside the boundaries of the project that can be used to represent and evaluate the reference scenario over time. There remain some outstanding issues regarding the reference scenario. One issue is the extent to which the reference scenario should remain static for the lifetime of the project or should be revised to reflect unanticipated changes in local, regional, or national conditions affecting the project.

In addition to identifying the factors that influence the emissions without and with the project, project developers must attempt to determine the timing of the GHG benefits generated by their projects. This type of information is of particular interest to potential investors. In the cases where project developers estimated only cumulative GHG benefits in the proposal materials, the USIJI Program has worked with the developers to report the flow of GHG sources and sinks on an annual basis. In some cases, annual emission and sequestration estimates reported for USIJI projects are averages derived from estimated cumulative totals over a period of several years. In other cases, emissions and sequestration estimates are developed directly on an annual basis.

Another challenge facing project developers is defining the spatial and temporal boundaries of a project and its associated GHG benefits. Although the projects accepted to date have a discrete lifetime, some of the projects, particularly those involving forest regeneration and preservation and the construction of energy-generating facilities, could have long-term GHG impacts that continue after the USIJI project activities have officially ended. In addition, several of the developers of land-use change and forestry projects anticipate that the demonstration and education elements of their projects will generate GHG benefits in a secondary “zone of influence" outside the project area. Because these types of GHG benefits are difficult to predict, measure, and verify, project developers have generally provided a qualitative, rather than quantitative, assessment of these benefits.

The initial measurement of GHG benefits is obviously critical to the success of a JI regime. While project-specific circumstances may limit the applicability of a single general rule for emission measurement, adequate information now exists to construct guidelines for international use in this area.

5. Identifying Non-GHG Project Impacts

The USIJI project criteria require project developers to identify the non-GHG impacts of their project. The projects accepted to date are anticipated to generate a number of benefits that are additional to GHG emission mitigation, including biodiversity conservation, watershed protection, reduced consumption of nonrenewable resources, increased availability of electricity (including in areas not connected to a grid system), public education and training, local economic development, and technology transfer. Project developers have also evaluated the potential negative impacts of their projects, such as ecosystem impacts resulting from establishment of monocultures or the use of land for facility construction; the operation of vehicles for ecotourism and land-management activities; and the generation of solid, liquid, and airborne wastes by facility construction and operation. In cases where these impacts are deemed significant, project developers have outlined steps for their mitigation. In most cases, developers have been able to provide only qualitative, rather than quantitative, information about the positive and negative impacts of their projects. Although further work is needed to develop effective methods for measuring and verifying the non-GHG impacts of USIJI projects, existing project experience can be used to establish some preliminary guidelines to help identify where such impacts are likely to occur for any given sector.

6. Monitoring and Verfying Project Results

The USIJI project criteria require that project developers include provisions for monitoring and externally verifying project results. The monitoring and verification of project results are areas in which many project developers have requested technical assistance from the USIJI Program. In the case of land-use change and forestry projects, the monitoring plans can be complex, involving the collection of a broad range of data necessary to track changes in on-site carbon stocks and GHG emissions as well as data pertaining to local land-use trends and socioeconomic factors. Data collection activities range from analyzing satellite imagery to conducting on-site biomass stock surveys, establishing permanent plots for periodic biomass sampling, and collecting information on socioeconomic indicators. In some projects, this monitoring is conducted by separate organizations with specialized expertise. In other projects, local project participants are specifically trained to conduct monitoring activities. In the case of energy projects, the monitoring plans typically include record keeping on national trends in energy supply, fossil fuel consumption, and energy production.

The USIJI projects accepted to date generally include procedures for internal verification of data generated by monitoring activities, and all hate agreed to submit the results of their projects for external verification upon request. Some project developers have proactively -published their initial project results for review by interested parties. The USIJI Program is currently conducting and sponsoring research on the issues of monitoring and verification. The primary goal of this research is to develop guidelines for the development of monitoring plans and verification methods, and to apply these guidelines to existing joint implementation projects. While some USIJI projects have developed sound and p6tentially replicable monitoring and verification plans, there are not yet enough in place to address the monitoring and Verification needs of all types of projects.

7. Preventing Loss or Reversal of Project Benefits

The USIJI project criteria require that project developers provide adequate assurance that GHG benefits generated by their project will not be lost or reversed. One particular issue of concern is the potential for leakage of project benefits: on-site GHG benefits generated by the project may be offset by a project-related increase in emissions outside the project area. Project developers must demonstrate that any changes in land uses or other activities resulting from the project will generate a net GHG benefit and will not simply result in the displacement of those land uses or activities from the project area to another area. To further demonstrate that project benefits will not be lost or reversed, project developers should address the disposition of the project area or activities after the end of the project lifetime.

Potential causes of loss or reversal of project benefits vary according to the project sector. In the case of land-use change and forestry projects, loss or reversal of project benefits can result from the leakage of benefits due to displacement of land uses from one area to another; natural disasters (e.g., fire, flooding, and hurricanes) that destroy carbon stocks; lack of commitment of landowners in project activities due to factors such as cultural traditions, political unrest and changes in the local economy; and lack of control over land disposition after the project has ended. In the case of energy projects, which generally consist of alternative energy generation or capture of fugitive emissions, loss or reversal of project benefits already achieved is not an issue. Estimated benefits, however, may not be achieved due to factors such fluctuations in the energy market or plant disruptions.

One problem that has faced many project developers is how to set appropriate spatial and temporal boundaries for assessing leakage. In some cases, leakage of project benefits can occur due to local, regional, or national developments that are beyond the control of the project developer. The USIJI program recognizes that there is a tradeoff between the level of effort that can be reasonably expected of a project developer, and the additional cost of eliminating or accounting for leakage.

The USIJI projects accepted to date have adopted a variety of strategies for addressing the issue of loss or reversal of project benefits. In the case of projects involving forest preservation, project developers have tried to prevent leakage by providing direct compensation, alternative income sources, and alternative land-use training to discourage local populations from relocating their deforestation activities to non-project areas. Many forest management projects have included measures to mitigate the impact of natural disasters, particularly in the form of fire prevention and fire preparedness activities. To encourage local participation in land-use initiatives, some project developers have worked closely with the communities involved to design project activities that are consistent with their cultural and economic needs. To ensure that forests preserved or regenerated during the course of the project will not be cleared after the project bas ended, project developers have presented information about the possession of land titles and trends in government land-use policies. In the case of energy projects, developers have demonstrated that there is a sufficient market for the energy they will produce. Some projects have entered into power purchase agreements to ensure continued demand for their product.

8. Crediting Emission Reductions

Under the pilot phase for AIJ, credit for emission reductions is currently not granted. Experience in the USIJI Program has shown that, in the absence of credits, potential project developers are less likely to invest in a USIJI project. In general, this has greatly reduced the ability of USIJI projects to attract investment and, ultimately, to achieve GHG emission reductions. Several USIJI project developers, however, in preparing project proposals, have established credit sharing arrangements among themselves in the event a crediting system should be implemented in the future.

An international system of crediting would provide an overwhelming incentive for JI. Without crediting, many of the broader benefits of JI, such as technology transfer and sustainable development, will not be achieved. Further research, coupled with the experience being gained under the USIJI and other countries' JI programs, will provide the foundation for developing simple implementation guidelines for an international crediting system.

The Use of Benchmarks to Determine Emissions Additionality in the Clean Development Mechanism

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Disclaimer: The views expressed herein are those of the author in her individual capacity and do not necessarily reflect those of the organization with which she is affiliated. This paper has not been submitted to the United States Environmental Protection Agency and, therefore, does not reflect the view of the agency or the United States Government. No official endorsement should be inferred.

Acknowledgments: The author would like to acknowledge research and analysis by Tellus Institute (Michael Lazarus, Sivan Kartha, Michael Ruth, and Steve Bernow) and Stratus Consulting (Carolyn Dunmire). Also, to ICF (Catherine Leining, Elizabeth O'Neill, John Venezia, and Barbara Braatz) for their work on counter-factual baselines.

INTRODUCTION

The Clean Development Mechanism (CDM) allows countries with greenhouse gas emissions targets (Annex 1) to meet these targets through greenhouse gas (GHG) emission reduction/sequestration projects in countries without GHG emissions targets (non-Annex 1). An essential element of the CDM is that it establishes an implicit bargain between developed and developing countries. Annex I Parties get access to less expensive emission reductions while the sustainable development objectives of developing countries are supported.

In order for CDM to be effective, both environmentally and economically, it must meet several criteria. According to the Kyoto Protocol, creditable emission reductions must be "real, measurable, and long term". The CDM, however, will be effective only if transaction costs are kept low to encourage greater participation. Meeting these goals is largely dependent on setting the correct baseline for a project.

The availability of CDM certified emission reduction units (CERs) are expected to provide an incentive to project developers to operate in a more carbon efficient manner (e.g., purchasing energy efficient equipment, sequestering carbon, capturing and reusing methane) than would have occurred in the absence of the credits (i.e. that the reductions are 'additional'). In order to assure that emission reductions are additional, a baseline must be developed that represents estimated emissions that would have occurred in the absence of CDM credits. Getting the baseline right is very difficult. One of the most difficult factors is accurately estimating what would have occurred anyway. The need for accuracy often competes with retaining low transaction costs and encouraging broad participation.

Baselines construction falls into two broad categories: bottom-up baselines (e.g., project-by-project baselines) and top-down baselines (e.g., benchmarks). This paper explores the use of benchmarks as a means of assessing emissions additionality[1] in CDM projects.

TRADITIONAL BOTTOM-UP BASELINES

Bottom-up baselines have traditionally been used for tracking project-level greenhouse gas emissions tracking. Both the Activities Implemented Jointly (AIJ) pilot phase under the UN Framework Convention on Climate Change (UNFCCC) and the U.S. Energy Policy Act section 1605(b) rely on project-specific baselines. Typically, a project-specific baseline will estimate a "without-project" scenario that is compared to a "with-project" scenario. The difference in GHGs sequestered/emitted between the two scenarios is considered the greenhouse gas impact of the project. For example, if a developer plans to construct a wind farm, the developer would estimate what electricity source the project would displace.

The U.S. experience with both programs has shown project-level counter-factual baselines to be problematic. The main difficulty lies in predicting "without-project" emissions scenarios. It is difficult and time-consuming to try to predict "what would have occurred anyway". Estimating the counter-factual baseline for the above wind project example would entail assumptions of fuel costs, electricity supply and demand, government policies, weather patterns, and a host of other factors. Varying assumptions can drastically alter the amount of emission reductions that are attributed to the project.

US International Joint Implementation (USIJI) experience demonstrates that the right assumption is not always evident. For example, in the Dona Julia hydroelectric project in Costa Rica, the baseline reported to the UNFCCC Secretariat[2] based displaced electricity assumptions on the national energy goal as elaborated by the Costa Rican Ministry of Environment and Energy. The goal was to eliminate fossil fuel electricity generation by the year 2000 and rely solely on renewable energy for electricity generation. Had assumptions been based instead on forecasts for energy demand, resource mix, fuel-cost projections, operation and maintenance costs, and precipitation patterns (affecting hydroelectric generation), the emissions reductions would have been far greater[3].

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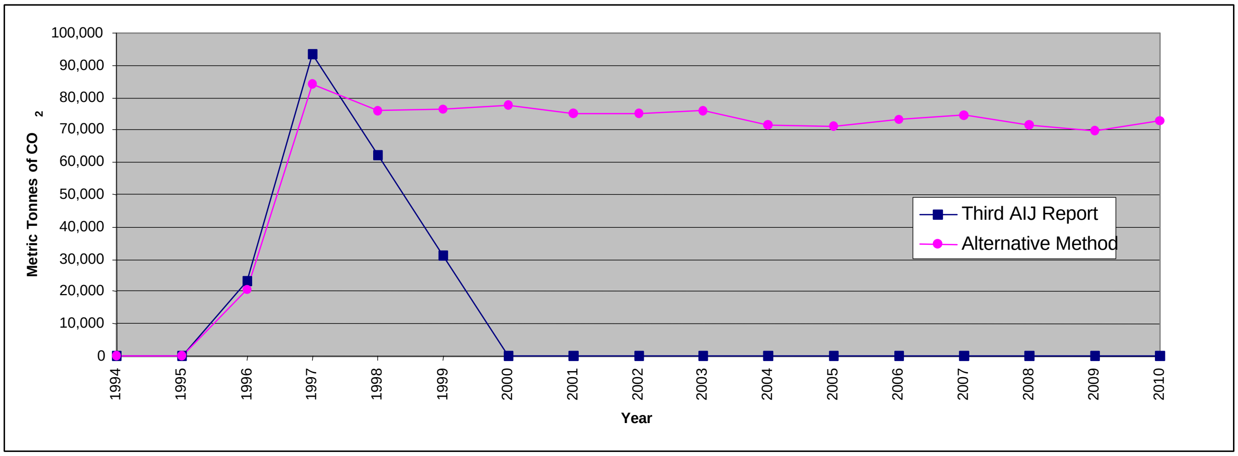
[1] Demonstrating 'additionality' refers to proof that emissions reductions would not have occurred in the absence of incentives provided by the CDM.

[2] United States Environmental Protection Agency. "Activities Implemented Jointly: Third Report to the Secretariat of the United Nations Framework Convention on Climate Change". Volume 2. November, 1998. EPA 236-R-98-003

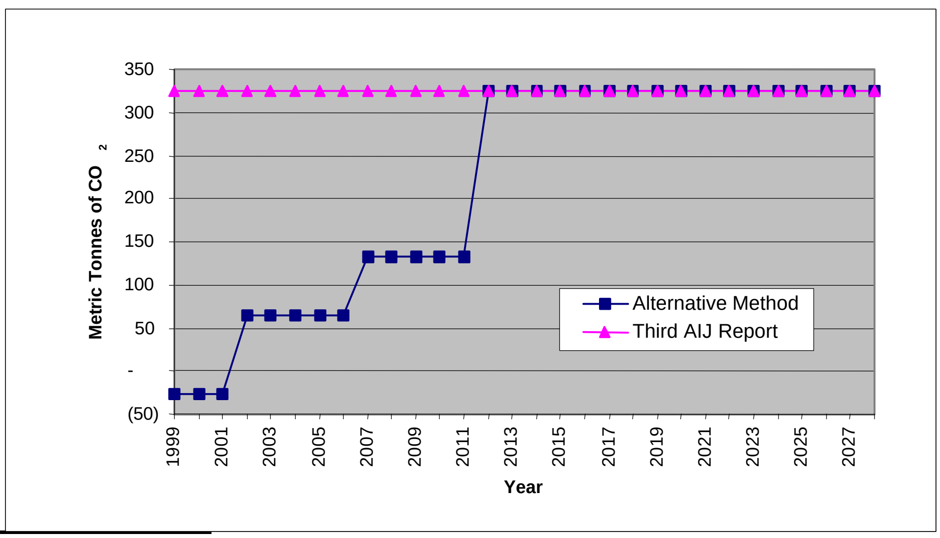
[3]Leining, O'Neill, Venezia, Braatz. Memo to US EPA "Charts Illustrating USIJI Project Baselines" December 18, 1998

Figure 1: Difference Between Reported[4] and Alternative Baseline Calculations (Dona Julia Hydroelectric Project)



In the APS/CFE Renewable Energy Mini Grid Project in Mexico shown below, alternative assumptions would have reduced emission reduction estimates. The town serviced by this electricity generation project currently uses three hours of electricity a day (provided by diesel). The reported reductions were based on the assumption that diesel-based electricity production would increase to 24 hours/day in the absence of the project. An alternative assumption could result in more gradual increases in energy demand, leading to fewer emissions reductions claimed[5].

Figure 2: Difference between Reported[6] and Alternative Baseline Calculation (APS/CFE Renewable Energy Mini Grid Project)



[4] United States Environmental Protection Agency. "Activities Implemented Jointly: Third Report to the Secretariat of the United Nations Framework Convention on Climate Change". Volume 2. November, 1998. EPA 236-R-98-003

[5] Leining, O'Neill, Venezia, Braatz. Memo to US EPA "Charts Illustrating USIJI Project Baselines" December 18, 1998

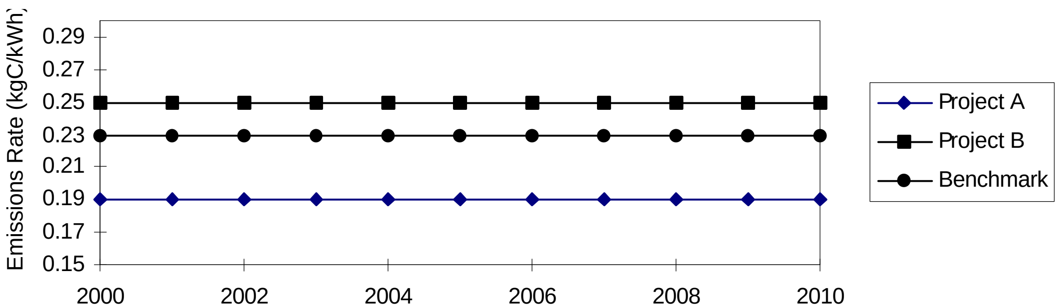
[6] United States Environmental Protection Agency. "Activities Implemented Jointly: Third Report to the Secretariat of the United Nations Framework Convention on Climate Change". Volume 2. November, 1998. EPA 236-R-98-003

BENCHMARK CONCEPT

A benchmark sets a standardized emissions/sequestration performance standard across a sector. Any project that is more carbon efficient than the benchmark can be considered additional. For the CDM, certified emissions reductions (CERs) could be determined based on the difference between the benchmark and the project performance. Thus the benchmark serves as the baseline for an entire sector or sub-sector, eliminating the need for project-specific baselines.

Figure 3 illustrates the benchmark concept for a hypothetical efficient electricity generation project. In this example, Project A would be considered additional and be awarded credits for every 0.04 kgC / kWh of electricity produced or sold. Project B would not be considered additional and would not be awarded any credit[7].

Figure 3. Hypothetical Illustration of the Benchmark Concept



An advantage of a benchmark, rather than a project-specific counter-factual baseline, is to lower transaction costs and reduce subjectivity. The transaction costs are lower because counter-factual baselines need not be produced for each project. Avoiding project-specific baselines is less expensive for both the project developer and for the overall system since each baseline would not have to be negotiated and verified. Using benchmarks also reduces the subjectivity of baselines. In effect, a benchmark would simulate what would have occurred anyway, however, projects within that category and region would be subject to the same assumptions.

BENCHMARK TRADE-OFFS

Once guidelines are established, developing the benchmark could be quite straightforward. Establishing guidelines, however, may be a difficult process. There are few clear answers and most decisions will entail a trade-off between competing goals. Environmental integrity of the benchmark will need to be weighed against low transaction costs and high participation.

Environmental integrity versus low transaction costs

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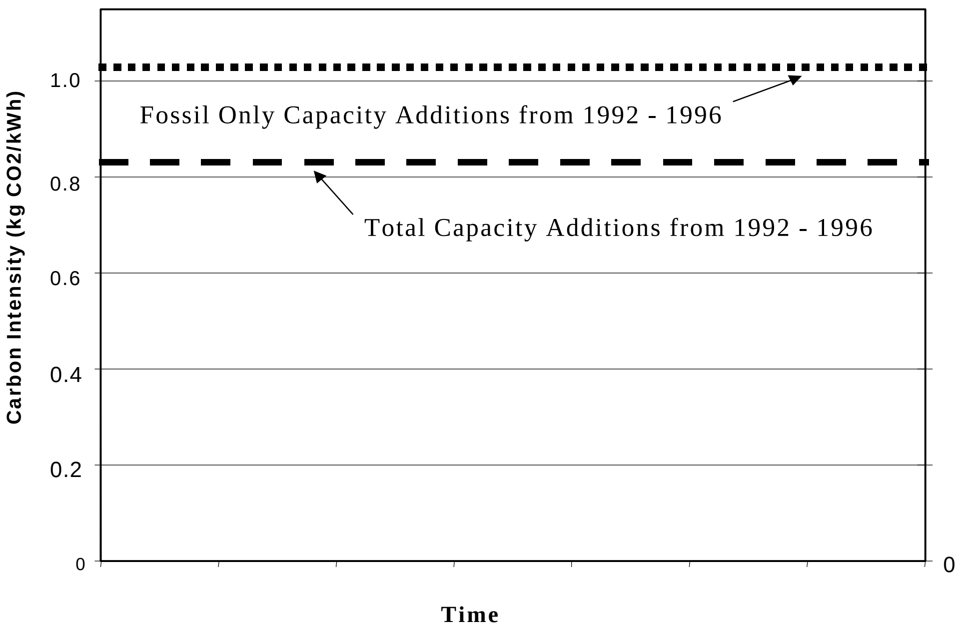
[7]Bilello, Friedman, LeFranc, "The Role of Benchmarks in Assessing Additionality and Emission Reductions under the CDM" . Unpublished draft paper. USEPA. September, 1998

The level of geographic and sectoral disaggregation will greatly affect the benchmark. The greater the aggregation, the lower the transaction costs since fewer benchmarks need to be established. Greater aggregation, however, may also lead to an ineffective benchmark. Higher levels of aggregation do not necessarily lower the benchmark, as illustrated in Figure 4 below. For example, China's electricity generation is largely based on coal and hydro. All capacity additions between 1992 - 1996 in China emitted about 0.83 kg of CO_2/kWh, however, fossil only capacity additions from the same years emitted about 1.07 kg of CO_2/kWh[8]. In this case a less aggregated benchmark would lead to a higher emissions standard than one more highly aggregated.

Figure 4: Two Benchmark Examples: Varying levels of Sectoral Aggregation in China



The appropriate level of aggregation is likely to differ by sector. Some industrial sectors may need such a high level of disaggregation that benchmarks are not feasible. For example, chemical production is very energy intensive, however, energy intensities differ among many products. In order to construct a meaningful benchmark (one that creates an incentive to produce chemicals more GHG-efficiently) the several benchmarks would be needed. The number of likely projects may not warrant the cost of creating these benchmarks.

Environmental Integrity versus High Participation

High participation in CDM will both lower compliance costs for Annex B countries and increase investment flows for developing countries. Both sides therefore have an interest in high participation. It is important, however, that the emissions reductions that are creditable be real. Figures 5 and 6 below[9] shows the trade-off between high participation and environmental integrity.

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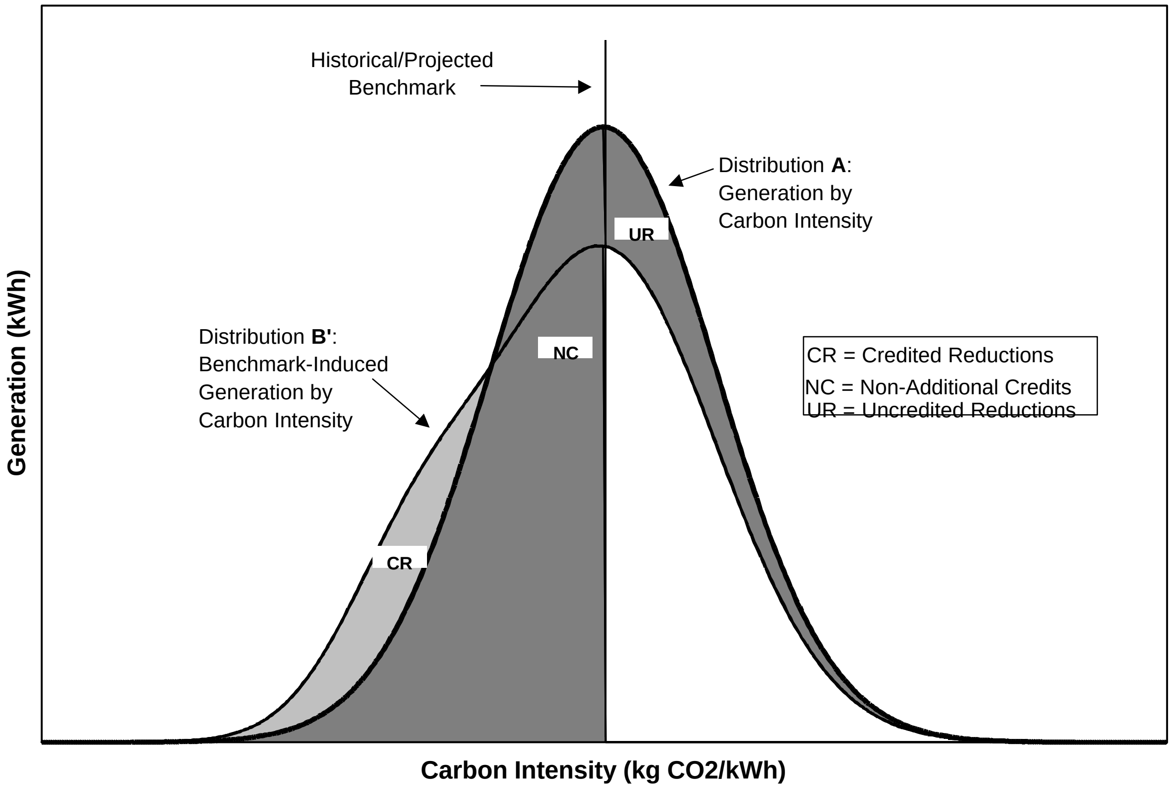
[8] Lazarus, Dunmire, Kartha, Ruth, Bernow. "Clean Development Baselines: An Evaluation of the Benchmarking Approach" Draft Report to EPA. Prepared by Tellus Institute and Stratus Consulting. January 1999

[9] Ibid

Figure 5: Benchmark Example #1: High Participation

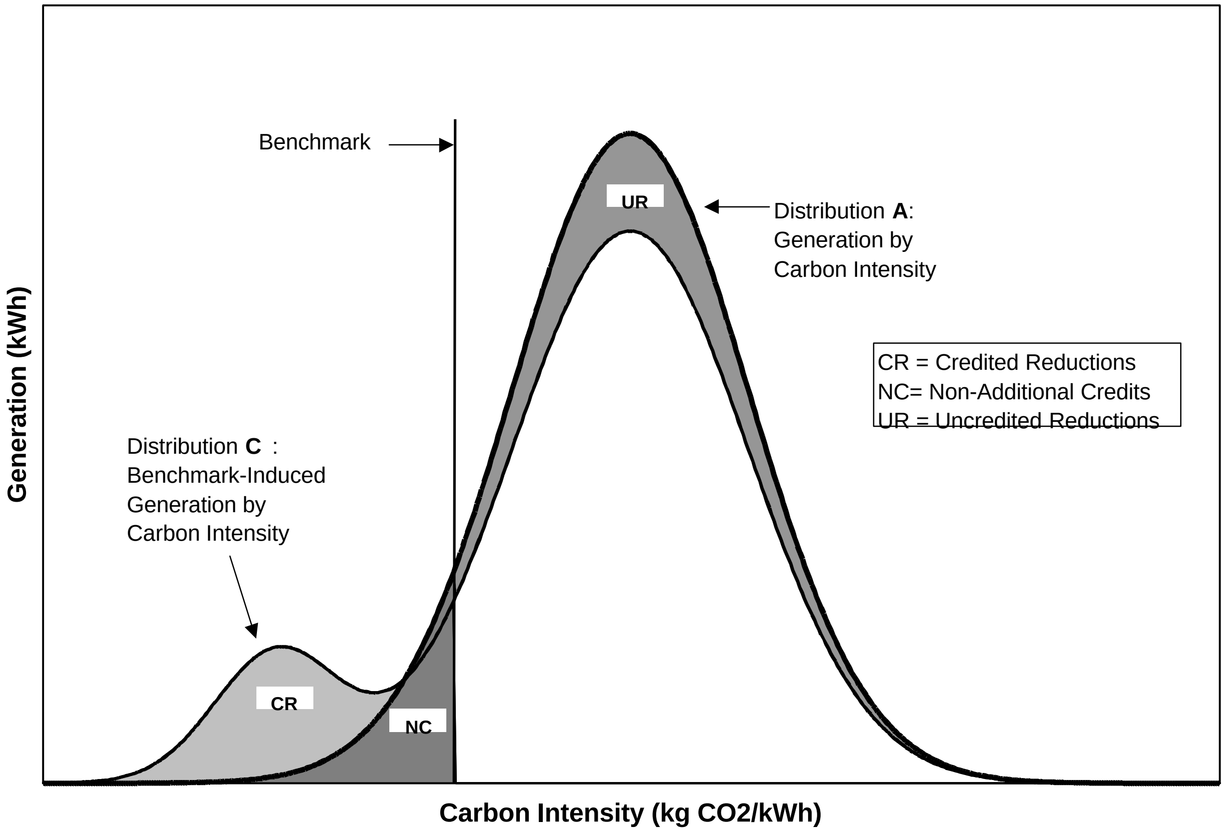


The above illustration shows a theoretical benchmark set at approximately an average carbon intensity. In this example, CDM creates the incentive to move from Distribution A, which has higher aggregate emissions, to Distribution B, which has lower aggregate emissions. The total amount of electricity generation remains the same, but the carbon intensity is lower. Credited reductions (illustrated by the light solid shaded portion of the curve) are emissions reductions that occurred as a result of the CDM. Non-additional credits (the striped portion of the curve) represent electricity generation that is credited because they are below the benchmark, however, no changes in behavior occurred to earn these credits. Uncredited reductions (the dark solid portion of the curve) represents the emissions reductions that are not credited because they are still above the curve. For example, a benchmark set at 0.9 kg of CO_2/kWh may create an incentive for a project developer to build a coal plant with an efficiency of 0.8 kg of CO_2/kWh over the default choice of a coal plant with an efficiency of 1.0 kg of CO_2/kWh. In this instance they reduce their emissions by 0.2 kg of CO_2/kWh, but are only credited for 0.1 kg of CO_2/kWh. Therefore, 0.1 kg of CO_2/kWh is the uncredited reduction.

The benchmark in Figure 5 emphasizes high participation. Although total emissions are reduced, this benchmark allows a significant amount of non-additional generation to be credited.

Figure 6, shows how a benchmark might be created in order to emphasize environmental integrity (crediting only additional emission reductions), that results in low participation. Although the amount of non-additional credits is reduced, the amount of uncredited reductions increases (as shown by the dark shaded area of the curve).

Figure 6: Benchmark Example #2: Fewer Non-Additional Credit
The appropriate choice will depend on objectives established for the CDM.



APPLICABLE SECTORS

Benchmarks are not an appropriate baseline choice for all sectors. Sectors that are most conducive to benchmarks will have the following characteristics:

- *Homogenous output or activity*: A benchmark will serve as the baseline for all relevant projects within a given category. The benchmark cannot be an absolute amount of reductions since productivity within the benchmark category will vary by project. Therefore, the benchmark will need to be based on activity data (e.g.,. kWh sold; tons of steel; value shipments of pulp; tons of biomass; acres of trees; etc.). Homogenous activity data is necessary to construct a meaningful benchmark. For example, the pulp and paper industry has several different types of products, each with distinct markets and energy intensities. Table 1 shows a variety of pulp and paper products and the related average energy efficiency requirements in South Africa.

Table 1: Total production and the energy intensity of the pulp and paper industry in South Africa.

Product	production (tons)	steam (GJ/ton)	Electricity (GJ/ton)	total (GJ/ton)
Tissue	114,000	20	17	37
Uncoated mechanical	61,000	19	10	29
Uncoated woodfree	238,000	19	9	28
Coated woodfree	53,000	24	11	35
Newsprint	320,000	8	8	16
Linerboard	550,000	12	8	20
Fluting	220,000	12	6	18
Paperboard	145,000	16	9	25
Other	108,000	19	9	28
Pulp exports	450,000	8	4	12

Source: Energy Research Institute of South Africa, 1998

Creating one benchmark for paper production would be difficult due to the heterogenous types of output within that sector. It may be possible to create a pulp benchmark since there are fewer types of pulping processes.

- Data Availability: Benchmarks will be based on historical data or on projections (which are typically based on historical data). Therefore, reliable data is essential to constructing the benchmark. In most cases, host country cooperation will be needed to collect the data that may not be readily accessible(for example, unit level electricity data that would be needed to understand the impact of various benchmarks may not be made public, but host countries may have access to it.). In other sectors, data may not be available at all. This is appears to be the case for methane emissions from oil and coal extraction. During extraction, methane is considered a waste product and therefore is not tracked.[10]

  An additional data consideration is equity. Dependable data may not be available for all countries in a given sector. In this case, global benchmarks may be appropriate, or some countries may be aggregated to form a regional benchmark.

- *High Participation.* Constructing a benchmark will require data gathering and analysis. Benchmarks reduce transaction costs only if the cost of constructing a benchmark is less than that of constructing and evaluating project-specific baselines. Therefore, a high volume of CDM projects will increase the cost-effectiveness of the benchmark.

  It is difficult to predict the types of projects that will apply for credits within the CDM. Historically, forestry projects have been popular under the AIJ pilot phase. Electricity production is likely to be an important sector since every country generates electricity and it is tightly linked to development.

Electricity, some industrial demand sectors, energy supply (e.g., natural gas pipelines or coal mining methane recapture), and residential appliance may qualify for benchmarks. The use of benchmarks for forest activity needs further examination.

[10]Ibid

Conclusion

Benchmarks provide an opportunity to increase the efficiency of the CDM by eliminating the need for subjective and time-consuming project-specific baselines in sectors where benchmarks are possible. In sectors for which benchmarks are not possible, alternative baselines will be needed.

Benchmark construction will require difficult decisions regarding the priorities of CDM. International action and cooperation is needed to begin to test benchmarks as a way to determine additionality under the CDM. According to the Kyoto Protocol, projects can begin to accrue credits through the CDM beginning in the year 2000. If we are going to provide early incentives, it is important to begin to address baseline issues, such as benchmarking, now.

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Overall Issues for Accounting for the Emissions Reductions of JI Projects

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Abstract

In this paper we examine some of the accounting issues concerning Joint Implementation (JI) under Articles 6 and 12 of the Kyoto Protocol, particularly methodologies for the accounting of emissions reduction of JI projects in the face of the large uncertainties in the estimations. Since these uncertainties can be exploited to the detriment of environmental protection, measures to limit gaming and increase environmental efficiency are discussed. We also consider the differences between the accounting processes for Article 6 JI and Article 12 (the Clean Development Mechanism). This work is drawn from an EC-supported study 'Accounting and Accreditation of Activities Implemented Jointly under the UN FCCC'. Much of the research is based on an analysis of data from thirteen bilateral pilot emissions reduction projects in the energy sectors of Estonia and the Czech Republic. Under accounting, we consider environmental efficiency issues such as baseline construction and possible standardised approaches. Sources of uncertainty are also examined and possible packages of measures for the operationalisation of JI in a simple, yet environmentally efficient manner are constructed.

1. Introduction

The concept of Joint Implementation (JI), whereby a 'donor' country (or countries) funds pollutant emissions reduction projects in a 'host' country in return for a relaxation of its domestic emissions targets, has been incorporated into the Kyoto Protocol to the UN Framework Convention on Climate Change (UN FCCC). In principle, it is argued, this should allow for greater cost-efficiency in meeting global targets, since abatement action can be taken first, where it is least costly to do so.

Whilst the exact term 'Joint Implementation' has not been used in the Kyoto Protocol, the mechanism clearly forms the basis of Articles 6 and 12. Under Article 6, countries with emissions reduction targets may fund JI projects in other countries with targets (known as Annex I countries) and receive credits which may contribute to compliance with their targets. Article 12 defines a Clean Development Mechanism (CDM) under which countries with targets may receive credits for funding JI projects which take place in countries *without* targets (known as non-Annex I countries).

In this paper we summarise some of the main research and policy recommendations produced by the European Commission-supported study 'Accounting and Accreditation of Activities Implemented Jointly under the UN FCCC' particularly with respect to accounting for emissions reductions. It then look at similarities and differences between Article 6 JI (A6JI) and the CDM. The choices available and the final approach to accounting implemented is placed in the multi-objective context of the Convention and Protocol.

In terms of accounting for GHG emission reductions from JI projects, one of the main issues has been the need for a methodology to be able to construct simple, credible baselines for the emissions path for what would have happened in the absence of the JI project. This is then compared to the JI project emissions path to estimate the reductions achieved. The counterfactuality of this baseline is one of the main problems in that no-one can ever know exactly what would have happened. The choice of the technology in the baseline and the timing of its introduction is open to interpretation and cheating. A methodology must therefore balance the need for a credible baseline incorporating suitable checks to ensure environmental goals are achieved with the need to make it practical and minimise transaction costs. Our approach has been to examine the uncertainties associated with different ways of constructing the baseline by examining specific energy sector projects in Estonia and the Czech Republic. By doing this we are able to assess the environmental efficiency of different approaches and to simplify where undue effort is required for little gain. There has been much discussion in the literature on possible baseline approaches (eg Luhmann et al, 1997; Ardone et al, 1997; CCAP, 1998; Michaelowa, 1998), and hence we compare these approaches to those proposed here.

The paper is divided as follows. In section 2, we discuss the issue of accounting for emissions reduction from a JI project, with particular reference to uncertainty, baseline construction, and possible standardisation of the procedures. 'Packages' of measures in addition to the standardisation of the baseline are then proposed as a methodological approach to minimise gaming and limiting the bounds of the uncertainties. In section 3, we look at the JI accounting procedure approach and how they may be applied in the A6JI and CDM cases. We then examine some of the accounting issues relevant to the CDM. In section 4, we summarise some policy recommendations from the analysis.

2. Accounting

In this section we discuss the analytical methods we have used for the estimation of GHG emissions reduction from JI projects, and the conclusions we have drawn from this work. First, in section 2.1, we briefly describe the JI projects we have assessed. In section 2.2, we review the types of accounting analysis we have carried out, whilst in section 2.3 we look at sources of uncertainty, and suggest how they may be reduced. In section 2.4 we go into some detail about baseline construction methodologies, and the possibilities for standardisation. We then discuss how the recommendations from sections 2.2-2.4 can be combined to form a 'package' of measures to guide the accounting process. Finally, in section 2.6, we draw some policy relevant conclusions.

2.1 Projects

The work in this section is based on a detailed examination of thirteen bilateral emissions reduction projects in Estonia and the Czech Republic. These projects are summarised in Table 1. Many of the projects examined have been approved under the 'Activities Implemented Jointly' (AIJ) pilot programme of the FCCC. They cover the areas of heat supply and demand, electricity supply and cogeneration, using a variety of fuels. Data was obtained initially from the donor organisations. However, reliable data was difficult to obtain and has required in some cases a series of site visits.

2.2 Types of Analysis

As we have mentioned, accounting for GHG emissions reductions involves the comparison of the JI project situation with that of a counterfactual baseline. In this study we have carried this out using three types of analysis:

- project level assessment
- system level assessment
- uncertainty analysis

The first was carried out for all of the projects, whilst (2) and (3) were only applied to a smaller subset. All three methods have been applied to both emissions reduction calculations and costs calculations, but we only deal with the former here. (Analysis of costs can be found elsewhere, eg Begg et al, forthcoming; Parkinson et al, 1997.)

Project level assessments of GHG emissions have be carried out using a spreadsheet model, which has taken into account a wide range of relevant project variables. However, given a particular technology and fuel, the specific GHG emissions (tonnes of CO_2 equivalent emissions[1] per MWh of output), *s*, is simply given by

$$s = 3.6 e_f / r \qquad (1)$$

where

e_f = emission factor of fuel/ plant in tCO_2/GJ

r = plant efficiency

3.6 is the factor needed to convert GJ into MWh

Since standard values for e_f and r are available from data tables (eg McInnes, 1996; Grohnheit, 1996) for a given technology and fuel, standard values for *s* can be easily calculated. For example, a typical district heating boiler run on heavy fuel oil has specific GHG emissions of 0.33 t/MWh. Data obtained from the actual performance of boilers in this study found that there is little variation in these figures in practice: less

[1] Emissions of GHGs have been converted into 'CO_2 equivalent emissions' by use of the standard values for Global Warming Potentials or GWPs (IPCC, 1996).

than ±10% (Begg et al, forthcoming). Hence, we feel that a set of standard values for *s* for a number of commonly used technology and fuel combinations would be a useful simplification that would not significantly reduce the accuracy of estimating GHG emissions. However, as we discuss in section 2.3.3, calculation of actual emissions *reduction* is not necessarily as straightforward as differencing the two values of *s* for the JI project and the baseline. The point should also be made that if account is taken of the GHG emissions of the whole fuel cycle, or indeed or possible leakage[2] then this value is likely to change. It is important that consistent assumptions are made.

System level assessment involves the use of an energy-economic model for the host country. In this study we used the EFOM model for the Czech Republic (van Harmelen et al, 1995). In deciding whether or not to carry out a system level assessment, consideration must be given to whether a project is 'separable' or 'non-separable' from the energy system. Separable projects, eg many district heating supply projects, do not interact significantly with the energy supply system, hence assessment at a project level would be expected to be accurate. However, this is not the case for 'non-separable' projects. For example, a plant supplying electricity can replace a range of different types of plant depending on whether the plant is replacing base, medium or peak load stations, hence such 'system effects' must be included in the assessment.

The final assessment of emissions reduction undertaken is uncertainty analysis. In particular we have used Monte Carlo Simulation (eg Parkinson and Young, 1998) to estimate the range of uncertainty in the emissions reduction for each project. This is discussed in the next section.

2.3 Uncertainty

In this section we discuss the issue of uncertainty in accounting for emissions reduction. We begin by assessing the sources of uncertainty and then investigate ways of dealing with this uncertainty.

2.3.1 Sources of Uncertainty

The main sources of uncertainty in estimating the total emissions reduction of a JI project over its lifetime are shown in Table 2. We have grouped them into four categories:

- project performance;
- counterfactuality;
- measurement;
- background.

Figure 1 shows an estimate of the combined uncertainty (due to all four types) in the emissions reduction for one AIJ pilot project using a project level assessment. The

[2] 'Leakage' is the term applied when the GHG emissions reduction achieved by the JI project is partly or totally offset by an emissions increase outside of the system boundaries of the project.

range of uncertainty is 97ktCO_2 ± 112% (95% confidence limits). Similar levels of uncertainty are seen for the other projects assessed (Begg et al, forthcoming). Sensitivity analysis reveals that it is the counterfactual uncertainty of the choice and timing of the baseline fuel/ technology, together with the background demand variations that contributes most towards this range. Annual monitoring can significantly reduce the uncertainty in the demand: bringing the uncertainty in the emissions reduction down to ±80% (see the next section). However, our assessment concludes that, despite detailed analysis of projects, *counterfactual uncertainty cannot be reduced by baseline construction methods*. Consequently, the choice of baseline has to be specified to avoid exploitation. This is shown by Figure 2 which compares the counterfactual uncertainty in emissions reduction for five AIJ projects assessed in this study with the values officially reported to the FCCC secretariat (UN FCCC, 1998). As can be seen, the official values vary from the lower end of the range to the upper, mainly due to different assumptions about how long the existing plant could have continued.

2.3.2 Dealing with Uncertainty

There are a number of ways in which the uncertainty in accounting can be reduced and/ or managed. In this section, we summarise the main approaches to limiting the uncertainties, but deal with the issue of baseline construction separately in section 2.4. Table 3 contains a summary of these approaches.

Operating Data

Figure 3 shows that calculations of emissions reduction based on feasibility data have tended to be overestimates by as much as 70%. Assessments reveal that, in these cases, the main reason has been a large drop in demand due to re-organisation of the energy sector in the countries concerned. However, design and operator faults, multi-firing with a range of fuels and fires and flooding have also played a role. Consequently feasibility data should not be used in the calculation of emissions reductions. We recommend that they should be calculated annually based on the reported output and fuels used from the JI plant. A further benefit of this practice is that it would give an incentive for the donor and host to ensure the long term viability of the JI project. It also limits opportunities for gaming as long as there are verification protocols for spot checks. The risk of crediting a project which has failed is removed by using operating data.

Baseline Revision

The counterfactual uncertainty in the baseline and increases considerably over time, due to unforeseeable changes in host country energy sector, technology, policies, fuel availability and prices etc. The baselines therefore need to be checked and revised after a period of time which we would recommend to be about 8-12y. We should clarify that we are advocating corrections to the baseline *for the remainder* of the JI project lifetime, not for the period up to revision. If the latter were to be applied, this would cause the revaluation of credits already issued (if we assume annual crediting of JI): this could significantly increase investor risk and undermine confidence in the system. It may even be found that, around that time, the project would have been undertaken anyway because of host country development and hence should not be credited further. Increased stringency could require 5 yearly checks.

Limiting crediting lifetime

Limiting the lifetime for crediting also limits the uncertainty of assumptions about the future and hence reduces the possibility of overestimation of the reductions. It could also be attractive from an investor perspective as there could be more certainty over the crediting compared with, eg, a system which involved baseline revision. However, for long term projects, it may not be an attractive option.

Verification

There is an incentive for the donor and, in the case of the CDM, the host as well to overestimate emissions reductions by over-reporting the output from the plant. Hence, independent verification procedures would be required. (Implicitly, this process would ensure that the JI project actually exists!) The number and frequency of these checks is open to discussion, the trade-off being between the transaction cost and environmental efficiency. At a minimum there should be one spot check during the project lifetime.

2.4 Baseline Construction

As we stated in the section 2.3, the counterfactual uncertainty of the baseline is, to a large extent, irreducible and hence the choice of one particular baseline is very subjective. The purpose of baseline construction, therefore, is not so much to reduce this uncertainty, more to prevent its exploitation by interested parties. The key aim of baseline construction, therefore, is *to reduce the chance of overestimation of emissions reductions* due to JI projects.

The following sections give a brief description of our approach. This is based on experience with a range of real AIJ and AIJ-type projects, and hence the uncertainties and possible biases in the calculation of emissions reduction are well understood. The trade-offs between ensuring environmental effectiveness, equity and minimising transaction costs can therefore be made transparent. We start, in section 2.4.1, with a review of the other approaches to baseline construction. Then we discuss the basis for our approach (section 2.4.2) and the elements which should be included in a baseline for separable and non-separable projects. This is followed by our proposals for a range of different types of simplified baselines for use under a range of conditions (section 2.4.3).

2.4.1 Review of Methods

Proposed approaches to baseline construction in the literature are carried out either at a project level or system level[3]. An example of a project level approach is that of Luhmann et al (1997), who suggest a 'filter' method to identify the reference plant for suitable JI projects followed by the use of specific GHG emission calculations for project and baseline (similar to those described in section 2.2 above) corrected by the utilisation factors as required. Hence, for each project type and country (or region) a reference situation is defined which is valid for the crediting life of the JI project. The 'matrix' approach (CCAP, 1998) is very similar to this. CCAP (1998) also suggest two other approaches to baseline construction. The first, known as 'benchmarking', is where some projections of the baseline are made into the future in a standard defined way either at a project or system level. The second approach, called the 'project scenario' method, is where the baseline technology is identified based on investment criteria at a project level, and the estimate for emissions reduction is made conservatively.

A system level approach is favoured by Ardone at al (1997). They have developed the Perseus model, based on the EFOM energy-economic model, and have applied it in countries such as Russia, Germany, and Indonesia. This model is much more complex than EFOM, containing a higher degree of detail concerning load curves and technological characteristics. Puhl and Hargrave (1998) also favour a system level approach and use an energy-economic model to calculate baselines. Some of the current approaches have been reviewed by Michaelowa (1998) who concluded that a project level approach is the way forward.

2.4.2 Considerations in Baseline Construction

This section summarises the main considerations necessary in order to construct a baseline. We particularly look at where projects are ‘separable’ or independent of the energy system and the ‘non-separable’ situation where there would be expected to be significant interaction with an energy system. Table 3 shows where careful baseline construction can minimise the chance of overestimation and manage some of the uncertainty and reduce the opportunities for cheating.

Elements in Separable Project Baselines

A number of decisions have to be made in constructing a baseline:

- *choice and timing of reference technology/ fuel*: which defines technical variables such as efficiency, emission factor;
- *equivalence of energy service*: consideration needs to be given to whether the baseline plant can provide the same energy service as the JI project over the plant lifetime;

[3] A number of authors have described project level baselines as 'bottom-up' baselines and system level baselines as 'top-down' baselines. However, system level baselines make use of energy-economic models which are often referred to as 'bottom-up' models to distinguish them from macroeconomic 'top-down' models. So, to avoid confusion, we retain the use of the terms 'project level' and 'system level'.

- *crediting lifetime*: this is either the technical lifetime of the JI project, or the estimated time until the JI project becomes financially viable for the host to carry out.

Baseline construction also needs to consider the following:
- *background country scenario:* economic and policy developments within the host country, international fuel prices, structure of energy system and fuel supplies;
- *costs:* costs (eg investment, operation and maintenance, fuel) of the JI project and possible reference technologies will affect the choice of the baseline;
- *leakage:* account needs to be taken of the possible other GHG emissions in the fuel production cycle and in the fate of the replaced plant and fuel in the country economy;
- *time dependencies, demand projections:* there may be significant variations in the future on key parameters in the calculation of emission reductions.

We have found that even if the project replaced a known plant, which is the case in most of the projects studied, there are still several equally likely baseline situations which reflect the time before the plant would have been changed anyway, or would have been changed to another technology. The construction of such baselines is therefore reasonably detailed and has high data demands.

Non-separable Projects

Baseline construction for non-separable projects can involve the use of an energy systems model, and a series of assumptions particularly concerning national energy demand and international fuel prices. A comparison of the emissions reduction estimated by a system level assessment (using the energy-economic model, EFOM) and a project level assessment for the two electricity supply (windfarm) JI projects in the Czech Republic (Begg et al, forthcoming) has shown little difference between them. Experiments using scaled up versions of these projects (from a few MW to a few hundred MW) also found this. This indicates that the extra effort of using a system model to construct a baseline could not be justified in this case, and hence we do not consider this issue further in this paper. It should be recognised that this result may be specific to the project type (windfarm) or country (Czech Republic), or may change if a model with more sophisticated modelling of load curves, eg Perseus (Ardone at al, 1996), is used. Further work is being undertaken to examine these questions.

2.4.3 Standardised Approach to Baselines

As we have seen, baseline construction is a complex process. Hence, simplification which does not compromise the environmental goals of JI would be very useful. The following approach is one possible way forward which could be applied under a range of circumstances.

Since no significant system interactions have been found by our analysis, we suggest standardisation at the project level. We have also found that country specific conditions are important, along with sector, project type and size. Hence, given these parameters, it would be possible to calculate emissions reductions using the *specific* GHG emissions (tCO_2 equiv./MWh), as described above in section 2.2, for both the baseline technology/ fuel and the JI technology/ fuel. This makes our suggestion similar to the Luhmann and 'matrix' approaches described above. However, since the baseline plant is likely to change during the project lifetime, we feel that a scenario is necessary: similar to the 'benchmarking' approach. However our approach differs from other approaches as we combine the simplification process with other measures designed to reduce uncertainties and limit the risk of overestimation of reductions (section 2.3.2 above). We detail the process below.

Step 1: Choose the relevant baseline type

Four examples of a standardised baseline for energy sector projects are shown in figure 4, expressed in terms of specific emissions. Type 1 is where constant specific emissions is defined for a limited lifetime. The value for the specific GHG emissions is defined as that for the existing plant/ situation, and corrected to ensure equivalence of service with the JI project. The lifetime is limited to about 10y because not only are projections unlikely to have any validity beyond this time period but most significantly, it is highly likely that the project would have been carried out anyway. Therefore the crediting lifetime would not be expected to be longer than 10y. Type 2 is the same as Type 1 for the first period. After about 10y, as the original assumptions lose validity, the baseline becomes the mean of the specific emissions of technologies/ fuels in the sector *at that time* (based on up-to-date energy statistics). This level remains constant either for another 10y (after which this level is again revised) or the end of the technical life of the JI project is reached. Type 3 is a simple constant average of the fuel mix for the relevant sector and Type 4 is where the specific emissions of a number of different baselines are calculated, and the mean taken over the technical lifetime of the JI project. Both would need to be revised regularly, as discussed in section 2.3.2, during their lifetime. Type 4 would be created by independent analysts based on a small number of test JI projects (eg pilot AIJ projects) of the same type and in the same region/ sector.

Table 4 summarises the four types which we suggest could apply in a range of circumstances for the project types studied. For short term projects, or ones which are likely to be implemented anyway in the near future, and where the substituted plant is known, a 'Type 1' baseline is adequate. For longer term projects, the validity of a long term baseline is in question and we would advocate Type 2 where the substituted plant is known and Type 3 or 4 or a variation of that for where the substituted plant is unknown. We do not consider that the possible loss of technical accuracy with the use of the specific emissions method is significant compared to the other uncertainties.

The simplified approach described above has to be based on conservative values (for particular countries, sectors, and project types and sizes - both separable and non-separable) to counter possible leakage and gaming effects as discussed earlier. Type 2 and 3 requires data on the energy system of the host country, whilst type 4 also needs to take into account the energy and environmental policy context in order to produce the relevant values. However once these are calculated for a project type/ country/ sector/ size and made available, the results can be applied to the appropriate JI projects with minimum effort by investors. It will of course have a limit on the time for which it remains valid.

Step 2: Calculating the emission reductions

GHG emissions for the JI project and the baseline are calculated by multiplying the specific emissions of each by the annual output (using measured values as discussed in section 2.3.2) of the JI plant. The emissions reduction is thus the difference. This procedure assumes that the baseline technology can deliver the same energy service as the project. If this cannot be assumed, eg some electricity supply projects where the utilisation factors are different, then corrections should be made (Begg et al, forthcoming). As mentioned above the specific emission figures would be valid only for a limited time and a reappraisal would be required after 8-12y. For biomass plants there are the added questions of the long term carbon neutrality of the fuel source and its avoidance of additional counting as a sink. These aspects would have to be incorporated as part of the 8-12y appraisal procedure for these projects.

2.5 Package of Measures for Emission Reductions Accounting

From this discussion it is clear that though standardisation goes some way to limit gaming, 'packages' of measures are required to balance concerns for environmental efficiency as the uncertainties are still high. There are many possible combinations of the simple measures discussed above, but here we give one example.

Example 'Package'

- Type 2 standardised baseline - specific emissions based on conservative values
- specific emissions for the JI project
- annual operating data for output
- baseline revision every 10y
- annual crediting over operating life of plant
- one verification check for confirmation of operating conditions

An environmental and social assessment of the JI project should also be carried out to ensure that the local impacts in the host are acceptable.

This option requires more work initially for an independent body to prepare the baselines but allows more long term projects to be assessed. It does address most concerns of an appropriate reduction in the risk of overestimation of emission reductions and it is relatively simple to put into operation.

The process is summarised in Figures 5 and 6. Figure 5 shows the standardisation procedure to be followed by an independent body who would allocate the resulting choice of baseline to the investor. In Figure 6 the investor would interact with the independent body and supply simple project description and annual operating data.

This would be used to calculate the emissions reductions. There are several possible accounting option combinations besides the one illustrated. For example a standardised baseline and limited crediting life would not require baseline revisions and would deal with the residual and still significant uncertainty in the estimations.

2.6 Implications for policy

From the analysis in this EU study, the baseline construction proposals are made on a simplified basis in recognition of the large irreducible uncertainty introduced by having a counterfactual baseline. Baseline construction protocols cannot by themselves address all the issues in the calculation of emission reductions and therefore additional simple measures are proposed which start to form 'packages' of measures for the successful implementation of JI as fair and efficient. Our work elsewhere (Begg et al 1997, forthcoming) indicates that, in addition, the approval criteria are important and need to be well defined and the host country requires a clear JI country strategy to avoid overcommitments and underpricing of credits.

3. Broader Issues related to Accounting

3.1 Application of package approach to A6JI and the CDM

The analysis detailed in the foregoing sections dealt with projects in transition economy countries. In our view, the conclusions concerning simplifications made and the need for a package of additional measures could be applied to CDM host countries. The approach of using assessment at project level is even more important for a CDM project as there are likely to be less well developed energy systems.

Empirically, consideration of A6JI with Annex I donors and hosts, both with targets, would suggest that A6JI should be treated separately from the CDM and the two forms of JI should probably require a different range of processes and safeguards. This has been suggested because there is theoretically an in-built safeguard for the environment where countries have targets. However in the case of some countries in transition, where institutional structures are still being developed and other factors have a more pressing priority, this may not be the case and targets may not be adhered to. Additional measures would have to be funded by the host to maintain compliance with its targets. Either that or non-compliance procedures penalising countries already struggling economically would be enforced which seems counterproductive. For countries without targets it is considered that there are incentives for gaming or ‘talking up’ the baselines to achieve as many credits as possible and more verification procedures would thus be required. Therefore, in both types of host it is important to ensure that the emission reductions are not overestimated although for different reasons.

There has also been a suggestion that for the CDM, the baseline should be constructed in a more complex fashion. From the analysis above, where we showed that there is a limit to the usefulness of the baseline construction methodology for decreasing uncertainties, we would suggest that increased stringency would be better manifested by increasing the safeguards to minimise gaming and decrease the bounds of the uncertainties as indicated in the suggested example package above in section 2.5. Thus the frequency of revisions or verification checks could be increased for CDM projects or there could be limited crediting life or partial crediting which would ensure environmental efficiency without increased institutional requirements.

3.2 CDM Accounting Issues

In the following discussion we would like to draw attention to some areas where the CDM would pose some quite different problems or where more work is required.

First of all consideration needs to be given to the range of the stage of development of host countries. The transition economies studied were at very similar stages and moving towards EU standards and procedures for membership status. For the 'most developed' developing countries such as Argentina, Brazil, etc there could be easily applied parallels. However a range of circumstances not covered by the considerations above could emerge when considering CDM hosts where the development agenda is even more important and the contribution of the project to its development priorities and to its sustainable development path is and should be an important aspect of the project. Under these circumstances the size of the 'appropriate' projects could be very small and there may need to be arrangements similar to those applied to 'umbrella' projects in Costa Rica where the government spreads the risk for the investor. Data availability and quality could also be very low.

The dual function aspect of the projects means that the projects invariably increase the energy service supplied and therefore the equivalence of energy service between the baseline and the project has to be dealt with either by assuming that the new total service would have been supplied in the baseline or that only that part of the new service, eg lighting to replace candles, is accounted for.

Indirect effects of this are that the original criterion of additionality of the project may be hard to apply in practice as additionality is designed to encourage projects which will reduce emissions more than the normal market choice and that this is likely to cost more. In this way real reductions are ensured as these projects would not have been carried out by the market anyway. However, this definition of additionality assumes there is an efficient market in the host country and that 'no regrets' options would have been carried out. The operationalisation of additionality in the less well developed countries must be addressed to ensure reductions are real but recognising the limitations of the original definition in terms of both financial and environmental additionality.

The 'appropriateness' of the technology being transferred is also an important issue for these host countries if the criteria of 'sustainable development' and 'in line with the host country priorities' are to be meaningful. In line with the Århus Convention, we suggest that these require a process of strategic planning involving public participation. It is particularly important as development experience indicates that without due attention to local benefits and conditions the project may well fail and there will be no long term reductions. In other words, the equity of the process of the CDM is extremely important. Consideration of the local benefits and any adverse impacts from the project, whether it is affordable and easily maintained by the local community, whether it fits with the existing or wanted lifestyle, and what the strategic resource implications are, are all crucial in the choice of technology for the CDM project.

4. Conclusions and Policy Recommendations

This EC funded project has examined the implications of different types of approaches to the assessment of emission reduction of GHGs using real AIJ and AIJ-type projects in the energy sector in Eastern Europe. The analysis has concentrated on the environmental efficiency of the approaches and looked in detail at the inherent uncertainties and how to minimise them with a package of measures including a simplified approach to baseline construction. The analysis points the way for possible options for the implementation of JI as a fair and efficient means of reducing GHG emissions. The following points emerge from the study.

- The largest source of uncertainty in accounting for emissions reductions is the counterfactuality of the baseline.
- Within the baseline, the main sources of uncertainty tend to be the choice of technology and timing of its introduction. To a large extent such uncertainty cannot be reduced even with a detailed case by case assessment.
- No evidence was found that the use of an energy systems model enhanced the estimate of emissions reduction due to a JI project up to a capacity of a few hundred megawatts. However, our analysis was limited in that it only looked at two windfarms in one country.
- Our analysis shows that significant simplifications in baseline construction can be made without compromising the environmental objectives of the FCCC and examples are given for some separable and non-separable JI projects.
- In estimating total emissions reductions, it is important to include safeguards in the accounting procedure to minimise uncertainties not addressed by the baseline construction and to minimise scope for gaming which will act against the environmental objectives of the FCCC. Consequently we suggest a combination of the following:
    - use of conservative values for specific GHG emissions (ie tCO_2/MWh) of particular technologies/ fuels;
    - the use of annual operating data rather than feasibility data;
    - baseline revision every (eg) 10y; or limited crediting life
    - independent verification of the project data.
- Hence 'packages' which combine some of these measures can be produced to ensure the environmental efficiency of the process.

- By using these packages of measures as a basis for implementing A6JI and the CDM, explicit trade-offs can be made of practicality, cost efficiency, environmental efficiency and equity.
- Due to the particular requirements of the CDM, ie in being compatible with the development needs of the host country, the accounting framework must take account of:
    - different market circumstances, which affects the operationalisation of additionality;
    - the 'appropriateness' of the technology; and
    - problems with the assumption of equivalence of energy service.

This EU study has examined in detail packages of measures which are intended to address the overall implementation of JI while reconciling equity, efficiency and environmental goals. Full details will be published elsewhere (Begg et al, forthcoming).

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Acknowledgements

We wish to thank the European Commission, DG XII, for supporting this work within the project "Accounting and Accreditation of Activities Implemented Jointly under the UN Framework Convention on Climate Change and the Oslo Protocol on Sulphur Emissions" (Research Programme: Environment and Climate, Area: Human Dimensions of Environmental Change). We also wish to acknowledge our collaborators for their invaluable help: Sune Westermark of NUTEK, Sweden for supplying the project data; Lise Nielsen of RNL, Denmark; Klemens Leutgoeb and Herbert Ritter of EVA, Austria; Tiit Kallaste and Toomas Pallo of SEI-Tallinn, Estonia; Mike Chadwick of LEAD-Europe, Switzerland; Jurgen Salay of Lund University Sweden, and Angela Liberatore, of EC DG XII.

Table 1 - Summary of the emiss16ions reduction projects examined in this study

Project	Type	Fuel	Donor
Estonia			
Aardla-Tartu	Heat supply	Biomass	Swedish Govt.
Haabneeme	Heat supply	Biomass	Swedish Govt.
Mustamaa (2 stages)	Heat demand	n/a	Swedish Govt.
Turi	Heat supply	Biomass	Danish Govt.
Valga	Heat supply	Biomass	Swedish Govt.
Voru	Heat supply	Biomass	Swedish Govt.
Czech Republic			
Decin-Bynov	Cogeneration	Natural gas	Danish Govt/ USA industry
Jesenik	Electricity supply	Wind	Danish Govt
Kardasova Recice	Heat supply	Biomass	Austrian Govt
Lettland*	Electricity supply	Wind	German Govt
Mrakotin	Heat supply	Biomass	Austrian Govt
Stare Mesto	Heat supply	Biomass	Austrian Govt
Velesin	Heat supply	Natural gas	Austrian Govt

* This project was actually undertaken in Latvia, but the assessment was carried out as though it had been situated in the Czech Republic in order to carry out a comparison between a project level assessment and a system level assessment using the Czech EFOM model.

Table 2 - Main sources of uncertainty in estimating emissions reduction of a JI project

Type	Source
Performance	Performance of project (eg based on feasibility data), operator error
Measurement	Efficiency of plant/ network (project or baseline) Emission factor (fuel/ technology characteristics) Utilisation factor
Counter-factuality (applies to baseline)	Choice of baseline technology Performance of baseline technology Timing of replacement; length of crediting lifetime Equivalence of service
Background (applies to project and baseline)	Projections of Demand for heat/ electricity Fuel availability and prices Energy system development Energy and environmental policy changes Indirect economic effects Country priorities Risk of failure

Table 3 - Dealing with Uncertainties in the estimation of emission reductions

Specific Uncertainties	**Measures**
1. Technical parameters for calculation	a) Make specific measurements of plant (reference and project), for the output, efficiency, calorific value of fuel, carbon content of fuel where possible b) Incorporate these into baseline methodology calculation eg specific emissions calculation c) use conservative estimates
2. Changes in efficiency and emission factors for fuel of reference or project over time	a) Use conservative estimates of existing data b) Baseline revision after eg 10y for long lifetime project can revise estimates where necessary c) Use operating data d) Verification check
3. Output / demand variations over time for reference and project	a) Use operating data; specifically output and fuel input data on an annual basis. Feasibility data have been shown to lead to serious overestimations b) verification check
4. Choice of baseline technology and timing of replacement	a) Baseline standardisation attempts to deal with this problem eg type 2 after 10y or type 3 b) Baseline revision for long lifetime projects after eg 10y
5. Fuel availability and prices for project	a) operating data
6. Energy system development, indirect economic effects and changes in policy and country priorities	Baseline revision
7. Leakage	Baseline revision
8. Risk of failure	a) operating data b) verification check

Table 4 - Summary of standardised baselines

	Where applicable	Advantages	Disadvantages
Type 1	a) short to medium lifetime b) substituted plant is known c) **project types:** heat supply	a) low chance of over-crediting b) number of credits relatively certain c) simple	a) higher chance of under-crediting if medium lifetime
Type 2	a) any project lifetime b) substituted plant is known at start c) **project types:** heat supply	a) can be used for any project lifetime	a) more complex than type 1 b) restricted by availability of sector data
Type 3	a) any project lifetime b) substituted plant unknown c) **project types:** electricity supply and demand, heat supply and demand, cogeneration	a) can be used for any project type and lifetime	a) more complex than type 2 b) requires some independent research c) restricted by availability of sector data
Type 4	a) any project lifetime b) substituted plant unknown c) **project types:** heat supply and demand, cogeneration	a) can be used for any project type and lifetime	a) more complex than type 3 b) requires more data from independent research c) restricted by availability of data and cost of obtaining it

Figure 1 - Uncertainty in emissions reduction for Valga AIJ project. Uncertainty is due to baseline choice, operating uncertainty and technical uncertainty.

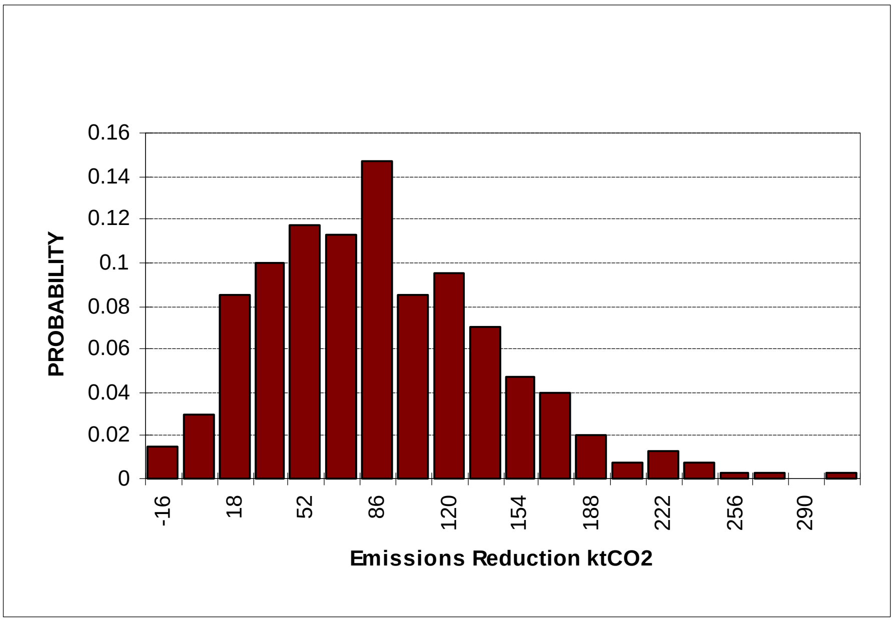


Figure 2 - Comparison between uncertainty in emissions reduction due to baseline and UN FCCC reported values for 5 AIJ projects

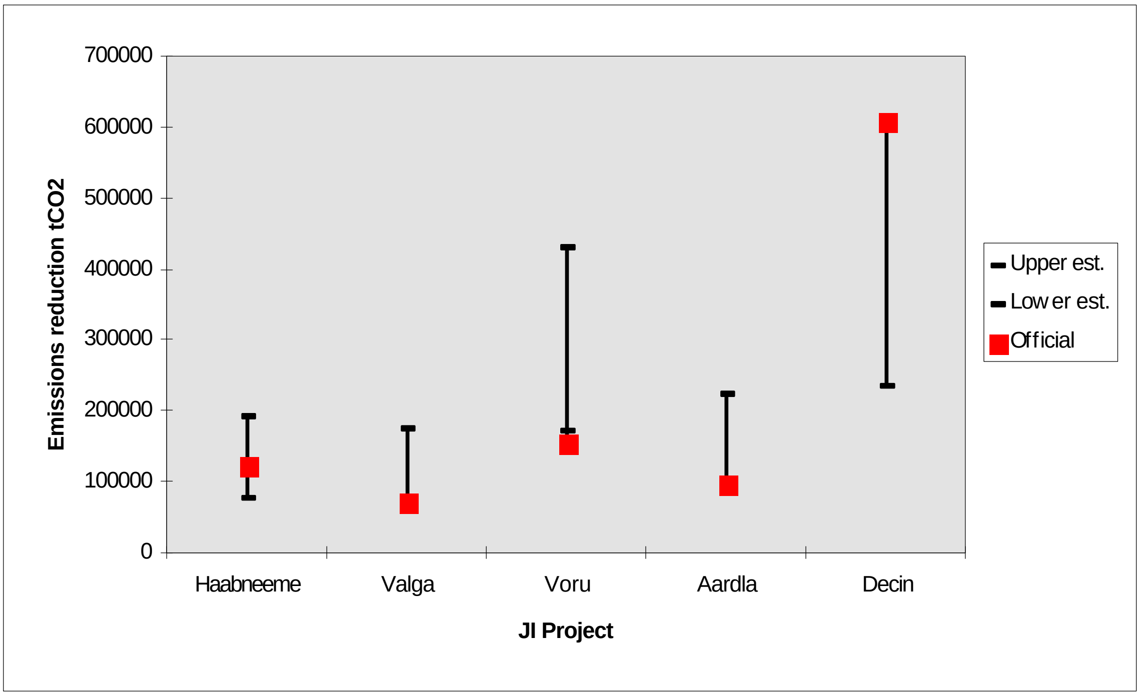
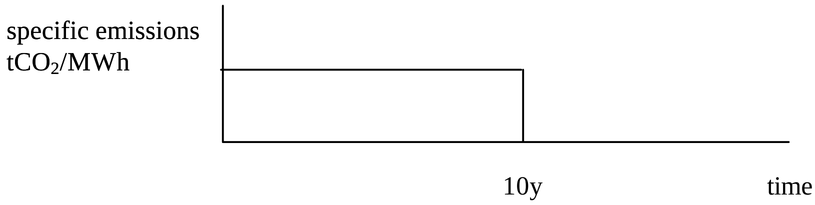
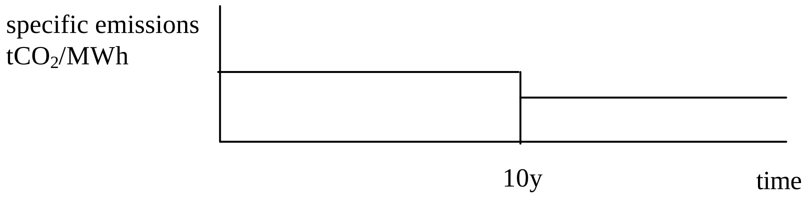


Figure 3 - Standard baselines

Type 1 - Substituted Technology for Limited Life



Type 2 - Substituted Technology initially then average fuel mix in sector



Type 3 or 4 - Average of sector fuel mix or
Average of Project Baselines

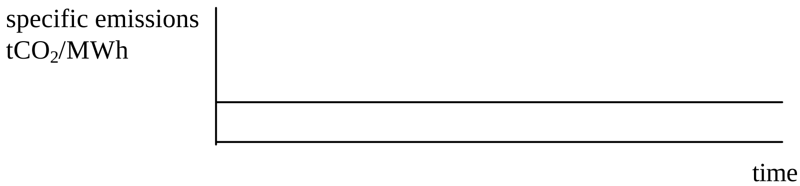
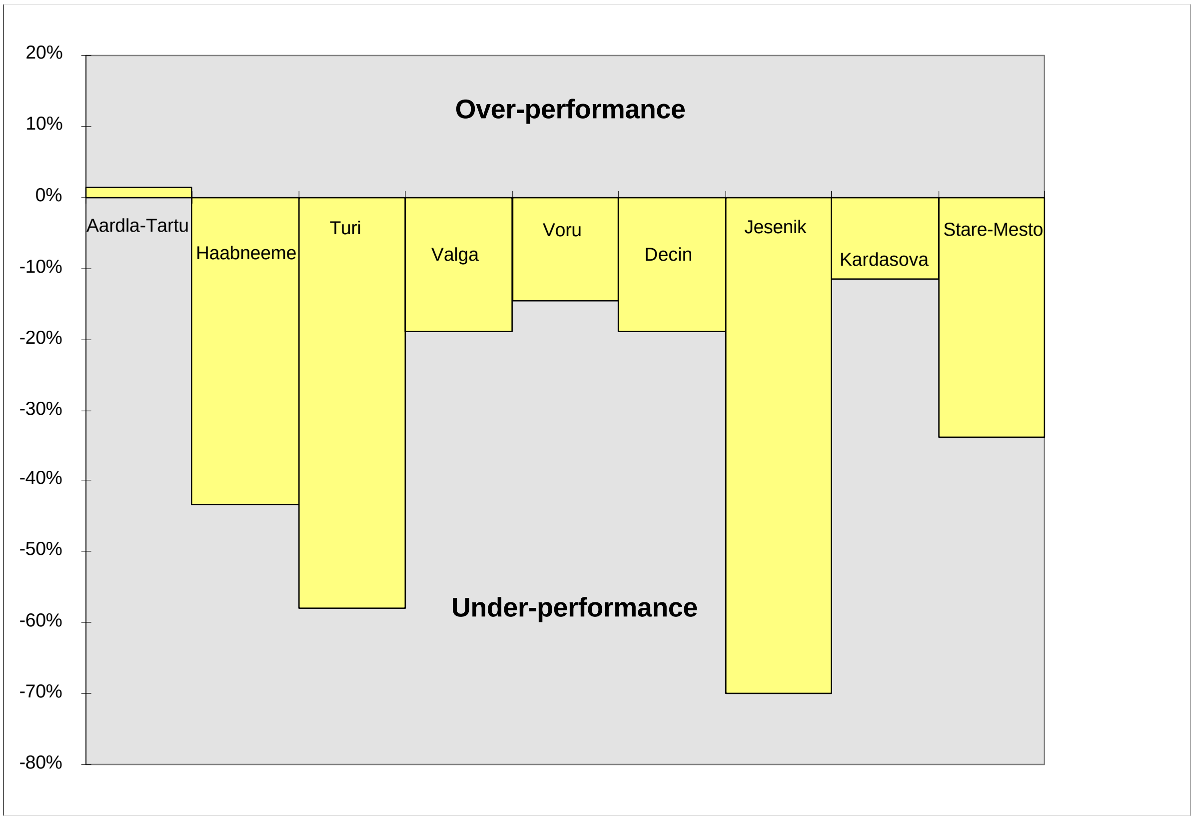


Figure 4 - Comparison between emissions reduction, based on feasibility data, and that based on 1 to 4y of operating data for nine AIJ projects in eastern Europe. (Negative values mean the project has under-performed with respect to the feasibility data.)



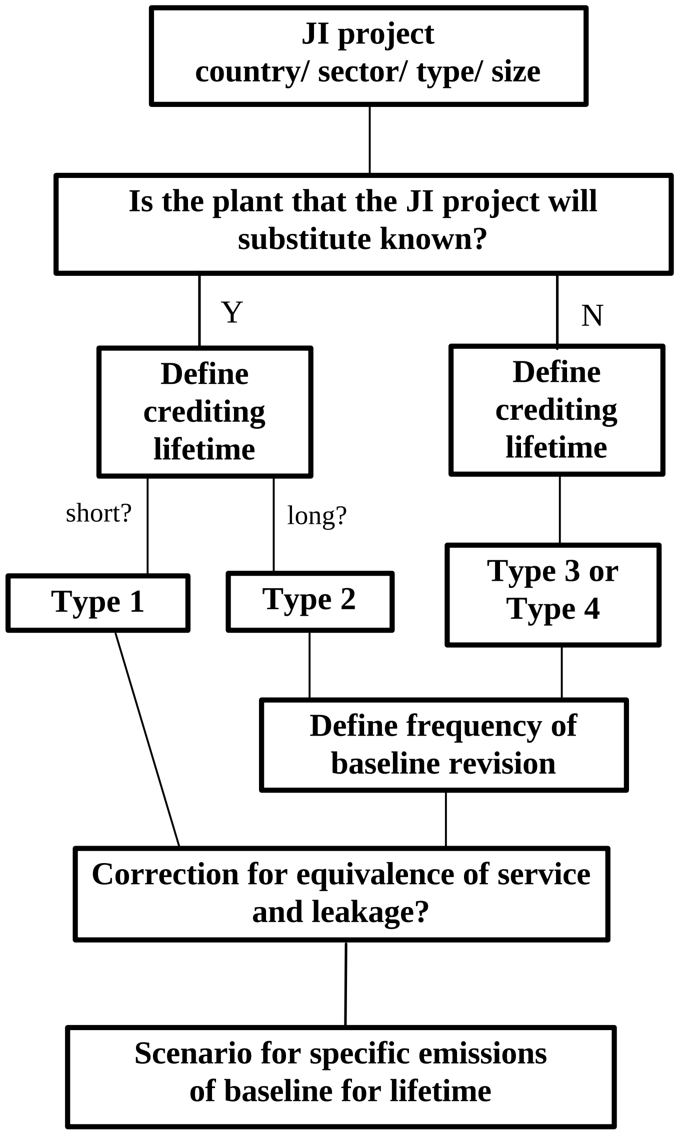


Figure 5 -Standardised Baseline Construction

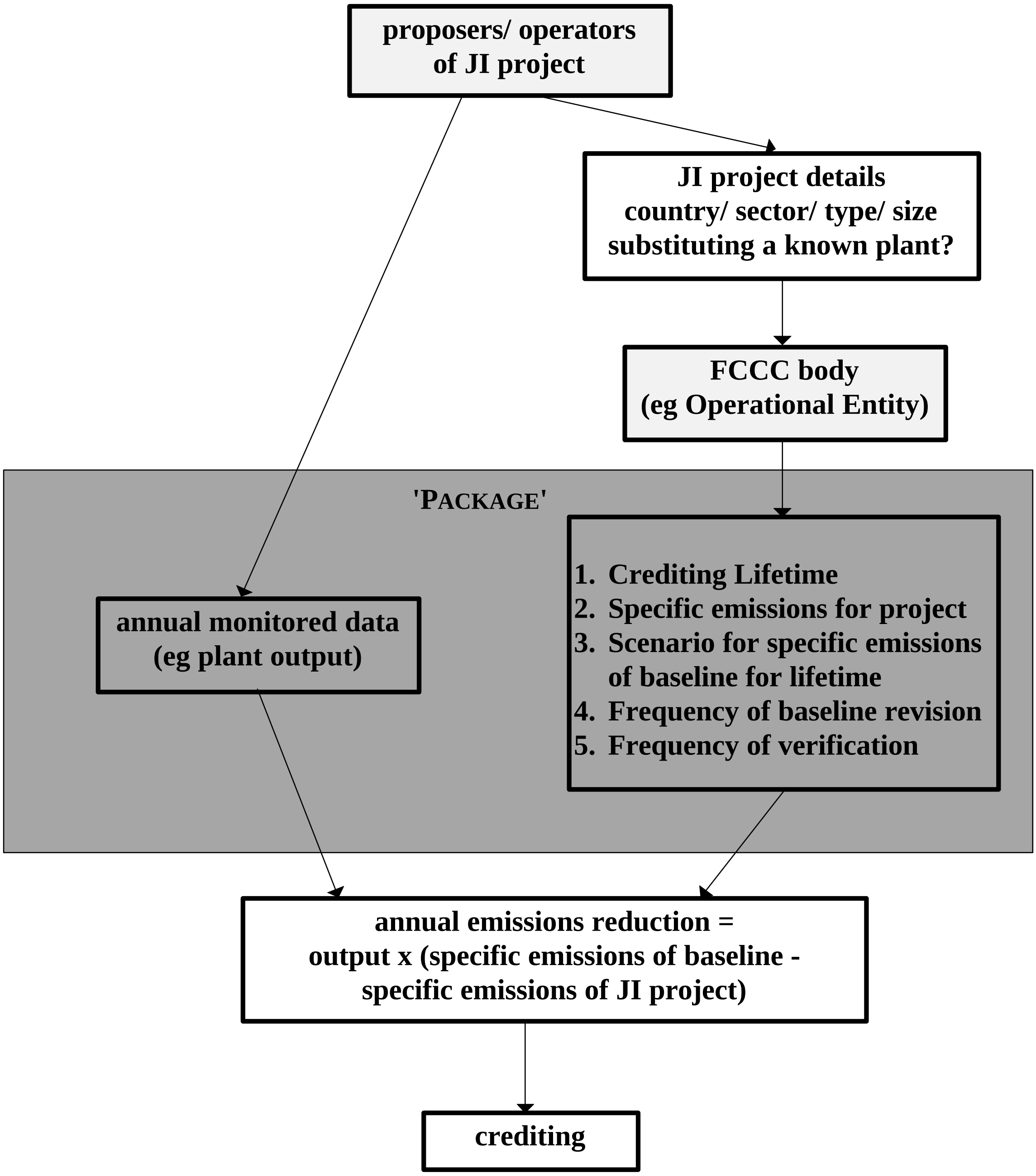


Figure 6- A Standardised Approach to Accounting

Determining a Baseline for Project Co-operation under the Kyoto Protocol: A General Overview

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1 Introduction

Already since the inclusion of Joint Implementation (GHG) in the UNFCCC in 1992, the issue of additionality of projects has been an important one. In order to determine what the greenhouse gas emission reduction or sequestration of a JI project is it is necessary to determine a reference scenario to estimate what the emissions at the project site would have been in absence of the project. The main difficulty with determining such a reference scenario (often referred to as the *baseline*) is that it is counterfactual, e.g. it describes a situation that will, because of the project, never exist. As a result, many have argued that because of this the additionality issue is the weak point of JI. Since Parties may have an incentive to inflate the baseline so that a higher emission reduction can be claimed (especially in the CDM system), a careful (third party) check is required to judge whether a project's baseline is correct and fair or not. The discussion on this is not finished yet, and will be continued at the future sessions of CoP and CoP/MoP.

Several options for baseline determination have been proposed in the literature. The fundamental point in this respect seems to be how one wants to consider the essential characteristics of a baseline. On the one hand, it may be argued that the baseline needs to be an as technically precise as possible description of the counterfactual situation of a particular JI project. This approach requires detailed information about the conditions, under which a particular project is undertaken, and so on. On the other hand, an opposite view can be taken by arguing that irrespective the amount of detailed information gathered to construct a baseline, bold assumptions will, to a certain extent, always have to be made to construct the baseline. In other words, baseline determination will to a certain extent be an arbitrary, and therefore, subjective process. According to this approach, the particular characteristics of a project are therefore not extremely relevant. What matters, though, is what a *reasonable* baseline could be in a situation that is broadly comparable to the circumstances of the project at hand. For just an illustration of the difficulties that may surround the determination of a baseline for JI and CDM projects, the reader is referred to Box 1.

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Box 1 How to choose a baseline for JI and CDM?[2]

The following stylistic example illustrates the complexity surrounding the choice of the 'right' baseline for a JI or CDM project. Suppose that a company from an OECD country wants to invest in a coal gasification project in India. The greenhouse gas emissions per unit of energy of the technology the company wants to implement in the project amount to 400 tonnes. Technologies applied by comparable multinationals from the OECD in a similar investment would cause an emission of 450 tonnes greenhouse gas per unit of energy (let us call this the OECD average). In India itself the GHG emissions per unit of energy from the most modern power plant available amount to 500 tonnes and those from an average power plant to 600 tonnes. Finally, the greenhouse gas emissions from an average power plant in South Asia amount to 700 tonnes per unit of energy.

What would the most appropriate baseline be if this investment would apply for CDM recognition? Unfortunately, the answer is not very straightforward. One (say the UNFCCC) could argue, for example, that since it might be very complicated and time-consuming to determine a baseline for each CDM power plant project in India and other countries in South Asia, the best way to calculate a baseline is to take the South Asian average as a reference. In that case, the baseline would amount to 700 tonnes per unit of energy, resulting in 300 tonnes as 'credits' (700 minus the new plant's emissions of 400 tonnes).

One could also argue that the differences between India and several other countries in South Asia are too big to use an average South Asian baseline for CDM power plant investments in India. In that case, only the average for India should be taken, which is 600 tonnes per unit of energy. Using this figure as the baseline would result in 600 - 400 = 200 tonnes per unit of energy to be credited to the CDM investment.

But even this baseline could overestimate the greenhouse gas mitigation through the project. After all, why should we take the current average emissions from a power plant in India as a reference point, as it may be fair to assume that as a result of India's economic development better and more efficient power plants will be established anyway? Then we could perhaps better use the greenhouse gas emissions from the most efficient power plant that is currently used in India as the baseline. In that case, the 'credits' would only amount to 500 - 400 = 100 tonnes per unit of energy.

A fourth possibility to determine a baseline on the basis of the information given in this example is not to look at the emissions from Indian power plants but to take the current average greenhouse gas emissions from power plants in OECD countries into account. After all, a successful economic development in India may result in a commercially driven transfer of the current average OECD power plant techniques to India. This approach would amount to 50 'credits' only (the current OECD average of 450 tonnes per unit of energy minus 400) for the CDM investors.

Finally, one could simply argue - as some still do, even if this is no implication that can be derived from the Protocol text - that investing in this project is commercially feasible anyhow,

[2] Derived from Jepma, 1997. "Progress with AIJ during the Pilot Phase", in: K. Chatterjee (ed.), 1997. *Activities Implemented Jointly to Mitigate Climate Change: Developing Countries Perspectives,* Development Alternatives, New Delhi, India, pp.59-76.

so that no CDM credits should be given at all, e.g. because the project would not satisfy the additionality criterion.

This example, which is summarised in table 1, has shown that one could easily derive five different baselines for this CDM gasification investment on the basis of at first sight (seemingly) reasonable arguments. It is therefore a very important task for the CoP to formulate modalities and procedures (see Article 12.7) for CDM baseline determination and elaborate guidelines for JI (see Article 6.3) project baselines. Given the facility to bank early emission reductions of CDM projects, time seems to run very short for this process to be successfully completed in time (i.e. before the start of the year 2000). The fundamental trade-off in the procedure of determining the baseline does seem to be between precision, fairness and transparency on the one hand, and transaction costs and loss of time and momentum on the other hand.

Table1 Theoretical example of how to choose a baseline for a CDM gasification project in India

Baseline (tonnes GHG emission per unit of energy)	GHG emissions CDM project (tonnes per unit of energy)	'credits'
I South Asian average (700)	400	700-400 = 300
II Indian average (600)	400	600-400 = 200
III Most efficient Indian power plant (500)	400	500-400 = 100
IV OECD average power plant (450)	400	450-400 = 50
V Project commercially feasible (400)	400	400-400 = 0

In the following, and against the background of the remark made above, four different approaches to baseline determination will be discussed in somewhat greater detail, thereby shifting from primarily the first to predominantly the second approach.

2 Project-specific baselines

The first option for baseline assessment is straightforward and deals with **a project-specific best acceptable estimate** of what the emissions on the site would have amounted to in absence of the project. This estimate can be made in several ways and depends on the characteristics of the project and the host country where the project is to be implemented. We will not elaborate in great detail on the many complexities (for instance, with respect to project boundaries, incorporation of externalities, etc) that will arise in this approach because this has extensively been dealt with elsewhere.[3] It may be illuminating, though, to just illustrate how difficult it is to determine what the *ex ante* baseline is, even if the AIJ/JI/CDM project seems to be rather straightforward.

Just to give a small illustration, let us take, for example, a number of pilot projects improving energy efficiency carried out in the Baltic region under the auspices of the Nordic Council of Ministers. According to the report compiled by the Council, most of these projects turned out to have only speeded up the investments.[4] Without the projects, the investment would

[3] For example, see Chomitz, 1998. *Baselines for Greenhouse Gas Reductions: Problems, Precedents, Sollutions,* paper prepared for Carbon Offsets Unit, World Bank, Washington, D.C., USA.

[4] Nordic Council of Ministers, 1997. 'Criteria and Perspectives for Joint Implementation', *TemaNord,* Kopenhagen, Denmark.

probably have been made by the host countries anyway, but with a delay of three to five years. If these projects were JI projects under the Kyoto Protocol, the projects' baseline would only deviate from the actual emissions (e.g. result in credits) during the first three to five years of the projects. It should be noted, however, that this conclusion does probably not hold for all countries in Central and Eastern Europe. Some of them have a better-developed infrastructure and have achieved a higher income and welfare level than other countries with economies in transition. The projects studied by the Nordic Council of Ministers are mainly implemented in countries that belong to the first category. For countries belonging to the latter category it will probably take (much) longer before they are able to carry out the investments themselves.

This example clearly illustrates the complexity of baseline determination. Some of the potential host countries are undergoing a process of a rapid economic transition (like, for example, most of the countries in Central and Eastern Europe or some rapidly growing developing countries). In these countries, several JI (or CDM) projects probably only speed up investments that would have been carried out by themselves anyway in the medium term. For several other potential host countries (for example, lower income developing countries), it is less likely that the JI (or CDM) project investment would have been carried out anyway in the short or mid term. For these countries, the period for which the JI (or CDM) project is additional, is often (much) longer.

Determining the length of the period, during which a JI (or CDM) project is additional, is not the only uncertainty surrounding the baseline determination. Also factors like economic growth, energy prices, currency prices and political risks can be important. The difficulty is that if the project developers have determined a project baseline that indicates an additional emission reduction resulting from the JI (or CDM) project during a period of 10 years, but after five years it turns out that the host country would obviously have carried out the project itself (for example, because the host country itself invests in several similar projects), the reported emission reduction is larger than what has actually been achieved. Such a case is obviously beneficial for the investing Party and could be advantageous for host country Parties (for example, if it has some surplus in its assigned amount), but is clearly disadvantageous for the global climate.

3 Top-down baselines

A second approach for baseline determination, developed by the US Center for Clean Air Policy, was recently added to the debate: the methodology of **top-down baselines**. The idea is that national governments of JI host countries would use their Quantified Emission Limitation or Reduction Commitment (QELRC), or, which boils down to the same, the assigned amount that follows from this restriction, as a basis to calculate for their respective sectors and/or technologies what the per unit of energy used GHG emissions would amount to, at which their commitment could be fulfilled. So, to give an example, it might be that the QELRC of a Central and Eastern European Party can only be achieved if - as a part of a whole set of measures - the CO_2 emissions per unit of energy produced in the power sector would become, say, 20 percent less than the average in the present situation. In that particular case, the minus 20 percent figure would then determine the baseline for JI projects in that particular sector, and so on.

With respect to CDM projects, a similar top-down methodology cannot be applied, simply because the non-Annex I Parties will be the host countries here, and they have not accepted QELRCs. A similar norm for baseline determination, as was suggested for projects in Central and Eastern European Annex I Parties, can, therefore, not be applied for the non-Annex I

Parties. To solve this dilemma, it has been suggested to nevertheless try to construct baselines on the basis of acceptable *simulated* targets for potential non-Annex I Parties (which is obviously a politically tricky affair). The latter element of the top-down approach is rather contentious indeed, which made Goldberg (1998)[5] once remark that this could create ‘tropical air’ in the determination of CDM projects’ baselines.

4 A baseline default system

A third option, which was proposed for baseline determination quite recently, notably by Iestra, Jepma and Michaelowa[6], is to adopt default project/technology specific baselines with a possible differentiation per country/region. 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 categorisation could then be extended to a categorisation by *regions or countries* resulting in a *region-by-project* matrix. As such, a *matrix of baselines* can be constructed, which project developers can consult. If an investing and a host country party agree on a project, they can just look up the baseline in the matrix and calculate the credits. An example of what the elements of the matrix may look like can be found in Michaelowa (1997).[7]

Some advantages of this option are the following. First, the transaction costs for the project developers will be lower, as they probably do not have to hire consultants anymore, or at least to a much lesser degree. A visit to, for example, the UNFCCC internet homepage may be sufficient. Second, also a third party check for each individually determined baseline is no longer necessary, which may also result in a significant cost saving. A third advantage of such a categorisation system is that it provides a way out of the dilemma of choosing the correct baseline out from several ones, each of which can equally well be defended as being correct (see also the dilemma illustrated in Box 1).

One could argue that the matrix approach is too imprecise because in particular circumstances the matrix elements are so clearly unfair to the project participants that an *ad hoc* adjustment seems to be imperative in terms of fairness. Therefore, as an additional element of this matrix approach, it has been suggested to include the possibility for the project participants to appeal for an adjustment of the baseline used in their particular case. This would be an optional opportunity. In other words, project participants can decide for themselves if they take the risk to lose the appeal, by making an investment in data gathering, in order to apply for an exemption. The extra costs associated with this procedure - the costs associated with the appeal - as well as with possible extra third party verification, will have to be born by the project developers.

With respect to the procedure to set up the matrix system just mentioned, it has been suggested to let UNFCCC authorised international third parties participate in the process of determining the aggregate sector/technology set of baselines. Furthermore, a periodical international verification process of the aggregate baselines would be necessary insofar as technological progress would require this. A particular point in this respect is the risk of leakage between sectors: setting a target for a sector in a non-Annex I Party may affect the appropriate target for other sectors, and so on.

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[5] Goldberg, D., 1998. *Carbon Conservation: climate change, forests and the CDM*, CIEL, CEDARENA, Washington, D.C./San José.

[6] JIN, 1998a. Joint Implementation Quarterly, vol. 4, nr. 2, pp.11-12.

[7] Michaelowa, A., 1997. *AIJ: the Baseline Issue from an Economic and Political Viewpoint*, HWWA, Germany.

5 Will the baseline stay the same throughout the project duration?

Suppose, the project developers have determined a project baseline that indicates an additional emission reduction resulting from a particular JI (or CDM) project during a period of 10 years. After five years, however, it turns out that the host country would obviously have carried out the project itself. It is clear, then, that with hindsight the reported emission reduction is larger than what has actually been achieved. Such a case is obviously beneficial for the project partners, but may be considered an undesirable outcome for the global climate.

Some would therefore suggest to allow for ***ex post* corrections** of the baseline, simply because only then would the generated credits most likely be based on real emission reductions. The main counter-argument, however, is that the possibility to face *ex post* baseline corrections will scare off potential investors, who feel like being subjected to unpredictable future moves of bureaucratic systems frustrating their well-informed overall assessment of the project's commercial potential. A second option for dealing with the baseline issue is to follow the approach just mentioned, but to allow for *ex post* corrections of the baseline. Such corrections may be required if it turns out that the underlying assumptions of the reference scenario were not correct. For investors, but also for the host country parties, this may increase the risk to invest in JI (or CDM), as it will not be clear beforehand how many credits will be generated by the project. On the other hand, *ex post* corrections of the baseline have the advantage that the generated credits are, most likely, more based on real emission reductions than without *ex post* corrections. In this case, as far as the project is concerned, it is not the global climate that runs the risk of losing, but the project partners.

Were CoP to decide, if necessary, on *ex post* corrections of baselines, the project developers will probably tend to select only those projects, of which it would seem extremely likely that they would not have been carried out by the host countries themselves, even not on the medium term. In this respect, it is worth mentioning that on the basis of a detailed analysis of 30 projects in Central and Eastern Europe,[8] it was concluded that mainly three factors hamper the automatic improvements in the processes of energy production and consumption in the region:

- The funding required for emission reduction investments in power plants and district-heating plants is often insufficiently available.
- In several Central and Eastern European countries, the legislation prescribing energy efficiency improvements is often lacking.
- The technical and management skills to implement and maintain new energy efficient technologies are often insufficient.

With respect to this, the above-mentioned analysis by the Nordic Council of Ministers[9] makes a distinction between projects at the energy demand side (for example, district heating) and those at the supply side (for example, power plants). First, energy supply side investments are often much larger than demand side investments, which makes it relatively easier to invest in district heating improvements. Second, as a result of the gradual reduction of energy subsidies during the transition process, there is a larger pressure on governments to improve the energy efficiency at the energy demand side. Finally, consumers in Central and Eastern European countries are becoming more and more eager to have comfortable living conditions, including a comfortable domestic heating system. Based on this analysis, the Nordic Council of

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[8] CCAP/SEVEn, 1996. Joint Implementation Projects in Central and Eastern Europe, Prague, Czech Republic.

[9] Nordic Council of Ministers, 1997. 'Criteria and Perspectives for Joint Implementation', *TemaNord*, Kopenhagen, Denmark.

Ministers concludes that there is a larger pressure on the governments to invest in projects at the demand side of the energy market than to invest in project at the supply side. As a result, in case of *ex post* corrections of baselines, JI energy supply side projects in Central and Eastern Europe are probably less risky than demand side projects, since the baseline for supply side projects is probably more stable.

An example of a project, for which a methodology has been developed to deal with *ex post* baseline corrections is the Costa Rican *Protected Areas Project*.[10] This project aims at sequestering 15.6 m tons of carbon-equivalent on an area of 530,000 ha. Through an international verification and certification procedure carried out by the Oxford-based Société Générale de Surveillance (SGS),[11] the government of Costa Rica has been able to issue a certificate (a so-called certified tradable offsets, CTO) for the first one million tons of carbon sequestered via the project. In order to ensure the buyers of CTOs, a risk free (98 percent covered) offset, 700,000 tons of carbon have been retained in buffer. According to the project developers, the largest component of the coverage of the buffer relates to uncertainty about the position of the baseline. They expect this uncertainty to correspond with 16.1 percent of the total amount of carbon sequestered.

To summarise the above, it could be put as simple as possible:

- The project-based approach to the baseline is micro-based and focuses on what (most likely) *would* have happened without the project.
- The matrix-approach to the baseline is meso-based and focuses on what *could* have happened (acceptable approximation) without the project.
- The top-down approach to the baseline is macro-based and focuses on what *should* have happened without the project.

The various approaches can be assessed on the basis of various criteria, and may be ‘scored’ as follows:

Criterion	**Project-specific**	**Matrix approach**	**Top-down**
Externalities covered	?	+	?
Transaction costs	-	0	+
Cheating potential	-	+	+
Uncertainty for investor	-	+	+
Political sensitivity	+	0	-
Time required to operationalise	+	0	
Potential measurement error	+	0/+*	-
Host country capacity bottle-neck	-	+	+
Baseline objective and non-normative	0	+	-

*   If appeal procedure is included
\+   positive assessment
0   neutral assessment
\-   negative assessment

[10] This example is included in this section for illustrative reasons. As will be discussed later in this report, it is still unclear whether forestry will be eligible for CDM and whether forest conservation projects, as the one described here, will be eligible for JI.

[11] For a description of this project, see JIN, 1998b, ‘Costa Rican Carbon Offsets Certified,’ *Joint Implementation Quarterly*, vol. 4, nr. 2, pp. 10-11.

It may be obvious that the views on the above assessment may differ, and also that one can take different perspectives with regard to the weights to be attached to the various criteria.

6 Baseline determination for JI projects

A final issue that will be addressed in this paper is the question whether a baseline for JI projects would have to be verified by an independent third party or that this can be left to the Parties themselves. Some observers argue that the answer could be the latter option because if Annex I Parties, for example, deliberately inflate the baseline, in order to obtain more credits, the actual total emissions of both Parties together will be higher than the total of both Parties' assigned amount. This would imply that the Parties (or one of them) are not in compliance with their commitment under the Kyoto. Assuming that a reliable compliance system will exist under the Protocol, the Parties (or one of them) will have to compensate for the excess of emissions.

A stylistic example may illustrate this argument. Suppose that the Netherlands wants to set up a JI project with Poland. Both the Netherlands and Poland have an assigned amount of, say, 100. Under a business-as-usual scenario, Poland's annual emissions during the commitment period would have amounted to 104. Suppose now that both countries set up a JI project in Poland, resulting in an annual emission reduction during the commitment period of 10 units, of which the Netherlands acquires 6. Poland's annual emissions will be 10 units lower, of which it can only use 4. Or, in other words, Poland's assigned amount has been lowered with 6 units and the Netherlands has increased its assigned amount with 6. The final record of the JI co-operation is that the Netherlands' assigned amount has increased with 6 (becomes 106), whereas Poland's emissions have decreased to 94 (= 104 - 10) and its assigned amount to 94 (= 100 - 6) as well. In this example, both Poland and the Netherlands have achieved their QELRCs, assuming that the Netherlands will stay below the emissions level of 106.

What if the Netherlands and Poland decide to deliberately inflate the baseline and to claim 20 units of emission reduction, whereas in reality the project's reduction is only 10 units?[12] In case of a 50-50 percent credit sharing agreement, the Netherlands acquires 10 units as credits, whereas Poland's assigned amount, as a result of the double-bookkeeping principle of the Kyoto Protocol, is reduced with 10 units. In other words, Poland transfers 10 units of its assigned amount to the Netherlands. The final record of the JI co-operation now is that the Netherlands has more domestic flexibility - its assigned amount has increased with 10 units to 110 - whereas Poland's assigned amount has decreased to 90. Poland's actual emissions level, however, has only decreased with 10 units, so that Poland is short of 4 units (104 units under business-as-usual - 10 units emission reduction = 94). Poland is now in non-compliance (again, assuming that the Netherlands will not surpass its assigned amount of 110), but who is responsible and who is liable?

Those, who are in favour of a system without third party registration and verification of baselines, actually argue that the host country (Poland in our example) is liable. The host country may, in fact, transfer as many credits to the investing country as it wishes, as long as it compensates for the difference between its assigned amount and its actual emissions level during the commitment period in case the latter is higher. It may be obvious that this is a risky business for the host countries. If they make some miscalculations, and transfer too many

[12] It should be noted that deliberate inflation is not the only risk in this respect. Also a change in the value of the underlying economic and demographic variables of the baseline during the project lifetime may cause the project to result in less emission reduction than expected beforehand (see also the discussion in section 2.3 on *ex post* baseline corrections).

credits to the investing countries, they will have to make up for that later on. This may make potential host countries reluctant to get involved in JI projects.

Some have argued that the responsibility in case of baseline inflation (be it deliberate or not) should be shared between the host and the investing Party. This could be an argument in favour of having third party checks and verification. If, for example, a host country has 1000 JI projects, of which a few may have an incorrect baseline, how can those incorrect projects be identified if there is no third party verification? Third party verification could be a tool to distinguish the right from the wrong projects if the host countries are not able to do this themselves. An additional argument in favour of third party verification of JI projects could be that it could have a strong learning component.

Recently, the question was raised if determining a baseline for JI really is an issue. To a certain extent, the answer may be ‘no’. After all, because of the double bookkeeping system of the assigned amount system under the Kyoto Protocol, it is certainly not anymore in the interest of **both** Parties to inflate the baseline of JI projects. However, it is still in the interest of the investors to do so. If they could, in one way or another, claim too many emission reductions from JI projects (for example, because of a lack of capacity and equipment in the host country to control the baseline calculations), the host countries have to compensate for this at home. The reluctance this could create among the potential host countries may eventually turn out to be a higher price than the extra transaction costs associated with third party verification.

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