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FOREWORD

This document was prepared by the OECD and IEA Secretariats in October 1999 at the request of the Annex I Expert Group on the United Nations Framework Convention on Climate Change. The Annex I Expert Group oversees development of analytical papers for the purpose of providing useful and timely input to the climate change negotiations. These papers may also be useful to national policy makers and other decision-makers. In a collaborative effort, authors work with the Annex I Expert Group to develop these papers. However, the papers do not necessarily represent the views of the OECD or the IEA, nor are they intended to prejudge the views of countries participating in the Annex I Expert Group. Rather, they are Secretariat information papers intended to inform Member countries, as well as the UNFCCC audience.

The Annex I Parties or countries referred to in this document refer to those listed in Annex I to the UNFCCC (as amended at the 3rd Conference of the Parties in December 1997): Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, the European Community, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom of Great Britain and Northern Ireland, and United States of America. Where this document refers to “countries” or “governments” it is also intended to include “regional economic organisations”, if appropriate.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Executive Summary

The Kyoto Protocol establishes two project-based mechanisms: the clean development mechanism (CDM) and Joint Implementation (JI). Emission baselines for JI and CDM projects aim to quantify "what would have happened" in terms of greenhouse gas emissions in the absence of those projects. Actual emissions from JI or CDM projects are measured against baseline emissions, and, if lower, can generate emission credits. Baselines are, by definition, hypothetical reference cases and are subject to a number of uncertainties.

There are differing views about whether or not CDM and JI require the same framework for setting baselines. This paper does not attempt to prejudge the outcome or potential implications of political negotiations on this issue. The paper focuses on the *technical* aspects of baselines.

Once established, rules and/or guidance for JI and CDM under the Kyoto Protocol are expected to cover many aspects of the mechanisms and not just the baseline. The linkages between the emissions baseline and other aspects of project-based mechanisms, such as eligibility criteria and monitoring and reporting requirements means that the rules for one may influence others.

There are different ways to set up an emissions baseline. Ideally, baselines should be credible, transparent, simple and inexpensive to set up. In practice, drawing up baselines is likely to involve tradeoffs among these criteria. Moreover, the level of baseline aggregation and standardisation can vary widely. Baselines can be established so they apply to one project only ("project-specific"), aggregated to a sub-sector or sector level ("multi-project"), or be in a grey area somewhere between these two levels of aggregation ("hybrid"). The literature also mentions the possibility of aggregated nationwide baselines ("top-down"), but this paper focuses on the three other approaches.

Project-specific baselines are the least aggregate type of emission baselines, and evaluate emission reductions generated from one particular project (rather than a group of similar projects). These baselines are established by using project-specific assumptions, measurements, or simulations for all key parameters: they tend to take output levels into account implicitly rather than explicitly. Most AIJ projects to date have used project-specific baselines when calculating the emission benefits of those projects.

Multi-project baselines seek to standardise emission levels or rates, and are designed to be applicable to multiple projects of a similar type. Individual projects would be measured against these baselines to see whether or not they were eligible for emissions credits, and, if so, how many credits they would generate. Multi-project baselines may be calculated based on assumptions about the emissions *rate* (e.g. g CO_2/kWh) as well as on an absolute emissions *level*. Multi-project baselines can be highly aggregate and be applied to many projects, or fairly disaggregated and applied to a smaller range or number of projects.

Hybrid baselines would be designed for projects that do not quite "fit the mould" for a multi-project baseline, or would simplify the process of collecting and monitoring data for projects which are unique and thus require individually tailored baselines. Hybrid baselines would be more aggregate and standardised than project-specific baselines and less aggregate and standardised than multi-project baselines. Hybrid emission baselines would, like project-specific baselines, be made up of various components. But the parameter values, or the methodology used to determine one or more of the baseline's underlying data points, would be standardised. This

would mean that establishing a hybrid baseline would be a more streamlined process than establishing a project-specific baseline.

Some cross-cutting issues are relevant to all baseline approaches. These include the length of time emission credits can accrue, and whether or not the baseline is fixed at the start of the project (static) or revised during the project operation (dynamic). Static baselines are predictable and reduce the uncertainty surrounding the level of credits generated from a project. Dynamic baselines may better reflect actual trends, but would need to be re-estimated and re-reported at certain intervals. A number of analyses suggest that dynamic baselines may be more appropriate for some project types.

The total number of credits generated by a project is very sensitive to the length of time over which they can accrue (the emissions timeline). If a standard methodology to calculate an emissions timeline could be agreed, it would increase the comparability between projects, and also offers a potentially simple way of limiting the effects of free riders and gaming.

The approach used to determine an emissions baseline for a JI or CDM project has consequences for the project's transaction cost, transparency and administrative feasibility (including data, monitoring and reporting requirements) as well as for its environmental additionality. This study considers each of the main baseline approaches against these performance "criteria".

Data, monitoring and reporting requirements are important because they affect the costs and administrative feasibility of project preparation and review. These requirements vary across different baseline approaches. Project-specific baselines have relatively heavy data requirements and may require some monitoring of current activities before the actual JI/CDM project or activity starts. Using multi-project baselines requires less or no monitoring of the pre-JI/CDM project situation for project participants. However, data are required to establish these baselines.

Different baseline approaches also have different cost implications[1]. Using a baseline approach that incorporates either standardised methodologies or assumptions will be cheaper and easier than developing a project-specific approach. While there are costs involved in developing all baselines, who pays for their development may differ depending on the approach. By lowering the costs of project preparation, an agreement on standardised approaches could increase the number of JI and CDM projects. In turn, this could help increase the effectiveness of JI and CDM by increasing their contribution to cost-effective emission abatement.

The transparency of a baseline also varies with different baseline approaches. In general, the more assumptions related to an individual project or to a system that are included in a baseline, the more documentation is needed with that baseline to make it transparent. Increased transparency may help to increase participation, and may also facilitate any verification and certification.

The environmental additionality of a JI/CDM project can be affected by the baseline approach as this can influence the potential level of gaming, free riders and leakage. Increased levels of gaming, free riders and leakage would artificially inflate the number of credits resulting from a project. For the CDM, this would mean that not all credits accruing from CDM projects would represent actual emission reductions and may lead to higher total Annex I emissions. Artificially

1 The cost of establishing an emissions baseline is one component of the transaction costs associated with JI and CDM projects, but should ideally be kept as low as possible to encourage investment through these mechanisms.

high credit levels for JI projects will not affect the overall Annex I assigned amount[2], although it could make it more difficult for some host countries to meet their individual Kyoto commitments. The potential for gaming may be particularly high for CDM project-specific baselines. Multi-project baselines may be more vulnerable to potential free riders in some cases, although the level at which the baseline is set – and this is true for all baseline approaches- is crucial in this regard.

The environmental additionality of individual projects is clearly correlated to the level or stringency of the baseline. The stringency of an emissions baseline varies depending on the assumptions used in setting it up. This paper presents a preliminary survey of analyses done on the effect that different baseline approaches and/or assumptions have on the level of credits generated by a particular project. This paper also presents case studies that illustrate the influence of national circumstances on the absolute level of the baseline and the relative level (compared to other technologies/processes). For example, if both India and Brazil use the same multi-project baseline approach to set a baseline for new electricity projects at the level of their current average emissions, gas-fired electricity projects could generate certified emission reductions (CERs) if they were undertaken in India, but not in Brazil.

The assessments presented in this paper indicate that **assumptions used to develop baselines and baseline approaches (e.g. project-specific, multi-project) are independent variables. Both can influence the level of credits for a particular project.** In the examples examined here, the range in different possible assumptions within one baseline approach can be as large as the range in assumptions between different baseline approaches. However, not all approaches may be equally appropriate in all circumstances, and different approaches may be viewed more or less suitable for different types of projects (e.g. forestry, electricity or landfill).

Both baseline assumptions and approaches will have an impact on the overall environmental effectiveness of the mechanisms[3]. The baseline approach will influence the effectiveness of the mechanism through its impact on the complexity of setting up an emissions baseline. All other things being equal, more complex methods are likely to limit the number of projects initiated by adding to the transaction costs associated with developing a CDM or JI project. Within each approach, baseline assumptions are also likely to have an impact on the effectiveness of the project-based mechanisms through their impact on the baseline stringency, which affects the level of credits, and through this the number of projects initiated. Regardless of the approach used, stringent baselines could limit the number of projects initiated due to their effect on the cost of credits while lax baselines could obviously have a negative environmental effect.

In circumstances where different baseline approaches are plausible, the independence of baseline stringency and approaches suggests that **maximum environmental effectiveness across the project-based mechanisms (as opposed to individual projects) is likely to be achieved by optimising baseline stringency and reducing baseline complexity**. In practice, this means: (i) seeking to minimise baseline complexity, as long as the ability to determine "what would have happened otherwise" is not compromised; and (ii) optimising the baseline stringency so that it

2 As long as each Annex I country meets its emissions commitment.

3 Unlike the CDM, JI is a zero-sum game in which transfers and acquisitions of emission credits will not affect the total Annex I emissions, as allowed by the Kyoto Protocol. The implications on environmental effectiveness are thus different.

maximises the overall global environmental effectiveness from the project-based mechanisms. The optimal strategy takes into account that a high volume of projects will be needed to deliver strong environmental effectiveness from the mechanisms: a greater number of good projects will be more beneficial for the environment (in terms of total GHG reductions) than a lower number of individually better projects.

Progress on technical issues would be greatly facilitated if policy makers decided which baseline approach(es) are to be used for each JI and CDM project/project type. Such an agreement would allow analysis to focus on how such approach(es) could be applied in a comparable manner or, in the terminology of this paper, on finding assumptions that provide the balance between the environmental effectiveness and encouraging participation given different circumstances. An agreement would also facilitate the resolution of other outstanding questions (e.g. reporting formats) which could also help in the development of the mechanisms. In addition, understanding of the issue would be improved if common definitions and a common vocabulary for key baseline-related parameters could be reached.

A decision on baseline approach(es) would open the door for assessment and eventual agreement on other credit-related aspects of JI and CDM projects, such as:

- how to determine the value of key assumptions;
- how long any project should be allowed to generate emission credits for (the emissions timeline);
- whether or not emissions baselines should be static or dynamic;
- maximising the environmental effectiveness of the project-based mechanisms by minimising the level of leakage, free riders and gaming; and
- assessing how to determine the environmental additionality of a climate-friendly project in a country that has low emission levels.

1. Introduction

The Kyoto Protocol (KP) establishes two project-based mechanisms: the Clean Development Mechanism (CDM) and Article 6 projects (usually referred to as Joint Implementation, JI). Article 12.5(c) of the KP states that CDM project activities should result in "reductions in emissions that are additional to any that would occur in the absence of the certified project activity". Article 6.1(b) of the KP states that JI projects should provide "a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to any that would otherwise occur".

Estimating business-as-usual reference scenarios (i.e. what would happen otherwise) is thus necessary to evaluate the environmental "additionality" (in terms of emission reductions) of JI and CDM projects. These reference scenarios are defined as "baselines".

The international community has not yet decided how these baselines should be established, reported and verified. However, baselines are an important issue within the ongoing negotiations on the Kyoto Protocol to the UNFCCC.

Activities Implemented Jointly (AIJ) was established in 1995 at the first Conference of the Parties (COP1) as a pilot phase of Joint Implementation. Some experience with emission baselines has been gained during the AIJ pilot phase. This experience is mainly with emission baselines that have been established on a project-specific (case-by-case) basis. However, these emission baselines have been relatively expensive and time-consuming to draw up. Lack of international guidance on how exactly to draw up these emission baselines has also meant that they are often neither transparent nor consistent.

There are other possible options by which to develop emission baselines, and many countries have expressed an interest in examining in more detail how such options would function and what would be their implications. This paper seeks to define and explain the different baseline approaches and to examine how the various approaches can impact the assessment of project environmental additionality and the overall environmental effectiveness of the project-based mechanisms. A survey of experiences with baseline approaches under AIJ, as well as quantitative case studies, are included to illustrate the potential use and implications of different baseline approaches.

1.1 Objectives and approach

The objectives of this paper are:

- to define and assess how different baseline approaches could function for JI and/or for CDM projects;
- to determine whether the use of a particular baseline approach (over another approach) could influence the evaluation of environmental additionality of a particular project; and,
- to determine whether and how the use of a particular baseline approach could influence the incentive to participate in CDM and JI projects (i.e. the potential effect on the number of projects).

This assessment is then used to examine the potential effect of baseline approaches on the overall effectiveness of the project-based mechanisms[4] in helping meet the objectives of the Kyoto Protocol, i.e. contributing to sustainable development[5] and helping Parties achieve their Kyoto commitments most cost-effectively. In addition, this paper outlines the potential data, monitoring and reporting requirements for each baseline approach, the likely cost implications of these requirements, and assesses the applicability of each approach to different project types. Implications of using different baseline approaches in the verification process of emission reductions from CDM and JI projects are also examined.

This paper assesses[6] different baseline approaches under a number of criteria including:

- the environmental credibility of the baseline (which is related to the potential levels of gaming, free riders and leakage);
- the relative costs of developing and using the baseline;
- the data, monitoring and reporting requirements of the different baseline approaches; and
- transparency.

The variation in these criteria is likely to influence the transaction costs associated with a project, the number of projects initiated under the project-based mechanisms, each project's environmental additionality, and therefore, the environmental effectiveness of JI and CDM as a whole[7].

The paper also looks at the potential implications of the *assumptions* used to develop baselines (using different baseline *approaches*) on the level and stringency of the baseline. In addition, the paper provides an initial assessment of the relationship between the assumptions and the different baseline approaches as well as between the stringency and the complexity of baselines.

1.2 Context

Emission baselines for project-based activities aim to quantify "what would have happened" in the absence of those activities. Baselines are estimated reference cases for likely future emission pathways, and are therefore hypothetical[8]. If actual emissions from JI or CDM projects are lower than the baseline, they are viewed as additional[9] and can be used to generate emission credits.

4 As explained later in section 1.2, there are different views on whether or not baseline-setting framework should be the same for JI and CDM.

5 Article 12.2 of the Kyoto Protocol explicitly states that one of the purposes of the CDM is to assist non-Annex I Parties (i.e. the developing countries) "in achieving sustainable development".

6 This assessment is in section 5.

7 The implications on environmental effectiveness may be different for JI and CDM.

8 Even an emission baseline based on factual data is hypothetical because it is based on the hypothesis that future and past performance will be the same – which may or may not be the case.

9 In this paper, "additional" is defined solely based on the impact of the project on GHG emissions. No financial criteria are taken into account though this is another important area of consideration.

It is important to note that there are different views on whether or not rules and guidelines for setting emissions baselines for JI and CDM projects should be the same. Whereas JI can be viewed as a "zero-sum" exercise where the total assigned amount for Annex I countries does not change as a result of the transfer and acquisition of ERUs, the CDM can be viewed as a "plus-sum" exercise.

Global emissions remain unaffected by ERUs from JI projects (as long as the JI host country meets its Kyoto commitments), regardless of the uncertainty surrounding estimated environmental additionality. On the other hand, CERs generated from CDM projects are *added* to the Annex I assigned amount. The inherent uncertainty associated with the estimation of CERs resulting from CDM projects can lead to positive or negative impacts on the level of global greenhouse gas emissions. For these reasons some Parties are of the view that CDM projects and JI projects should be treated differently. In this view, *rules* about baseline-setting would be appropriate for CDM projects, while only *guidance* about baseline-setting would be necessary for JI projects. Other Parties, however, do not support such a distinction between the two project-based mechanisms. As the Kyoto Protocol (Articles 6 and 12) states that emission reductions resulting from a CDM or JI project must be "additional to any that would" occur in the absence of that project, these Parties are of the view that both mechanisms should have a consistent treatment of environmental "additionality." Emissions baselines are important to this debate because they are used to assess environmental additionality.

While this paper notes these differing views and their potential implications, no attempt is made to prejudge the outcome of political negotiations on this issue. Instead, the paper focuses on technical aspects of baselines, their relationship with environmental additionality, participation in the mechanisms (i.e. potential number of projects), and more broadly with environmental effectiveness. Environmental effectiveness, while recognising that implications may be different for JI and the CDM, is defined in the paper by the environmental additionality of each individual JI and CDM project, (compared to what would have happened without such projects), and the likely number of projects undertaken.

Leaving aside the debate on whether or not setting CDM and JI baselines require the same framework, an ideal emissions baseline should:

- be environmentally credible (to ensure long-term benefits greater than what would happen otherwise);
- be transparent and verifiable by a third Party;
- be simple and inexpensive to draw up (low transaction costs); and
- provide a reasonable level of crediting certainty for investors.

In practice, any baseline approach is likely to involve tradeoffs among the criteria above.

If the baseline level is higher than the emission level that would "happen otherwise", an artificially high number of emission credits would be generated per project. A high baseline level would also result in more projects being eligible for JI/CDM status and could increase the number of free riders as well as lower the cost of emissions credits. On the other hand, if the project baseline is very stringent and set at a level lower than the emission level that would "happen otherwise", the amount of emission credits per project would be artificially small. A low baseline will by definition limit the number of eligible projects, and may even disqualify some potentially climate-friendly projects. A low baseline is also likely to reduce the number of profitable projects and to increase the cost of emissions credits from those projects that do qualify[10].

Uncertainties in emission baselines cannot be eliminated as it is not possible to prove what would "happen otherwise" in these hypothetical reference cases. However, there are concerns about the potential incentives to create greater inaccuracies in the baselines, e.g. by biasing them upward in order to generate a greater number of credits for the CDM/JI project participants (i.e. "gaming").

Apart from the impact of the baseline *level*, this paper considers the impact of different baseline approaches and assumptions on the environmental effectiveness, as defined above, of the CDM and JI. The analysis recognises the need to strike a balance between maximising the environmental credibility of the baseline and minimising the costs of developing the baseline in order to encourage participation and a high level of investment in emission-reducing projects.)

2. Baseline approaches described

There are many different ways by which emission baselines could be set up for JI and CDM projects. This paper assesses three main types of options:

- **project-specific**: baseline determined on a case-by-case basis, with project-specific measurements or assumptions for all key parameters;
- "**multi-project**" (which can be at many levels of aggregation such as by technology or sector): baseline is equivalent to an "activity standard[11]" or policy target that is aggregated at a certain level; and
- **hybrid**: baseline determined in a hybrid fashion, with some key parameters project-specific, and others standardised (the number and level of the standardised parameters will vary for each different project category).

These baseline approaches are outlined in Table 1.

The literature also mentions baselines drawn up at the national level, referred to as "top-down" baselines (e.g. Puhl 1998). These top-down baselines are highly aggregated, reflect national government objectives/targets and policies and have therefore been most often referred to in the context of JI or AIJ projects. These baselines could be used to assess emission reductions resulting from *policy* initiatives (e.g. Puhl et al.1998) and not only concrete *project activities*, as is the case for the other baseline approaches. Because of this fundamental difference with the other baseline approaches considered in this paper, top-down baselines[12] are not treated further in this paper.

There are many possible variations to the three baseline groups assessed in this paper. For example, the time over which emission credits can accrue (the "emissions timeline") can vary.

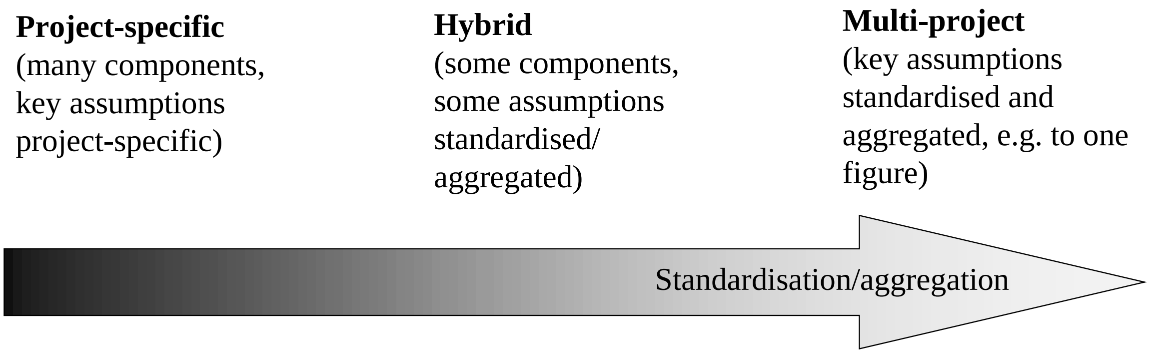
10 Estimating whether or not a hypothetical baseline was overestimated (lax) or underestimated (stringent) is likely to be difficult, uncertain and best carried out only several years after the start of the project (e.g. if the assessment is to be based on data regarding comparable, but non-JI/CDM, projects).

11 This type of baseline includes those variously referred to as "benchmarks", "activity standards", "project-category", "technology matrix" and "sectoral".

12 In some cases, top-down baselines refer to sectoral baselines based on national data. In this paper, such baselines would fit under the "multi-project" typology.

These, and other cross-cutting issues, such as whether or not baselines should be static or dynamic, are discussed in section 3 of this paper.

Figure 1: Representation of different baseline approaches



Terminology and baseline approaches

The vocabulary surrounding emission baselines is under development. At present, there appears to be no international consensus either on terminology, or on the definition of baseline categories.

In some cases, one term is used to describe more than one concept. For example, some use “dynamic” baselines to refer to a baseline that is not at a constant level throughout the crediting life of the project, e.g. because of projected changes in output from that project. Some use it to mean a baseline that has been retroactively altered. Others use the same term to refer to a baseline that is revised during the course of a project. This paper uses the latter definition for dynamic.

In other cases, there are many different labels describing one concept, such as using one aggregate factor to determine the emissions credits from a project. In this case, the aggregate factor has been variously referred to as an activity standard, benchmark, project-category, or intensity indicator. This paper uses “multi-project”.

In addition, the approach used to determine a baseline’s level can be distinguished in different ways, e.g. by level of aggregation, whether underlying data were historical or projected, and to what extent models were used. Since many different data points are needed to establish a baseline, and since each of these data points can vary in level of aggregation etc. any categorisation is likely to be blurred. This paper distinguishes baseline approaches by the level of aggregation and standardisation.

Table 1: Terminology of different baseline approaches

Baseline approach	Description	Calculation of annual Credits
Project-specific	Baseline determined on a case-by-case basis, with project-specific measurements or assumptions for key parameters.	Difference between measured project emissions and estimated baseline emissions.
Multi-project (various designs):		
- technology level	Baseline emissions are specified per technology, e.g. on a rate basis such as t CO_2/GWh.	Difference between measured project emissions and inferred baseline emissions.
- (sub-)sector level	Baseline is equivalent to a "performance standard" (or intensity indicator) that is aggregated at a certain level (e.g. sub-sector X in country Y, or sector P in country region Q).	Projects/activities would only qualify for credits if emissions (per unit activity or output) were under the performance standard. Credits would be based on the difference between project emissions and the performance standard.
Hybrid	Baseline determined in a hybrid fashion, with some key parameters project-specific, and others standardised (the number and level of the standardised parameters will vary for each different project category).	Difference between measured project emissions and estimated baseline emissions.

2.1 Project-specific baselines

Project-specific baselines are the most disaggregate type of emission baselines. They are developed to evaluate emission reductions generated from one particular project (as opposed to a group of similar projects). These baselines are established by using project-specific assumptions, measurements, or simulations for all key parameters, such as fuel and technology characteristics and changes in output/fuel/technology over the life of the project.

The project-specific baseline approach was the most commonly used in AIJ pilot phase projects, and is therefore the baseline approach for which there is most experience. These baselines were drawn up on a case-by-case basis for a particular project. For project-specific baselines, each key component used to establish the emissions baseline is individually assessed to determine what would have happened in lieu of that particular project. These different data components of a project-specific baseline may be measurements, estimations, simulations or assumptions, and may be unique to a particular project (e.g. distance from current electricity or gas grids) or applicable to a group of projects (e.g. the technical lifetime of the equipment installed).

Despite the project-specific nature of this baseline approach, it may still be subject to considerable uncertainty and thus lead to uncertain estimates of the "environmental additionality" of JI or CDM projects. One analysis (Begg et. al. 1999) indicates that using a project-specific baseline to estimate emission reductions from refurbishment-type energy sector projects results in uncertainties of the order of $\pm$ 80% - and these type of projects are those usually thought of as the "easiest" projects for which to draw up emission baselines! The same analysis indicates that the largest component of this uncertainty is the hypothetical nature of the baseline, i.e. the choice and timing of baseline fuel and technology options.

Most project-specific baselines in AIJ projects were established using measurement and expert judgement for key parameters, though model simulations or comparisons were also used to a lesser extent. These baselines were often drawn up by a consultant acting on behalf of the investor, before being reviewed by a team in the investor's country and agreed to by the host country. Because of the lack of rules or guidance governing what needed to be measured and/or reported in order to set up an emissions baseline, AIJ project reports did not include a consistent set of data in their elaboration of the emissions baseline (Ellis 1999). Moreover, the detail of data and underlying assumptions presented in the project reports submitted to the UNFCCC varied significantly between different AIJ projects. The costs of establishing tailored emission baselines for some JI-type projects have been estimated at 1-8% of total project costs (Puhl 1998).

Project-specific baselines could be made more consistent and transparent than those used to date. This would be achieved if each project type had a uniform reporting format in which to report specific information (such as fuel and technology characteristics) from that project type. This could encourage an agreement on methods on how to calculate emissions baselines. Such a baseline could then be classified as hybrid or multi-project in some cases[13].

Data requirements for determining tailored emission baselines vary by project type. Initial reporting requirements for selected project types have already been suggested by some analysts (e.g. MacDicken 1997, Vine and Sathaye 1999, Ellis 1999) and are listed in Annex A. These suggested reporting requirements are quite data intensive, and may in some cases

[13] The current Uniform Reporting Format for AIJ projects does not request the reporting of specific data, but "estimated emissions without the activity (project baseline)" and "estimated emissions with the activity". Consistent methods would result in greater transparency irrespective of baseline type, and are discussed further in section 2.5.

necessitate monitoring and reporting fuel and/or technology use over an extended period of time before the project is in place, as well as during the life of the project. For example, the current Dutch approach to establishing a baseline requires information “for twelve successive months prior to the start of the project” (JIRC 1997). The tables in the UNFCCC’s current Uniform Reporting Format imply that annual monitoring and reporting of project emissions is required for AIJ projects.

Project-specific emission baselines are elaborated on a case-by-case basis and could, by definition, be used for all project types in all sectors.

2.2 Multi-project baselines

Multi-project baselines[14] indicate the emissions level associated with certain activities, often at a sectoral or sub-sectoral level. Potential CDM or JI projects would be measured against these aggregate baselines to see whether or not they were eligible for emissions credits, and, if so, how many. In the energy and industry sectors[15], these baselines would probably be based on an emissions *rate* (e.g. t CO_2/GWh) rather than on an emissions *level*[16]. In comparison, project-specific baselines are usually, but not always, based on an emissions level.

Multi-project baselines are an extremely broad category of baseline. They could encompass baselines drawn up at differing levels of geographical or sectoral aggregation, and baselines using each level of aggregation could be based on historical data, trends or projected data. At a disaggregate level, e.g. specific to a particular technology, sub-sector and country, multi-project baselines can approach the level of detail of a hybrid project baseline[17]. Alternatively, highly aggregate project categories could be drawn up, e.g. sectoral level. The AIJ pilot phase includes at least one project (cement manufacture in the Czech republic[18]) where the emission benefit was calculated by using a sectoral baseline.

Multi-project baselines are potentially simple, transparent, predictable and low-cost. They may also reduce “micro” gaming (gaming at the project level) compared to other baselines, if they were developed by a (neutral) third party.

Opinions differ on whether multi-project or other baseline approaches give a more plausible estimate of the hypothetical emission level that would occur without the JI or CDM project. Multi-project baselines are defined and applied to a group of projects. This means that the environmental additionality of each project credited under a multi-project baseline has not been assessed on what would have happened in lieu of that *particular* project, although multi-project baselines can nevertheless represent a plausible estimate of the overall situation that would have happened otherwise. Ultimately, projects assessed against multi-project baselines can generate the same number, greater or fewer emission credits than if they were assessed

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14 Many different alternative labels for this type of approach have been used, including “benchmarks”, “intensity indicators”, “activity standards”.

15 Little work has been done to date on the possibility of using benchmarks for biotic projects. However, some initial thinking on the issue (see Trexler 1999a) indicates that a binary (yes/no) determination of additionality may be more appropriate than a rate-based determination, at least for some LUCF sub-sectors.

16 Using a baseline based on an emissions rate allows changes in output to be taken into account.

17 Further disaggregation is possible, e.g. for multi-project electricity sector baselines which could separate fossil/non-fossil sources, peak/off-peak etc.

18 See http://www.unfccc.de/program/aij under the Cze/Fra project

under project-specific baselines, depending on the assumptions used for the two baseline approaches.

Multi-project baselines could be set up at a fairly **disaggregate** level, such as by technology in a particular country (or part of a country). In this case, emissions from e.g. a gas-fired plant installed as a JI/CDM project would obtain emissions credits if the per kWh emissions were lower than that designated for that project category.

Of course, the key issue would be where to set the baseline level. Should this level reflect the host country average; the regional average; the country or regional average for recently installed technology; the marginal technology; or the best equivalent system already installed in the host country? Alternatively, should the baseline level be determined by the best economically attractive system? These different choices in assumptions underlying the emissions baseline have a significant effect on the number of credits that could be generated for a project, and are illustrated in section 4.3.

However, once the exact technology characteristics that will form the baseline have been chosen, the baseline could be relatively simple to establish, for example if it was determined relative to the emissions performance of best available technology (BAT), e.g. 10% greater emissions than BAT.

Alternatively, **aggregate** multi-project baselines could also be drawn up, e.g. at a sector level. As for more disaggregate multi-project baselines, they could be based on historical data or on projected performance of the sector.

2.3 Hybrid project baselines

Project-specific emission baselines are made up of many different components. Standardising the value of one or more of these components, or the method by which they are elaborated, would increase the transparency and comparability between the emission baselines of different projects and would also reduce the time and cost of establishing an emissions baseline[19].

“Hybrid” project baselines could therefore be designed to be applicable to a small number of projects. These baselines would therefore include a greater degree of standardisation for one or more of the key baseline components than project-specific baselines, but would be less aggregated and less standardised than e.g. multi-project baselines designed for particular sub-sectors. The local and regional variability of the different baseline components will determine the extent to which standardisation is feasible. For example, a JI/CDM project that reduces leaks of methane from a natural gas distribution system is likely to need to use a project-specific value for leakage rate as this rate likely to be specific to the system concerned.

Whether or not a component used to calculate emission baselines can be easily standardised depends on the component itself. These are examined in Table 2. The components that are bolded are those likely to have the greatest impact on a baseline’s level.

[19] A hybrid baseline would not necessarily result in similar projects generating identical emission credits because of project-specific variations in certain parameters and countries’ different circumstances. Nevertheless, it could reduce the wide divergence of emission reductions for similar projects undertaken in different circumstances that was notable for AIJ projects.

Table 2: Potential for standardising different components of emission baselines

Baseline component	Project types for which assumption is important	Potential for standardisation	Comment
	All	High	Standardised **methodologies** could be agreed on how to determine the timeline (standardising the actual timeline length would be more difficult, although possible at a disaggregate project category level). These methodologies could be further subdivided by project category, and by project type (e.g. greenfield/replacement). It may also be possible to obtain political agreement on the absolute timeline, such as 10 years for power plants.
Baseline fuel used	"Greenfield" and refurbishment energy/industry projects	Medium-high (short-term). Low (longer term).	Some standardisation may be possible for some countries (e.g. those with a predominant fuel use in a particular sector and limited changes in fuel trends). Longer-term fuel use more difficult to determine because of the possibility of autonomous fuel switching (e.g. coal/oil to gas).
Autonomous energy efficiency measures	D/S-side energy efficiency projects. Fuel transportation	Medium	Arbitrary efficiency improvements could easily be factored into baseline/credits, although different factors may need to be elaborated for different countries/sectors.
Accounting for energy-efficiency measures	S/D-side projects that reduce demand for fossil fuels, or that reduce demand/displace fossil electricity	Medium/High	Standardisation could be easy in principle (e.g. by using average C/kWh values for displaced electricity)[20], but difficult to determine at the start of a project because of the influence of a changing fuel mix. Lack of data may also prove to be a barrier to determining average values. Values may need to be "deflated" in order to take any rebound effect into account. The actual effects of energy efficiency measures may, however, deviate significantly from "average".
Fuel emission factors	Energy/industry projects	High (for CO_2), Low/Medium (other gases)	Default emission factors (e.g. as in the IPCC guidelines) could be used for CO_2 from fuel combustion. Standardisation more difficult for other gases/sectors, often being site or region specific (e.g. CH_4 from mining, landfills or rice production).
Carbon content	Biotic projects	Medium	Site-specific differences and natural variabilities result in variations in the order of ± 25% (WBGU 1998).
Sequestration rates	Forestry projects	High	Best used in local or regional areas.
Host country policies	All	N/A (except at a country level)	May be a critical component for baselines in some sectors.

Development of standardised components for hybrid or multi-project emission baselines might best be carried out by experts working within the framework of an accepted process (such as the process used by the IPCC/OECD/IEA inventory programme to elaborate methods for calculating national emission inventories).

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20 Average national values for this could be calculated by using national or international statistics on electricity productions and associated carbon emissions (see e.g. IEA 1998c and 1998d).

Michaelowa (1998) makes some recommendations for methods on how to calculate hybrid emission baselines for some project categories. These include methodological recommendations for some energy supply project types, summarised in Table 3.

Table 3: Replacing old power plant with new plant using renewable energies - examples of suggested baselines and timelines

Baseline	Emission reduction	Project lifetime	Case in which baseline applies
Efficiency level of old plant	E (old)	Commercial life of old plant (approximate value: depreciation value)	Plant still operating economically
Average level of efficiency in new plant operating on old fuel built in the last 5 years	E(mean)	Commercial life of new plant (approximate value: depreciation period)	Commercial life of old plant has run out, reference is previous fuel since autonomous fuel substitution cannot be assumed
Efficiency level of the old plant	E (old)	10 years	Transitional solution for out-dated power stations; to start 3 years at the latest after the JI mechanism comes into force.

Source: Michaelowa 1998

The level of emission credits is highly dependent on a few key assumptions (e.g. timeline, fuel use, technology type). Reaching agreement on adequate default value(s) for these assumptions is crucial, and may be difficult, as there are likely to be different views that will need to be considered.

3. Cross-cutting themes

There are certain issues of relevance to many different baseline options. These include:

- whether or not the baseline should be re-estimated over the life of the project (i.e. whether the baseline is "static" or "dynamic");
- the emissions timeline (the length of time over which a project can generate emissions credits); and
- how data are used to calculate the emissions baseline are generated (i.e. whether data are historical, observed by comparing against a control group, or simulated/projected e.g. via models).

These cross-cutting issues are discussed in this section. Other cross-cutting issues, such as whether or not a distinction should be made between refurbishment and "greenfield" projects, the importance of the renewal rate of technology, implications of inclusion/exclusion of non-CO_2 greenhouse gases in emissions baselines and pre-combustion emissions, are not discussed here.

3.1 Dynamic vs Static baselines

Emission baselines can either be fixed at the start of the project for the lifetime of the project ("static") or revised during the project operation ("dynamic"). Static baselines are predictable, and therefore reduce the uncertainty surrounding the level of credits generated from a project. They therefore give investors a greater level of certainty than dynamic baselines. Static baselines are also less of an administrative, monitoring and reporting burden than dynamic baselines because they require only one estimate of a baseline. They thus result in lower transaction costs. Some Parties explicitly favour static baselines, at least for certain project types (e.g. DISR 1999).

Dynamic baselines will need to be re-estimated (and therefore re-reported, and the amount of future expected emission credits revised) at certain intervals during the project's life. This re-estimation will allow the baseline to reflect more closely changing "best estimates" for the key parameters used in drawing it up. Dynamic baselines may therefore reflect more accurately than a static baseline what would have happened in the absence of the project. Dynamic baselines may therefore ensure the continuing environmental additionality of a project more consistently than static baselines, as they would enable a baseline to be adjusted downwards if the environmental performance of the sector/process improves. Dynamic baselines result in a greater level of investor uncertainty in the number of credits for a particular project than static baselines. However, this uncertainty can be reduced if investors know exactly when, after what time interval, and upon what factors the baseline is to be re-calculated[21].

Both policy and technology factors could lead to the need for baseline changes. For example, Costa Rica has announced that they would phase out non-renewable sources of electricity supply by 2001[22]. If this policy is successfully implemented, average per kWh emissions will decrease to zero (within the lifetime of any proposed AIJ/CDM electricity supply project). An electricity project proposed before the policy announcement may have assumed a

[21] For example, if investors know that a baseline is fixed for eight years, and subsequently recalculated, this dynamic baseline may nevertheless provide sufficient certainty to encourage investments. However, if a baseline may be recalculated at any point during the project's lifetime, uncertainty will be much greater, and investment likely to be less.

[22] It is unclear, however, if this objective will be achieved even without CDM projects.

continued proportion of fossil fuels in electricity supply. Such a baseline would be significantly higher than one taking the policy into account.

Technological improvements or process changes can also be relatively sudden and unpredictable. Such changes could make even relatively recent emission baselines outdated. For example, recent process changes in adipic acid production have resulted in a ten-fold drop in the N_2O emission factor (although some allowances might need to be made for a lag-time for existing plants to be retrofitted). In both cases, a dynamic baseline would help maintain the environmental effectiveness of projects that had previously been initiated in these sectors by adjusting the baseline during the course of the project to one that is a more realistic projection of what would have otherwise occurred.

Most experience to date with emission baselines for project-based activities is with static baselines, which were used in the majority of AIJ projects. However, at least one AIJ project has a dynamic baseline: the project on cement production in Cizkovice (see the France/Czech project under http:/www.unfccc.de/program/aij) has a baseline that will be re-estimated after the first five years of project operation. In addition, many of the Swedish AIJ projects revised their (static) emission baselines between the first and subsequent reports to the UNFCCC. Some AIJ projects, such as the Romania/Swiss one, used a combination of (static) baselines[23].

A number of analyses have suggested that dynamic baselines may be appropriate for some project types. Begg et. al. (1999) suggest that the best way of dealing with baseline uncertainty is to check and revise the baseline every 8-12 years. They clarify that any revisions should apply to the remainder of a project’s lifetime only, and should not be applied retroactively. Ernst Basler & Partners suggest that either a dynamic baseline, with reassessment after approximately 8 years or a short timeline is needed in projects that require long-term assumptions about a system’s electricity production. No analysis of the cost implications arising from the use of dynamic versus static baselines has been undertaken – but clearly, the responsibility for reassessing credits during the life of a project will add to the transaction costs.

Both static and dynamic baselines can be set up in such a manner as to make them environmentally effective. The effectiveness of a baseline is not only determined by the level at which it is set (which in turn is influenced by which baseline option is used), but the length of time over which it allows credits to accrue to the investor. The emissions timeline is assessed in the following sub-section.

3.2 Emissions timeline

The total number of emissions credits generated by a JI or CDM project will be extremely sensitive to the time during which emissions credits are allowed to accrue. The investing party in both JI and CDM projects will therefore have an interest in obtaining the longest possible “emissions timeline” in order to maximise the emission reduction units (ERUs) or certified emission reductions (CERs) from their investment. Given the absence of emission commitments for CDM host countries, many potential CDM hosts may wish to accept a timeline proposed by the investing party, particularly as a longer timeline may increase the likelihood of CDM investments occurring in their country. However, JI host parties may favour shorter timelines that would limit the number of ERUs transferred.

The AIJ projects examined in a previous paper (Ellis 1999) had widely differing emission timelines, even for projects of a similar nature. Creating a standard methodology to calculate

23 Available at http://www.admin.ch/swissaij/in_meth_baselinestep.html.

an emissions timeline would have many advantages. It would increase both the transparency of emission baselines and the comparability between projects. A standardised methodology would also reduce the time and costs of setting up an emissions baseline, as the method would be one factor that the developer would not have to develop themselves. If this standardised methodology was conservative (stringent), it could also help to ensure the environmental integrity of the projects by aiming to err on the side of caution.

However, there are many different views on how an emissions timeline could be set. These include:

- numerical limits, e.g. 5 years for energy-sector JI-type projects (NEFCO, quoted in Puhl 1998) and 99 years for biotic projects (the Dutch FACE foundation);
- project-category formulae, e.g. 10 years for replacing an old power plant with one based on renewable energies, or the commercial life (depreciation period) of a new power plant (Michelowa 1998); or
- the technical or economic lifetime of the project.

Because the effect of the timeline on total credits from a project is so important, standardising a methodology to assess a project's emissions timeline offers perhaps the easiest way of limiting the negative effects of free riders and gaming. A standardised timeline methodology would therefore offer a simple way of working to ensure environmental effectiveness when calculating emission baselines and emission credits from a possible project. Moreover, all emission baselines will need an emissions timeline, so a standardised methodology could be used to affect all projects. Nevertheless, applying one standard methodology to all projects is unlikely to be appropriate. At a minimum, the methodology would need to vary between projects that reduce emissions and those that increase sinks.

3.3 Data sources

Different data sources could be used when drawing up an emissions baseline. For all approaches, data could either be based on past performance (historical trends), a snapshot of current performance (e.g. by comparing the project to current investment trends in a particular sector or to a control group), or a simulation/projection of future performance. The use of these different data types will influence the perceived credibility of the baseline, as well as its data, monitoring and reporting needs, transparency, and the levels of free riders and gaming associated with a particular baseline.

There are advantages and disadvantages associated with using the different types and sources of data. For example, projections may be viewed as a more plausible reflection of what would happen under a future business-as-usual scenario than baselines based on historical data. On the other hand, the inherent speculative nature of some of the information needed to establish baselines based on projections means that these baselines may not be not be transparent unless extensively documented. They may also be more open to gaming and basic error than baselines constructed using other data sources.

The availability (or not) of the data sets needed may in turn influence the approach used to calculate an emissions baseline[24], as the baseline approaches assessed in section 2 could be based on any of these data types.

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[24] For example, if data are available for a comparable project a comparison-based project-specific baseline could be used. If sectoral data are not available, it would be difficult to use a multi-project baseline at the sectoral level.

4. Quantitative comparison of baseline approaches

This section examines whether and how different baseline approaches could affect the level of emissions baselines for JI and CDM projects. Sections 4.1 and 4.2 are based on an analysis of available literature. This literature is mainly on electricity and heating plants in EIT countries. Section 4.1 examines the effect of different baseline approaches on projected credit levels from AIJ or AIJ-type projects. Section 4.2 examines the effect of different baseline assumptions on crediting levels.

Section 4.3 simulates case studies that examine the impact of different assumptions on the amount and potential value of emission credits under a multi-project baseline in the electric power generation sector in Brazil and India. By examining the implication of varying baseline assumptions on the cost of CDM credits, it is possible to understand better the significance of these decisions on the potential volume of CDM project activity.

Variation among countries' industry structure, fuel mix, land-use, investment patterns, policies, evolution of supply and demand all affect the assumptions underlying any emission baseline. This means that the relative levels of emission baselines established by a common approach may be different depending on the country and region. The resulting emission credits would also vary between regions and sectors. This supports the need to establish baselines at a level where circumstances are similar, which may be at the "sub-country", country or regional level, depending on the country/sector examined. Thus, while some baseline approaches are found to result in more or less generous crediting levels in certain cases than other baseline approaches, this does not necessarily hold for all project types in all countries. Different baseline approaches may be appropriate in different circumstances.

4.1 Survey of experience with different baseline approaches

Some analysis has been done on how the level of emissions baselines would vary under different baseline approaches. This section summarises relevant results.

4.1.1 Conversion of heat plants in the Czech Republic

The following assessment is based on an analysis of Swiss-Czech co-operation in the conversion of heating plants in the Czech republic (Ernst Basler & Partners 1999[25]). The analysis assesses what potential credits could be for two different project types and four different emission baselines. The projects examined were fuel switching (mainly from coal or coke to natural gas) in 70 existing heating plants, and cogeneration. The results for the four different baselines examined are shown in Table 4.

The relative credit levels from the different baseline approaches are due to the different underlying assumptions. Technology-standards (a disaggregate form of multi-project baselines) gave relatively high levels of offsets for both project types because the reference technologies used were coal[26]. However, other assumptions could have also been valid that

[25] The projects analysed were not designed as AIJ projects; official acceptance, endorsement or approval of them as AIJ projects was not sought; and the Swiss government is seeking no emission credits for these projects as potential JI projects. Nevertheless, these projects fulfill the AIJ criteria specified internationally (UNFCCC 1995) as well as the development criteria specified by the Czech government, and illustrate issues relating to emission baselines as well as an officially endorsed AIJ project.

[26] Coal was chosen as the reference technology as the majority of Czech heating plants are coal-fired.

would result in a lower baseline (and crediting levels). The most extreme example in this case would be if the reference technology were the marginal unit. Since the Czech Republic has recently approved construction of a nuclear power station, and since nuclear power emits no CO_2, the marginal unit would in *this* case give a baseline of zero emissions.

Table 4: Variation in calculated carbon offsets under different baselines: simulated Swiss/Czech projects

Project Types	Offsets under different baselines (t CO_2)* - see text for baseline descriptions			
	Project-specific	Technology-based standards#	Sectoral standards#	Top-down##
Fuel switch	175000	430000	180000	195000
Cogeneration	41000	43000	21000	22000

Source: adapted from Ernst Basler & Partners, 1999

* The figures represent calculated offsets for the entire project life.

\# Both these baselines would be included under the "multi-project" category described in this paper.

\## This baseline is based both on current sectoral performance and future emission targets.

The size of the difference in offsets under different the baselines in this Swiss-Czech analysis is due to the difference in per kWh emissions between gas and coal-fired technologies (which is in turn a factor of the differing carbon contents of gas and coal, and the relative efficiencies of gas and coal technologies). The highest number of offsets will occur if comparing against 100% coal, and the least if comparing against 100% gas. Any baseline that mixes the two, e.g. by comparing to the relative importance of gas and coal, will give offsets somewhere in between the two extremes.

The top-down and sectoral baselines gave lower potential credit levels because they assumed that the starting point was a mixture of coal and other fuels, and that per unit emissions would gradually decrease between the start and end of the project. The project-specific baseline gave a relatively low number for the fuel switch projects because the baseline assumed that all units would become gas-fired within 15 years. However, the project-specific baseline gave a relatively high level of potential credits for the cogeneration project because it assumed that the electricity displaced by the CHP plant was generated by coal. The differences in the credit level are thus a result of the underlying reference case more than the baseline approach *per se*.

4.1.2 Boiler conversions in Estonia

Some recent (June 1999) AIJ project reports for Swedish-funded projects in Estonia calculated emission reductions using both a project-specific and a multi-project approach (http://www.unfccc.de/program/aij). The project reports examined in this section involved converting a heating boiler from fossil fuels to biomass. The multi-project approach examined the whole country by sector and compared competing energy production options (taking into account government policy such as targets for increased renewable energy supply, and the emission commitments agreed to at Kyoto). The project-specific approach examined the likely scenario in production and emissions from a particular heating plant with and without the AIJ project. Earlier reports for the same projects had also drawn up baselines on a project-specific basis, although they were slightly different from those presented in the June 1999 baselines.

The results of the four separate baseline studies for one project (e.g. Viljandi boiler conversion) are outlined in Table 5. The projected emission benefits of the same project with the four different baselines vary by 23% over the lifetime of the project when comparing the benefits calculated with one timeline[27]. (One of the suggested baselines had a shorter timeline, which resulted in significantly lower expected emissions reductions from the project when compared to longer timelines).

4.1.3 Other projects

One Dutch AIJ project report (installation of a micro-hydro plant in Bhutan) states that it will use two different forms of project-specific approaches to calculate the project's baseline (using both a project-specific approach as well as a baseline based on the evolving performance of a comparable situation). However, because the comparison-based approach was dynamic in its nature, it was not presented in the report submitted to the UNFCCC, and quantitative comparison between the two is not currently possible.

27 Because of the different relative shapes of the different baselines, the variation in projected annual emission benefits varied by less than this amount at the beginning of the project, and by more at the end of the project's emissions timeline.

Table 5: Comparing four estimates of the emission benefits from Viljandi boiler conversion AIJ project

Report	Baseline	Timeline (y)	Annual emissions (***t*** CO_2)						Cumulative emission reductions*
			y1	y2	y3	y4	…	Final year	
1997	Project-specific: status quo	10	9800	9800	9800	9800	9800	9800	98000
1998	Project-specific: status quo energy production but mazout replaced by natural gas after 2 years - projected reductions - actual reductions	15	 9800 3245	 9800 8500	 9800 8100	 9800 n/a	 …	 9800 n/a	 147000 (137445)
1999p	Project-specific: status quo - projected reductions - actual reductions	15	 4146 3379	 10280 8899	 10280 10598	 10280 10512	 …	 10280 n/a	 158345 (159531)
1999t	Multi-project, including consideration of government policy, such as increased use of renewables: - projected reductions - actual reductions	15	 3629 3022	 8670 7790	 8583 8776	 8496 8776	 …	 7317 n/a	 122516

* Emission reductions = baseline emissions – project emissions

Source: http://www.unfccc.de/program/aij/

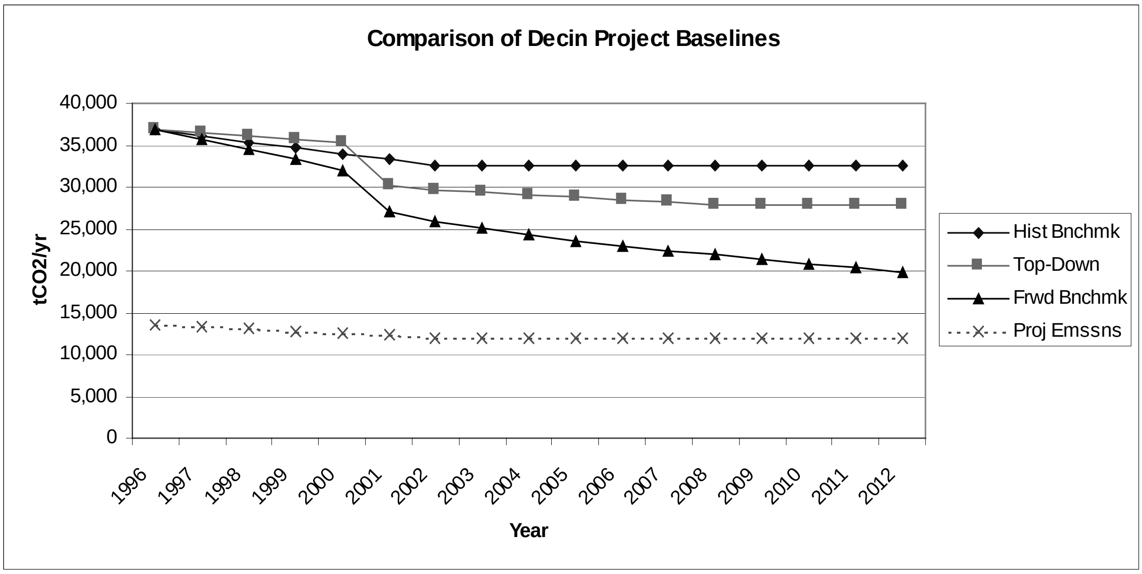
4.2 Survey of experience with different baseline assumptions

Other studies have also compared the effect of different assumptions on baseline level (and therefore on the level of emission benefits) from selected AIJ projects.

For example, the Centre for Clean Air Policy (CCAP) has undertaken a qualitative estimation of different baselines possible for the AIJ project situated in Decin, Czech Republic, Figure 2, (CCAP 1999). This AIJ project converted a coal-fired district heating plant to one fired on natural gas. The project also included building a new co-generation unit that would supply electricity locally and feed surplus into the grid.

The CCAP exercise demonstrates that, as also illustrated above, different valid assumptions for baselines can significantly alter the level of credits generated by a project. The exercise analysed two forms of "benchmark" (multi-project) approaches. The "historical benchmark" baseline was based on emissions from average heat and electricity production facilities, and continuing energy efficiency improvements. The "forward looking benchmark" assumed further improvements in energy efficiency and a greater penetration of natural gas in heating and electricity sectors as well as some new nuclear generation. The "forward looking benchmark" baseline also sought to take the country's Kyoto commitment into account, as well as sectoral development plans, when assuming gradual improvements in emissions per unit from heating and electricity production. (The actual emissions baseline used for the Decin project is in fact none of those below, although it follows a similar pattern to the historical benchmark line).

Figure 2: Comparison of Decin Project Baselines



Source: CCAP 1999

Some AIJ projects presented multiple baselines in their report to the UNFCCC (e.g. a Dutch/Russian horticultural project in Tyumen). The Dutch/Russian analysis in the Tyumen project report includes five different baselines, all calculated using a project-specific baseline approach but with different assumptions for fuel use, technologies and project boundaries. The emission benefits of the project (presented on a *per unit* basis) vary by more than a factor of two between the different baselines, and the lowest baseline was used to calculate the emission benefits of the project.

Other AIJ projects have had more than one baseline drawn up for them, with one chosen as the most likely scenario by the project participants and then submitted to the UNFCCC. Some of these alternative baselines are public (e.g. for the Norway/Slovakia project - see Yager et. al. 1998), and others are not (e.g. for the US/Russia Rusafor project - see Michaelowa 1998). The three project-specific baseline scenarios with different underlying assumptions drawn up for the Norway/Slovakia project (converting a coke-fired heating boiler at Jochy to biomass) result in emission benefits that vary by a factor of nine from the same project[28]. Even discounting the baseline scenario judged unrealistic (a 100% switch to biomass in the absence of the AIJ project), the other two baselines vary by almost a factor of two (estimating emission benefits from the 2 * 300 kW boiler project as 20 or 35.6 kt CO_2).

4.3 Case study simulations with multi-project baselines

This section examines examples of hypothetical multi-project baselines for new electricity generation[29] projects in two potential CDM host countries: Brazil and India. The simulations are developed to illustrate the implications of some alternative multi-project baseline assumptions on the potential amount of emission credits that could be generated by such projects. The section also considers the differences in investment and operation cost estimates of different power generation alternatives, and how the relative economic feasibility of these alternatives could be affected by the potential value and amount of emission credits under different multi-project baseline assumptions[30].

Assumptions and Caveats

Various sources were used to obtain emission and cost data and estimates for these case studies although most data were obtained from publications of the IEA and NEA (NEA/IEA 1998 and IEA 1997b). Consequently, the data presented may not always be fully comparable.

Cost estimates, types of energy sources, technology and resulting emissions vary according to each country's specific national circumstances. In particular, cost estimates are highly dependent on assumptions for discount rates and future prices of energy. In this section, the discount rate used is 10 percent. It is also important to note that costs may be underestimated in some cases, as they were estimated based on a stable political and socio-economic context, which may not reflect the real investment conditions. Cost estimates for renewable energy sources are difficult to compare as some, such as wind and solar, are intermittent and are thus not comparable to sources used for baseload generation; while others, such as hydro and biomass, are very site-specific making cost comparisons between sites quite imperfect.

For the purpose of these case studies, CERs are calculated based on projects generating emissions lower than a set baseline standard, i.e. using a range of multi-project approaches, as described in section 2, at the sectoral level. No judgements are made to determine whether such CERs would meet an environmental "additionality" test or whether they would meet the host country's sustainable development priorities, although both are of course critical aspects of the CDM.

28 However, the lowest baseline - corresponding to an autonomous fuel switch to biomass - was not considered as a viable alternative because of investment constraints.

29 Electricity generation was chosen for this case study for several reasons. It is a large and growing source of GHG emissions in many countries; it is a sector with a homogenous output; and relevant data (e.g. on emission characteristics of current technologies and BAT, and demand projections) were relatively easy to obtain.

30 The assessment of economic feasibility is based on the amount of emission reductions (under a particular multi-project baseline assumption) divided by the difference in investment and operation costs between two potential electricity generation options.

The different multi-project baseline assumptions simulated in this section include: weighted average emissions from all sources, average emissions from each fuel, 25% improvement on average emission performance, planned new technology emission performance and BAT emission performance (see tables in Annex B). Alternative sectoral multi-project baselines are possible, e.g. using the emission performance of marginal units constructed, and different sectoral aggregations, which may be viewed as a closer representation of business-as-usual. However, these are not examined here because of current lack of data.

These case studies are intended to provide an illustration of the potential practical implications of different simple multi-project baseline assumptions in different countries. They should not be taken as a model for the development of baselines for CDM projects in India and Brazil.

4.3.1 Electricity Generation in Brazil

According to the projected energy market scenarios of the Brazilian National Electric Energy Plan 1993/2015 published in 1994 (NEA/IEA 1998), Brazil's consumption of electricity is expected to grow to 534.1 TWh by 2015 (i.e. an increase of 95% from 1993) under the lowest scenario. Under the highest scenario, it is projected to grow to 743.3 TWh (i.e. a 171% increase from 1993). It is important to note that scenarios[31] on Brazil's electricity generation indicate a decrease in its reliance on hydropower, which represented about 92% of its total electricity generation in 1996 (see tables in Annex B), and an increase in thermoelectric sources (including oil and coal, but mostly natural gas). Although there is still significant hydro potential remaining in Brazil, most economic sites are already exploited. Furthermore, about 50% of the remaining potential is located in the Amazon area, which may not be considered as appropriate for reservoir development. This area is also a significant distance from the most developed region of the country (i.e. Rio de Janeiro and São Paulo), where the main source of growth in electricity demand is expected to occur.

The predominance of hydro in Brazil's electricity generation mix has important implications for the construction of an emissions baseline. For example, if a single multi-project emission baseline for Brazil's power sector were set at the level of the weighted average of emissions from all sources (i.e. 43.9 t CO_2/GWh), this emissions baseline would preclude all fossil fuel sources generating CERs from CDM projects. In addition, under a weighted average emissions baseline, the amount of CERs generated from even non-GHG emitting projects would be quite low compared to similar projects in other countries (see below) that have a more fossil-fuel intensive electricity sector. Under a multi-project baseline set at the weighted average emissions level, new hydro capacity could qualify[32] as a CDM project and could therefore generate some CERs. However, hydro is not expected to be the cheapest option for future new electricity generating systems as most economical sites are being exploited and large up-front investment capital is required. Moreover, further development of hydropower may be subject to other constraints such as those related to transmission infrastructure or a reluctance to developments in particular areas.

Thus, under a weighted average emissions baseline in Brazil, even the most efficient new gas-fired plants would not generate any CERs. However, a multi-project baseline set at this level would mean that a new wind project could generate around 44 CERs/GWh (assuming that 1 CER = 1 t CO_2).

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[31] Information from the Electrobras website: www.embratel.net.br/infoserve/electrobr/evindice.html

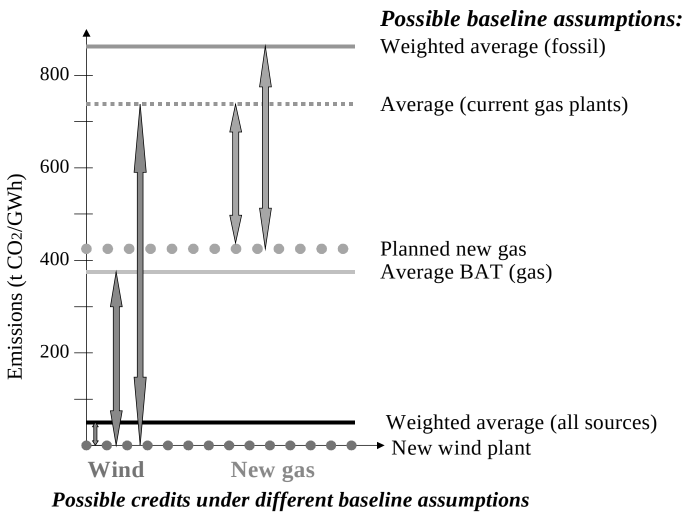
[32] Such projects would also need to meet Brazil's sustainable development objectives.

Given that projections indicate a significant growth in electricity generation, it is interesting to examine what these potential emission baselines and credits could imply for future investments in electricity generation projects in Brazil. Different electricity generation alternatives have different costs[33] for investors, as shown in table B2. However, the potential value of the CERs under different multi-project baseline assumptions resulting from electricity generation projects may provide different investment incentives than would otherwise be the case when CDM is not taken into account. For example, wind electricity is currently more costly than gas-fired electricity in Brazil, but could become an economic alternative to a gas plant if CERs are worth more than 340 USD/t CO_2[34], and an economic alternative to a coal plant if CERs are worth more than 130 USD/t CO_2.

Given that scenarios for Brazil's future electricity generation indicate a significant increase in the use of thermoelectric sources (and not hydro), it may be deemed appropriate to design baselines based on these technologies. Multi-project baselines set at 25% better (i.e. 25% less CO_2-intensive) than the current average for thermoelectric sources, or at the emissions level from best available technology of various sources, could provide incentives to invest in more GHG-friendly thermoelectric sources and technology than would otherwise be the case. The baselines and resulting crediting levels for different multi-project baseline assumptions are illustrated in Figure 3. The length of the arrow is proportional to the number of credits obtained per GWh.

Figure 3 shows that, for example, a wind (or biomass, or other renewable-based) CDM project could generate 44 CERs per GWh (represented by the length of the arrow at the left of figure 3) if using a baseline set at the level of the weighted average emissions of all plants. This would increase to 382 CERs/GWh if the baseline were set at the level of BAT gas plants, 755 CERs/GWh if it were set at the level of weighted average thermal generation and 882 CERs/GWh if it were set at the level of average fossil fuel emissions. (See table B1 for other examples).

Figure 3: Effect of different baseline assumptions on baseline levels, Brazil



Of course, the actual investments in such projects will very much depend on whether the value of CERs cover any increased expense (compared to business-as-usual investment plans) that would need to be incurred to generate electricity emitting GHG emissions below the baseline level. For example, if a baseline is set at 25% better than average gas emission levels (i.e. 556 t CO_2/GWh), the investment in BAT natural

33 Investment and operational costs are provided at a national level.

34 The difference between the cost of electricity generated by wind in Brazil (4.47 US cents/kWh) and gas-fired electricity (3.38 US cents/kWh) is 1.49 US cents/kWh or 14,900 USD/GWh. Based on this cost differential, investment in wind is economic if a CER is worth at least 340 USD per ton of CO_2 (i.e. 14,900 USD/GWh divided by 43.9tCO_2/GWh).

gas plants (i.e. more efficient CCGT) may become an economic alternative to the gas plants currently planned if CERs are worth more than 79 USD/t CO_2. Under this same emission baseline (i.e. 556 t CO_2/GWh), wind generation would become an economic alternative if CERs were worth more than 27 USD/ t CO_2.

It is important to note that while these examples examine the potential implications of alternative *unique* multi-project baseline assumptions for new projects in Brazil' s electricity sector, another possibility may be to consider developing more than one multi-project baseline for the electricity sector. For example, one for thermoelectric sources and a separate one for non-GHG emitting sources. However, this possibility is not examined further in this paper.

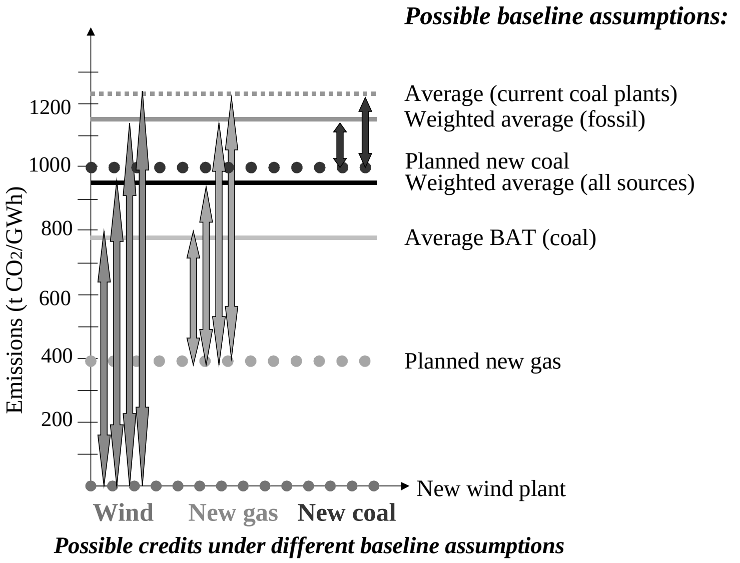
4.3.2 Electricity Generation in India

India is the world's largest coal producer. Coal is used in the generation of more than 70% of Indian electricity, and is expected to remain the main fuel source for power generation to at least the year 2020. Coal is also the most economical electricity generation option, as shown in table B4 (see Annex B), and benefits from the most developed infrastructure, including mine-mouth electricity stations. However, the current average efficiency of coal plants is quite low relative to other countries, particularly OECD countries: average generation efficiency was 27% in 1996 (IEA 1998), although this masks significant variations in average efficiency at the state level. The low efficiencies are due to various factors, such as the age of power plants, poor maintenance and lack of appropriate quality of coal.

India's power sector has been experiencing significant peak and supply shortages. Shortfalls in the investment and construction of new power plants, poor-quality transmission lines and theft are the main reasons for the supply shortages. These are exacerbated by the lack of an inter-connected grid across the nation, as states with surplus power do not transfer that surplus to states facing power shortages. Plans to bridge the gap between increasing electricity demand and supply include, in addition to greater use of coal, increasing India's nuclear power generation capacity, as well as (on a smaller scale) increasing the use of renewable energy. India's Ninth five-year plan (1997-2002) includes a target for non-hydro renewable capacity of 3000 MW.

Figure 4 shows various multi-project baseline assumptions for India's electricity sector, along with their associated crediting levels.. For example, based on 1996 data provided in Table B3, if a sectoral multi-project baseline was set at the weighted average of current generation in India, it would equal 945 t CO_2/GWh. In effect, this would mean that electricity generated by all sources other than coal (using current Indian technology) would be below this emission baseline, including coal plants using the best available technology (i.e. clean coal). Under such a scenario, new wind (or other renewable) plants would generate 945 t CO_2/GWh. This would decrease to 786 t CO_2/GWh if the sectoral multi-project baseline were based on BAT coal emissions, and decrease further to 382 t CO_2/GWh if the baseline was based on BAT gas plants. Planned new coal plants would not be eligible for any credits at all if the multi-project baseline assumption chosen was the weighted average emission for all generation sources, BAT coal, or of course, BAT gas.

Figure 4: Effect of different assumptions on baseline levels, India



However, the lower emission level of coal BAT plants is associated not only with the better technology, but also with higher levels of maintenance than currently observed in India. This results in the investment and operational cost of these plants being higher than that of actual planned coal plants in India by about 0.92 US cents/kWh (Table B4). Although various factors are taken into account in investment decisions, the incremental cost associated with investing in BAT coal plants means that the investment attractiveness, from a strict economic perspective, of BAT coal plants is less than that of currently planned coal plants. To create the incentive to switch from planned plants to the best available technology for coal plants, under a baseline set at 945 t CO_2/GWh, the revenues from 159 CERs would have to at least match the difference between the cost difference between the two types of plants. This means that each CER would need to be worth a minimum of 58 USD/t CO_2 to make BAT coal plants an economic option, compared to planned coal plants, under this multi-project baseline assumption.

However, setting a sectoral multi-project baseline at the level of the weighted average for all sources in India would mean that all *planned* gas plants[35] would be able to generate CERs if they were initiated as a CDM project. According to the cost estimates in Table B4, installing a new BAT gas-fired plant [36] would cost about 5,400 USD more per GWh than the cost of installing a "planned" coal plant in India. In terms of emission reductions, the BAT-type gas plant would generate emissions reductions totalling about 563 CERs. In this example, the additional investment cost of a BAT natural gas plant would be economical, compared to the cost of a planned coal plant, as long as a CER was worth more than 9.6 USD per tonne of CO_2. A wind electricity plant would be economic compared to a new coal plant if CERs were worth 23 USD (assuming that a unique sectoral multi-project baseline was based on the weighted average emissions of all sources).

As mentioned previously, only scenarios involving a unique multi-project baseline for India's electricity sector are examined here. However, scenarios with more than one sectoral multi-project baseline could also be envisioned.

[35] Emissions associated with natural gas electricity generation may be underestimated as only CO_2 emissions are taken into account in this study.

[36] BAT figures in this study are derived from data on planned plants in OECD countries (NEA/IEA, 1998). In the case of natural gas, there is not a large difference between planned CCGT plants in India (at 50% efficiency) and OECD planned CCGT plants (at 52.9 efficiency).

4.3.3 Simulation Results

This case study only takes a very preliminary look at the potential implications of using different sectoral multiple-project baselines in the electricity sector. More work in this area may be desirable in order to understand better the effects associated with different multi-project baseline assumptions.

This analysis shows that a key issue in determining the emissions credits associated with a project is the stringency of the baseline level. Multiple-project baselines can be designed to be more or less stringent within one country. However, if different countries choose to use the same multi-project baseline assumption, it could result in different baseline levels and different implications for potential CDM projects.

For example, a multi-project baseline in the electricity sector set at weighted average emissions would equal 945 t CO_2/GWh in India, and 44 t CO_2/GWh in Brazil. This would mean that if a unique multi-project baseline based on weighted average emissions was chosen for the power sector in both Brazil and India, all clean coal-fired projects would be below the baseline in India, whereas no thermoelectric plants would be in Brazil. The implications for CERs, in such a scenario, would consequently be different in both countries: new gas plants could generate 542 CERs/GWh if they were installed in India, but none in Brazil. The current diversity in conditions in the electricity sector among different countries (and sometimes, between different regions within a country) is expected to continue. It may therefore be useful to consider the applicability of different multi-project assumptions for different countries, as well as perhaps more than one sectoral multi-project baseline within the same country.

In all cases, a less stringent multi-project baseline level results in a greater amount of credits being generated by each project, as well as potentially leading to a greater total number of projects by increasing the range of "eligible" projects. The tradeoff for lax baselines is that eligible projects may not be, on their own, strictly environmentally "additional.".

With a less stringent multi-project baseline the value of each emissions credit can be relatively low while still making the additional CDM investment feasible. With a more stringent baseline (where the level of the emission baseline is lower) fewer credits will be generated from a particular project, so the value of each emission credit will need to be higher to recoup the same incremental investment costs.

5. Qualitative comparison of different baseline approaches

The different baseline approaches and their application outlined above may differ in:

- data, monitoring and reporting requirements;
- baseline development or transaction cost;
- transparency; and
- environmental effectiveness, including a project's environmental additionality (related to the potential for gaming, free riders and leakage).

Using these criteria, this section compares and assesses each of the different baseline approaches.

5.1 Data, monitoring and reporting requirements

The data needed to establish a baseline for a JI/CDM project will vary by project type, but will also vary depending on the approach used to establish the baseline. Higher data requirements are also likely to increase the cost of setting up an emissions baseline. This section assesses the data requirements and monitoring and reporting needed to establish an emission baseline under different baseline approaches[37].

Project-specific baselines

Project-specific baselines are relatively data intensive. Experience from the AIJ pilot phase shows that establishing these project-specific baselines, in the absence of any centralised guidance on what needs to be monitored and how, is often costly and time-consuming.

Project-specific baselines may require some monitoring of current activities before the JI/CDM project or activity starts in order to be set up. This type of information would vary by project type, and would also depend on whether the proposed project is a refurbishment project or at a greenfield site. For example, some of these data, such as the age of the current installation (in the case of a refurbishment project), are likely to be readily available. However, other data, such as a plant's thermal efficiency, may need measuring specifically in order to set up the emissions baseline. Examples of information that may need to be gathered and reported for selected project types are shown in Annex A. Project-specific baselines can in theory be applied to all JI and CDM project types.

Multi-project baselines

Using a multi-project baseline does not require monitoring if it has already been developed. As with all approaches, of course, a certain amount of project-specific data will need to be reported (such as project size and output) during the project operation.

Multi-project baselines can be based on the performance of current installations or the projected performance of future installations. To establish such a baseline requires information on:

- current technology characteristics of sector (i.e. the current distribution of technologies used in that sector); and
- the emission characteristics of each technology type.

[37] This section does not explore the data, monitoring and reporting requirements needed to monitor the actual performance of a project.

Multi-project baselines at the technology level could also be used where there is not enough data on a sectoral level to construct a sectoral baseline. For example, a technology-level baseline could be set at an emissions level 10% higher than the best available technology of that type.

The development of multi-project baselines would require some resources and agreement at a level other than that of the participants (e.g. governments, international organisations). The development of these baselines may require balancing competing interests, e.g. between investors and hosts for JI projects.

Constructing multi-project baselines may not be appropriate or possible for all sectors in all countries. For example, not all countries may have complete data coverage for particular sectors. However, there are a number of straightforward possibilities, as demonstrated in section 4.3.

Hybrid baselines

Hybrid baselines are between project-specific and multi-project baselines on the continuum of possible baseline approaches (Figure 1). They are therefore likely to need more data, monitoring and reporting than multi-project baselines, and less data, monitoring and reporting than project-specific baselines. However, how much more or less would depend on how many of the baseline components were standardised (which is in turn dependent on project type).

5.2 Baseline development cost

The cost of developing an emissions baseline is related not only to the data requirements, outlined above, but to the number of projects it, or some of its components, could be used for. In the case of multi-project baselines, or hybrids of this approach, the cost in time to achieve international consensus on the basic approach and rules for its application must also be considered. There is a trade-off here with the ease of implementation once agreement is reached. The cost of using a baseline will therefore not be the same for each baseline approach. If the international process can be assumed to move quickly to reach consensus on basic starting points, using a standardised methodology, or an off-the-shelf multi-project baseline will be cheaper than developing a project-specific baseline from scratch.

The cost of an emissions baseline is also related to its complexity. For example, a simulation baseline that needs a system model will be expensive and time-consuming to set up and run. The cost of developing such a model may mean that this approach is only used in future for either very large-scale projects, such as forestry, or where many similar projects are likely to occur, such as in fast-growing sectors such as electricity or cement production.

Limiting the time needed to establish and approve the baseline will also help to limit the cost of the baseline. This can be done if agreement is reached on:

- what data to monitor and report;
- how to monitor/report this data;
- calculation methods; and
- value(s) of the baseline (e.g. for multi-project baselines).

Many potential emission mitigation projects are small scale, e.g. increased household use of renewable energy and energy efficiency technologies. In order to maintain small-scale projects as an attractive JI and/or CDM opportunity, the up-front costs for these projects need to be low relative to the cost of the project. Having a simple emissions baseline or crediting formula for small-scale projects would be one way of keeping the costs related to construction of the baseline low. Of course, for both large and small-scale projects, the proportion of total project costs used to establish the baseline will also need to be kept low in order not to create barriers to investment under JI and CDM.

The level at which baselines are aggregated (e.g. sub-sectoral or sectoral level) will influence the number of projects for which the baseline could be used, and ultimately the cost per project. The degree of standardisation between different baseline approaches also has cost implications. More standardised methods and reporting formats, irrespective of the level of aggregation, would mean that each project developer would not have to spend time and money developing methodologies or reporting formats but would instead apply those already developed. However, reaching agreement on standardised calculation methods, parameters, and/or reporting requirements could have significant up-front time and cost implications.

However, setting up an emissions baseline does not represent the only costs involved in establishing a JI or CDM project. Other costs include the costs of identifying the potential project, administrative costs (for both the host and investor), ongoing costs related to monitoring, reporting and verification, and, for the CDM, contributions to funding adaptation.

5.3 Transparency and ease of third party verification

A transparent baseline is one where the construction is clearly explained, where the parameters and methods used in the baseline are referenced and traceable, and where the baseline can be reconstructed by a third party. Use of transparent baselines for JI and CDM projects would help to "demystify" emission baselines; would help potential project developers better assess CDM or JI projects, and associated emission credits; and would facilitate any verification of a project's emission baseline. They would therefore increase confidence in the effectiveness of the project-based mechanisms.

The transparency of a baseline will vary with the baseline approach used, and will also depend on how baseline assumptions were arrived at (e.g. model simulations, expert judgement) and how these assumptions and supporting information were reported to the UNFCCC.

Many baselines used for AIJ projects were not transparent. This is partly because which data had to be reported, how, and in what detail was not established[38]. Thus, many project reports do not reference or explain key assumptions, and do also not report all relevant underlying data and information. Transparency could be improved for future reports of project-based activities if guidance was available on the assumptions to be reported.

Another reason behind the lack of transparency of AIJ baselines is due to the project-specific nature of many of those baselines. Since project-specific baselines are made up of many components, listing each of these components and explaining why they (rather than alternatives) were chosen would be a time-consuming exercise. Given the uncertainties surrounding the underlying components of emission baselines, and the importance of expert judgement in drawing up project-specific baselines, a degree of subjectivity is inevitable.

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[38] A draft revised version of the Uniform Reporting Format has been prepared and is available in document FCCC/SB/1999/5/Add.1

While emission baselines based on projections may be viewed as a closer representation of what would happen otherwise, basing emission baselines on projected data (simulations) is also likely to result in baselines that are not as transparent because of the inherent uncertainty associated with projections. Lack of transparency is due to the importance of expert judgement in projections, and also because any simulation would need to be explained fully in order to enable a reconstruction.

Baseline transparency is likely to increase if there are fewer components to an emissions baseline (e.g. in the case of multi-project baselines), or if the components and/or methodology used to set up the baseline are standardised to some extent. In addition, standardisation could help to group similar projects together[39] and thus facilitate centralised, and presumably more streamlined, verification (e.g. by governments, by the UNFCCC, the CDM's Executive Board or another body) of emissions credits by allowing easy identification of "outliers".

5.4 Environmental effectiveness

There are at least two components to environmental effectiveness. The first is at the project level, i.e. the environmental additionality of the project. The second is the performance of JI or the CDM as a whole with respect to whether they contribute to achieving the objectives of the Protocol by limiting global emissions in a manner that is least cost.

5.4.1 Project-level environmental additionality

The difference between a project's actual emissions and emissions baseline is a measure of the environmental additionality of that project. Of course, the emission baseline needs to reflect a credible business-as-usual scenario in order to assess emissions "additionality". This additionality is also affected by the extent of free-riders, gaming and leakage (see glossary and below) associated with a project and its baseline[40]. This section assesses how and if the approach used to establish an emissions baseline can affect these different factors.

Project-specific baselines enable an individualised assessment of environmental additionality based on what could have happened in the absence of that particular project. In contrast, hybrid and multi-project (both aggregate and disaggregate) baselines are not developed expressly for one particular project and therefore represent an average approximation of "what would have happened otherwise".

Gaming can have a substantial effect on the level of baselines for individual projects, and therefore the *level of credits* associated with a single project. For project-specific baselines, gaming could take place for each of the many components that make up the emissions baseline. This is because the assumptions used to develop a project-specific baseline might be expected to vary significantly from project to project even for those that appear to be similar (sometimes referred to as "micro" gaming). Gaming would have the effect of weakening the stringency of the baseline, and therefore increasing the level of credits associated with that project. The relatively high potential for gaming was a significant drawback noted to the project-specific baselines used in AIJ pilot projects.

Gaming might also extend across whole project categories (sometimes referred to as "macro" gaming), e.g. if gaming was prevalent in establishing agreement on the levels of multi-project

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39 This is not necessarily the case in the AIJ pilot phase, where the different categories are so wide that there not all projects within each category are comparable.

40 As mentioned previously, the implications for global GHG emissions may be different for CDM and JI.

baselines. However, the potential for gaming can be expected to be lower in the case of standard assumptions being developed by bodies not having specific economic interests in the projects.

As the examples in sections 4.1 and 4.2, and in other sensitivity analyses (e.g. Ellis 1999), demonstrate, baseline levels are more sensitive to some assumptions than others. For example, for energy projects emission benefits are highly dependent on e.g. the emissions timeline and the baseline fuel/technology. Gaming is possible when assessing and deciding both of these assumptions.

In the case of a coal-fired power plant, emissions per kWh are approximately double those of gas-fired electricity (due to gas' lower carbon content and the higher combustion efficiency of gas-fired stations). Therefore, comparing a proposed JI or CDM project against a coal-fired baseline could double the ERUs or CERs compared to a gas-fired baseline. It may be appropriately argued that a coal-fired baseline is a valid assumption for a new plant if coal-fired generation makes up a substantial proportion of baseload generation in the proposed host country. However, coal may not be the type of plant that is presently being used for new baseload facilities in that country. Nevertheless, assuming that a plant currently fired by coal would continue to be so could be considered a valid assumption for a baseline in a proposed refurbishment-type JI or CDM project, even in a country where policies aim for a decarbonisation of electricity supply.

Gaming could significantly alter the credits associated with a particular project, especially with respect to fuel input assumptions. This in turn could limit or cancel the environmental effectiveness of the project. Clear rules on how to choose specific baseline assumptions in different situations could limit the amount of possible gaming.

Free riders would obtain emission credits for whole projects that would have gone ahead in the absence of the project-based mechanisms. Without clear rules on baseline selection and thus project eligibility, free riders could inflate the *number of projects* obtaining credits. Free riders could therefore artificially inflate the estimated "environmental benefits" or credits arising from JI and CDM projects.

"Free-riding" is essentially a matter not of the baseline approach, but of baseline stringency. For example, if projects are deemed automatically eligible for credits by fulfilling certain criteria (e.g. by having per unit emissions below a certain level), a lax baseline could systematically result in free riders[41]. Project-specific baselines may also give rise to free riders. This could occur as a result of the potential for gaming in developing project-specific baselines (e.g. in the case that a project developer falsely stated that the project would not have gone ahead in the absence of JI/CDM), or because of uncertainty in the emission baseline (e.g. if a developer estimates a baseline in good faith but is proved wrong at a later date).

Some have suggested that multi-project baselines could also be set in such a way to allow crediting only for low-emitting project types or categories (Friedman 1999b). This has been referred to as "forcing", and could reduce the risk of free riders. However, if "forcing" led to low baseline levels, it may inhibit some projects that may nevertheless be environmentally beneficial (e.g. a gas-fired plant where coal is being widely used).

41 However, assessing that some technologies are *a priori* additional may result in lower or higher numbers of "free rider" credits depend on which technologies were assessed as automatically additional. For example, allowing all non-hydro renewable projects to obtain credit is still likely to result in only a small number of "free rider" credits if only a limited number of projects that are small-scale are initiated.

Free riders and gaming may pose more of a problem for CDM projects than for JI projects: CDM hosts potentially gain investment in CDM projects and do not lose anything if a CDM project is demonstrated to be a free rider. However, the global atmosphere may lose from free-riding in the CDM. Similarly, free rider projects in a JI host country could make it more difficult for that country to meet its emission commitment.

Leakage occurs if the actual emission reduction or increase in sinks from a JI or CDM project results in emissions increasing elsewhere. Leakage could occur because system boundaries may be drawn in such a way as to ignore emission increases from the proposed JI or CDM project.

Potential sources of leakage vary according to project type, and which emission sources and/or effects are taken into account (or not) in a project's baseline. This may be influenced by the type of baseline used. Multi-project baselines could result in relatively low levels of leakage if the baselines account for all emissions in a sector/country. Project-specific baselines could result in higher or lower levels of leakage, depending on where the boundary for assessing the emissions baseline is drawn.

5.4.2 Overall environmental effectiveness of JI/CDM

The foregoing discussion points out that different baseline approaches result in different potentials for gaming, free riders and leakage. However, it is difficult to assess the aggregate effect of these three factors without knowing the number and mix of projects that would be eligible and initiated under each of the different approaches.

The overall environmental effectiveness of JI/CDM[42] will be a factor of both the environmental additionality of projects and the total number of projects undertaken under the mechanisms. Environmental performance will be greatest if the mechanism is set up so that a high number of clearly additional projects are established. Performance will be lowest if many projects, none of which are additional, are established. It will be positive, but not optimal, if a few projects with a high additionality are undertaken, or if many projects with low additionality are undertaken. The challenge is to balance the number of projects with the environmental additionality of individual projects in order to maximise overall environmental effectiveness of the mechanism.

Figure 5 illustrates the possible effect of baseline complexity and baseline stringency (a proxy for the environmental additionality of a project) on the number of projects undertaken. One of the reasons suggested for the relative paucity of AIJ projects was that setting baselines was too complex and costly. Reducing the complexity and cost of setting baselines will therefore reduce one of the barriers to implementing project-based mechanisms (IEA 1997), and is therefore likely to increase the numbers of projects initiated. This is represented in Figure 5 by the left-hand side assuming a greater number of projects than those on the right hand side at the same level.

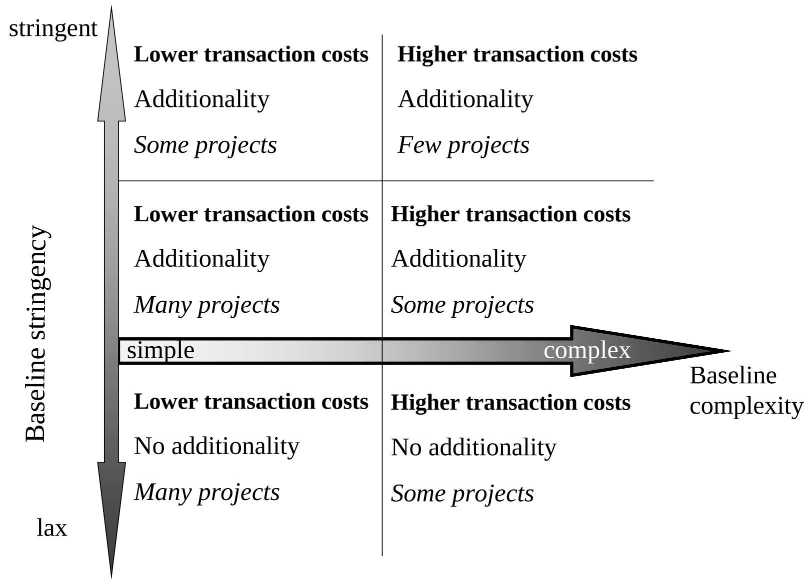
Figure 5 also illustrates the hypothesis that project numbers are related to baseline stringency. A stringent baseline is one using assumptions that result in a lower, rather than higher, baseline level. A stringent baseline will therefore lead to fewer credits per project, but - despite the uncertainties surrounding baselines - is more likely to result in a project that is environmentally additional. If investors in project-based mechanisms are rational actors, they would prefer having a less stringent (or a lax) baseline as this would result in more credits for

42 The implications of different levels of effectiveness may be different for JI and for CDM because of the differences already noted between these mechanisms (see section 1.2).

the same project. This is shown in Figure 5 by the assumption that project numbers will be larger with a lax baseline than with a stringent one.

The third hypothesis implicit in Figure 5 is that the baseline complexity is not related to the baseline stringency. Thus, complex baselines could be either stringent or lax, and therefore generate credits for projects that may be additional or not. Equally, simple baselines could lead to greater or lesser stringencies – therefore leading to projects where the additionality is more or less certain. Clearly, some degree of complexity may be warranted. For example, we would not choose to set a random level for a baseline in the forest sector – but rather would need to know something about expected business-as-usual lifetimes of existing trees and new trees planted; developing such a baseline could be a data intensive, and relatively complex operation.

Figure 5: Possible effect of baseline stringency and complexity on project



numbers and project's environmental additionality

If these three hypotheses are correct, the maximum environmental effectiveness of the project-based *mechanisms* (as opposed to individual projects) is unlikely to be achieved either with highly complex baselines, or with overly stringent baselines. As a general rule, minimising the degree of complexity for emission baselines is desirable as long as we do not compromise our ability to determine "what would have happened otherwise". Similarly, maximising the environmental stringency of the baseline must be traded off against the desirability of maximising the overall global environmental benefits from the project-based mechanisms – a greater number of good projects will be more beneficial for the environment than a smaller number of individually better projects. However, neither the relationship between project numbers and baseline stringency or between project numbers and baseline complexity is known. It is therefore not yet possible to determine at which baseline level(s) the number of projects are likely to be so low that the mechanisms would no longer be an effective means of reducing global GHG emissions.

Table 6 summarises the different criteria for, and consequences of, different emission baseline approaches.

Table 6: Summary comparison of different baseline approaches

Baseline approach	Lead time for rulemaking[1]	Data needs and costs for project preparation and approval	Transparency	Applicability to many different sectors/ project types	Possible significance of:		
					Free riders	Gaming	Leakage potential*
Project-specific	Low	High	Low	High	Low-Medium	High	--
Multi-project							
- technology level	Medium-High	Low	High	Medium	Low	Low	--
- aggregate (e.g. sector, subsector)	High	Low	Medium-High	MediumHigh[2]	Medium[3]	Low-Medium[4]	--
Hybrid	Medium	Medium	Low	High	Low	Low	--

* The leakage potential is likely to vary substantially between different baseline approaches. However, since this paper does not analyse this in depth, a qualitative assessment is not presented in this table.

[1] e.g. for some aggregate baselines, either host countries, researchers, organisations or others may be involved in setting up baselines.

[2] Once a baseline is established for a project, it could be applied to any project in that sector. The difficulty will be to gather enough data to form a baseline for some sectors.

[3] Whether or not this baseline type could systematically lead to free riders is highly dependent on the level of the baseline.

[4] Gaming could be important at the macro level if not independently verified.

6. Conclusions

There are many technical issues that still need to be resolved for both JI and the CDM[43]. These include questions related to baselines as well as to additionality, eligibility, monitoring, reporting and verification. Many of these issues are interlinked; defining one will influence others. Determining how to set emission baselines for project-based mechanisms may need to be advanced in parallel with these other rules, in order to take these other rules into account.

Determining emission baselines is critical for the assessment of a project's environmental additionality, but it can be a complex process. Moreover, baselines estimate what would happen in future, and are therefore hypothetical and subject to uncertainty. If "perfection is the enemy of the good" a balance needs to be drawn between striving for a perfect baseline and what is practical from an environmental, institutional and investor's point of view.

There are different approaches that could be used to establish emission baselines for project-based mechanisms. "Project-specific" approaches evaluate emission reductions generated from a particular project. "Multi-project" approaches can be applied to many different projects of a similar type or types. "Hybrid" baselines could also be designed, and would aim to maximise the benefits from the other approaches. Distinguishing between different approaches may be difficult in some cases.

Some cross-cutting issues are relevant to all baseline approaches. These include the length of time emission credits can accrue and whether or not the baseline is fixed at the start of the project (static) or revised during the project operation (dynamic). Static baselines are predictable, less of an administrative, monitoring and reporting burden, and cheaper. Dynamic baselines may better reflect actual trends, but would result in greater uncertainty as to how many credits a particular project would generate. A number of analyses suggest that dynamic baselines may be more appropriate for some project types.

There are many different views on how an emissions timeline could be set, but given the importance of the timeline on total credits from a project, applying standardised methodologies to assess a project's emissions timeline could offer a simple way of limiting the effects of free riders and gaming. Any such methodologies would need to vary between projects that reduce emissions, where short timelines help to ensure the environmental additionality of any credits, and those that increase sinks, where longer timelines would have the same effect. A distinction may also be needed between the timelines for JI and CDM projects, given the potential emission leakage associated with the latter.

Baseline approaches differ in their costs, transparency, data requirements and monitoring, reporting and verification needs. They may also, in some cases, have different environmental additionality implications. Different baseline approaches may also be most appropriately applied for different project types. For example, projects with homogeneous output (e.g. in the electricity sector) may be more suitable for multi-project baselines than highly site-specific projects.

High baseline development costs will discourage potential investment in JI and CDM projects. The relatively high cost of establishing project-specific baselines for AIJ pilot phase projects has stimulated interest in less costly, more standardised approaches. Moreover, although baselines that could be applied to more than one project may be costly to develop at the outset, they could lead to economies of scale and facilitate project preparation once initial guidance is established.

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43 There are different views on whether or not the baseline-setting framework should be the same for JI and CDM.

The environmental additionality of different emission projects is based on the difference between the baseline and actual emissions. Different baseline approaches can influence the environmental additionality of a project by influencing the level of gaming, free riders and leakage associated with it. Assumptions used to develop the baseline and what is included in that baseline can also have significant effects on these factors.

Gaming affects the *level* of a project baseline, and thus the resulting amount of emission credits generated by a JI or CDM project. Gaming is likely to be more prevalent in project-specific baselines where a large variation in underlying assumptions is expected. Free riders affect the *number of projects* credited, allowing projects that would have happened without JI or CDM credit to get credit anyway. The level of free riders could be significant if certain project types are deemed *a priori* eligible to obtain credits (e.g. by having per unit output emissions below a certain level). Leakage is a measure of how accurately the project boundary reflects the overall environmental effects of a project. The importance of leakage is likely to vary significantly by project type and may be lower in more aggregated baselines (e.g. multi-project baselines) where project boundaries are wider.

Increased levels of gaming, free riders and leakage would artificially inflate acquisitions of ERUs and CERs by investors. If not all CERs accruing from CDM projects were "real" the environmental effectiveness of the CDM would be lessened because the environmental benefits of CDM investment is not assured. Higher levels of gaming, free riders and leakage in JI projects will not affect the environmental effectiveness *per se*, (because the overall Annex I assigned amount would remain unaffected by acquisitions and transfers of JI credits). However, it could increase the difficulties for host countries in meeting their individual Kyoto commitments. Determining the relative importance of these different factors is difficult in the absence of information on emission baseline levels and on the number and type of projects likely to be undertaken under each approach.

This paper presents a preliminary survey of analyses done on the effect that different baseline approaches and/or assumptions have on the level of credits generated by a particular project. This paper also illustrates the influence that different national circumstances can have on the absolute level of the baseline and the resulting emission credits. For example, if both India and Brazil set a multi-project baseline for electricity projects at the level of current weighted average emissions, potential gas-fired projects could generate certified emission reductions if they were undertaken in India, but not in Brazil. Because of variable conditions in the electricity sector among different countries it may not be appropriate to use a common multi-project baseline assumption (e.g. average fossil fuel) across different countries

The review of empirical data presented in this paper, and the theoretical case study of electricity in Brazil and India, indicate that the assumptions and approaches used to develop baselines are independent variables. Both can influence the level of credits for a particular project. In the examples examined here, the range in different possible assumptions within one baseline approach can be as large as the range in assumptions between different baseline approaches. However, not all approaches may be equally appropriate in all circumstances, and different approaches may be viewed as more or less suitable for different types of projects (e.g. forestry, electricity or landfill).

Both baseline assumptions and approaches will have an impact on the environmental additionality of individual projects. They will also influence the overall environmental effectiveness of the mechanisms, i.e. the contribution of JI or the CDM <u>as a whole</u> to achieving the objectives of the Protocol.

The baseline approach will influence the environmental effectiveness of the mechanisms in part through its impact on the complexity of setting up an emissions baseline. More complex methods are likely to limit the number of projects initiated because of high transaction costs.

Baseline assumptions are also likely to have an impact on the effectiveness of the mechanisms through their impact on the baseline stringency, which affects the level of credits, and through this the number of projects initiated. Both stringent and lax baselines are possible under the different baseline approaches. Overly stringent baselines are likely to limit the number of projects initiated (and thus the amount of emission reductions achieved through the mechanisms). Overly lax baselines may encourage greater overall participation in the project-based mechanisms by raising project eligibility and the number of emission credits, but could have a negative environmental effect.

In circumstances where different baseline approaches are plausible, the independence of baseline stringency and approaches suggests that maximum environmental effectiveness across the project-based mechanisms (as opposed to individual projects) is likely to be achieved by optimising baseline stringency and reducing baseline complexity. In practice, this means: (i) seeking to minimise baseline complexity, as long as the ability to determine "what would have happened otherwise" is not compromised; and (ii) optimising the baseline stringency so that it maximises the overall global environmental effectiveness from the project-based mechanisms.

An optimal strategy takes into account that a high volume of projects will be needed to deliver strong environmental effectiveness from the mechanisms: a higher number of good projects will be more beneficial for the environment (in terms of total GHG reductions) than a lower number of individually better projects. However, since the relationship between project numbers/baseline stringency and between project numbers/baseline complexity are both unknown, it is not yet possible to determine the levels at which baseline stringency or baseline complexity will limit the number of projects initiated.

There may be differences in the most desirable baseline approach for different project types in different sectors. This would need to be examined further, as would how to minimise complexity within the different approaches. Any future decisions on baseline approaches and assumptions may therefore aim to reduce the complexity of baseline-setting procedures and to set the baseline stringency so that it properly balances environmental benefit, cost, and participation.

A decision on baseline approach(es) would open the door for assessment and eventual agreement on other credit-related aspects of JI and CDM projects, such as:

- how to determine the value of key assumptions;
- how long any project should be allowed to generate emission credits for (the emissions timeline),
- whether or not emissions baselines should be static or dynamic;
- maximising the environmental effectiveness of the project-based mechanisms by minimising the level of leakage, free riders and gaming, and
- assessing how to determine the additionality of a climate-friendly project in a country that has low emission levels.

Annex A: Possible reporting requirements for baselines

The current reporting requirements for emission baselines for AIJ projects are laid out in the UNFCCC's Uniform Reporting Format (URF)[44]. These reporting requirements cover all aspects of an AIJ project (including e.g. contact points, financial aspects etc.) as well as an estimation of emissions "with the project activity" (section E2) and "without the activity (project baseline)" (section E1). However, the guidance in the current URF of what should be reported in these sections is limited to a request for a "description of the baseline or reference scenario, including methodologies applied" and a "description of the scenario, including methodologies applied". The current URF does not, for example, request that underlying data (such as fuel use, fuel emission factors, technology efficiencies etc.) be reported, although some AIJ project reports do in fact include some or all of this information.

Emission baselines may need to be reported to the UNFCCC both for CDM and for JI projects. It may be decided that the URF for these project reports may need to be more detailed, and/or that more specific guidance is included, such as examples of what could/should be reported for different project types. More detailed reporting formats could help to reduce the time and cost of developing a reporting format for individual project developers, and could also help to reduce data-related costs by indicating which data are needed for which project type. This is a matter which will need to be decided in the negotiating fora. Nevertheless, possible more detailed reports for project-based baseline reports in selected sectors could include the following outlined overleaf.

Forestry: Re/afforestation projects (from MacDicken, 1997)

General information: Local name of project site
Address, State, Country
Latitude
Longitude
Elevation (m)
Species (before and after project)

Site history since last inventory: (description of significant changes in management, pest and disease problems, harvesting or other mortality).

Month of inventory determination

Carbon pool	Area (ha)	Mean carbon density (Mg/ha)	Total carbon (Mg)	Confidence interval (Mg)
Reference case Above-ground Below-ground Forest floor Soil to depth of 30cm Total- reference case	NA			
Project case Above-ground Below-ground Forest floor Soil to depth of 30cm Total- project case	ha			
NET CARBON STORED				

[44] Draft revisions to this URF are outlined in FCCC/SB/1999/5/Add.1.

Energy supply: replacement or refurbishment of isolated electricity/heat production facilities (from Ellis 1999)[45]

General information

- name of project site;
- address, country

What is the distance of the proposed plant from:

- the nearest gas grid;
- the nearest district heating system?

Is the plant currently connected to the electricity grid?

Old plant		Retrofit/converted plant	
Fuel(s) used*	>	Fuel(s) used*	>
Emission factor(s) (t C/TJ)	>	Emission factor(s) (t C/TJ)	>
Average annual quantity of fuel used in old plant (TJ or toe**)	>	Projected annual fuel use in retrofitted plant (TJ or toe**)	>
Average annual energy production at old plant:	> (electricity) > (heat)	Projected annual energy production at modified plant:	> (electricity) > (heat)
Age of plant (years)	>	Size and/or type of new equipment	> (size, MW) > (type, e.g. boiler)
Expected life of plant at construction (years)	>	Is this new equipment added or is it replacing other eqpt.?	>
Description of plant technology.	-	Expected life of retrofit plant	>

* If more than one fuel used, state approximate proportion of each

** It is important that this figure is expressed in terms of energy units in order to be consistent with the expression of the emission factor, and for comparison (transparency) purposes.

45 Reporting the information in the table would help to determine if emissions with the project were lower than emissions prior to implementing the project. However, it would not determine whether, for example, an existing plant would have been retrofitted anyway, or whether emissions would have been expected to decrease anyway because of decreasing demand. Such information could be requested either in this part of a new URF, or in the part of the URF indicating why the particular project fits with national economic development and socio-economic and environment priorities and strategies. The type of information reported for a new plant, and for a grid-connected plant may be different (because of its interaction with other plants in the same system).

Energy efficiency (from Vine and Sathaye, 1999a)

ENERGY USE AND CARBON EMISSIONS

Table A1: Estimated Energy Use and Carbon Emissions in Baseline [At Time of Project Registration]

Estimate annual energy use and carbon emissions (1) for the unadjusted baseline (without free riders), (2) free riders, and (3) for the baseline (adjusted for free riders). Indicate the level of precision for each value.

Estimated	*Unadjusted Baseline (1)*	*Level of Precision [a]*	*Free Riders (2)*	*Level of Precision [a]*	*Without - Project Baseline (3=1-2)*	*Level of Precision [a]*
On-site fuel use (Terajoules = 10^{12} joules/yr.)						
Carbon emissions factor [b] *Type of fuel:*						
Carbon emissions (tC/yr.)					-	
On-site electricity use (MWh/yr.)						
Carbon emissions factor [b] *Type of fuel:*						
Carbon emissions (tC/yr.)						
Off-site fuel use (Terajoules = 1012 joules/yr.)						
Carbon emissions factor [b] *Type of fuel:*						
Carbon emissions (tC/yr.) [c]						
Off-site electricity use(MWh/yr.)						
Carbon emissions factor [b] *Type of fuel:*						
Carbon emissions (tC/yr.) [c]						
TOTAL Carbon emissions (tC/yr.)						

a Indicate the level of precision used for project values: use either (1) standard deviation around the mean value, or (2) general level of precision (e.g., low, medium, high) Ñ if more information is available, additional levels of precision can be used.
b Specify type of fuel used for calculating carbon emissions factor.
c Indicate carbon reductions from off-site electric utility plant(s).

Table A2: Estimated Gross Changes in Energy Use and Carbon Emissions from Project [At Time of Project Registration]

Estimate annual energy use and carbon emissions (1) for the unadjusted project, (2) from positive project spillover, (3) from market transformation, and (4) for the "with-project" scenario. Indicate the level of precision for each value.

Estimated	*Unadjusted Baseline (1)*	*Level of Precision* [a]	*Free Riders (2)*	*Level of Precision* [a]	*Without - Project Baseline (3=1-2)*	*Level of Precision* [a]
<u>On-site</u> fuel use (Terajoules = 10^{12} joules/yr.)						
Carbon emissions factor [b] *Type of fuel:*						
Carbon emissions (tC/yr.)					-	
<u>On-site</u> electricity use (MWh/yr.)						
Carbon emissions factor [b] *Type of fuel:*						
Carbon emissions (tC/yr.)						
<u>Off-site</u> fuel use (Terajoules = 1012 joules/yr.)						
Carbon emissions factor [b] *Type of fuel:*						
Carbon emissions (tC/yr.) [c]						
<u>Off-site</u> electricity use(MWh/yr.)						
Carbon emissions factor [b] *Type of fuel:*						
Carbon emissions (tC/yr.) [c]						
TOTAL Carbon emissions (tC/yr.)						

a Indicate the level of precision used for project values: use either (1) standard deviation around the mean value, or (2) general level of precision (e.g., low, medium, high) Ñ if more information is available, additional levels of precision can be used.
b Specify type of fuel used for calculating carbon emissions factor.
c Indicate carbon reductions from off-site electric utility plant(s).

Table A3: Estimated Net Changes in Energy Use and Carbon Emissions from Project [At Time of Project Registration]

Calculate the net change in annual energy use and carbon emissions by subtracting "with-project" values (taken from Table A2) from "without-project baseline" values (taken from Table A1). Indicate the level of precision for each value.

Estimated	*Unadjusted Baseline (1)*	*Level of Precision [a]*	*Free Riders (2)*	*Level of Precision [a]*	*Without - Project Baseline (3=1-2)*	*Level of Precision [a]*
<u>On-site</u> fuel use (Terajoules = 10^{12} joules/yr.)						
Carbon emissions factor [b] *Type of fuel:*						
Carbon emissions (tC/yr.)					-	
<u>On-site</u> electricity use (MWh/yr.)						
Carbon emissions factor [b] *Type of fuel:*						
Carbon emissions (tC/yr.)						
<u>Off-site</u> fuel use (Terajoules = 1012 joules/yr.)						
Carbon emissions factor [b] *Type of fuel:*						
Carbon emissions (tC/yr.) [c]						
<u>Off-site</u> electricity use(MWh/yr.)						
Carbon emissions factor [b] *Type of fuel:*						
Carbon emissions (tC/yr.) [c]						
TOTAL Carbon emissions (tC/yr.)						

a Indicate the level of precision used for project values: use either (1) standard deviation around the mean value, or (2) general level of precision (e.g., low, medium, high) Ñ if more information is available, additional levels of precision can be used.
b Specify type of fuel used for calculating carbon emissions factor.
c Indicate carbon reductions from off-site electric utility plant(s).

Annex B: Data used to assess different possible baseline assumptions in India and Brazil

Table B 1 : CO_2 emissions from electricity generation, Brazil

	1996 electricity output (GWh)	1996 Source specific average (t CO_2/GWh)	25% less CO_2 intensive than average (t CO_2/GWh)	diff b/w source average and 25% more efficient (t CO_2/GWh)	planned new tech. In Brazil (t CO_2/GWh)	diff. b/w source average and planned tech. (t CO_2/GWh)	average best available technology (t CO_2/GWh)	diff. B/w source average and BAT (t CO_2/GWh)
Nuclear(i)	2429 (0.8%)	0,00	0.00	0.00	0	0.00	0.00	0.00
Coal (ii)	4764 (1.6%)	1102	827	275	1042	60.2	781	320
Oil (iii)	8929(3.1%)	776	582	194	n.a.	n.a.	n.a.	n.a.
Gas(iv)	714 (0.2%)	742	557	186	404	338	382	361
Bio & sugar cane**	7208 (2.5%)	0.0	0.0	0.0	n.a.	0.00	n.a.	0.00
Hydro**	265773 (92%)	0.0	0.0	0.0	n.a.	0.00	n.a.	0.00
TOTAL	289817	**437**	328	-				
Average (foss.fuel)		**873**	654	219				
Weighted average (all sources)		**43.9**	32.9	10.97				
Weighted average (thermal only)		**755**	566	189				
Weighted average (fossil only)		**882**	662	221				

Table B 2: Cost of electricity generation, Brazil

	Investment cost of new plant ('96Uscents/KWh)	Total cost (incl. O&M +fuel) of new plant (1996UScents/KWh)	total cost of average BAT ('96US cents/KWh)	approx. incremental cost of BAT (US cents/KWh)
Nuclear (i)	3.58*	5.15*	5.35*	0.2
Coal (ii)	2.41*	4.3 *	5.15*	0.85
Oil (iii)	n.a.	5.18*	n.a.	n.a.
Gas (iv)	1.41*	3.38*	4.77 *	1.39
Wind	n.a.	4.87*	6.4 **	1.53
Biomass/sugarcane residues*		3.27-6.54	n.a. (site-specific)	n.a.
Hydro*	33% below 3.27 39% b/w 3.27-5.75 28% above 5.75		n.a. (site-specific)	n.a.

Output and CO_2 (fossil fuel combustion) data from 1998 IEA Statistics, IEA 1998b, IEA 1998c
* Most cost data based on NEA/IEA (1998)
(i) nuclear assumptions : new plant is pressurised heavy water reactor; BAT includes reactors in several OECD countries, e.g. boiling water reactor, pressurised water reactor, advanced boiling water reactor.
(ii) Coal assumptions: planned new tech (pulverised coal comb. @ 33% efficiency); BAT (clean coal, i.e. pulverised coal comb. (supercritical) @ 44% efficiency, based on average of several OECD countries; mix of sub-bituminous(60%) & bituminous(40%)
(iii) Oil: no new oil-fired plants are planned in OECD (except Turkey)
(iv) Nat. Gas assumptions: planned new tech(CCGT@50% efficiency); BAT(CCGT@52.9% efficiency, based on average of several OECD countries)
** Renewables : zero value given to emissions, as per IPCC recommendations (however, lifecycle emissions estimates available in IEA 1998b; cost estimates from IEA 1997b

Table B 3: CO_2 emissions from electricity generation, India

	1996 electricity output (GWh)*	1996 Source specific average (tC02/GWh)	25% less CO_2-intensive than average (t CO_2/GWh)	diff b/w source average and 25% more efficient (t CO_2/GWh)	planned new tech. In India (t CO_2/GWh)	diff. b/w source average and planned new tech. (t CO_2/GWh)	Average best available technology (t CO_2/GWh)	diff.b/w source average and BAT (t CO_2/GWh)
Nuclear (i)	8400 (1.9%)	**0,00**	0,00	0,00	0	0.00	0.00	0.00
Coal (ii)	318357 (73%)	**1222**	917	306	1017	205	786	436
Oil (iii)	12000(2.8%)	**670**	503	168	n.a.	-	n.a.	-
Gas (iv)	27189(6.2%)	**515**	386	129	403	111	382	133
Renew.(wind..)**	57 (0.01%)	**0.0**	0.0	0.0	n.a.	-	n.a.	-
Hydro**	69072(15.9%)	**0.0**	0.0	0.0	n.a.	-	n.a.	-
TOTAL	435075	401	301	101				
Average (fossil fuels)		**802**	602	201				
Weighted average (all sources)		**945**	709	236				
Weighted average (thermal only)		**1123**	843	281				
Weighted average (fossil only)		**1150**	862	288				

Table B 4: Cost of electricity generation, India

	Investment cost of new plant ('96UScents/KWh)	Total cost (incl. O&M +fuel) of new plant (' 96UScents/KWh)	average total cost of BAT (UScents/KWh)	Approx. Incremental cost of BAT (US cent/KWh)
Nuclear (i)	3.73	5.19	5.35	0.16
Coal (ii)	1.59	4.23	5.15	0.92
Oil (iii)	n.a.	n.a.	n.a.	n.a.
Gas (iv)	2.18	4.50	4.77	0.27
Wind		n.a.	6.44**	-
Hydro	(almost all cost is capital inv.)	5.51*	n.a.	-

- Output and (fossil fuel) CO_2 data from the 1998 IEA Statistics, IEA 1998c, IEA 1998d
- Most cost estimates based on NEA/IEA (1998)
* Based on the IEA, World Energy Outlook assumptions
(i) nuclear assumptions : new plant is pressurised heavy water reactor; BAT includes reactors in several OECD countries, e.g. boiling water reactor, pressurised water reactor, advanced boiling water reactor.
(ii)coal assumptions : planned new technology is pulverised coal combustion @ 35%efficiency; BAT is clean coal, i.e. pulverised coal comb, (supercritical) @ 44% efficiency, based on average of several OECD countries; mix of lignite (6%), sub-bituminous(70%) & bituminous(24%), (NEA/IEA, 1998)
(iii) oil : no new oil-fired plants planned in OECD (except Turkey)
(iv) gas assumptions: As no India-specific data was available, costs estimated to be similar to those of Korea (in NEA/IEA, 1998) : planned new technology is CCGT @ 50% efficiency; BAT is CCGT@52.9% efficiency, based on average of several OECD countries (NEA/IEA, 1998)
Renewables (**) : zero value given to emissions, as per IPCC recommendations (however, lifecycle emissions estimates available in IEA 1998b; cost estimates from IEA 1997b

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- Tyumen (Nld/Rus)

- Cizkovice (Cze/Fra)

- Viljandi boiler conversion (Est/Swe) - 1997, 1998, top-down 1999, bottom-up 1999

- Jochy (Slv/Nor)

Glossary

AIJ	Activities Implemented Jointly
BAT	Best available technology
CDM	Clean Development Mechanism (defined in Article 12 of the Kyoto Protocol)
CER	Certified Emission Reductions (generated from CDM projects)
CH_4	Methane
CO_2	Carbon dioxide
COP	Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC)
EIT	Countries with Economies in Transition
ERU	Emission Reduction Unit (generated from Article 6 JI projects)
FCCC	United Nations' Framework Convention on Climate Change
GHG	Greenhouse gases
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation (outlined in Article 6 of the Kyoto Protocol)
KP	Kyoto Protocol
kt	thousand tons
LUCF	Land Use Change and Forestry
N_2O	Nitrous oxide
OECD	Organisation for Economic Co-operation and Development
URF	Uniform Reporting Format (form on which countries submit AIJ project-specific information to the UNFCCC)

Approach	The general methodology used to calculate an emissions baseline (e.g. project-specific,hybrid, or multi-project).
Assumption	The underlying component(s) used to develop an emissions baseline. For a project-specific baseline assumptions could include the technology type that would have been used and the efficiency that would have been achieved in the absence of the JI/CDM project. For a multi-project baseline, the potential assumption could be , for example,. Average performance, marginal performance, best available technology etc.
Baseline	An emissions baseline is a hypothetical emission reference case representing the estimated level of GHG emissions that would have been emitted in the absence of the JI or CDM project.
Complexity	The complexity of a baseline is a measure of how difficult it is to set up. Complexity will increase with the number of parameters in a baseline). A more complex baseline is likely to be more costly to set up than a simple baseline. A less complex baseline could also facilitate the verification process.
Credits	Unit used for the measurement, (e.g. in tonnes of CO_2-equivalent), transfer and acquisition of emission reductions associated with JI and CDM projects.
Dynamic baseline	A baseline that is revised during the lifetime of the JI/CDM project, without specifications at the outset on how the revision(s) will be made.
Emissions timeline	Time (number of years) over which emission credits resulting from a JI or CDM project accrue.
Environmental additionality	Difference between baseline emissions and actual emissions for a JI/CDM project. Environmental additionality of JI and CDM projects is required by the Kyoto Protocol
Environmental credibility	Quality of a baseline with respect to reflecting the emission level that would occur without the JI or CDM project(s). Given the hypothetical nature of emission baselines, environmental credibility is difficult to assess (even on an ex post basis).
Environmental effectiveness	Extent to which the JI and CDM regimes, under different baseline approaches and assumptions, result in maximum emissions reductions and maximum participation, thereby contributing to achieving the objectives of the Kyoto Protocol.
Free riding	A situation whereby a project generates emission credits from JI or CDM projects even if the project would have gone ahead in the absence of JI or CDM, i.e. is not "additional". Free riding therefore affects the numbers of projects obtaining credits.
Gaming	Actions or assumptions taken by the project developer and/or project host that would artificially inflate the baseline (and therefore the credits from the project). Gaming generally leads to lax baselines.
Greenfield projects	New projects, e.g. those taking place at a new site and increasing the host country's capacity for heat output, electricity generation etc. (as opposed to refurbishment projects that build on *existing* projects)
Hybrid baseline	A baseline made up of different components that could be applied to a number of projects. A hybrid baseline could combine some aspects of project-specific

baselines (e.g. incorporating some site-specific analysis) and some aspects of multi-project baselines (e.g. to include some standardised emission values for different technologies).

Leakage — Leakage occurs if actual emission reductions (or increase in sinks) from a project results in emissions increasing (or sinks decreasing) elsewhere. Leakage occurs if the system boundaries do not capture all emission effects of a project.

Multi-project baselines — Emission baselines (also defined as “benchmarks”, “activity standards”, “intensity indicators” in the literature) that can be applied to a number of similar projects, for example within the same sector of a country or region. These emission baselines may be drawn up using an engineering approach to set standard baseline values for a particular technology or industrial sector.

Project-specific baseline — Project-specific emission baselines are those that have been drawn up for individual projects by examining them on a case-by-case basis. Each project-specific baseline is used only for the project for which it was developed. The project-specific approach is based on some combination of engineering judgement and site-specific analysis.

Refurbishment projects — Projects in which existing equipment/processes is upgraded or replaced.

Standardised assumptions — Assumptions, e.g. on emission performance of a technology, that are standardised (generalised). These standardised assumptions may be used in the emission baselines for a number of projects.

Static baseline A baseline that is fixed at the start of the JI/CDM project and remains fixed for the duration of the project. It is possible to have a static baseline for which the level changes over time, as long as this is specified at the outset of the project.

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Stringency (of a baseline) — The stringency of a baseline is a measure of how difficult it is for projects to generate emissions below the baseline level. Given the uncertainty and measurement errors inherent in establishing a baseline, there is a range of plausible emission levels for any particular baseline. A stringent baseline will be at the low end of that range, and a lax baseline will be at the high end of that range. The determination of whether a particular baseline is stringent or not depends on the project types and national/regional circumstances.

Transaction costs — The costs associated with the process of obtaining JI or CDM recognition for a project and obtaining the resulting emissions credits. Transaction costs would include, for example, costs of developing a baseline and assessing the “additionality” of a project, costs of obtaining host country approval, monitoring and reporting, etc. Transaction costs would not include the direct investment, maintenance and operational costs of the project.

Transparency — A transparent baseline is one where the construction is clearly explained, where the parameters and methods used in the baseline are referenced and traceable, and where the baseline can be reconstructed by a third party. Transparency is also a quality that can reduce investors’ uncertainty associated with JI and CDM projects and the credits that they can generate.

Value of Credits	The monetary value resulting from the supply and demand of emission credits resulting from JI and CDM projects.