Probase

Procedures for Accounting and Baselines for JI and CDM Projects

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Final Report

Acknowledgements

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- Foundation Joint Implementation Network (JIN), the Netherlands (co-ordination)
- Decision Support System Laboratory of the National Technical University of Athens (EPU-NTUA), Greece
- Centre for Environmental Strategies at the University of Surrey (CES), UK
- Hamburg Institute for International Economics (HWWA), Germany
- French-German Institute for Environmental Research at the University of Karlsruhe (UNIKARL-DFIU), Germany
- Factor Consulting + Management Ltd, Switzerland

The research for PROBASE began in January 2001, shortly after the sixth session of the Conference of the Parties in The Hague, the Netherlands, had been suspended as Parties were not able to reach an agreement on the extent to which countries could use land use, land-use change and forestry (LULUCF) activities to fulfil their emission reduction commitments. The political background for the Kyoto Protocol was further weakened in March 2001 when US President George W. Bush decided to withdraw US support from the Protocol. However, despite these worrying developments, the international negotiators managed to successfully conclude the resumed COP-6 session in June 2001 by reaching an agreement on an overall framework for compliance, LULUCF eligibility, and financial and technological transfers to non-Annex I Parties. This general agreement was followed in November 2001 by a series of draft decisions, bundled in the so-called *Marrakech Accords* (COP-7, Marrakech, Morocco), to be endorsed by a future meeting of Kyoto Parties (COP-MOP).

Among the draft decisions in the *Marrakech Accords* are decisions on the design of Joint Implementation (JI) and Clean Development Mechanism (CDM) projects, which include recommended approaches for determining project baselines and procedures to monitor and verify the net emission reductions achieved by projects. The *Marrakech Accords* take as a starting point a single-project approach to baselines and accounting of greenhouse gas (GHG) emission reductions, but also recommend developing multi-project approaches.[2]

The PROBASE project has developed operational guidelines for baselines and accounting for JI and CDM projects. Starting from a codification of existing knowledge of baselines determination, PROBASE has strongly anticipated future COP-MOP decision-making on multi-project baseline and accounting procedures by devoting a considerable part of the research to developing multi-project baselines for power and heat sector projects. Furthermore, PROBASE has analysed to what extent steps in the accounting process for forestry projects could be standardised.

[1] Contract number: EVK2-CT-2000-00083.
[2] Para. (b)(i) and (b)(v) of Appendix C to Decision -/CMP.1 (*Article 12*).

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Abbreviations and acronyms

AAU	Assigned Amount Unit
AIJ	Activities Implemented Jointly
BAT	Best Available Techniques
BAU	Business as Usual
BREF	Best Available Techniques Reference documents
C	Carbon
CDM	Clean Development Mechanism
CERUPT	Dutch Certified Emission Reduction Units Procurement Tender for CDM projects
CHP	Combined Heat and Power
CMP (also COP-MOP)	Meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change serving as the Meeting of the Parties to the Kyoto Protocol
CO_2	Carbon Dioxide
COP	Meeting of the Conference of the Parties to the UNFCCC
COP-MOP (also CMP)	Meeting of the Conference of the Parties to the UNFCCC serving as the Meeting of the Parties to the Kyoto Protocol
DFIU	French-German Institute for Environmental Research at the University of Karlsruhe
DG	Directorate-General of the European Commission
DNA	UNFCCC Designated National Authority
DSM	Demand-side management
EBAT	Emissions-based additionality test
EF	Emissions factor
ERUPT	Dutch Emission Reduction Units Procurement Tender for JI projects
ERU	Emission Reduction Units
ETS	Emissions Trading Scheme
EU	European Union
FP	Framework Programme of the European Union
GAMS	General Algebraic Modelling System
GHG	Greenhouse gas
GIS	Green Investment Scheme
GTZ	German Corporation for International Technical Co-operation
GWh	GigaWatt hour
HWWA	Hamburg Institute for International Economics
IEA	International Energy Agency
IET	International emissions trading
IGES	Institute for Global Environmental Strategies
IPPC	Integrated Pollution Prevention and Control
IRR	Internal Rate of Return
JI	Joint Implementation
JIN	Foundation Joint Implementation Network
kt	Kilo tonnes
kWh	Kilo Watt hour
LULUCF	Land use, land-use change and forestry
MBS	Multiple Benchmark System
MHPP	Micro hydro power plants
MW	Mega Watt
NER	South African National Electricity Regulator
NTUA	National Technical University of Athens
OA	Observation area
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
PA	Project area
PCF	Prototype Carbon Fund of the World Bank
PDF	Portable document format
PERSEUS	Programme Package for Emission Reduction Strategies in Energy Use and Supply
PJ	Peta Joule = 10^{15}
PIA	Project influence area
PV/HS	Photovoltaic/hybrid systems: photovoltaic with a back up system
PLN	Perusahaan Listrik Negara
PROBASE	Procedures for Accounting and Baselines for Joint Implementation and Clean Development Mechanism Projects
Reflex	Reference emission factors for project-based flexibility mechanisms
RESS	Renewable Energy Supply System Project
RoR	Run-off-the-river project type
SHS	Solar Home Systems

SimBAT	Simplified Baseline Aggregation Tool
toe	Ton oil-equivalent
UNFCCC	United Nations Framework Convention on Climate Change
UNIS-CES	University of Surrey – Centre for Environmental Strategies
UNSG	Project developer and contractor to PERTAMINA under the Sarulla project
UPS	Unified Power System
WP	Workpackage

Introduction

This report describes the output of the research project *"Procedures for Accounting and Baselines for Joint Implementation and Clean Development Mechanism Projects"* (PROBASE). PROBASE was carried out by a European research consortium (see Annex I for the participants) under the Fifth Framework Programme (FP5) of the European Union, which set out the priorities for the EU's research, technological development and demonstration activities for the period 1998-2002. Part of the FP5 was a sub-programme on Energy, Environment and Sustainable Development, which included a so-called Key Action on "Global Change, Climate and Biodiversity". This key action provided the scope within which the PROBASE research took place. PROBASE started in January 2000 and completed its work in December 2002.

The focus of PROBASE was on the accounting of greenhouse gas (GHG) emission reductions achieved through Joint Implementation (JI) and the Clean Development Mechanism (CDM).[3] Both concepts refer to a project-based co-operation between two or more countries where GHG emission reductions take place in the country with relatively low marginal abatement costs. In other words, a country that has adopted a quantified GHG emission reduction or limitation commitment under the Kyoto Protocol (adopted in Kyoto, Japan, December 1997) can fulfil part of this commitment on the territory of another country where the marginal costs are lower. In the case of JI and CDM, a so-called investor country invests in a GHG emission reduction project on the territory of (and in co-operation with) the so-called host country. The GHG emission reductions achieved through the project will be (partly) transferred as GHG credits to the investor country that can add these credits to the GHG emissions budget assigned to him under the Protocol. In this context, JI refers to a project-based co-operation between two (or possibly) more industrialised countries, which have quantified commitments under the Kyoto Protocol (so-called Annex I Parties, *i.e.* OECD countries and countries with economies in transition).[4] The CDM envisages a project co-operation between industrialised countries (with commitments) and developing countries, which have been exempted from quantified commitments under the Protocol.

The main benefits that can be expected from the project-based Kyoto mechanisms are, on the one hand, that they potentially reduce industrialised countries' costs of meeting the Kyoto Protocol targets, whereas, on the other hand, they are to support the host countries' objectives regarding sustainable development. In order to realise these benefits a number of conceptual issues related to JI and the CDM need to be resolved first, of which calculating the GHG emission reductions achieved through the project (the process of accounting) has turned out to be most complicated one.

The main objective of PROBASE was to provide recommendations to policy makers on how to deal with this complication. For that purpose, as a basis for its research, PROBASE identified the following steps to be taken in the GHG accounting process of JI and CDM projects:

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[3] JI (defined in Article 6 of the Kyoto Protocol) and the CDM (Article 12) together with international emissions trading (IET, Article 17) are generally referred to as the flexibility mechanisms or Kyoto mechanisms.
[4] The Protocol commitments refer to the period 2008-2012 when GHG emissions must have been reduced or limited to an amount specifically assigned to each Annex I Party.

- Determine the system boundary within which the project activity takes place and which comprise those emission sources that are significant and measurable and under the control of project participants.[5]
- Describe what emissions would have taken place within the system boundary if the JI/CDM project had not taken place, *i.e.* determining a baseline scenario and consequently additionality.
- Identify possible knock-on effects of the project on factors outside the project boundary which may (partly) offset the GHG emission reduction achieved within the system boundary and are therefore often referred to as leakage.
- Identify types of uncertainty that are related to the process of calculating GHG emission reduction and identify safeguards to reduce these uncertainties.

In addition to the above steps, which directly influence the amount of emission reductions calculated from a project, other elements of the project cycle are:

- The validation of the project design document: once the system boundary has been set and a baseline determined for the situation within that boundary, the emissions are estimated that would have taken place within the system boundary in absence of the project activity. Before the project implementation starts, this baseline scenario needs to be validated by an independent, private sector entity or a government agency. Once validated the baseline is the emissions level below which the emission reductions achieved by the project are calculated.
- The monitoring of the project results: important in the process of calculating emission reductions is the comparison of the project's actual emissions (including a correction for leakage) with the validated baseline emissions. In order to ensure the reliability of the actual emissions figures, a monitoring of the actual data needs to take place. The project partners themselves could possibly carry out this monitoring.
- Subsequently, the monitored data will be subject of verification by an independent entity (endorsed by the Kyoto Protocol Bodies) after which the emission reduction will be determined by taking the difference between the validated baseline for the project and the verified actual emissions.
- The resulting reductions will be certified by the Kyoto Protocol Bodies after which the countries involved as investor and host in the project can fulfil the transfer of the emission reduction credits.

Of the steps described above, generally most attention is paid to the development of the baseline of JI and CDM projects. A key characteristic of the baseline is that it describes a hypothetical situation, *i.e.* the baseline scenario will never take place due to the project. This counterfactuality of the baseline has led to a general concern that the scenario may not always be a reasonable description of what would have happened within the project's system boundary without the project activity. For example, project developers might have an incentive to overstate the baseline emissions level thereby aiming at acquiring more emission reduction credits than actually achieved. In order to prevent such baseline inflation the *Marrakech Accords* contain several safeguards (see below) to assist project developers in following a methodology leading to reasonable baselines.

In addition, the *Marrakech Accords* have suggested developing multi-project criteria for steps in the project cycle described above. Such standardisation of steps in the GHG accounting process would involve

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[5] Para. 52 of Annex to Decision -/CMP.1 (*Article 12*).

defining *e.g.* a standard project boundary for projects of a particular type in a particular host country, and/or a standard baseline scenario for that project type, and/or a standard correction factor for leakage, as well as a standard crediting lifetime for the project. The most obvious advantage of such standardisation would be that transaction costs for the development and implementation of JI/CDM projects could be significantly reduced. For example, a project developer who aims at upgrading a power plant in a developing country could apply the standardised values for power plants derived for that country instead of calculating specific values for this project. In addition to saving transaction costs, standardisation is considered to be an effective safeguard against project partners who might have an incentive to overstate the GHG emission reductions achieved through their project by setting a higher than reasonable baseline. The latter incentive generally creates an uncertainty when JI and CDM emission reductions are calculated from a single-project baseline without standard parameter values. A potential disadvantage is that standardisation provides scope for free riders, *i.e.* parties that under a single-project accounting process would not have managed to plausibly demonstrate that their project's emission reductions are additional and reduce GHG emissions from a baseline, could with standardised procedures acquire GHG credits as long as their project beats the multi-project baseline.

With a view to the above, the overall objective of PROBASE was to develop operational procedures for determining multi-project baselines for the project-based Kyoto mechanisms, JI and the CDM, which would ensure environmental effectiveness (*i.e.* reasonable certainty that GHG emission reductions are additional) and economic efficiency (*i.e.* simplicity and transparency with low transaction costs). In order to fulfil this objective PROBASE carried out a package of activities, which are introduced below.

Overview of existing baseline knowledge

Through an extensive literature review PROBASE provided a systematic overview of issues related to determining baselines and assessing additionality for JI/CDM projects' emission reduction as well as a codification of views expressed in the literature and applied in actual practise (Annex 4). This overview has led to a description of different approaches for dealing with additionality and baselines, as well as a discussion of accounting issues such as leakage and uncertainties. Furthermore, the review explored approaches for standardisation as discussed in the literature and applied in practise.

Standardisation of procedures, parameters and emission factors

Based on the literature review PROBASE distinguished the following types of standardisation in the process of designing a JI/CDM project:

- *Standardising procedures,* which involves the identification of specific steps to be taken by all project developers in the design of a JI/CDM project and which will be subject to the validation of the project design document. Generally, this type of standardisation does not involve standardised parameter values. An example of a programme where standardised procedures have been applied can be found in the JI/CDM tender programme of the Netherlands' government (ERUPT/CERUPT, see Senter, 2000 and 2001), which provides a specific step-by-step guidance to project developers. A proposal for a standardised step-by-step guidance has furthermore been developed by the Japan Working Group on JI/CDM Baselines (Japan Working Group, 2001).
- *Standardising parameters.* This involves determining standard parameter values for *e.g.* the baseline, such as: a standard system boundary (*e.g.* one or two levels upstream and downstream), a standard fuel basis (*e.g.* average emissions of currently operational coal-fired boilers of a particular host country), standard

geographical scope (*e.g.* Northeast region of the host country), fixed crediting lifetime (*e.g.* maximum of 10 years, or 7 years with the possibility of extension through renewal periods, or just the period 2008-2012 as in ERUPT/CERUPT), a standardised correction for leakage (*e.g.* 10% leakage correction factor), *etc.* Standardising parameters would upgrade the 'blue print' of the standardised procedures to a 'cookbook', where the fixed steps have been (partly) standardised with standard parameter values.

- *Standardising emission factors.* This involves the calculation of multi-project GHG emission reduction factors for a particular project type in a particular host country. These emission factors or benchmarks need to be multiplied with the project activity level in order to obtain a multi-project baseline. PROBASE derived a number of such benchmarks for the power and heat sectors in a number of host countries.

Benchmark values

To determine multi-project forward-looking baselines in the energy sector, PROBASE applied a two-step methodology (Annex 6). In a first step the structure of the future energy system was determined as precisely as possible in order to provide the data necessary for calculating multi-project forward-looking baselines. For this step the optimising energy-system models PERSEUS and Reflex, developed at the French German Institute for Environmental Research (DFIU) at the University of Karlsruhe (Germany), were used. These models project the current and future energy systems in the potential host country with the relevant economic and technical boundary conditions. The resulting model projection describes the expected development of the electricity and heat demand in the relevant region of the host country (*e.g.* for a period up to 2020). Assuming cost-optimised energy systems, the models subsequently describe which technologies will be used to supply the electricity and heat demanded. In a second step using an aggregation tool (the so-called SimBAT), the corresponding GHG emissions levels per unit of output are aggregated from the expected deployment and activity level of the technologies identified by the optimising model. The aggregation has been carried out on different levels (sectoral, regional, load-range specific) and led to aggregated baseline emission factors (benchmarks) for a sector, a region, or a particular load-range of power and heat production in the host country. The above calculations are carried out for a number of years ahead, so that the projected baseline figures can differ from year to year, leading to a dynamic baseline. Finally, the resulting multi-project baselines are tested on a number of case study projects selected in the countries for which the energy sector is modelled.

Country or region-specific benchmarks

Deriving country or region-specific benchmarks, *e.g.* when an OECD-average GHG emission value is used as a benchmark value for a retrofit project in Bulgaria, generally leads to baselines that are (partly) disconnected from the particular circumstances of the project site. Such benchmarks could, for instance, be derived from factors in comparable countries or regions. For example, if a Central European JI host country is expected to become an EU Member State in about 5 years, the current emissions level of the EU could be taken as a proxy for what the emissions in the host country would likely have amounted to in the absence of the project. Similarly, for a developing country which is in the process of catching up with the economic development of its region, the average emissions level for the region could be used as a possible baseline. PROBASE has carried out an extensive analysis for the purpose of illustrating the impact of choosing varying geographical scopes for baselines.

Standardising forestry baselines

Next to analysing the GHG emission reduction accounting for the power and heat sector PROBASE also analysed the extent to which the calculation of carbon sequestration through forestry projects can be standardised (Annex 7). PROBASE analysed a number of actual forestry projects in Brazil, Costa Rica and the Czech Republic in order to explore whether and to what extent multi-project procedures and baseline parameters could be derived for forestry activities.

Country context

In the process of analysing and testing the standardisation of procedures, parameters and baseline emissions factors, nine potential JI and CDM host countries were selected as case study countries: Brazil, Bulgaria, Costa Rica, the Czech Republic, the Republic of Indonesia, the Russian Federation, the Republic of South Africa, Sri Lanka, and Zimbabwe (Annex 3). For each of these countries multi-project baselines were derived for either the heat and power sector, or the forestry sector. Subsequently, these baselines were tested on actual projects to find out whether the multi-project baselines would indeed provide a reasonable description of the business-as-usual situation without the project activities. An important prerequisite in the process of determining multi-project baselines for a country is to collect relevant data about the country context. For that purpose a systematic data collection was carried out aiming at collecting general data on the country, as well as specific data on the energy sector or, where applicable, forestry sector.

Uncertainty

As mentioned above, the complexity of determining a baseline for a JI/CDM project is that the situation it describes will never exist because of the project. Consequently, the baseline reflects a counterfactual scenario, which can, taken as a whole, not be monitored and verified.[6] The uncertainty related to the counterfactuality of the baseline could significantly affect the environmental integrity of JI and the CDM-based crediting if no appropriate measures are taken to 'ensure' that the baseline is a *reasonable* representation of the situation without the project (as required by the *Marrakech Accords*[7]).

In order to explore the environmental integrity of baseline types, an assessment was carried out of the range of uncertainty in determining baselines for specific case study projects (Annex 8). By generating a set of relevant baselines for particular projects and analysing where (and why) they differ an indication was obtained of the magnitude of uncertainty. Subsequently, PROBASE suggested safeguards in order to reduce uncertainty with the baseline, such as for example: choosing conservative baselines (or baseline parameters), limiting crediting lifetime (*e.g.* similar to the CDM proposal in the *Marrakech Accords*[8]), and/or carrying out a data quality control. With a view on this, it was furthermore explored to what extent

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[6] To a certain extent, the underlying data for the baseline could be monitored, but this would still not allow for a monitoring of the full baseline as this would require a monitoring of the formulation of how the data has been transferred into a baseline. The latter is, however, a typical example of the counterfactuality and strongly builds on assumptions and professional judgements.
[7] Para. 44 of Annex to Draft Decision -/CMP.1 (*Article 12*).
[8] Para. 49a of Annex to Draft Decision -/CMP.1 (*Article 12*).

standardisation of procedures for stages in the overall GHG accounting could reduce uncertainties (*e.g.* correction factors for leakage).

Other issues

- With respect to potential JI projects PROBASE acknowledged that several potential JI host countries are currently undergoing the EU Accession process, which implies, among several other requirements, that they have to adopt EU environmental standards in their domestic legislation and implement these in actual practice. As a consequence, several initially potential JI project investments are currently being implemented in these so-called Candidate countries as part of their EU Accession process. In other words, the baseline for these projects is basically the GHG emissions level that corresponds with the relevant EU environmental standards. PROBASE analysed the interaction of JI baselines in the Candidate countries with the EU Accession process (Annex 5).
- There are particular problems in using large complex models with their associated large data requirements in a least developed country context. Particularly, there could be data problems associated with *e.g.* low institutional capacity and cultural issues, poverty issues. With a view on these problems, PROBASE investigated baseline-setting methods using a simplified approach based on spreadsheet models for the heating sector and the power sector (Annex 6), which was applied to a range of project types/sectors in some case study countries.
- Procedures for baselines and accounting require institutional capacity in the host country, which relates to data availability and quality, capacity to identify project boundaries, capacity for baseline determination, determination of leakage factors, monitoring, carrying out audits, *etc.* (Annex 9).

Table I.1. Overview of PROBASE workpackages

WP.1	Stage for co-operation + management of consortium	Annex 1
WP.2	Data collection	Annex 2
WP.3	Project case study 'contexts'	Annex 3
WP.4	Literature review of baselines, additionality, and leakage	Annex 4
WP.5	Baselines for Joint Implementation projects in EU Candidate Countries in the context of the *Acquis Communautaire*	Annex 5
WP.6	Standardising baselines for the heating sector	Annex 6
WP.7	Standardising baselines for the power sector	Annex 6
WP.8	Standardising baselines for the forestry sector	Annex 7
WP.9	Accounting and uncertainty assessment	Annex 8
WP.10	Simplified baselines for sectors in developing countries	Annex 6[9], Annex 8[10]
WP.11	Institutional implications for baseline and accounting approaches	Annex 9
WP.12	Evaluation and policy recommendations (incl. Additionality assessment)	Annex 10
WP.13	Database for recommended accounting and baseline options	This report + e-manual Annex 11
WP.14	Review team	

[9] Large-scale projects
[10] Small-scale projects

Recommended Baseline options and calculating GHG reductions using an e-manual

Finally, PROBASE prepared baseline and accounting packages with recommendations on different baseline approaches and (institutional) safeguards, such as choosing conservative parameter values, limiting crediting lifetimes, monitoring and verification, *etc*. These packages are tailored to different operational circumstances *e.g.* JI projects in Candidate countries, JI projects in non-Candidate countries, CDM projects in least developed countries, forestry projects, *etc*.

In addition, PROBASE developed an electronic manual, which uses the multi-project baselines calculated by the PERSEUS and Reflex models and the SimBAT method. The manual is set up as an Internet-based decision tree, which guides the project developer through a number of decision steps: selection of the host country, (if applicable for that country) the region within the host country, the project sector, the project type, whether the project is typically large-scale or small-scale, and whether the project offers base load, intermediate load or peak load energy.

After having completed these steps the manual will automatically select a multi-project baseline emissions factor that applies to the project. Subsequently, the project developer must fill out the project crediting lifetime, its annual output and its actual GHG emissions. The output of the manual is a report, which shows a baseline scenario and calculates the (net) emission reductions.

The main objective of the PROBASE e-manual is to assist project developers in calculating the baseline for a JI or CDM project thereby using multi-project baseline emission factors while observing the conditions set by the *Marrakech Accords*.

Research approach

With the above overview and objectives in mind, the overall research approach used by PROBASE is as follows:

1. Describe the background of baseline determination and discuss how describing the counterfactual situation of a JI or CDM project has been dealt with in the *Marrakech Accords* of 2001 (Section 1).
2. Review and examine the overall process of accounting of GHG emission reduction, which includes baseline construction, ensuring the additionality of climate benefits, and verifying climate benefits through project monitoring (including measures to manage uncertainty) (Chapter 2 and Annex 4).
3. Data Collection (Section 3.2):
   - Identify and describe representative JI/CDM projects from different project categories, and economic sectors in the case study countries.
   - Collect the relevant technical, economic, environmental and social data for these projects.
   - Collect technical, economic, environmental and social data related to the background conditions in the case study countries, which may be relevant to baseline construction and additionality.
   - Carry out a data quality assessment.
4. Develop generic approaches to multi-project baseline determination:
   - Using the data collected in (3) and taking into account the analysis in (2), explore the baseline construction for the range of project types (heat, electricity and forestry sectors) in a range of host JI and CDM countries using selected multi-project baseline methodologies for heat and power projects (future benchmark modelling, country sector averages and region sector averages, Section 3.3 and 3.4) and forestry project (Section 3.6)

- Estimate the range of uncertainty associated with the case study projects by applying sensitivity analysis (using single-project baselines) (Section 4.1).
- Investigate any host country situation, which may be problematic for the determination of multi-project baselines, *e.g.* lack of efficient markets, lack of equivalence of service, lack of data, *etc.* (Section 4.2).

5. Analyse how additionality of a project's emission reductions can be assessed through multi-project baselines, both through an implicit assumption of additionality under the multi-project baseline and through a combined barriers assessment (Chapter 5).
6. Elaborate on emissions reduction accounting 'packages' (*i.e.* baseline construction and management of uncertainty) and compile an electronic, user-friendly manual for project developers including steps to calculate the emissions reduction achieved through a JI or CDM project (Chapter 6).

1 Baseline determination and GHG accounting in the *Marrakech Accords*

1.1 Possible baseline approaches

The *Marrakech Accords* of the seventh Conference of the Parties (COP-7)[11] contain draft decisions on the modalities and procedures for JI and CDM projects.[12] Both draft decisions define the baseline as the scenario that reasonably represents the anthropogenic emissions by sources of GHG that would occur in the absence of the JI or CDM project.[13] In these decisions the word 'reasonably' is of crucial importance. Because of its hypothetical character (the baseline scenario will never take place precisely as a result of the project) the baseline is surrounded with uncertainties regarding the choice of the 'right' methodology, parameters, key factors, *etc*. As a consequence, even the 'best' baseline is just a scenario which reasonably describes the situation in absence of the project without claiming that this situation would for sure have taken place.

In the *Marrakech Accords* the reasonability of JI and CDM baselines is further defined in the Appendix B to the Draft Decision on JI and in the Annex to the Draft Decision on the CDM (see elsewhere in this chapter). It should be noted that the procedures and modalities for CDM project baselines have been defined in the *Marrakech Accords* in much more detail than for JI project baselines, which relates to the fact that for JI a so-called two-track approach is envisaged. A JI host country that meets certain eligibility criteria (see Section 1.4) could verify the JI emission reductions as being additional and transfer ERUs derived from that to an investor country without the official approval of the JI Supervisory Committee. This procedure is generally referred to as the fast JI track or Track-1. Parties that do not meet the eligibility criteria must have their JI projects verified through the Supervisory Committee, which is the so-called slow track or Track-2. In practice, the project design of JI Track-2 projects is likely to resemble the detailed CDM project design requirements.

For the determination of CDM project baselines (and possibly also for JI Track-2 baselines) the *Marrakech Accords* list three approaches from which project participants must select the one which they consider most appropriate for the project activity:[14]

- In the first approach the baseline is derived from existing actual or historical emissions relevant for the project, as applicable. This approach assumes that the (recent) historic and actual emissions of GHGs at the project site (*i.e.* within the project's system boundary) form a good representation of what reasonably could have happened in absence of the project during its crediting lifetime.
- The second approach calculates a baseline by identifying a technology that represents 'an economically attractive course of action, taking into account barriers to investment.'[15] This approach assumes that under business-as-usual circumstances an economically attractive course of action would have occurred, although it does specify economic attractiveness as a concept, which could imply that several different economically attractive options would qualify as a baseline ranging from the

[11] COP-7 was held in Marrakech, Morocco in October/November 2001.
[12] Draft decision-/CMP.1 *(Article 6)* defines modalities and procedures for JI projects whereas Draft decision-/CMP.1 *(Article 12)* deals with the CDM.
[13] Para. 1 of the Appendix to the Decision -/CPM.1 (*Article 6*) and para. 44 of the Annex to Decision -/CPM.1 (*Article 12*).
[14] Para. 48 of the Annex to Decision -/CPM.1 (*Article 12*).
[15] Para. 48b of the Annex to Decision -/CPM.1 (*Article 12*).

economically most attractive course to less attractive ones. The choice of the baseline in this approach is to a certain extent narrowed down by the condition that investment barriers would not hamper an economically attractive course of action. There could be an overlap between this approach and the first one if actually existing technologies represent an economically attractive course of action.

- The third approach described in the *Marrakech Accords* differs from the first two in that it actually describes a multi-project application, whereas the first two approaches can both be applied for single-project and multi-project baselines. It specifies that the baseline or benchmark is to be derived from the "average emissions of similar projects undertaken in the previous five years, in similar … circumstances, and whose performance is among the top 20 percent of their category."[16] In this approach actually two samples are taken. First, the average GHG emissions of all investments in a particular project category undertaken during the last five years are considered. In this respect the approach resembles the historic emissions baseline approach mentioned above. Second, out of all currently operational plants within the project category it is determined which ones belong to the top 20% of the category in terms of the GHG emissions level. Subsequently, the baseline is determined by taking the average emissions of those plants that belong to the top 20% in their category and that have become operational during the previous five years.

Although the third baseline approach mentioned in the Marrakech text actually describes a multi-project baseline, it is specifically stated in the text on the CDM that baselines shall be established on a project-specific basis.[17] At first sight, this seems to rule out the possibility of determining baselines by using multi-project approaches, but upon closer look the *Marrakech Accords* specifically allow for multi-project baselines too, provided that such standardisation leads to reasonable and conservative estimates of the emissions within the project's system boundary in absence of the project.[18] The extent to which multi-project baselines can be determined within the framework of the three baseline approaches for the CDM defined in the Marrakech has been the main theme of the PROBASE research and will be further introduced in the next section.

1.2 Standardisation of baselines in the Marrakech Text

In the parts of the *Marrakech Accords* dealing with the procedures and modalities for the project-based Kyoto mechanisms several references are made to standardising the accounting of GHG emission reductions. For example, the draft decision on JI projects states that a baseline shall be established "[o]n a project-specific basis and/or using a multi-project emission factor."[19] Next to a clear reference to standardisation of baselines, it also indicates that applying a project-specific baseline methodology does not exclude standardisation of certain baseline parameters (see also below). In this context a baseline could *e.g.* be established using the historical emissions data for the project's system boundary (project-specific), under the condition that this historical data for the host country where the project takes place, should only be taken from recently added capacity (standardised parameter). Several comparable

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[16] Para. 48c of the Annex to Decision -/CPM.1 (*Article 12*).
[17] Para. 45c of the Annex to Decision -/CPM.1 (*Article 12*).
[18] Para. (b)(v) of Appendix C to Decision -/CPM.1 (*Article 12*).
[19] Decision-/CMP.1 (*Article 6*), Appendix B, criterion 1.

combinations between project-specific and standardised baseline methods are possible within the three (CDM and possibly JI) baseline approaches listed in the *Marrakech Accords* (see Section 1.1).[20]

A strong reference to developing multi-project/standardised procedures for CDM baseline methodologies can be found in Appendix C to the Draft decision -/CMP.1 (*Article 12*). The Appendix states that the CDM Executive Board shall provide guidance on the "appropriate level of standardization of methodologies to allow a reasonable estimation of what would have occurred in the absence of a project activity wherever possible and appropriate,"[21] which is a clear reference to multi-project baselines. In addition, the Executive Board shall develop and recommend to the COP-MOP specific guidance on the "[d]efinition of project categories (*e.g.* based on sector, sub sector, project type, technology, geographic area) that show common methodological characteristics for baseline setting."[22] Finally, COP-7 decided that the Executive Board shall explore the possibility of using "[d]ecision trees and other methodological tools, where appropriate, to guide choices in order to ensure that the most appropriate methodologies are selected, taking into account relevant circumstances,"[23] which goes into the direction of standardising procedures for calculating GHG emission reductions, e.g. by developing a (electronic) manual for project developers.

An important question in the context of baseline standardisation is to what extent multi-project baselines would fit in the three baseline approaches defined by the *Marrakech Accords* for the CDM.[24] As mentioned in Section 1.1 this will not be a problem for the third baseline approach, which in fact already describes a multi-project baseline methodology. Applying multi-project baseline methodologies under the first approach – baselines derived from existing or historical emissions – would in principle be possible too. A single-project baseline in this approach would consist of a scenario for the project's crediting lifetime based on the existing actual or historical emissions that would otherwise have taken place. A multi-project baseline within this approach could be derived from the historic or existing emissions of comparable project activities in the same category (*e.g.* a particular sector). Any proposed CDM project would need to beat this sector-based emissions level to achieve emission reductions.

Applying multi-project baselines under the first baseline approach, however, still leaves quite a large range of possible baseline methodologies. For example, *the existing actual or historical emissions* approach does not specify whether the existing emissions should refer to the average emissions for all fuels within a sector, or average emissions of the particular fuel that is being replaced by the project. Furthermore, the methodology does not clearly specify whether the actual or historical emissions should refer to all technologies in the sector that were operational in the recent past or that are currently in operation, or to marginal technologies, which have recently been added to the sector via new installations. The latter option derives the baseline from the latest, and assumingly more efficient, technologies installed.

According to the second approach, baselines must represent an economically attractive course of action. A multi-project baseline methodology under this approach could be to determine for a sector within a host

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[20] Strictly speaking, each baseline, whether single-project or multi-project of nature, will to a certain extent be project-specific in that *e.g.* the baseline is calculated for an activity level within a project-specific system boundary.
[21] Para. (b)(v) of Appendix C to Decision -/CPM.1 (*Article 12*).
[22] Para. b(i) of Appendix C to Decision -/CPM.1 (*Article 12*).
[23] Para. b(iv) of Appendix C to Decision -/CPM.1 (*Article 12*).
[24] Para. 48 of the Annex to Decision -/CPM.1 (*Article 12*).

country, or for the host country as a whole, possible courses of action that are economically attractive. Subsequently, from this set a scenario is selected which provides a reasonable projection of the development in the sector or the country, *i.e.* a development, which is economically attractive and not hampered by significant investment barriers. From the actual practice, the single-project Dutch ERUPT key factor method for baseline determination could fit in this approach as it requires project developers to carry out an analysis of relevant key factors which taken together describe a likely course of action based on such information as national energy policies in the host country, energy market development, energy subsidy policies, international commitments, *etc.*; this approach could relatively easily be standardised if for a particular project type in a host country a standardised key factor analysis is done, which would apply for multiple projects of the same type in the country.

A more sophisticated method of standardising baselines for energy sector projects (which was the main focus of PROBASE) under the second baseline approach in the *Marrakech Accords* is to determine GHG emission benchmarks with the help of energy sector models. The PROBASE project has applied this method with the help of the traditional energy sector model PERSEUS. Assuming a cost-minimising course of action, the PERSEUS model projects the energy market development in a host country, thereby identifying (if necessary) different regions in the country, as well as differences in project-scale and the different load ranges for the energy production. From the model outcomes a multi-project baseline emissions scenario can subsequently be derived which assumes a cost-optimal attractive course of action in the host country (for an extensive description of the heat and power modelling methods applied by PROBASE, see Chapter 3 and Annex 6).

1.3 Other accounting issues in the *Marrakech Accords*

1.3.1 Additionality

A general requirement of a JI/CDM project is that it must result in additional emission reductions, *i.e.* the emissions reduction would not have taken place in absence of the project. The main rationale behind the condition of additionality is to reduce the chances that project developers take a free ride on the credits for GHG emissions trading projects. Conceptually, additionality and baselines differ from each other in that the first concept just analyses whether the emission reductions would have taken place anyhow in absence of the project, whereas the baseline describes an emissions scenario that would have taken place in absence of the project. Following this it is often argued that an additionality assessment is redundant if the baseline scenario turns out to show higher emissions levels than the project scenario itself. After all, such a situation would already imply that the project is additional.

However, that line of reasoning passes over the counterfactual character of the baseline. The fact that the baseline scenario is higher than the project's emissions scenario does not ensure that in absence of the project a similar investment had not taken place. The fact that the baseline describes a hypothetical situation implies that at best a reasonable estimate of the situation in absence of the project can be made. Therefore, a baseline scenario that is higher than the project is no guarantee that the project is additional.

For some international climate policy observers this has been a reason to propose carrying out a separate additionality test next to determining the baseline.[25] Such a test could, for instance, contain an extra investment barriers analysis next to the baseline or be a threshold emissions value that the project must beat in order to be eligible as an additional project[26]. However, a separate test does not guarantee additionality either, because it can neither do more than judge about a hypothetical situation.

From the text of the *Marrakech Accords*, which basically only refers to additionality of emission reductions, it can be derived that international UN negotiations seem to have concluded that in order to be able to achieve *additional* emission reductions, project developers must beat a reasonable and likely relatively conservative baseline, thus reducing the chances for investors to acquire credits for activities that would have been implemented anyway. In other words, the view that seems to be reflected in the *Marrakech Accords* is that once a comprehensively designed baseline emission scenario turns out to be higher than the project's actual emissions, the project can thus reasonably be considered additional.[27]

Given the debate on additionality and the desirability of separate additionality tests, in conjunction with the freedom for individual investors and/or hosts to implement stricter rules than those of the *Marrakech Accords* themselves, PROBASE has carried out a study on additionality assessment thereby identifying both approaches with separate additionality tests, and approaches which assume that additionality can best be assessed as part of the baseline analysis for a JI or CDM project. The results of the study are presented in Chapter 5.

1.3.2 JI 2-Track approach

Although the general definitions of baselines for JI and CDM projects basically do not differ from each other,[28] there is an important difference in the *Marrakech Accords* between JI and CDM with respect to the overall calculation of GHG emission reductions. Emission reductions achieved through CDM projects are subject to an external verification by or under the auspices of the CDM Executive Board. For JI a so-called two-track approach has been developed. Paragraph 21 of the *Guidelines for the implementation of Article 6 of the Kyoto Protocol* [29] states that an Annex I Party is eligible to transfer and/or acquire emission reduction units (ERUs) if it complies with a number of eligibility requirements:

- It must be a Party to the Protocol;
- Its assigned amount has been calculated and recorded in accordance with the Marrakech decision on Modalities for the accounting of assigned amounts;
- It has in place a national system for the estimation of anthropogenic GHG emissions in accordance with Article 5.1 of the Protocol;
- It has in place a national registry in accordance with Article 7.4 of the Protocol;
- It has submitted annually the most recent required inventory, in accordance with Article 5.2 and Article 7.1 [of the Kyoto Protocol];

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[25] For examples of a number of such positions, see http://www.northsea.nl/jiq/editrep.htm.
[26] *E.g.* Sathaye, *et al.*, 2001.
[27] Para. 2(e) of Appendix to Decision -/CPM.1 (*Article 6*) and para. 45(b) Annex to Decision -/CPM.1 (*Article 12*).
[28] The two differences in the general baseline definitions for JI and the CDM are first that the JI definition also refers to removals by sinks of GHGs (*e.g.* forestry), whereas the CDM baseline refers to emissions of GHG sources only, and, second, that the CDM baseline definition also explicitly refers to the fact that CDM baselines shall be established in a transparent and conservative manner regarding, among others, additionality.
[29] Decision -/CPM.1 (*Article 6*).

- It submits supplementary information on assigned amount in accordance with Article 7.1.

A Party that meets these eligibility requirements may "verify reductions in anthropogenic emissions by sources or enhancements of anthropogenic removals by sinks from an Article 6 project as being additional to any that would otherwise occur … Upon such verification, the host Party may issue the appropriate quantity of ERUs in accordance with the relevant provisions of decision -/CMP.1."[30] This provision has been identified as the JI Track-1 procedure, which implies that when both Parties meet the above eligibility requirements, they can transfer and acquire ERUs from JI projects without the approval of the JI supervisory committee, *i.e.* without an external verification of the emission reductions by an operational entity designated under the Protocol. The verification of emission reductions of JI projects that are implemented by the Parties, which do not meet the eligibility requirements of the above paragraph 23, shall occur through the verification procedure under the JI supervisory committee. This procedure is called the JI Track-2 and it is generally expected that this procedure will to a large extent resemble the CDM project design procedures.

1.3.3 The project design document

Table 1.1 gives an overview of the issues/steps to be resolved or taken in the process of calculating the net GHG emission reductions achieved through the CDM as incorporated in the *Marrakech Accords*. The table is based on the CDM project design document, which, as mentioned above, may also apply to JI Track-2 projects. Of these issues, additionality and baseline determination have been introduced in the formers sub-sections. Below some of the other issues/steps are briefly introduced.

[30] Para. 23 of Annex to Decision-/CMP.1 (*Article 6*).

Table 1.1. Accounting issues in the Project Design Document of the Marrakech Accords

Accounting Issues	Marrakech Project design document[31]
Additionality	Emission reductions shall be additional to what would otherwise occur
Project boundaries	All anthropogenic GHG emissions under the control of the project participants that are significant and reasonably attributable to the project
Baselines	• Reasonable representation of emissions in absence of the project • Project-specific and/or using multi-project factors • Take into account relevant national/sectoral policies and circumstances • Take into account project activity level • Simplified procedures for small-scale projects
Leakage	Measurable changes in emissions outside project boundary attributable to project
Crediting lifetime	For CDM projects either three possible periods of 7 years with 2 revision moments, or one period of 10 years only
Baseline validation	Operational entities
Monitoring plan approval	Monitoring plan to be validated
Monitoring for project	• Monitoring of project emissions • Environmental assessment
Monitoring for baseline and leakage	Marrakech text requires monitoring of leakage under the baseline and monitoring of baseline data. However, leakage is neither part of the baseline, nor can it be monitored. Baseline data could be monitored but purpose is not clear
Verification and certification	Designated operational entities
Issuing of credits	No *ex-ante* crediting; issuance after reductions have been verified at intervals to be agreed

In the sections above references were made to the project's system boundary, which defines the *e.g.* technical system or geographical area for which the baseline is calculated. In other words, the baseline describes what would have happened within the system boundary in absence of the JI/CDM project. In the Marrakech Text the project boundary is defined as encompassing all anthropogenic GHG emissions by source under the control of the project participant.[32] Setting a boundary, however, does not imply that a project does not have an influence on GHG emission sources outside the boundary. Where such effects take place and where these are significant and reasonably attributable to the JI/CDM project, the emission reductions calculated within the system boundary will have to be corrected for this *leakage*.[33]

Leakage has not been a key focus of the PROBASE project, but the issue is extensively discussed in Annex 4 to this report. Leakage can be considered as a reduction in the GHG emission reduction achieved by a JI/CDM project due to knock-on effects caused by the same project (so-called spill-over effects work in the opposite direction). The context of leakage is outside the project boundary, which conceptually separates leakage (outside the boundary) and baselines (inside the boundary). However, the *Marrakech Accords* text is not really consistent in this respect, as it clearly defines the project boundary as the system for which the baseline must determined and leakage as emissions due to the project but outside the project boundary, but nevertheless requires "a description of how the baseline methodology addresses potential leakage",[34] which seems to suggest that leakage calculations are part of baseline methodologies.

[31] Appendix B to Decision -/CPM.1 (*Article 12*).
[32] Para. 52 of the Annex to Decision -/CPM.1 (*Article 12*).
[33] Para. 51 of the Annex to Decision -/CPM.1 (*Article 12*).
[34] Para. 2(b)(ii) of Appendix B to Decision -/CPM.1 (*Article 12*).

Moreover, the Text is not specific about the monitoring of leakage. Given the counterfactual nature of leakage itself, identifying leakage sources would be complicated, let alone estimating the size of leakage.

Another accounting issue is defined in the Appendices for the Decisions on JI and CDM and relates to the criterion that a baseline for a JI/CDM project shall be established "in such a way that ERUs[/CERs] cannot be earned for decreases in activity levels outside the project activity or due to *force majeure*."[35] This could be illustrated as follows. Suppose, in a municipality where a district heating system is renovated as part of a JI project, the local government during the project's crediting lifetime unexpectedly decides that one apartment building block will be closed (*e.g.* for safety reasons). For the inhabitants of the block, replacement housing will be arranged outside the range of the district heating system. As a result, the GHG emissions of the district heating system will drastically drop and become much lower than *a priori* expected. If the baseline remains fixed for the crediting period, the project participants would then earn more emission reduction credits than anticipated and which is due to a factor beyond their control. This is what the Marrakech Text tries to prevent.[36] A possible option to deal with this issue is to express the baseline in terms of GHG emissions per unit of output of the district heating system, which automatically absorbs any change in activity level.

Finally, the CDM draft decision requires a monitoring of baseline data: project participants shall make *"… a monitoring plan that provides for… [t]he collection and archiving of all relevant data necessary for determining the baseline … within the project boundary during the crediting period."*[37] Logically, the text does not provide for a monitoring of the baseline as a scenario, since a hypothetical situation represented by the baseline can by definition not be monitored. At most, data used for the baseline calculation can be monitored, but the *Marrakech Accords* text is not clear about what might be the consequence of such a monitoring effort. Possible answers could be that the monitoring could lead to a revision of the baseline during the crediting period (as is possible in the approach of the PCF) or that the monitoring results will be used for setting and validating a baseline for a subsequent crediting period.[38]

1.4 Implications of 'Marrakech' for PROBASE

What are the implications of the texts on JI and the CDM in the *Marrakech Accords* for PROBASE?

- The starting point for baseline determination in the *Marrakech Accords* text on JI and CDM[39] is project-specific, but
- there is ample scope in the Text for standardising JI and CDM project baselines procedures, of which the third baseline approach specifically refers to benchmark methods, whereas under the other two approaches also multi-project baseline methodologies could be applied. The multi-project baseline

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[35] Para.47 of Appendix of Draft decision -/CMP.1 (*Article 12*).

[36] An example of where determining the project activity level could be problematic is an efficiency improvement in a district heating system which takes place simultaneously, but under separate project activities, with a demand-side management improvement in the same district. The demand-side management improvement leads to a lower heat demand, which must be reflected in the project activity level of the supply-side improvement project. Not doing so would lead to an overestimation of the emission reduction through the so-called second-order effect. This effect is explained in more detail in the background document to the e-manual (Annex 11).

[37] Para. 53 of the Annex to Decision -/CPM.1 (*Article 12*).

[38] Still, however, this seems to partly overlap with paragraphs 48 a-c, which already define that baselines for CDM projects should be determined partly based on historical data.

[39] As mentioned earlier in this document, the official status of the Decision is that of a recommendation to the COP-MOP-1 in the form of a Draft Decision.

modelling methodology applied by PROBASE fits in both the first and the second baseline approach. The PROBASE Multiple Benchmark System analysis partly covers the third and the second approach. The PROBASE baseline uncertainty assessment presented in Annex 8 considers several different baseline types that would fit in each of the three approaches.

- Furthermore, the Marrakech Text explicitly refers to a standardisation of procedures by suggesting the development of a 'decision tree' for CDM baseline determination. The JI Decision is less explicit about baseline methodologies and options for standardisation, which is partly because of the fact that a JI project is only due for verification by the JI Supervisory Committee if (one of) the Parties involved in the project is not in compliance with the eligibility requirements for JI Track-1 treatment.
- Baselines must be determined with a view on the criterion that no ERUs or CERs can be earned for a decrease in the activity levels outside the project activity. This could provide a scope for expressing baselines in terms of GHG emissions per unit of activity output.
- COP-7 did not incorporate additionality threshold values for determining performance standards and investment additionality, which were proposed in the COP-6*bis* negotiation text. In the final text of CoP-7 (the *Marrakech Accords*) additionality for CDM projects was not defined as a separate project modality. Clearly, project participants must describe *how* the project reduces emissions below those that would have occurred in absence of the project.[40]

[40] Para. 2(d) of Appendix B to Decision -/CPM.1 (*Article 12*).

2 Identification of baseline methodologies in the literature

The first step of PROBASE in developing procedures for baselines for JI and CDM projects is to explore the several baseline methodologies that have been identified in the literature and which could fit in the approaches for baselines identified by the *Marrakech Accords*. For this purpose PROBASE has carried out an extensive literature review (see Annex 4), which is summarised in this chapter.

2.1 Elements in the construction of a baseline

As explained in Section 1 the *Marrakech Accords* have identified several methodological issues, which must be confronted in deriving baselines for JI/CDM projects. The main ones are:

- Defining the system boundary of the project;
- Choosing the project type and baseline technology/fuel
- Analysing the timing of any changes;
- Choosing the timeframe over which the project/baseline comparison is to be made;
- Assessing the equivalence of energy service between the project and the baseline;
- Assessing uncertainty under the baseline; and
- Considering the host country context.

These issues are briefly discussed in the sections below (for a more detailed discussion, see Annex 4).

2.1.1 System Boundaries

According to the Draft decisions on the CDM project design document[41] the project boundary must be determined in such a manner that it encompasses all anthropogenic GHG emissions sources, which are under the control of the project participant(s). In this definition (see also Section 1.3.3) the key term is *control*, although it is not specifically defined how to precisely interpret this term. One way of dealing with the control issue for energy sector projects is to analyse to what extent the project is considered to be (in)dependent of any supply system in terms of their operation. Following this approach, a JI or CDM project can directly substitute an existing plant or a well-defined planned project, *e.g.* a planned development of a coal-fired district heating plant is changed to a natural gas-fired plant. Also an off-grid energy efficiency project in a rural area in a developing country can reasonably be assumed to be independent of the grid-connected energy system. For such a project, the project area could be a sufficient project boundary.

In case the project under consideration is not independent of other parts of the energy system, and introducing it into the energy system will cause system interactions, the project boundary may need to be set at the energy system level. An example could be a conservation programme substituting a well-defined part of the energy demand system, *e.g.* an efficient lighting programme where compact fluorescent lamps are substituting ordinary incandescent light bulbs. These kinds of projects are related to both the supply and demand side of the energy system. With new forms of supply arrangements, however, where costs are paramount, the normal system based on plant practicalities, will no longer hold, *e.g.* large coal-fired systems are not easily switched on and off. An energy system model is required for a full analysis.

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[41] Para. 52 of the Annex to Decision -/CPM.1 (*Article 12*).

Typically, analysis at the overall country (or even a region of countries) level will take place when the project includes energy programmes that have a clear impact on the overall economic and social development of the country. A macro-economic model may be used in this case. The project level is a subset of the system level, which again is a subset of the overall country level and interactions are possible between these three levels. Various characteristics thus define the relevant level for the analysis. An example of such an interaction could be the current and future energy-market liberalisation trend in European energy markets which is likely to create large interconnected systems across Europe and which would make it false to establish a project boundary at the project level itself as the impact of an investment in one plant could have geographically and systematically far-reaching effects.

Considering the above, baselines may generally be constructed at the project level, the system level (*e.g.* the grid to which the project's power plant is connected) or the country level depending on the interactions of the project with the wider economy or supply systems. However, even if a project boundary is set at the narrowest level, the project itself (which assumes that the project participants cannot control sources outside the project area), there is still a need to take into account the policy context for the host country where the project takes place, pending legislation, and other drivers for change in the country, which will affect energy and environmental choices.

The details of each project will determine exactly which level of analysis is necessary. What a wind farm is substituting may have to be analysed at a system level using an energy economic systems model for the country. However, it may be sufficient to explore this at a project level and use a simple average for the energy mix of what is being replaced by such an intermittent source.

In principle, the restrictions on the use of the project level approach are given by the possibility that the boundary for the JI/CDM project under consideration is not the same as the boundary for the substituted project (*e.g.* the plant to be replaced) in relation to the total system. In other words, the question that needs to be asked is: can both the JI/CDM project and the substituted project be assumed either to be independent of other parts of the energy system or to have approximately identical interactions with this system? If this is the case, the effect of substituting of a JI project for an existing or planned project can be assumed to be separable from the overall system. In practice, identical interactions are not likely but projects can still be separable from the energy system. The size of the plant is important for its separability, as smaller plants will have a correspondingly small interaction with any system's net they are involved in.

2.1.2 JI/CDM project types

Next to and in line with the definition of the project boundary it is important to determine the type of project, which basically tries to answer the question what (expected) situation is replaced by the project. For example, a project aiming at installing a gas-fired boiler could be replacing a coal-fired boiler, which will, because of the project, be written off. The project could also envisage the installation of the gas-fired plant on a site where formerly no energy was produced. JI/CDM projects could also aim at reducing GHG emissions by upgrading an existing plant by applying techniques that are more modern. Furthermore, projects could be aiming at supply-side measures or at reducing emissions through demand-side measures. These possible characteristics of a project make that in practice one cannot easily speak of an energy sector project given that within this sector several different project types are possible.

Therefore, before discussing the several possible baseline options, some possible project characteristics are described first.

A first method to distinguish projects is by looking at the context in which the project is planned. This method generally identifies two main groups of projects:

- *Retrofit* projects are projects, which aim modifying existing plants to operate in a different way. For example, a JI/CDM retrofit project could modify an old oil-fired boiler in order to produce the same output with a gas-fired boiler. No new sites are involved with this type of project.
- *Greenfield* projects, on the other hand, always involve a new or 'greenfield' site and are usually plants, which have been planned to meet an increase in demand. For determining a baseline for greenfield projects it is important to estimate with what other sources the increase in demand would have been met in absence of the JI/CDM project, which may not be easy to identify even with any country energy plans for meeting increased demand.

Second, project types can be described in terms of the activity that is affected by the project. Examples of such activities are:

- Improvement of the e*nergy efficiency* of a particular production process in a plant, *e.g.* energy production, cement production, *etc*., or a reduction in *e.g.* energy or heat distribution losses. For example, in an old coal-fired power station the efficiency of conversion of the fuel to electricity may only be about 30%, whereas a new plant may have 38% or higher efficiency. In an industrial process, efficiency gains through better insulation or recycling of heat can improve the efficiency of the use of energy.
- Switching from one fuel to another. The objective of such *fuel switching* under a JI/CDM project generally is to replace a relative carbon-intensive fuel technology with a less carbon-intensive or even carbon-free technology. For example, an oil-fired district heating plant may change from the oil to biomass burning or from coal to gas or to wind and thereby reduce the GHG emission resulting from burning fuels in order to meet a particular demand.
- *Demand-side management* projects, which affect the demand for heat or electricity service. Examples of demand-side management are projects substituting energy saving compact fluorescent light bulbs for ordinary incandescent bulbs, or projects that install thermo-regulators in public building and in private homes thereby replacing heat supply systems which could only regulate temperature by completely closing or fully opening the tab of the heating in combination with opening the windows.

Third, a JI/CDM project can be categorised in terms of the service, which they provide, such as:

- Electricity supply,
- Heat supply, and
- Co-generation (heat and electricity).

Finally, JI/CDM project categories can be described by the technology that the project actually applies. For example, a gas-fired boiler project or a micro-hydro plant project[42] implement these techniques under the project, irrespective of what they replace.

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[42] Micro-hydro projects are generally considered as renewable energy investments: investments in technologies, which do not involve the use of fossil fuels. Renewables include biomass from a carbon neutral source, wind, mini, micro and pico-hydro plant, photovoltaics, biogas, geothermal, *etc*. This category also includes LULUCF activities.

Clearly, the above four methods of project categorisation are not mutually exclusive. For example, an oil-to-biomass conversion project can be categorised as a heat supply project, which is a retrofit and a fuel-switching project. The several categories are included in the descriptions of single-project baseline methodologies (Section 2.2) and multi-project baselines (Section 2.3). Chapter 6 of this report presents an electronic manual, which provides a step-wise guidance for project developers into the accounting procedure of GHG emission reductions. Table 2.1 lists the project categories for the heat and power sectors as identified for inclusion in the manual using the above-mentioned project categorisation.

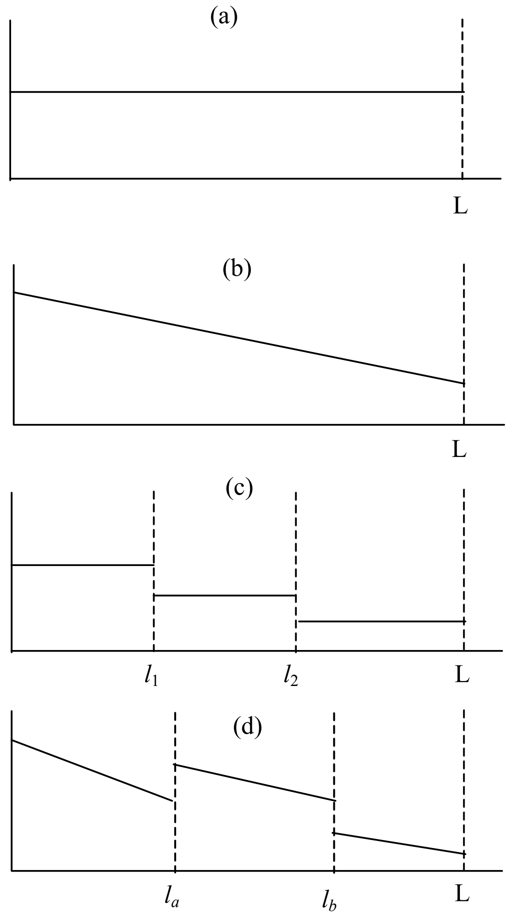
Table 2.1. Project categories for baselines in the power and heat sector

Fuel-switch projects in the power sector:	• Coal-to-oil switch • Coal-to-gas switch • Coal-to-renewables switch • Oil-to-gas switch • Oil-to-renewables switch • Gas-to-renewables switch
Greenfield and/or retrofit projects in the power sector, with a baseline based on:	• Coal • Oil • Natural gas • Renewables
Demand-side management project types:	• Reduction of base load • Levelling of peaks

2.1.3 Baseline variation over time

A baseline can be specified in terms of a set of constant parameters[43] or ones which are time-varying according to some predefined procedure, *e.g.* based on projected improvements in the energy sector efficiency. In addition, a baseline projection (whether constant or time-varying) can be fixed at the start date of the project and extend for the crediting lifetime, or it can be subject to revision at periodic intervals. This later practice is called baseline revision (*e.g.* Begg *et al.*, 2001). Confusingly in the literature, the term 'static' has been used to describe both baselines with constant parameters and baselines, which are fixed at the start date of the project. Similarly, the term 'dynamic' has been used for time-varying baselines and for ones subject to periodic revision. Figure 2.1 illustrates the four combinations for baselines that are possible whether baseline parameters are constant or varying and whether baselines are subject to revision or not.

[43] For example, a baseline parameter may be the technology/fuel that is replaced by the project.



a) constant, no revision baseline – parameters do not vary over crediting lifetime, L, with values set on the project start date

b) time-varying, no revision baseline – parameters vary over crediting lifetime according to calculations agreed at project start date (note: diagram shows a declining linear variation – this could equally be increasing and/ or non-linear)

c) constant, periodic revision baseline - parameters do not vary during periods l_1, (l_2-l_1), (L-l_2), but values are revised at l_1, l_2. The length of the periods may be equal or may not.

d) time-varying, periodic revision baseline - parameters vary over period, l_a, according to calculations agreed at project start date; over period (l_b-l_a), according to calculations agreed at l_a; over period (L-l_b), according to calculations agreed at l_b. Again, the length of the periods may be equal or may not. (Note: again diagram shows declining linear variations – this could equally be increasing and/or non-linear).

Figure 2.1. The four main types of baseline variation over time

A constant baseline is most appropriate for a project, which is substituting, for example, an existing plant, for which it can be reasonably assumed that it would have continued to have the same operating parameters for the crediting lifetime. A time-varying baseline, on the other hand, is more suited to a project, which is part of a system and for which it may be assumed that changes in the system would have had influence on the project site under the baseline case. In the case of an electricity supply project, the baseline may be the average mix of generation, which will vary over the crediting lifetime.

The concept of baseline revision was introduced to deal with the problem that, the further baselines are projected into the future, the more uncertain they become. One way of dealing with this is to revise the baseline projection at periodic intervals on the basis of more up-to-date data. It is important to note that such a revision would not apply retrospectively, only to the baseline from that point onwards. Of course, whilst baseline revision is likely to increase the environmental integrity of the project, it will increase transaction costs and investor uncertainty. Consideration of both these aspects are thus required in determining to what extent the practice should be used.

2.1.4 Crediting Lifetime

The crediting lifetime of the JI/CDM project may be the technical lifetime of the technology, or it may be adjusted by consideration of what might have happened in the baseline. For example, if the host country has GHG emissions targets (such as under JI) or has international commitments to meet certain environmental standards (*e.g.* the EU accession process), it is likely to introduce low emission technology. Hence, it is possible that the project simply represents an acceleration of developments likely to happen, *i.e.* the baseline might resemble the project itself delayed by, *e.g.*, 5 or 10 years. Consequently, the accounting timeframe may therefore be the length of this delay: significantly shorter than the technical lifetime. As mentioned earlier the agreed Marrakech text limits the crediting lifetime for CDM projects to either 10 years with no revision and no renewal, or to 3 periods of 7 years with a baseline renewal after each 7-year period. The Marrakech text does not define a limited crediting lifetime for JI projects. However, if the JI Track-2 will in the future indeed resemble the CDM project design document of the *Marrakech Accords*, a 3-period renewal period could also be applied for JI projects not eligible for Track-1.

2.1.5 Equivalence of service

Following convention, in order to calculate the GHG emission reduction of a project, the baseline should provide the same 'service', *e.g.* in terms of energy output or land area (see Section 1.3.3). This concept is known as 'equivalence of service'. In practice such equivalence may be difficult to ensure if, for example, a project power plant has a different capacity than the one assuming under the baseline. In that case it is necessary to assess whether peak demand can be met by the lower capacity plant, and if not, whether this peak demand would be met from another source. Differences in efficiency, reliability, or fuel price between the project and the baseline may all cause plants to respond differently to the same demand.

Moreover, it may be the case that equivalence of service can never apply. For example, a lighting project using solar photovoltaic panels and compact fluorescent light bulbs to replace kerosene lamps will provide 20 times the lighting service at $1/25^{th}$ of the energy input. Clearly, the concept is meaningless in this case. Projects that do not meet the equivalence of service condition cannot be compared on an activity basis *e.g.* $kTCO_2/MWh$. Other approaches may need to be taken, such as $ktCO_2/capita/y$ (Begg *et al.,* 2000). Hence it is important to consider carefully whether this concept should apply and how it might be practically applied.

2.1.6 Uncertainty

As already mentioned in the Introduction, the complexity of determining a baseline for a JI/CDM project is that the situation it describes will never exist because of the project. This creates an inherent uncertainty that the baseline refers to a counterfactual situation that can never be monitored or verified. There has not been a great deal of effort devoted to the estimation of the size of this uncertainty, but Begg and Parkinson (2001) summarise the results of two attempts which are reproduced in Table 2.2.

Table 2.2. Uncertainty in GHG Emissions Reduction of 19 Case Study Projects

Sector	Type	Uncertainty	No. projects assessed
Heat	• Biomass-fired • district heating plants	±45%	5
	• Biogas digesters (family scale)	±25%	1
	• Improved Cooking Stoves	±30% to ±40%	3
	• Building insulation	±35%	2
Electricity	• Micro-hydro	±25% to ±50%	3
	• Mini-hydro	±55%	1
	• Solar photo-voltaic	±30%	2
	• Wind	±60%	1
Cogeneration	Natural-gas fired district plant	±55%	1

The uncertainties vary from ±25% to ±60%, depending on a number of factors. For example, projects which interact significantly with an external system like a national electricity grid (mini-hydro, wind and cogeneration) tend to have the highest uncertainty (±55% to ±60%). Another factor is the crediting lifetime. Projects that have lower values for this parameter (building insulation, improved cooking stoves) tend to lead to lower values of uncertainty (±30% to ±40%). Poverty in the project area often restricts the number of alternative baselines that are available. Hence, projects in areas with significant poverty (biogas digesters, micro-hydro, improved cooking stoves) tend to have lower uncertainty (±25% to ±40%[44]). The quality of data, particularly concerning the pre-project situation on which some baselines are based, can also influence the level of uncertainty. It is also worth noting that a number of simplifying assumptions have been made in producing the values in Table 2.2, hence they should be considered minimum values for uncertainty.

With a view on the above discussion four sources of uncertainty related to baseline calculation can be distinguished:

- Project performance uncertainty, which takes account of lack of knowledge of future demand or output and project operation.
- Counterfactual uncertainty, which arises from an inability to determine exactly the technology/fuel in the baseline, its performance, timing of replacement, and equivalence of service.
- Measurement uncertainty, which relates to the accuracy of the data used in the calculation.
- Background uncertainty, which refers to the lack of knowledge of the influence of future political, environmental, economic factors on the baseline and includes energy system development, fuel availability, *etc*.

These types of uncertainty will be further addressed in Section 4.1. In addition to the above sources of uncertainty it is also mentioned here that an extra source of uncertainty might arise in case of benchmark modelling with respect to *e.g.* the accumulation of uncertainty in subsequent aggregation steps of a model used to determine a benchmark. Section 4.1 will extensively address the uncertainty aspects related to benchmark modelling.

[44] One of the micro-hydro projects yielded an uncertainty estimate of ±50% and is not included in this range. This was because some local commercial funding was available and hence more opportunities were available to the village in the absence of external grant-based funding.

2.1.7 Host country context

A baseline for a JI/CDM project is determined for the situation within the project boundary. As explained in Section 2.1.1 ring fencing the baseline scope by the project boundary does not imply that sources from outside the boundary cannot influence the sources within the boundary. It is therefore important to place the JI/CDM project in the context of the host country and to consider possible economic, environmental, legal and social policy developments within that country, as well as expected developments of exogenous variables such as fuel prices (which may be national or international), which may have an impact on the choice of the baseline and its parameters.

The Netherlands' ERUPT programme, in its guidelines document for project developers, requires JI project baselines to take into consideration the host country context for project through the description of so-called external key factors (*i.e.* factors from outside the project boundary, which have a considerable impact on the baseline). Project developers must identify and describe these external key factors and their impact on the current and (planned) future project activity thereby indicating the extent to which a change in the value of a key factor is likely to affect the GHG emissions level within the project boundary. Unless not applicable, the baseline developer should explicitly consider under ERUPT (and report on that in a transparent manner specifying data sources and uncertainty margins) the following country context elements:

- Adopted and planned legislation,
- Sectoral reform projects,
- The economic situation in the project sector,
- Socio-demographic developments,
- Existing subsidies or incentives (*e.g.* for forest clearing),
- Changing energy prices (due to removal of subsidies),
- The fuel supply policy,
- Economic developments affecting energy demand,
- The financial situation in a country,
- Consequences of a liberalized energy market, and
- Emission legislation (*e.g.* for acidifying compounds).

Especially for long-term projects, it is essential to give a clear indication of the 'business-as-usual' development of the values of the key factors mentioned for a country, region or sector. Such values may be taken from information contained in National Communications, as these cover agreed assumptions on future developments, or other publicly known documents with some legal status. In PROBASE also extensive country context studies have been carried out for the case studies. These are briefly described in Section 3.2.2 and in full detail in Annex 3 to this report.

2.2 Single-project baselines

Single-project (or: project-specific) baselines are reference scenarios, which are constructed from the elements discussed in Section 2.1 and which relate specifically to the particular project and its circumstances. In theory, there may be more than one plausible baseline scenario, which is inherent to the counterfactual nature of the baseline and the fact that the choice of the baseline, next to the project characteristics described above, depends on the assumptions regarding what would have taken place in absence of the project. In the literature several methodologies for project-specific baselines have been identified and these are discussed briefly below (see for a more extensive discussion, Annex 4).

2.2.1 Scenario analysis: existing actual or historical emissions

The scenario baseline method applies a GHG emissions scenario based on (recent) historical and current practice within the project's boundary. In this type of single-project baseline, it is known what is being substituted by the project. For example, a project installs a gas-fired boiler thereby replacing a coal-fired boiler that provided district heating. In this case, the baseline technology and fuel is taken from the situation replaced by the project, *i.e.* the coal-fired boiler, and there is an assumption that this situation would have continued into the future with or without some sort of refurbishment.

How far into the future and what other alternatives may have been put in place other than the existing coal-fired or the new gas-fired boiler could also be explored in a range of possible baseline scenarios consistent with the host country's development plans. Future baselines can explore a range of possible scenarios in terms of different technology and fuel combinations that are consistent with country contexts (see also Section 2.2.2). This approach is described in detail in Parkinson *et al.* (2001). For the scenario baseline analysis, information is required on the country context for the project (see above), as well as technical and cost information on the operation of the existing plant, in particular its efficiency, fuel characteristics, fuel use, and annual output, but also on other possible technology and fuel combinations.

Starting from the recent historical and/or actual situation it is relatively easy to construct a range of likely baselines as these scenarios are based on an existing pre-project situation, in combination with likely developments of key factors in the future. The range of possible projects to which this approach could be applied is large. In fact, it could be applied to any type of project, although it should be noted that for 'greenfield' projects only a future-oriented scenario could be applied since these projects do not have historical or present data from which the baseline can be derived (see Section 2.2.2). Within the context of the *Marrakech Accords*, the recent history or existing actual baseline scenario typically fits in the first baseline approach identified for the CDM.[45]

Possible drawbacks of the scenario method for baselines are, first, that determining a range of likely baseline scenarios might be relatively time-consuming and requires many data. The latter would also place a large burden on baseline validation, as this requires validating the underlying data, too. It would help here if the data were already monitored. The high data requirements could make the scenario approach rather expensive for project developers. Finally, the approach could provide scope for gaming as project developers might try to inflate the baseline emissions scenarios, so that the overall range of baselines would on average represent too high emissions levels.

2.2.2 Future-based scenarios

The history-based or existing situation-based baseline methods can be applied in cases where the project aims at improving, through energy efficiency or fuel-switch measures, the operation of an existing plant, which would have continued its operation in the future without the JI/CDM project. In cases where the

[45] Para. 48a of Annex to Decision -/CMP.1 (*Article 12*).

operation of the existing plant on the project site would have ceased, it must be explored what plant, under business-as-usual circumstances, would have been installed as a replacement of the existing plant. In other words, a JI/CDM project can only achieve GHG emission reduction credits if its GHG emissions performance is better than that of the plant that would have been installed in absence of the JI/CDM activity.

Applying the first approach in the *Marrakech Accords* requires that existing or historical data can be found for comparable situations where the operation of an existing plant was ceased and where a new plant was started up, or where a comparable 'greenfield' investment was implemented. Taking such a comparable replacement or 'greenfield' as a basis, a key factor analysis (similar to the history-based/existing situation-based baselines) could be applied to show which factors would have affected the GHG emissions on the project site during the crediting period of the project.

An example of where existing or historical emissions data on a project site cannot serve as a basis for determining a baseline is the case where the JI/CDM project installs a new plant to cater for new demand (*e.g.* a greenfield project). Such a case could fit in the second baseline approach of the *Marrakech Accords*, according to which baselines are determined by assuming that under business-as-usual circumstances "an economically attractive course of action, taking into account barriers to investment"[46] would have taken place.

2.2.3 Economically most attractive

The economically most attractive baseline methodology assumes that if there were no emission credits involved an investor would have implemented the economically most attractive business option. This option can be determined by using investment parameters such as the net present value, the internal rate of return, or the payback period. The difference between the GHG emissions of the project and the emissions estimated for the economically most attractive investment option under the baseline would be the emission reduction of the project.

The data requirements for this baseline approach would be high and as a significant part of this data has a financial nature, the problem of confidentiality may arise. Businesses may not be willing or able to disclose the financial data needed for determining the most economically attractive baseline option. Examples of the financial data sources are: cost streams, *e.g.* investment cost, and operation and maintenance costs, as well as financial revenues.

Another key problem with the economically most attractive investment approach is that it does not take account of the actual state of efficiency in a country or on the project site. The baseline automatically assumes that the economically most attractive option would be implemented irrespective of whether barriers (*e.g.* policy distortions, lack of capacity) might have prevented this option. Consequently, when barriers have been standing in the way of investing in the economically most attractive techniques present emission level will be different from what an economically most attractive scenario would have predicted. This is where an important difference exists with the history-based baselines. Where the latter baselines start from the historical and present situation, the economically most attractive business scenario starts

[46] Para. 48b of Annex to Decision -/CMP.1 (*Article 12*).

from a fictitious present situation (similar to the future-based based described in Section 2.2.2) irrespective of whether barriers have stood in the way of installing the economically most attractive techniques in the present and recent past.

As a method for determining single-project baselines, the economically most attractive scenario baseline could fit in the second approach of the *Marrakech Accords*, although it should be noted that this second baseline approach does not require project developers to find the economically *most* attractive course of action.[47] As such the economically most attractive baseline methodology is less conservative than the second *Marrakech* approach suggests.

2.2.4 Control group

The idea behind the control group analysis as a baseline approach is to observe two comparable groups, the main difference between them being that one group becomes involved in a JI/CDM project and the other not. By observing the without-JI/CDM project group – the control group – an indication can be obtained of the direction in which the JI/CDM project group would have developed without the emission reduction credits. The term 'group' can, for instance, be interpreted as a number of households where demand-side measures have been installed, a district heating plant where a retrofit is carried out, a forest where a forest management project has been set up, *etc.*

Roughly speaking, two types of control groups can be identified. First, the pre-project situation can be taken as the control group. This approach would best be possible if the only difference between the pre-project situation and the project situation would be the project itself, which may be difficult to verify in practice. Moreover, the pre-project control group method could imply a certain moral hazard in that it might give an incentive to stakeholders not to improve the plant now, knowing that their plant might qualify for JI/CDM in the near future. The pre-project situation control group method would fit in the first baseline approach of the *Marrakech Accords*[48]as it takes historical emissions, *i.e.* of the control group, as a basis. At first sight, the method, if applied very strictly, could also fit in the third 'Marrakech' baseline approach, which focuses on baselines derived from emissions of similar project activities in the previous five years in similar circumstances. This approach typically describes a control group method, but since it is combined both with the requirement that the baseline shall take into account the average emissions of similar project activities and with an emissions performance threshold, it is more suitable for multi-project baseline methods.

Second, a control group can be selected which operates parallel in time with, and on a different location then the JI/CDM project group. Under this option 'next to' the project site a comparable site (the control group) is being analysed whereby it is assumed that the project group would have behaved similarly to the control group without the JI/CDM project status. According to Chomitz (1999, p. 45), this type of control group analysis, which he calls 'concurrent control,' allows for controlling for unpredictable factors such as weather circumstances, capacity utilisation, prices, *etc.* In this way, unrelated changes in the background system can be factored out.

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[47] Para. 48b of Annex to Decision -/CMP.1 (*Article 12*).
[48] Para. 48a of Annex to Decision -/CMP.1 (*Article 12*).

The application of this type of control group is essentially a way of generating an ongoing real life baseline for the project. Such an approach implies that dynamic, revisable baselines are used. After all, there would not be much purpose in simultaneously analysing a control group without allowing for *ex post* baseline adjustments for the JI/CDM project. One could opt for applying the revised baselines to new projects only and leave the baseline for the ongoing projects unchanged for the agreed upon project's crediting lifetime, but then the control group analysis would not differ much from the above-mentioned pre-project control group. In general, this type of control-group analysis does not seem to fit well in the three baseline approaches of 'Marrakech', which either take the past or current comparable situation or situation on the project site as a starting point for single-project baselines, or reasonably expected future trends in case past or current situation data for the project are not available. An intra-temporal comparison of the baseline control group, which operates simultaneously with the actual project is not really envisaged in the Marrakech baseline approaches.

At first sight, demand-side management projects are well suitable for control group analysis. The scale of these projects is often relatively small and their effect on the rest of the sector relatively small or even absent. An important condition with respect to the choice of the control group is that their members have not been given the opportunity to join the demand-side management project. After all, if the control group would consist of individuals who have chosen not to join the project, the complication could arise, as Chomitz (1999) states, that the control group is biased because apparently their preferences differ from those of the project group in terms of *e.g.* the discount rates used or incentives.

Moreover, the JI/CDM project may create a spill-over effect to other groups in society, including the control group, in terms of, for instance, technological diffusion, *i.e.* due to the project its technology has become more easily available and accessible for other groups. As a consequence, the eventual adoption by the control group of the technology used by the project group does not have to be a token of a reduced additionality of the project, but might be an indication of the fact that the emissions trading project technology has 'spread' itself around. This would create a biased control group, too. A final drawback of the method could be that the project group might recruit employees from the control group to support the implementation of the project, which would also reduce the representativeness of the control group.

2.2.5 Single-project baseline evaluation

The above sections have identified the following single-project baseline methods:

- Scenarios of possible baselines based on recent or current practice on the project site or elsewhere (Sections 2.2.1 and 2.2.2),
- Economically most attractive course of action (Section 2.2.3),
- Control Groups (Section 2.2.4).

The analysis of the strengths and weaknesses of these options as baselines, as well as their applicability under the 'Marrakech' approaches is given in Table 2.3.

Table 2.3. Assessment of single-project baselines			
Baseline type	**Strengths**	**Weaknesses**	**Compatibility with 'Marrakech'**
Scenarios: historic/ existing/future	• Gives the range of likely baseline projections derived from the context of the project location • Allows the most conservative to be identified and chosen • Can be applied to any project type • Is rigorous if not based purely on historic emissions • Is used in practice by *a.o.* ERUPT	• Data requirements are relatively high • Could be open to some gaming and validation, verification has to be careful	• Historic/existing data baselines fit in first approach 'Marrakech' • Expected future data baselines fit in the first approach if data of comparable investments is available; it could possibly fit in the second approach if an economically attractive course of action is assumed
Economically most attractive	• Can be applied to project types with or without revenue flows	• Cost data requirements high and these can be confidential and could be manipulated • The project should be additional automatically but this is not straightforward • High potential for gaming on discount rates, cash flows, *etc.* and is seen as having less environmental integrity • Economically attractive varies with the company. • No reference to efficiency standards	• Could fit in second baseline approach of 'Marrakech', although the requirement of 'most attractive' is generally less conservative than the second 'Marrakech' approach
Control groups	• This is particularly applicable for demand-side projects such as building insulation or installation of CFLs • It can also be useful for retrofit projects • Has reasonable integrity	• It requires data gathering over time to produce sufficient information • Requires independent control groups • Risk of moral hazard in case of pre-project control group. • Is not specifically recommended under JI/CDM	• Pre-project control group method could fit in first 'Marrakech' approach; also the third approach could apply, but then it could not be a single-project baseline. • Intra-temporal comparison group method: does not typically fit in any of the Marrakech approaches.

2.3 Multi-project baselines and benchmarks

2.3.1 Introduction

Multi-project (or standardised) baselines are generic baselines derived for application to multiple projects; a benchmark is a subset of this and is defined as a performance level generic baseline, which may or may not be single country dependent. Benchmarks could assume a particular technical performance in the host country. For example, if for the power sector in a host country it can be reasonably assumed that under business-as-usual circumstances the power plants had used gas-fired boilers then this would be the technical performance on which to base the benchmark. The level of aggregation of these benchmarks depends on the project situation, but this could vary from aggregating the project technology/fuel situation to the sector and perhaps to the country level. Most technology-based performance standards will be country dependent but some may even apply across more than one country.

The discussion on baseline standardisation was stimulated by the experience with the pilot phase for Activities Implemented Jointly (AIJ) under UNFCCC. The AIJ project reports submitted to the UNFCCC Secretariat have shown that the descriptions of the project baselines are far from consistent. Some project reports contain detailed technical baseline descriptions, but with unrealistically long project lifetimes, whereas for other projects baseline information was only minimal without a basis for external review.[49] From a practical perspective, AIJ project developers considered the costs of determining a specific baseline for each project as relatively high and it was generally felt that, if the AIJ pilot phase cost information were representative for the JI/CDM phase, high transaction costs in the project design phase could reduce the cost-effectiveness potential of JI/CDM projects.

In addition, discussion arose about whether more detailed project-specific (or single project) baselines would indeed have a higher environmental integrity than multi-project baselines. Initially, it was assumed that higher information density of single-project baselines would imply that such baselines would form a better description of what would have taken place in absence of the project. However, single-project baselines also are more sensitive for gaming as project developers could have an incentive to claim more credits from a project by setting the baseline at an emissions level that is higher than what could reasonably be expected. The risk of such gaming is larger for single-project baselines than for multi-project baselines because project developers generally cannot control the latter. Finally, even if a project developer had no such incentive to inflate a baseline, the larger data requirement for single-project baseline does not automatically imply a better baseline. After all, both single and multi-project baselines describe a counterfactual situation based on a set of assumptions about project, meso and macro level parameters.

An early approach to develop multi-project baselines was proposed by Luhmann *et al.* (1995) who suggested a filter model through which a default project could be developed for a particular sector in a host country. This default project would subsequently serve as a standardised reference project for JI projects and would include a baseline scenario for that type of project. Presenting the default baseline values for the projects or for a particular technology in a systematic way per sector/technology and host country would lead to matrices of multi-project baseline values.

Given the above descriptions, a benchmark can be defined as an aggregate business-as-usual GHG emissions factor (CO_2-eq. emissions per unit of output) for a given country or region and for a given project-type or sector derived from either historical trends or forecasts of future emission trends in the host country. Multiplying the benchmark emissions factor with the output of the project (assuming equivalence of service) then results in a project baseline scenario.

The benchmark might also be partly based on a normative assessment by, for instance, the project host or the host's governance structure implying not only what would have happened in the absence of the project, but also what should have happened. In the latter sense, the benchmark approach resembles the application of the top-down baseline systematic for emissions trading projects where baselines are derived from a national emissions target. It should be mentioned here that the multi-project baseline derived from the latter type of benchmark could not easily be categorised in one of the three baseline approaches of the

[49] Jepma *et al.*, 1998.

Marrakech Accords and only slightly relates to the project context, which may conflict with the Marrakech requirement that baselines must be project-specific.

An important issue with respect to the application of benchmarks for baseline determination is on which installations/units the benchmark value should be based. In the literature several methods have been suggested for this (see Annex 4),[50] such as:

- *Recent comparable 5-year benchmarks*, which assume that the technology implemented in the sector in the country during the last 5 years most likely will also be the technology that would have been implemented in the future in absence of the project.
- *Currently best available techniques benchmarks*, which assume that in the future the host country would have implemented the best techniques (technologies or management programmes, such as demand-side management) available in the country. This method requires an (economic and technical) analysis to determine which techniques are feasible for the host or a policy analysis to find out what techniques are mandatory by national or international policies.
- *Better than average current practice benchmarks*, which assume that the country's or the sector's average current practice is the most reasonable description of the business-as-usual situation. A project can only be eligible as JI/CDM if its emissions are lower than those corresponding to the average current practice in the sector or country.
- *Economically most attractive/least cost technology benchmarks*, which assume that in the country the least cost/economically most attractive technologies would have been implemented in the business-as-usual case.

The above benchmark methods to a certain extent overlap. For example, the *recent comparable 5-year technology* and the *better than average benchmark* methods both refer to the currently existing average technologies, as well as to the recent or perhaps soon to be implemented technological addition. A difference between the two methods is that the *recent comparable 5-year benchmark* focuses on recently installed technologies and therefore takes into consideration plants installed in the margin, whereas the *better than average current practice benchmark* calculates average emissions of currently operational plants without specifically analysing the emissions level of the latest-built (or marginal) plants. The differences and similarities between the benchmark methods are discussed in more detail in the next sub-sections.

From the listing of benchmark approaches above a number of benchmark parameters can be derived, which could broadly be categorised as follows (see below for a graphical overview):

- First, a benchmark can be determined using data for one fuel/technology combination ('technology/single-fuel') or be based on an (weighted) average of fuels/technologies for the sector or country (multi-fuel benchmarks; the 'sector average' mentioned in diagram).
- Second, benchmarks can be based on recently added capacities in the host country or region (*e.g.* r*ecent comparable 5-year benchmarks*), either nationally or in a sector, or based on expected future added capacity (*e.g. Currently best available techniques benchmarks* or *Economically most attractive/least cost technology*

[50] The methods listed here may not all neatly fit in the 'Marrakech' baseline approaches (see also Table 2.7), but with a view on the discussion on standardising baseline parameters and determining benchmark using energy sector models in Chapter 3, they are still worth discussing as they represent illustrations of differences between baselines in terms of fuel technology chosen, geographical aggregation and time horizon taken.

benchmarks). This consideration leads to the decision on the time horizon to apply for determining a benchmark for a particular host country.

- Third, a benchmark can be set for a region within a country, nationally, or regionally for a group of countries, which deals with the choice of geographical aggregation.
- Fourth, benchmarks can be determined in a dynamic or static way, whereby dynamic is defined as benchmarks with time varying parameters and static refers to constant parameters (see Section 2.1.3).

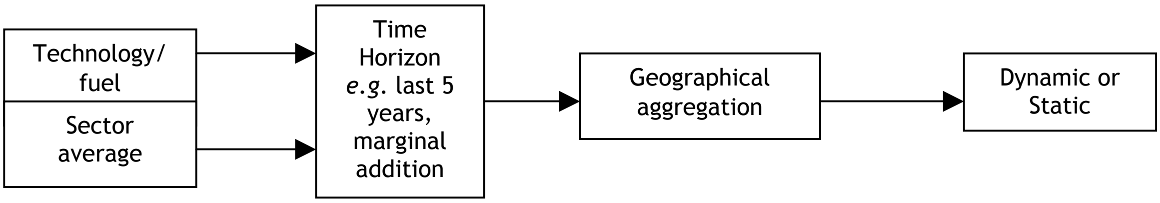

Figure 2.2. Benchmark parameter choices[51]

Figure 2.1 as well as the discussion on parameters below shows that several benchmarks are possible given the combinations and range of the parameter values. The advantage is that the determination of a benchmark allows conservative baselines to be chosen in a similar manner to the single-project baseline methodologies described in Section 2.2.

Technology/fuel combination and/or sector average

When determining benchmark emission values for JI/CDM projects, it is necessary to determine what kind of project is dealt with in the sector under consideration. This is illustrated in Table 2.4 where an exemplary list of possible projects is shown for the power and heat sectors. For example, suppose that a project aims at a boiler conversion fuel-switch investment, a number of project types are possible: the project could make a switch within a plant from burning coal to burning oil or to natural gas or, should the current fuel used be oil, switching from oil to gas. Assuming that the sector average or multi-fuel method (showing the energy mix in the sector), in this particular case, provides a more reasonable basis for describing the business-as-usual situation than the single-fuel method, a benchmark for each of these fuel-switch projects would be determined on the basis of the average emissions of all currently operational plants in the sector (with the emission levels expressed as kg CO_2-eq. per unit of kWh or GJ). It is obvious that such a sector-average benchmark would reduce the scope for crediting a fuel switch from coal-to-oil if the sector average benchmark were lower than the average emissions of operational coal-fired plants.

Taking the technology/single-fuel path approach instead, as a benchmark for a coal-to-oil or coal-to-gas project the average emissions of currently installed coal-fired boilers would be taken (for the oil-to-gas project the average emission levels of oil-fired plants could be used). In this case the coal-to-oil project earns credits for sure and is likely to earn more credits than with the multi-fuel benchmark. The 'technology/single-fuel method' could even be taken one step further by comparing the technology of a new energy source under the JI/CDM project with the average or recently installed technology for that energy source. For example, for a coal-to-gas project the benchmark would then be based on the average or recently installed gas-fired boiler technology, instead of on coal-fired boilers. A drawback of this more conservative approach is that it would not really be appropriate for renewable energy projects. After all, a

[51] The parameter choices shown in Figure 2.2 are explored in more detail and placed in the context of a complete classification of baselines according to standardisation, aggregation and stringency in Figure 2.3.

benchmark for a coal-to-renewables project would, according to this approach, be based on (average or recent) renewables and therefore not earn credits, thereby neglecting that those projects lead to the maximum emission reductions possible. A hybrid approach, *e.g.* that would build upon a multi-sector approach but allow high carbon intensive projects to use a single-fuel approach based on the fuel replaced, could also be an option.

Table 2.4. Benchmark approaches for heat and power projects*

	'Sector average/multi-fuel' benchmark approach	'Single-fuel' approach
Fuel switch projects	**Benchmark fuel**	**Benchmark fuel**
Coal-to-oil	**Coal** (average emissions of the energy sector/energy mix)	• **Coal** (average emissions of coal-fired plants in the sector) or • **Oil** (average emissions of oil-fired plants in the sector)
Coal-to-gas	**Coal** (average emissions of the energy sector/energy mix)	• **Coal** (idem) or • **Oil** (idem)
Oil-to-gas	**Oil** (average emissions of the energy sector/energy mix)	• **Oil** (average emissions of oil-fired plants in the sector), or • **Gas** (average emissions of gas-fired plants in the sector)
Energy efficiency improvement		
Boiler/burner system	'Average' **coal/oil/gas** (average emissions of the energy sector/energy mix)	'Average' **coal/oil/gas**
Demand-side management	'Average' **coal/oil/gas** (average emissions of the energy sector/energy mix)	'Average' **coal/oil/gas**

** An extended list of project types for the power and heat sector is presented in Chapter 6 to be applied in the PROBASE electronic manual for baseline determination using standardised baseline coefficients.*

It is important to note here that the decision which technology/fuel most reasonably represents the fuel that would have been replaced by a JI/CDM project largely depends on whether the project aims at meeting existing energy demand or new demand. In a situation where the energy demand in a host country is not expected to increase, the implementation of the project implies that an existing plant will become redundant and could be closed, *i.e.* the marginal plant. Identifying the marginal plant depends on the considerations made in the host country for such decisions, but an example could be that the oldest and least efficient plant would be closed first. Alternatively, if a country is largely endowed with coal, but must import natural gas, it could decide that the marginal plant could be a gas-fired boiler in order to become less vulnerable for international gas price increases. This, of course, assumes that the JI/CDM project does not install a gas-fired boiler itself, but, for instance, a hydro or wind energy plant. Kartha *et al.* (2002) have identified this determination of a marginal plant under existing demand as the *operating margin* baseline method.

Next to their operating margin method, Kartha *et al.* (2002) have also identified the so-called *built margin* method, which resembles baseline determination for energy projects that meet new energy demand. Assuming that in the existing situation the production capacity in the host country's energy sector is fully utilised, baseline determination for a JI/CDM project requires the identification of the marginal plant that would have been built in absence of the project in order to meet the new energy demand, *i.e.* the built margin plant.[52] Obviously, assuming a fully utilised energy sector capacity it is of crucial importance to identify whether a project aims at replacing a plant, which would have met existing or new energy demand. In the first case (operating margin) the baseline emissions level is generally higher than in the second case, where it is generally assumed that the latest technique installed in absence of the project (built margin) would have either similar to recently installed techniques (recent comparable 2y/5y, see Section 2.3.4) or Best Available Techniques (BAT, see Section 2.3.3). The choice of whether the project meets new or existing demand (in combination with the extent to which energy sector capacity is met) is a typical example of uncertainty related to baseline determination. This uncertainty, as well as other types of uncertainty, is further analysed in Section 4.1 (see also Section 2.1.6).

Time horizon

The benchmark parameter of time horizon deals with the question of whether the standardised baseline will be derived from historic emissions data in the sector or country or from expected and/or planned developments in the future. Historic emissions data could be collected for investments in the recent past or from currently operational plants. Assuming that recently installed plants are generally more efficient, a benchmark derived from recent investments would lead to a lower emissions factor than one derived from currently operational plants as this data set could also contain plants that have been operational for a longer period of time than, say, the last 5 or 2 years. The extent to which data from recently installed plants could lead to a reasonable benchmark depends, among others, on the number of plants in the data sets. If only one plant had been installed in the last two years, it might be difficult to derive a benchmark from that single plant. In order to broaden the sample, the last five years could be taken as a time period. In case that would not provide sufficiently representative data either, an average of currently operational plants could be used which would broaden the time period covered by the data set as it could include plants installed *e.g.* 20 years ago.

If benchmark values were determined on the basis of most recently added technologies or expected future technologies the benchmark for a coal-to-oil project could be the most recently installed or soon expected oil-fired technology in the host country. For the coal-to-gas project the most recently installed (or soon expected) gas-firing technology could be used as the benchmark, *etc.*[53]

Obviously, the benchmark paths are not fully separated and combined benchmarks might well be possible. For example, a sector average for the last five years may for a host country represent the average energy mix, whereas from the perspective of the project system the marginal technology (*e.g.* latest investment) is a more reasonable reference point for investments during the envisaged crediting lifetime. These choices are typically sector or country-specific.

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[52] In case new demand would arise in a situation with overcapacity in energy production, the new demand could be met by existing capacity. A JI/CDM project in this context would then, again, replace the operating margin project rather than the built margin project.

[53] Whether the benchmark in this case needs to be based on the technology that will be implemented (oil in case of an coal-to-oil project) – thereby indicating that the new technology's performance must be better than the performance assumed in the benchmark – or the one that will be replaced (coal in case of the coal-to-oil project) depends on the observed recent investment pattern, which in this method reveals what would likely have taken place in absence of the project.

Geographical scope

Multi-project baselines can be calculated for different levels of aggregation. The least aggregated multi-project baseline would be the one that covers a particular region within a country. A selection criterion for determining the region to which a benchmark applies could be the extent to which there are interdependencies between different regions. For example, in some large countries (e.g. China, India, Russian Federation) the several different geographical regions have relatively little dependencies with each other so that an investment in *e.g.* a power plant in one region does not affect the energy system in the other regions. When such a condition is fulfilled the region could be singled out for which a regional benchmark is constructed.

In case there exist significant interdependencies between different regions in a country determining a national benchmark would be a better aggregation option. However, as mentioned in Section 2.1.1, system interdependencies do not always stop at the national border, *e.g.* in case where the country is part of an international liberalised energy market, so that for these cases a multi-country benchmark would need to be derived. Finally, as a more abstract line of thinking, determining global scale benchmarks could be considered, which take the world average as a basis for multi-project baselines or *e.g.* select the world's best region as a reasonable reference case for a project.

An advantage of applying a low aggregation level is that fewer investment opportunities are missed as the individual situation of each country is described in more detail. Using national benchmarks will also lead resources to where they are most effective, *i.e.* to countries with highly carbon-intensive industries. However, this could result in a loss in environmental integrity since it would imply a smaller focus on projects replacing sources cleaner than coal and a biased distribution of investments between countries. Moreover, countries that in the past (indirectly) stimulated the use of carbon-intensive fuels, *e.g.* via coal subsidies, will be rewarded with higher baselines resulting in more credits for investors, whereas countries whose past energy policy has resulted in a less carbon intense production process will receive relatively little credits.

Using multi-country or even global benchmarks implies that there is no geographical 'preference' for investors because a particular project, *ceteris paribus*, will be rewarded with the same amount of credits irrespective of where it is implemented. However, there could be a problem that a global or even a country benchmark may not be justifiable for some project types. Moreover, a global, multi-country or even national-scale benchmark may contradict with the *Marrakech Accords* texts on baselines, which say that baselines should be project-specific. Although the latter does not exclude standardisation options (see Section 1.1), it requires baselines to be derived from the project context (with the exception of small-scale CDM projects), which seems to complicate applying global or multi-country benchmarks as these are almost entirely separated from the project context.

Variations in parameter values leading to different benchmarks

Benchmarks are determined by the choice of the values for each of the parameters described above. For example, it would make quite a difference if a multi-project baseline for a coal-to-gas JI project in a Russian power plant near St. Petersburg assumed:

- Coal as the baseline fuel technology, investments in the past 10 years as the time horizon, the whole Russian Federation as the geographical area and a static baseline[54] emissions level, or
- If it chose the European part of the Russian Federation as the appropriate region for the benchmark, chose gas as the baseline fuel, took recent 2-year investments in the region as the time period to collect the data for the baseline and explored future national or international environmental agreements the plant operator should comply with, so that this information could be incorporated in a dynamic baseline.

The example shows that it is obvious that varying the choice of the benchmark parameters could have dramatic impacts on the strictness of the multi-project baselines and its environmental integrity. The parameter value choice itself is based on assumptions regarding the business-as-usual situation in the sector in the host country, the host country itself or the region. Box 1 below shows an example of the Surduc-Nehoiasu run-off-the river hydro project in Romania (expected to come online in 2005; ERUPT approved), which shows how baseline assumptions could influence the eventual baseline emissions scenario (both for single-project or multi-project baselines).

Box 2.1. General assumptions and considerations for baseline selection Surduc-Nehoiasu project

- It is assumed that at the time when the project goes live (2005), the over-capacity in the Romanian grid will still exist, and that the project would therefore address *existing demand*.
- The project is a run off the river (RoR) plant, which means that it 'must run'. It is assumed that the plant displaces the *base load* fossil fuel grid mix. Assuming a baseline based on the fossil fuel grid mix, there could be two options:

  1. *A 'poor economy' scenario:* It could be argued that the analysis of what would be the marginal plant (the one to be substituted) may change over time. The costs of maintenance per output are highest for the old coal fired plants, which may have high outage time due to repairs. However, coal is a cheap and reliable domestic fuel. The gas-fired plants are easier to maintain, but the gas is much more expensive to buy and its price can fluctuate considerably on the international market. Thus in one scenario average fossil fuel grid mix could be assumed as a surrogate for the marginal plant. With respect to the development of this fossil fuel part of the grid mix during the lifetime of the project it could be assumed that the emissions factor of the grid mix is not going to increase during the lifetime of the project. If the economy does not improve, the overcapacity will allow the oldest and most inefficient plants to be closed down, and the emissions factor of the grid mix will decrease. However, this effect may be counteracted by high international gas prices so that gas imports will be reduced and the remaining coal-fired plants will be covering more of the output. This 'poor economy' scenario will be similar to the emissions factor of the current grid mix (BAU).
  2. If the *economy recovers well*, then the emissions factor of the fossil fuel component of the grid mix could show a marked decrease. This will be due to the fact that new plants will be added which are much more efficient, more gas will be imported and used and old plants will be phased out because more stringent environmental regulations will be enforced as accession to the EU proceeds.

- As an alternative to using the grid mix as a basis for the baseline, it could be assumed that the likely substituted base load plant is old coal.
- RoR hydro is a no-regrets option as its running costs are very low. The number of new hydro opportunities is limited in Romania so it can be assumed that in the case of new demand, the project would have eventually happened anyway. It would take a number of years to plan and build the plan. So, it is assumed that the project could have happened anyway in 5 years' time at the soonest. The building of new hydro plants would be most likely under a high economic growth scenario.
- The level of seasonality in the hydrological regime of the river is not known. The variability in the specific emission factor of the average grid mix over the year is also unknown, although it could be expected that the seasonal operation of CHP plants would influence the emission factor. But since the available data is aggregated over a whole year, seasonal fluctuations are not taken into account.

[54] Note that the parameter values of static or dynamic baseline have been discussed in more detail in Section 2.1.3.

The sections below describe a number of possible multi-project baselines or benchmarks, which differ from each other in terms of parameter values:[55]

1. The economically most attractive/least cost benchmark;
2. The best available techniques benchmark;
3. A scenario-based benchmark starting from recent (2 or 5 year, see Section 2.3.1) comparable projects;
4. The better than average current practice benchmark;
5. Sector average benchmarks determined for a single country or across several countries; and
6. Energy sector modelling benchmarks.

2.3.2 Least Cost Technology/ Economically most attractive option

Similar to its single-project equivalent discussed in Section 2.2.3, the multi-project *least cost technology/economically most attractive* baseline option assumes that in a sector or in the host country as a whole the economically most attractive or least costly technology investment option will be implemented under business-as-usual circumstances. Based on this assumption, the multi-project baseline for the sector or the host country is set at the GHG level corresponding with the economically most attractive course of action and only those projects that implement technologies with lower emissions than this baseline can generate credits. A crucial, and sometimes problematic assumption of this method is that investors generally only take costs or economic revenues into consideration and that implementation of these technologies in the sector or in the host country are not hampered by market inefficiencies and other barriers.

Another problem that might arise with the option is that in case the benchmark is derived for a sector encompassing all fuels/technologies, one technology with the lowest costs (in terms of investment, operation and management costs) would be singled out as the baseline. This technology could, for example, be biomass, even though there is only a small biomass-potential in the country, which makes this course of action unrealistic. In addition, it would create a bias away from projects such as coal-to-gas since these projects would earn no or only relatively little credits with *e.g.* biomass determining the benchmark. Alternatively, the *least-cost technology/economically most attractive* benchmark option could be applied on a single-fuel basis. This would result in *e.g.* the cheapest coal option as the benchmark for coal-to-gas projects, the economically most attractive option among oil-fired boilers for oil-to-gas projects, *etc.*, which would not create a bias away from projects switching from carbon intensive to less carbon intensive fuels.

Although at first sight the multi-project *least-cost technology/economically most attractive* baseline could fit in the second baseline approach of the *Marrakech Accords*,[56] there is an important difference. The second Marrakech approach refers to baselines describing an economically attractive course of business-as-usual action without mentioning that this course should be the economically *most* attractive one. The *least-cost technology/economically most attractive* benchmark option is neither easily suitable for the first and third baseline approaches of the *Marrakech Accords*, because it is not specifically derived from historical or existing actual emissions and does not result from a historical control group analysis as in the third approach.

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[55] The benchmarks described in this section all assume a homogeneous production process as they focus on energy and heat production. For an elaboration on setting benchmarks for heterogeneous production processes, the reader is referred to the literature review document in Annex 4 to this report.

[56] Para. 48b of Annex to Decision -/CMP.1 (*Article 12*).

2.3.3 Best available techniques

This method derives multi-project baselines from the best techniques that are assumed to be available in the sector or host country under business-as-usual conditions. An assessment of what could be the best available technique in the host country could be based on recently installed capacity and consider this technique as a token of the best techniques available in the host country in the near future, at least during the crediting lifetime of the project. As such the method would fit in the first baseline approach of the *Marrakech Accords*. Analysing best available techniques (BAT) for the host country could also lead to the conclusion that in the near future OECD technique standards will become available in the host country, or the best techniques already available in the region but not yet in the host country itself. Such an application of the BAT baseline method would fit in the second Marrakech approach provided that the OECD or regional technique standards represent economically attractive courses of action.

A concrete example of where a best available techniques standard baseline could be applied is that of energy projects in potential JI host countries in Central and Eastern Europe, which are in the process of pre-EU accession. This process implies that these countries have a commitment to incorporate the EU environmental standards (set by the so-called *Acquis Communautaire*) in their domestic legislation and implement these standards in practice. The *Acquis* is partly based on environmental standards formulated by EU Directives of which the 'Integrated Pollution Prevention and Control' (IPPC) directive is one of the most important. The IPPC directive defines BAT as follows:

> 'Best available techniques' shall mean the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole:
>
> - 'techniques' shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned,
> - 'available' techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator,
> - 'best' shall mean most effective in achieving a high general level of protection of the environment as a whole.[57]

Against this background, IPPC expert groups compile reference documents for the determination of BAT, which the EU Member States and the EU Candidate countries have to use as an input into their country-specific BAT(s) and the individual, plant-specific operational conditions. These reference documents (BREFs) are not legally binding, but their input into the BAT definitions is becoming more and more important given that they are continuously updated with the latest information about best available techniques. Thus, BAT is understood within a certain category of industrial processes. Official tables of BAT for each sector, either country-specific or global, provide the data needed for BAT-based benchmarks. A further elaboration of the BAT benchmarks in relation to the EU accession process follows in Section 4.3.

[57] IPPC Directive, 1995, Article 2.

The IPPC definition of BAT strengthens the above conclusion that this benchmark type could fit in the second baseline approach of the *Marrakech Accords* as it describes a course of action that is economically and technically viable in the host country. Note again, further to what has been argued in Section 2.3.2 that the second 'Marrakech' baseline approach does not requires baselines to identify the economically most attractive course of action.[58]

In the above, BAT was discussed from the viewpoint of what is best available in the host country. This may differ from country to country. However, BAT benchmarks could also be derived from the latest techniques developed in the world, thereby assuming that the latest technique developed in an industrialised country will soon spread around the world. Besides that the latter is not always realistic, it might considerably narrow down the potential for CDM projects and result in large numbers of missed opportunities as the projects can only reduce emissions if the technique implemented under the project is better than what is currently best available in the world. Moreover, although using latest technology BAT as a benchmark for CDM project was seen as a method to ensure state-of-the-art technology transfers under the CDM, one has to bear in mind that the latest technology may not always be the one most suitable for host country circumstances or CDM purposes. Besides being generally rather expensive technologies, it might require handling skills (*e.g.* management and human capital), which are sometimes not available in the host countries.

It can be concluded that BAT as a benchmark, if used at all, can best be applied if it refers to best techniques available in the host countries. For most of the potential JI host countries, the EU accession process provides much information about BAT standards for their energy sectors. However, only a few developing countries are likely to have a BAT standard defined. If such a definition exists, one still needs to differentiate if law requires its actual application (such as with the EU accession process). Without such a requirement a BAT-benchmark does not seem to fulfil the definition of a baseline in reflecting the situation 'that would have occurred in absence of the project'.

2.3.4 Historical benchmarks: recent comparable 2-year or 5-year

This benchmark approach assumes that the information derived from the recently constructed power or industrial plants best reveals what would have happened in the (near) future.[59] Contrary to the *least cost/economically most attractive* benchmarks, where actual efficiency standards and other barriers are not at all taken into account, it could be argued that the *recent comparable 2-year or 5-year* benchmark reveals efficiency standards, barriers, *etc.*, albeit implicitly, as these can be assumed to have been part of the decision-making process for the investments. In other words, this method assumes that recently installed technologies reveal all or at least most of the relevant information relevant for a project manager/operator who has to take an investment decision.

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[58] If that had been the case, the BAT benchmark would not have fit well in the *Marrakech Accords*.

[59] The choice between describing the recent 2 years or recent 5 years depends, among others considerations, on the number of comparable projects (see also Section 2.3.1) during the last 2 years. If the sample of projects over the last 2 years is too small, the time horizon could be broadened to 5 years, assuming that investments of 5 years back are reasonably representative for present investment conditions in the energy sector in the host country. Both the 2-year or 5-year time frames have been chosen rather arbitrarily and for the purpose of illustration. They could be adjusted depending on the relevant circumstances.

The basic issue in this benchmark method is the definition of comparable investments. For example, for a JI/CDM *energy generation* project, all energy production facilities, irrespective of the fuel/technology used, could be considered comparable (see also Section 2.3.1), which would result in an average GHG emissions level of recently installed energy production technologies. This would be beneficial for *e.g.* gas-to-wind power projects as their emission reductions will be calculated below a benchmark which is most likely much higher. On the other hand, the approach would probably 'undercredit' projects that replace a highly carbon-intensive technology (*e.g.* coal) with a renewables technology.

A more narrow option for setting a benchmark based on recent comparable investments is to adopt a single fuel-based concept (see also Section 2.3.1), which measures the emission reductions of *e.g.* a coal-to-gas project as reductions below a benchmark based on recently installed coal plants. As such, the single-fuel benchmark would give maximum credits for projects that switch from coal to another energy source. However, as was explained in Section 2.3.1, the single-fuel benchmark could also be based on the new technology that replaces the existing technology, *e.g.* for the coal-to-gas project a recent comparable benchmark based on gas-fired plant investments is determined. This could be justified if a significant trend shows a shift from coal to gas thereby revealing that under business-as-usual circumstances coal-fired plants would have been replaced with gas-fired plants anyway. Under these circumstances a project would only receive credits if its gas-fired technology has fewer emissions than the recently installed gas-fired plants.

One advantage of the *recent comparable 2y or 5y* benchmark approach is that the required data is generally known and monitored which reduces data uncertainty. The option is appropriate for 'greenfield' projects, too, as it could be assumed that investments implemented on 'greenfields' would contain up-to-date technology, *i.e.* technology recently installed elsewhere on sites in a comparable context. With respect to this, the best option may be to compare 'greenfield' projects with investments in other, recent, 'greenfield' projects.

Finally, there could be two potential problems with the *recent comparable 2y/5y* benchmark method. First, in some potential JI/CDM host countries there may be insufficient recent comparable projects to derive a benchmark from, which could create a risk that emission factors may vary significantly so that picking a 'comparable' value could be problematic. Setting fictitious standards could be an alternative, but this would create extra uncertainty with regard to the data used. Therefore, this benchmark approach works best in situations where there are a large number of recent investments so that a better picture of the investment situation for this particular investment is obtained. Second, although recent investments may largely reveal the present and near future investment situation, it may not be able to fully incorporate changing investments conditions in the future. Some of these expected changes may already be known and incorporated in the recent investment pattern – *e.g.* investments in line with the *Acquis Communautaire* standards or more investments in gas-fired boilers in order to take into account an expected phasing-out of coal subsidies, *etc.* – but other future developments may not yet have been incorporated in recent investment decisions. The Dutch ERUPT programme acknowledges this and has developed a key factor methodology, which requires project developers to explore expected future developments that are relevant for the project and which may not yet have been incorporated in recent investment decisions (see also Section 2.1.7).

2.3.5 Better than average current practice

The *better-than-average-current-practice* benchmark method for power and heat projects calculates the average current emissions of a sector based on the (weighted) emissions of all power and heat facilities in the sector. Basically, this approach does not differ much from the *recent comparable 2y or 5y* method because both approaches are based on currently operational capacity. One difference between them, however, is that the *recent comparable 2y or 5y* method only takes into consideration recently installed capacity, whereas the *better-than-average-current practice* method could also includes capacity that has been operational in the host country from before the last two or five years. With a view on this difference, the *recent comparable 2y or 5y* method likely results in lower benchmark emissions values as it generally considers more modern technologies. A second difference between both methods is that the *recent comparable 2y or 5y* method does not set the threshold that a project's performance must be 'better' than average. So, should the *recent comparable 2y or 5y* benchmark result in the same picture as average-current-practice,[60] the difference between both approaches is that only the *better-than-average-current-practice* method will determine how much better than average current practice a project must perform.

In order to manage the strictness of the *better-than-average-current-practice* benchmark some kind of threshold, *e.g.* a performance standard, must be chosen. In this case, two options need to be distinguished. First, one could define the threshold as the baseline itself. For example, this could be a top X percentile of current emission intensities. Second, one could use an even stricter threshold. In doing so, a very stringent threshold (*e.g.* top 20%, or 80th percentile) in terms of GHG emissions performance reduces the amount of credits a project can create. Such a benchmark would imply that for 80% of all facilities in a sector the emission level is higher than the chosen benchmark emissions level. A stringent benchmark could have two main implications. On the one hand, it may create missed opportunities as it excludes possibly additional emission reductions from crediting in the lower percentiles. On the other hand, a stringent benchmark lowers the risk of free riding, *i.e.* project developers who claim credits for non-additional emissions reduction.

The *better-than-average-current-practice* multi-project baseline method would fit in the third baseline approach of the *Marrakech Accords* [61]. A conservatively restrictive threshold (*e.g.* top 20-30%) would thus ensure that no outdated technology is credited ('technological additionality') and that free riding is limited. The *better-than-average-current-practice* method requires a relatively large amount of data as it needs specific emissions data of all active plants in the relevant sector of a country, without any time limitations, in order to determine the weighted average based on which the threshold is calculated. The potential problem of a lack of comparable projects, which might typically exist for *recent comparable 2y or 5y* benchmarks, is less important here since the number of plants that fit in the average calculation is generally larger than under the recent comparable method.

[60] Which is not likely as both benchmark methods generally cover different time periods with consequently different investment databases.
[61] Para. 48c of Annex to Decision -/CMP.1 (*Article 12*).

2.3.6 Sector averages in a single country or across several countries

The benchmark approaches described in the above sections either start from an observation of what installations are currently operational in a sector (*e.g. better than average current practice*) or which ones have recently been installed (*e.g. recent comparable 5y or 2y*), or take into consideration the future development in the sector using assumptions about investment behaviour (*e.g. economically most attractive*) keeping in mind, among others, policy packages prescribing particular technologies and techniques (*e.g. best available techniques*). In addition, benchmarks could be derived from a more top-down perspective by taking the national level benchmarks as a starting point on the basis of which it could be decided for each case whether to opt for regional benchmarks (where system interdependencies within the region are strong) or sub-national benchmarks (in countries with distinct grids or power pools that possess different resource profiles). This method largely resembles the *better-than-current-average-practice* method, although the top-down sector benchmark method usually is not linked with a threshold performance level as described in Section 2.3.5.

In order to determine a sector average benchmark for the electricity sector for a single country, first the actual CO_2 intensities for electricity production in the country are calculated (from fossil fuels[62]) in terms of CO_2/MWh (see Annex 3). Multiplying this multi-project output/unit-specific (in terms of MWh) benchmark with the forecasted annual power generation of the plant envisaged under the project during the crediting lifetime results in the baseline. Establishing such benchmarks can be quite straightforward as data for existing electricity generation capacity is available for over 100 countries (see, for example, the annual IEA Statistics on Energy Balances of non-OECD countries and CO_2 Emissions from Fuel Combustion). What is further needed is a determination of the project type within the sector, *e.g.* large hydro, fossil fuel, renewables, *etc.* For electricity generation projects it needs to be defined whether these are on-grid or off-grid plants. Table 2.5 presents an overview of advantages and disadvantages of applying sector-specific/single country benchmarks.

Table 2.5. Advantages and Disadvantages sector averages in a single country

Advantages	Disadvantages
• High degree of transparency and certainty. • Reduced transaction costs for project participants. • Low cost of baseline development, approval and revision (if applicable). • Takes into account the actual efficiency standards in host country. • Reduces scope for manipulation.	• Medium to High (depending on stringency) likelihood that projects switching from technologies with emissions lower than the benchmark receive more than in case of a single-project baseline. • Leniently determined sector average benchmark have higher risks of crediting non-additional emission reductions. • High potential for missed opportunities in the high carbon intensive project categories, *i.e.* the sector average benchmarks have generally lower emissions than high carbon intensive plants. Yet, a project switching away from high carbon intensive plants only receives credits below the benchmarks, which leads to an 'undercrediting'. • Not as accurate as more bottom-up benchmarks since it is based on a more robust method based on generalisations.

[62] Considering countries such as Angola (94% hydro electricity production), Brazil (±90% hydro electricity production), Cameroon (97% hydro electricity production), Congo (99% hydro electricity production) and others with high hydro electricity production, it seems fair to use the fossil fuels electricity production baseline as the country sectoral baseline.

Case-by-case decisions could determine whether to opt for regional benchmarks (where regional interconnections are strong) *e.g.* by following the IEA World Energy Breakdown[63] or by taking regional divisions on a higher aggregation level such as Annex I, Annex II, *etc.* The data needed for establishing benchmarks for power generation based on regional (across several countries) average performance could be derived from the IEA 'World Energy Outlook, 2000', which comprises relevant data using the IEA World Energy Breakdown. Except for the regional rather than country perspective, the data requirements for region-wide sector average benchmarks basically do not differ from the single country benchmark.

The *country or region-wide sector average emissions* benchmarks method would typically fit in the first baseline approach of the *Marrakech Accords* as it strongly builds upon existing emissions data in a sector in a particular host country. However, it seems conceivable to also add specifications in order to let the method fit into the second and the third 'Marrakech' baseline approaches as well.

2.3.7 Sector/Country-level modelling

Next to deriving benchmarks from observable projects, planned policy programmes, assumed investment behaviour and observable aggregated emission levels, multi-projects can also be determined using *sector/country-level modelling* methods. This approach describes a sector or country-level determination of (standardised) emission factors based on either bottom-up or top down-models:

- Bottom-up models may be defined as "a modelling approach, which arrives at economic conclusions from an analysis of the effect of changes in specific parameters on narrow parts of a total system."[64] Their presentation of energy systems is based on a detailed characterisation of technologies and processes.
- Top-down[65] models are characterised by an "approach that proceeds from broad, highly aggregated generalizations to regionally and/or functionally disaggregated details."[66] They comprise technical production conditions within energy systems at a more aggregated level, *e.g.* in terms of production functions.[67]

Bottom-up models are based on a technological representation of the entire energy sector, starting from the extraction of primary energy carriers to final energy use (via imports, conversion, transport, distribution of final energy). Technical systems within the energy sector are characterised by technological, economic and ecological figures and are inter-connected by energy or material flows. In contrast to top-down models, bottom-up models treat growth of GDP, as well as other macro-economic indicators, as fixed exogenous determinants. Examples are EFOM-ENV, MARKAL, E^3Net and PERSEUS (**P**rogramme Package for **E**mission **R**eduction **S**trategies in **E**nergy **U**se and **S**upply). Chapter 3 provides an extensive description of the PERSEUS bottom up model, including an overview of its input-output flows and the extent to which the model can be applied to multi-project baseline setting.

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[63] OECD North America, OECD Europe, OECD Pacific, Russian Federation, Other Transitional Economies, China, East Asia, India, Other South Asia, Brazil, Other Latin America, Africa and Middle East.
[64] WEC, 1986.
[65] One has to bear in mind the fact that the expression 'top-down model' differs from the one used within top-down approaches to baseline setting, such as with the benchmark approach of Section 2.3.6.
[66] WEC, 1986.
[67] Forum 1999, p. 21.

An optimising model such as PERSEUS results in a sector-specific baseline for the host country. Decisions already met, *e.g.* by the energy plan of a utility, can be taken into account as well as country specific circumstances (*e.g.* investment constraints). Since there may be sub-sectors of the energy sector – *e.g.* private households – in which the decisions of protagonists cannot be modelled with a methodology optimising for the criterion of minimal expenditures, the decisions in those sectors may be fixed in the model. The model benefits from the fact that it can be used for the analysis of all JI/CDM projects in a particular host country for the full crediting lifetime of the projects.

All measures are assessed according to the same economic criteria. For this reason, the decisions reached need not always be the same as the decisions from the point of view of individual actors. Hence, the results of the baseline definition of different countries are comparable and the methodology fulfils the requirements for transparency and credibility. The baseline definition for different countries and projects is performed according to uniform criteria – making manipulations more difficult in comparison with the application of national energy system expansion plans. However, the elaboration and application of energy models requires experience in handling such instruments and is time-intensive which could lead to high political transaction costs. Furthermore, even such a highly sophisticated model cannot eliminate all uncertainties that arise independent from the methodology used for baseline setting.

In contrast to bottom-up models, top-down models (synonymous: macro-economic models) usually not only take into account energy systems (both technologies and emissions) but also other markets as well as individual preferences of agents within the economy.[68] Top-down models are based on a representation of macroeconomic relations in which modelling of energy sectors may be included, usually by taking into account only a limited set of technologies. Within macroeconomic models, one may distinguish between input/output models and applied general equilibrium models. The characteristic feature of input/output models is that projections for the future are derived on the basis of past input/output relations within different sectors, which, at the same time, is the main starting point for criticism. Examples of input/output models are HERMES, MIDAS,[69] PANTHA REI or MIS.[70] Applied general equilibrium models are based on an aggregate representation of the entire economy and a profit maximization of producers and a maximization of benefits as perceived by consumers. Market relations are represented by supply and demand functions. The main advantage of applied general equilibrium models is the fact that inter-dependencies between different sectors are taken into account. Examples of such models are LEAN,[71] GREEN[72] or the Jorgensen-Wilcoxen model.[73]

The application of most top-down models to determining emission factors for JI/CDM projects is hampered by several drawbacks. Firstly, the representation of technologies within top-down models is generally realised at a relatively high aggregation level. However, in order to be able to derive as precisely as possible emission factors for different project types, modelling should preferably take into account technical features of conversion technologies such as fluctuation of renewable energies or utilisation of technologies within different load ranges. These technological characteristics are often neglected within

68 Forum, 1999, p.29.
69 Italianer, 1986.
70 Forum, 1999.
71 See Welsch, 1996.
72 See Burniaux *et al.*, 1992.
73 See Jorgensen and Wilcoxen, 1993.

top-down models. Secondly, top-down models are either world models, or national models in which further disaggregation to relevant sectors is usually not envisaged.[74] Hence, determination of emission factors according to a regional differentiation will then not be possible. Consequently, most top-down models may well deliver aggregate emission factors for entire countries or sectors, but do not account for the specific conditions of different project types and, thus, are less suitable for determining specific benchmarks for the evaluation of emission reductions realised via project-based flexibility mechanisms.

Determining benchmarks using bottom-up or top-down models would mainly fit in the second baseline approach of the *Marrakech Accords* [75] as it assumes a cost-optimal course of action in the sector described for the host country.

2.3.8 Evaluation of multi-project baselines

As mentioned earlier the counterfactual nature of determining baseline scenarios for JI and CDM projects creates an uncertainty about whether the baseline indeed is a reasonable representation of what would have taken place in absence of the project. This uncertainty provides some scope for gaming as project developers may have an incentive to set the baseline at a higher emissions level in order to acquire more credits. Especially, with single-project baselines, the latter requires a strict validation of the baselines, which generally increases the transaction costs of baseline determination.

Although standardising baseline procedures, parameters and emission factors does not remove the counterfactual character of a baseline, it reduces gaming as the baseline emission factors are determined on a multi-project basis and cannot be changed by individual project developers. This also reduces the pressure on validation because the multi-project baseline emission factors do not need to be validated for each specific project.

A potential problem with multi-project baselines is that they insufficiently take into account project-specific elements of the JI/CDM investment, which is specifically required by the *Marrakech Accords*,[76] However, it is not explicitly defined to what extent baselines must be project-specific. On the one hand, it could be argued that multiplying multi-project baseline emission factors – even those derived from a top-down baseline methodology – with the project activity level makes the baseline project-specific. On the other hand, the Marrakech text could require standardised baselines to have a strong link with the project context, which would exclude a number of top-down based benchmarks. It seems clear though from the Marrakech text that standardised baselines are eligible for JI/CDM projects given that the text refers to the option of multi-project variables for baseline determination and identifies a benchmark method as one of the three baseline approaches for the CDM.[77] For a graphical summary of the baseline approaches discussed in this chapter showing the different levels of standardisation, aggregation, and stringency, see Figure 2.3.

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[74] See Welsch, 1996.

[75] Para. 48b Annex to Decision-/CMP.1 (*Article 12*).

[76] Para. 45c of the Annex to Decision-/CPM.1 (*Article 12*).

[77] Para. 48c of the Annex to Decision-/CPM.1 (*Article 12*).

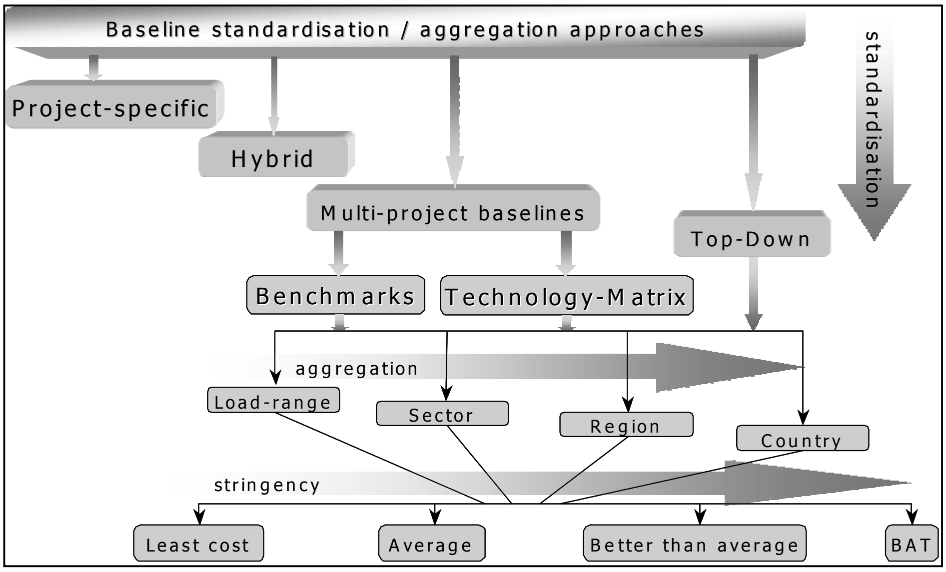

Figure 2.3. Classification of baselines according to standardisation, aggregation and stringency

Table 2.6 summarises the general applicability of multi-project baselines for JI and CDM projects with a view on the *Marrakech Accords*. The evaluation is based on three criteria:

- **Environmental integrity:** What will be important is that there is less scope for gaming and that of the many possible permutations of baseline types and parameters a link with the project context is maintained so that an appropriate range of multi-project approaches can be selected and a conservative one chosen.
- **Transaction costs, practicality and transparency:** Multi-project baselines have clear advantages in terms of reduced transaction costs and improved practicality of calculating emission reductions through baselines.
- **JI/CDM compatibility:** Multi-project benchmarks are in line with JI conditions under the *Marrakech Accords*. Although standardised baselines would have to be justified separately under the CDM, the text includes clear references to multi-project approaches.

Table 2.6. Evaluation of multi-project baseline approaches

Baseline type	Strengths	Weaknesses
Economically most attractive course of action benchmark	• Is in line with 2nd baseline approach of 'Marrakech' albeit less stringent than that (2nd 'Marrakech' does not refer to 'most' attractive course of action, but just to economically attractive course of action.)	• Most applicable for a single-fuel/technology baseline for the fossil fuel sector or energy efficiency projects • No account is taken of actual efficiency standards in the host country. • Cost data requirements high and these can be confidential and easily manipulated.
Best Available Techniques benchmark (BAT)	• Is in line with 1st baseline approach of 'Marrakech' if recent or actual practice is considered as best available in the host country • Is in line with 2nd baseline approach of 'Marrakech' if 'best' is only assumed to be 'available' under economically attractive course of action • For JI projects IPPC BREF reports provides much information	• BAT is no uniform concept and differs from country to country; topic of negotiations about what is 'available' • Too strict BAT creates missed abatement opportunities • Only a few developing countries have BAT defined for themselves

Historic: recent comparable 2y/5y benchmark	• Can be applied to any project type • Environmental integrity should be reasonable as relatively recent technology in baseline reduces risk of overestimation • Has been applied in practice by a.o. ERUPT in combination with key factor analysis • Data known • Is in line with 1st baseline approach of 'Marrakech'; would also fit in 2nd approach if recent investments are considered as proxy for economically attractive course of action in the near future; however, key factor analysis is recommended	• Only relies on recent historical or present situation data, without specifically analysing future development of key factors; is strongly based on assumption that current situation reveals near future course of action • Regional or national aggregation may not be appropriate • No credits for fossil fuel-to-renewables projects if benchmark is derived from recently installed renewables technology • Requires a relatively large amount of comparable investments in the sector
Better than average current practice benchmark	• Suitable for 'greenfields' and retrofits • Specifies to what extent projects must be better than average • Threshold option in this method could serve as a filter to limit free-riding • Is in line with 3rd baseline approach of 'Marrakech'	• High data needs • Current average practice could include old plants, which are still operational but which are not representative anymore for future investments; the average emissions level derived with this method could be lower than with the recent comparable 2y/57 benchmark.
Sector averages in a single country benchmark	• Appropriate for sectors with homogeneous output • Simple to produce • Applies to projects where what is substituted is not known • Is in line with 1st baseline approach of 'Marrakech'	• Risk of overcrediting in some cases • Risk of rewarding bad policies • Not useful for retrofits • Environmental integrity will depend on careful application
Sector average across several countries benchmark	• May be appropriate where interconnections between countries are strong *e.g.* electricity supply • Is in line with 1st baseline approach of 'Marrakech'; although link with project situation is weak or absent • Gaming practically excluded	• Not useful for retrofits • Risk of rewarding bad policies • It depends on careful application in appropriate circumstances • Hardly any link with project situation
Future benchmark based on model at sector or country level	• Will provide future scenario based on least cost or cost-optimal technology choices • Can build upon existing energy-sector models, which have already been used extensively. Projected energy sector developed can be relatively easily transformed into a baseline scenario • Environmental integrity will depend on appropriate application and uncertainties but takes full note of country context and leakage within sector • Is in line with 2nd baseline approach of 'Marrakech' as it is based on a cost-optimal course of action in the energy sector of the host country	• Needs model constructed for a particular country with potentially high time and data requirements • Subject to modelling uncertainties • Aggregation uncertainty • Typically bottom-up models are used

With a view on the three baseline approaches included in the Marrakech Accords and from which project developers must choose the one most appropriate for the project activity,[78] it can be concluded that the multi-project baseline methods described in this chapter could, as it seems, all be categorised under these approaches (see Table 2.7).

The *economically most attractive* multi-project baseline method described in Section 2.3.2 is less stringent than the second Marrakech approach and would need an assessment of existing inefficiencies or specific circumstances in the host country which cause that the economically most attractive option is not always automatically implemented. The *BAT* method could be applied here under the assumption that the definition of availability is country-specific and depends on an economically feasible course of action, which is common practice in the EU Accession process where BAT is defined for the Candidate countries in the framework of the IPPC Directives (see also Section 4.3). Finally, the *future benchmark based on sector/country modelling* would fit in the second Marrakech baseline approach as the model projections are based on a cost-optimal course of action.

The three benchmarks categorised under the second Marrakech baseline approach neither explore investment barriers preventing certain at-first-sight-economically-attractive options. For the *BAT* and *future benchmark based on sector/country modelling* methods this is not required as defining 'availability' for the BAT method already implicitly takes into account feasibility and the modelling is based on a bottom-up analysis which incorporates existing inefficiencies in the sector. Applying *recent comparable 2y or 5y* under the second baseline approach would assume that the recent and current investment patterns in the sector reveal an economically attractive, or at least feasible, course of action including barriers, which would then serve as a proxy for the investment pattern in the near future. To give an example, the Dutch ERUPT programme starts its baseline guidance with a scenario analysis based on recent and current investment behaviour, which needs to be adjusted with a key factor analysis of the (future) development of variables relevant for the project (see Section 2.1.7).

However, as mentioned above, applying the *economically most attractive* method would require an analysis of inefficiencies/barriers, which under business-as-usual circumstances would have prevented investors from taking the economically most attractive route.

[78] Para. 48 of Annex to Decision -/CMP.1 (*Article 12*).

Table 2.7. Compatibility of multi-project baseline methods with Marrakech baseline approaches

Approach	Multi-project baseline method
1. Existing actual or historical emissions	• **BAT** if recent or actual practice is considered as best available in the host country • **Recent comparable 5y/2y** • **Sector averages in a single country** • **Sector averages in a region**, although link with project is weak
2. Emissions representing economically attractive course of action, taking into account investment barriers	• **Economically most attractive**, which is less stringent than economically attractive and needs an assessment of inefficiencies in the host country • **Recent comparable 5y/2y**, if recent investments are considered as proxy for economically attractive course of action in the near future • **BAT** if best is available under economically attractive course of action • **Future benchmark based on sector/country-level modelling**: based on cost-optimal course of action in sector/host country
3. Average similar activities in recent 5y + top 20% threshold	• **Better-than-average-current practice,** including an explicit definition of how much better a project must be

3 Assessment of Multi-project Baselines for Power and Heat Sectors and Forestry

3.1 Introduction

This chapter analyses the actual application of the multi-project baselines discussed in Chapter 2 to JI/CDM projects in the power and heat sectors and to forestry projects. The objective of this analysis is to examine:

- The **applicability** of multi-project baselines, which deals with the practical feasibility of the methodologies for multi-project baseline setting in terms of political acceptability and applicability for project types. An important question is this respect deals with the data requirements for compiling multi-project baselines for particular project types in particular host countries and the extent to which the availability of data influence the level of aggregation of the multi-project baseline. For example, on the one hand, more data for the energy sector in a host country could allow for a more precise multi-project baseline on a higher aggregation level, *e.g.* a region within a country, but, on the other hand, precisely a lack of data could be a reason to construct a multi-project reference scenario being a reasonable approach for a baseline.
- The **accuracy** of multi-project baselines with a view on whether they **reasonably describe** what would have taken place in absence of the project activity.[79] With a view on this, the two opposing views are, on the one hand, that multi-project baselines are less project-specific, thereby less precisely describing what the emissions would have amounted to within the system boundary, whereas on the other hand it is argued that multi-project baselines do not entail the risk typically associated with single-project baselines where project developers might have an incentive to 'talk up' the baseline in order to acquire more credits (gaming). Moreover, multi-project baselines seem to be better able to deal with perverse incentives due to the existing policy regime.
- The **consistency** of multi-project baseline methods: to what extent are the results derived from similar projects comparable and how can it be ensured that results are reproducible and environmentally integer?
- The **transaction costs** associated with designing multi-project baselines as well as related to their application. Both political and market transaction costs will be taken into consideration in the analysis.
- To what extent the application of multi-project baselines increases the overall **transparency** of methods to describe what would have taken place in absence of a JI/CDM project activity

With a view to this objective PROBASE identified 12 potential JI/CDM host countries for which the following multi-project baseline analysis was carried out:

- To carry out bottom-up modelling exercises for the power sector in Indonesia and South Africa and for the heat and power sector in the Russian Federation in order to project a future energy sector development in these host countries, which results in an annual cost-optimal projected energy mix for the sector. This energy mix combined with GHG emission factors per unit of output, when multiplied with the project activity level, results in a baseline emission scenario. These modelled benchmarks are tested on actual projects (Section 3.3 and 3.4).
- To derive a number of benchmarks on the basis of international, region or country-specific information about (expected) GHG emissions in the near future in the heat and power sectors. These

[79] Para. 44 of Annex to Decision -/CMP.1 (*Article 12*).

benchmarks assume that in the absence of the JI/CDM project a technology would have been implemented within the project boundary which corresponds with *e.g.* World average techniques, OECD standards, regional average standards, *etc.* Using the project data collected, these benchmarks are subsequently tested and analysed (Section 3.5).

- To analyse the extent to which the accounting of carbon sequestration through forestry JI/CDM projects can be carried out through standardised procedures. This is tested on a number of forestry projects in Brazil, Costa Rica, and the Czech Republic (Section 3.6).

3.2 Data collection

3.2.1 Project data

In order to carry out the (multi-project) baseline analysis introduced above it was required to compile a set with data from actual projects. This data set has been used for the baseline analysis in this chapter for three purposes. First, the multi-project benchmarks determined in Section 3.3 through energy sector models should ideally be tested in actual practice with real projects to see whether the models lead to reasonable multi-project baselines. Second, a number of projects from the data set have been used for the determination of uncertainty associated with single-project baselines. By taking different assumptions about project-specific or macro-based parameters different baselines can be compared to find a range of uncertainty whereby *e.g.* large differences between baseline scenarios could be an indication that for a particular project the reasonability of baselines calculated is uncertain (see Section 4.1). Third, projects were selected for analysing the extent to which (elements of) forestry project baselines can be standardised. In total 22 projects were included in the PROBASE data set (see Annex 2 for summaries).

These projects are representative (pilot) JI/CDM projects from different project categories and economic sectors in the case study countries (see below). Sources of the data were: the AIJ project reports as published by the UNFCCC Secretariat, the World Bank's National Strategy Studies, the Netherlands' ERUPT programme, and forestry sector data for Brazil, Costa Rica and the Czech Republic. The data collected for these projects contains relevant technical, economic, environmental and social data.

Throughout PROBASE the process of data collection has been an iterative process, given that the process of project development under international carbon credit programmes such as ERUPT, Carboncredits.nl[80] and the PCF continues and results in more and more JI/CDM projects delivering increasingly better data. In order to check the reliability of data a data quality assessment has been carried out, which, for example, checks the origin of data and the extent to which the data has been reviewed, monitored and verified. The approach used for this is the NUSAP scheme, which is an acronym for *Numerical, Unit, Spread, Assessment and Pedigree*.[81] The main idea behind NUSAP is to create a system, which expresses and communicates uncertainties about data in quantitative information both by focusing on the quantitative and qualitative aspects of that information. An important principle of the system is that it considers single numbers standing alone as misleading.[82]

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[80] In 2001 the management of the Dutch tender programmes for JI projects (ERUPT) and CDM projects (CERUPT) was placed under the umbrella programme Carboncredits.nl of the Dutch government agency Senter.

[81] After Funtowicz and Ravets, 1990.

[82] Gherardi and Turner, 1987, p.11.

Table 3.1. Statistical information pedigree matrix

Definitions and Standards	**Data collection and analysis**	**Institutional culture**	**Review**
Negotiation	Task force	Dialogue	External
Science	Direct survey	Accommodation	Independent
Convenience	Indirect estimate	Obedience	Regular
Symbolism	Educated guess	Evasion	Occasional
Inertia	Fiat	No-contact	None
Unknown	Unknown	Unknown	Unknown

Source: Funtowicz and Ravets (1990, p. 160).

NUSAP evaluates statistical data in four phases, which are shown in Table 3.1. First, it looks at how the standards and definitions, for which data is collected, are determined. For example, data collected for internationally agreed variables, *e.g.* as in the UNFCCC Uniform Reporting Format for AIJ projects, would result in a more coherent set using, for example, similar units in which the data should be expressed.[83]

The second phase of the analysis is data collection and analysis, which refers to the operation in which field data is collected, analysed and reported. Setting up a 'task force' for this phase is considered to lead to the best data collection and analysis process, as it would imply an intensive study of the issues thereby incorporating the complexities and variabilities. Somewhat less intensive would be to carry out a 'direct survey' where various indicators are measured at the same time. In case it is impossible to directly measure variables, indirect estimates could be made using some other related variables. Sometimes, when it is not feasible to collect data for certain variables, 'best professional judgement' may be used leading to an 'educated guess' by *e.g.* engineers from the field who know 'the figures by heart.'

The third phase of NUSAP deals with the institutional culture and refers to the organisational character of the data collection exercise. This phase mainly focuses on the co-operation between 'superiors' and 'inferiors' in the organisational context from where the data is obtained. The 'dialogue' mode assumes that the institutional culture on the site where the data is collected is characterised by a shared interest and open communication between 'superiors' and 'inferiors.' The 'no-contact mode', on the other hand, assumes that the orders from superiors are simply ignored, which might lead to incomplete information published by the organisation. The other modes vary between these extremes. 'Accommodation' describes a situation in which tasks are performed more or less to everyone's satisfaction. 'Obedience' simply assumes that lower levels in an organisation's hierarchy just follow higher levels' orders without being interested in the purpose of that. 'Evasion' refers to the situation where only the formal aspects of a task are performed and nothing more.

The fourth phase of the pedigree is the review of the data collection and analysis. In this respect 'external review' is considered to contribute most to the data quality, as this would imply an outsider's neutral view on the quality. Important, too, is that the review should be independent in order to ensure unbiased judgements. 'Regular review' is considered standard for each properly run organisation and thereby considered superior to 'occasional review'.

[83] A consistent use of units for data collection alone does not necessarily lead to a consistent set of data, however. Jepma and Eisma (1998) found that a consistent use of data units in the AIJ Uniform Reporting Format does not imply a consistent determination of project baselines for AIJ projects (see also Section 2.3.1).

3.2.2 Country context data collection

As explained in Section 2.1.1 the context of baseline determination does not halt at the project boundaries. Although the *Marrakech Accords* explains that the project boundaries (or: system boundaries) should be set at the level where project participants cannot control emission sources anymore,[84] this does not imply that only factors from inside these boundary have an influence on the baseline. For example, determining a baseline for wind energy JI project requires, next to project-specific data such as activity level, plant ownership, energy distribution within the system, *etc*, also information about whether *e.g.* the host country fully utilises the energy production capacity or has an overcapacity or whether the back-up plant for the wind power plant is a coal-fired 'spinning reserve' plant or a large hydro energy reservoir (see for more concrete examples Section 4.1). Also the availability of fossil fuel reserves or imports in the host country and the country's energy policies can have a strong impact on the eventually resulting single-project or multi-project baseline.

For those case study countries for which PROBASE:

- Carried out a bottom-up modelling exercise for the heat and power sectors (Indonesia, Russian Federation and South Africa),
- Assessed uncertainty associated with single-project baseline determination (Costa Rica, Czech Republic, Indonesia, Poland, Romania, Russian Federation), and
- Analysed forestry project multi-project procedures (Brazil, Costa Rica, Czech Republic),

a country context was compiled using information about country and sector-specific items (box 3.1).

Box 3.1. Country context data for PROBASE

Country General Data:
- Name of country
- Geography
- Economy
- Economic, environmental, political, social and legislative developments

Country Energy Specific Data:
- Energy resources
- Energy strategies
- Energy-related environmental issues

Electricity Sector:
- Electricity generation (general issues - current situation - plans) and fuel mix
- Total electricity capacity installed
- CO_2 emissions and intensities in energy generation
- Fuel use for electricity generation
- Total electricity demand and forecast electricity demand and capacity
- Transmission grid characteristics
- Available electricity generation technologies

Heat Sector:
- Heat generation (general issues - current situation - plans)
- Heat generation fuel mix
- Total installed heat capacity
- CO_2 emissions and intensities in heat generation
- Fuel use for heat generation
- Total heat demand
- Transmission heat network characteristics
- Available heat generation technologies
- Forecast heat demand and capacity

For an explanation of the country context for forestry project baselines, see section 3.6.

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[84] Para. 52 of the Annex to Decision -/CPM.1 (*Article 12*).

The information thus collected provides insight in the present and future status of the heat and power sectors analysed (and forestry, see Section 3.6) and is therefore a valuable source of data for the determining both multi and single-project baselines. For the acquisition of the data, the majority of the sources used were official governmental documents and academic surveys and studies on energy and climate change issues (see Annex 3). Other sources that contributed to the collection of data were information pools published via the Internet from reliable international organisations and governmental bodies of the case study countries. The collected information concerning each country is categorised and documented in a specific and homogeneous format so that it can be easily utilised in the development of baselines. Taking into consideration the possibility that throughout the work on PROBASE extra data for the baseline assessments might be needed and given that initially collected data would need to be updated with the availability of new information (*e.g.* countries' National Communications to the UNFCCC), the adequacy of key data sources has continuously been examined.

Detecting conflicts and inconsistencies among the data derived from various sources as well as checking the validity and timeliness of all the information assess the quality of the data of each country. This has been especially relevant in order to prevent that information acquired via *e.g.* interviews in the case study countries could lead to 'talking up' multi-project baselines in order to give the impression that under business-as-usual circumstances GHG emissions would be higher than what would be reasonable to expect. With a view on this, non-governmental experts in the case study countries were consulted in order to verify acquired data.

Finally, the country context study carried out under PROBASE provides a step into the construction of a 'baseline manual' as the study provides recommendations on the collection of technical, socio-economic and political data as far as they are relevant for baseline setting. As such, country context studies support an early development of the outline for such a manual (see Chapter 6).

3.3 Benchmark modelling: PERSEUS and Reflex

3.3.1 Introduction

Single-project baseline methods have been applied and tested extensively within the AIJ pilot phase and under the JI/CDM programmes of ERUPT and the PCF. In contrast, multi-project baseline methodologies in terms of standardising baseline parameters and/or determining GHG emission factors have been applied only rarely.[85] Particularly, there is a lack of aggregate approaches to baseline setting based on modelling within the electricity sector, even though such models have successfully been applied within other fields of research very often.

In order to overcome this deficiency, one objective of PROBASE is to develop different multi-project methodologies for baseline setting in the electricity and heat sector, which are based on modelling techniques. Three different model-based aggregate approaches to baseline setting have been applied:

[85] Only the Dutch ERUPT programme in its second tender (2001-2002) offered JI project developers the possibility to use multi-project GHG emission factors for their baseline calculation. Moreover, the ERUPT guidelines standardise the parameter value of the project boundary as being one level upstream and one level downstream the plant installed or refurbished (project-specific exceptions to this standard are possible though).

- The energy and materials flow model **PERSEUS**, developed by the Institute of Industrial Production (IIP) at the University of Karlsruhe and applied under PROBASE by the French-German Institute for Environmental Research at the University of Karlsruhe (DFIU);
- The simplified energy systems model **Reflex** developed by the French-German Institute for Environmental Research at the University of Karlsruhe (DFIU); and
- The **Multiple Benchmark System** of the Energy Policy Unit (EPU) of the National Technical University of Athens (NTUA), which provides combined country and regional emissions reduction scenarios for electricity generation projects.

The PERSEUS and Reflex modelling methods are discussed in this section; Section 3.5 discusses the Multiple Benchmark System. A detailed background description of the three methodologies can be found in the extensive report of the PROBASE workpackages 6 and 7 (Annex 6).

Any baseline determination relies on input data from the GHG emitting energy system under consideration. This data can consist of historic emissions figures, projections for the future development of relevant baseline parameter or information about the present situation of the energy system. The data, which can be collected for the sector, the host country or the region in which the country is located, provide a readily applicable way to derive multi-project emissions baselines. However, the data do not necessarily account for immanent changes in the GHG emitting system under consideration. A prediction of the future development of the emissions baseline relying on solely historic emission factors could therefore be a rather imprecise basis for the assignment and calculation of emission reductions. For investors in JI and CDM projects who want a more solid and therefore acceptable calculation of emission reductions (*i.e.* credits to be earned), and with a view to the *Marrakech Accords*, which emphasise the importance of baselines being reasonable description of the without-project situation,[86] a forward-looking scenario can be of special interest.

In order to provide the data necessary for calculating multi-project forward-looking baselines in the energy sector, as a first step the structure of the future energy system has to be determined as precisely as possible. Figure 3.1 shows the modelling and standardisation approaches used under PROBASE. In the first step the current energy system in the host country is described, which is followed by a modelling and subsequent forecast of the future development of the energy system and the corresponding emissions for subsequent years with the relevant economic and technical boundary conditions. This modelling is done with the help of the cost-optimisation models PERSEUS and Reflex. The output of the first step – a forecast of GHG emissions belonging to a cost-optimised projection of the energy mix in the sector/country/region – is then used as an input into the second step in which the emissions are aggregated to benchmark values using a *Simplified Baseline Aggregation Tool* (SimBAT).

In this step the actual determination of the baseline takes place resulting in benchmarks typically expressed in terms of average emission factors for a country, a region, a sector, or a load-range. It must be noted that the analysis in workpackages 6 and 7 has shown that this type of aggregation makes most sense for grid-based electricity generation (see Annex 6). In countries (*e.g.* least developed and possibly some developing countries) where existing data on the current energy system as well as information on its future development is of such poor quality and/or detail that none of the optimising models can sensibly be

[86] Para. 44 of Annex to Decision -/CMP.1 (*Article 12*).

applied, an alternative is to use existing overall energy system data (statistics, historic data) directly as input for the aggregation step with SimBAT, while skipping the first optimising step. However, this relatively simple alternative only allows the determination of a static benchmark which does not incorporate any information about future changes in the sector.

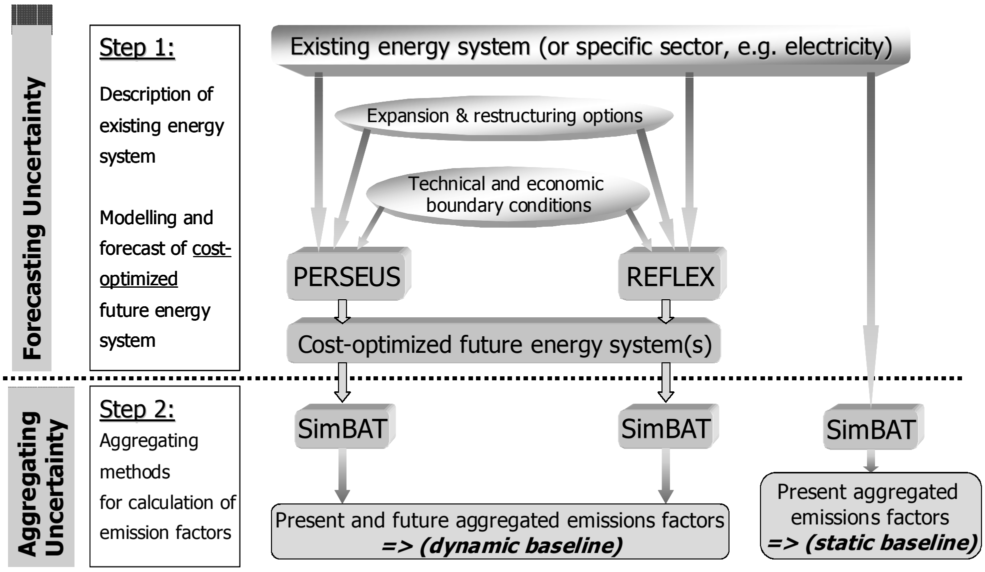

Figure 3.1. Modelling and standardisation approaches for baseline emission factors applied by PROBASE

3.3.2 PERSEUS

The PERSEUS methodology is based on a representation of energy conversion technologies and the interconnecting flows of energy (*i.e.* electricity and heat) and material (*i.e.* primary energy carriers, emissions of pollutants and GHGs). The complete energy sector of a country – starting from the resources via several energy-conversion technologies up to the supply of final energy – is modelled in a consistent approach. In the PERSEUS model, existing and future energy technologies are represented resulting in a linear programming approach implemented in *GAMS* (General Algebraic Modelling System), which makes it possible to consider the interdependencies between individual investment options.

Input data to PERSEUS comprises the detailed characterisation of the country's energy system. Technologies are characterised by technical (*e.g.* efficiency, lifetime), economic (*e.g.* investment, fixed and variable costs) and environmental (emission factors) parameters. As the variation in demand for energy, in particular for electricity and heat, depends on the season and the daytime, load curves for demand energy carriers at typical days of a year are represented in PERSEUS. Decisions already covered by *e.g.* the energy plan of a country can be taken into account as well as country-specific circumstances. Decisions in sub-sectors of the energy sector – *e.g.* private households – that cannot be modelled with a cost-optimisation methodology may be fixed in the model.

The main output of the PERSEUS model optimisation is a sector-wide optimal energy system defined by a minimisation of expenditures using a normative approach. The latter is based on a national economic assessment of measures and makes statements on which measures should be realised from a societal point of view. All measures are assessed according to the same economic criteria. For this reason, the decisions made in the context of the model need not be the same as the decisions from the point of view of individual actors. The PERSEUS models can be used for the analysis of all JI/CDM projects in a particular country for the whole lifetime of the projects. In order to do so, emissions resulting from electricity and heat generation as well as from distribution of energy carriers (*e.g.* natural gas) can be taken into consideration.

As mentioned above, the computer programme for the PERSEUS model family is written in GAMS. To facilitate the application of the model, a user-friendly, largely automated data management system (based on MS Access) has been implemented. Automated interfaces between this data management system, the GAMS model and additional, project-specific MS Excel modules allow for easy data manipulation and a quick realisation of different scenario calculations.

3.3.3 Reflex

Reflex (**R**eference **e**mission **f**actors for project-based f**lex**ibility mechanisms) is a simplified emissions and material flow model which, among others, renders future GHG emission factors for electricity production. Due to its modular structure, Reflex can both consider the entire energy system of a country and determine specific GHG emission factors for a geographic region or an economic sector of the particular host country. The Reflex model can also be applied to each different load range in electricity generation separately without taking into account the rest of the country's energy system. This is one of the major simplifications in comparison with conventional energy systems models (*e.g.* PERSEUS). However, in order to determine a set of specific emission factors for all load ranges in a sector, region, or country, Reflex must be run three times (see also below).

Reflex takes into account the projection of the electricity demand in a specific load range in a certain geographic area as well as losses due to transformation and distribution. Further input used in the model is data on energy carriers that are available for the production of electricity, data on to the economic and environmental circumstances related to the energy production technologies analysed. This input data provides the basis for the determination of a cost-optimal future energy system, which is designed to satisfy the given demand.

In contrast to PERSEUS, the optimisation in Reflex does not take into account information for all upcoming periods simultaneously; the optimisation of a certain period is only based on information for that particular period. By giving up the assumption of perfect foresight Reflex may be described as a step-by-step cost optimisation tool, which, starting from the existing energy system, determines a cost-optimal satisfaction of energy demand for the first period (period 0 in Figure 3.2). Afterwards, the 'new' energy system (output of period 0) will be handed over to the second period after which the optimisation for the second period starts, including incorporating capacity additions or switch-offs. As such, for each period within a project's crediting lifetime Reflex addresses a linear optimisation problem and passes the solution of this optimisation through to the next period where it will be the basis for a subsequent optimisation problem (see Figure 3.2).

Due to the simplified structure of Reflex, restrictions to the capacities of conversion technologies are very important. If a certain technology leads to minimum costs within a certain period, this technology will be added either until the entire energy demand is satisfied or until pre-defined restrictions of maximum capacity or the availability of the energy carrier utilised are met. This requires that in order to get a realistic picture of the future energy system, restrictions have to be set carefully taking into account the national and/or regional circumstances.

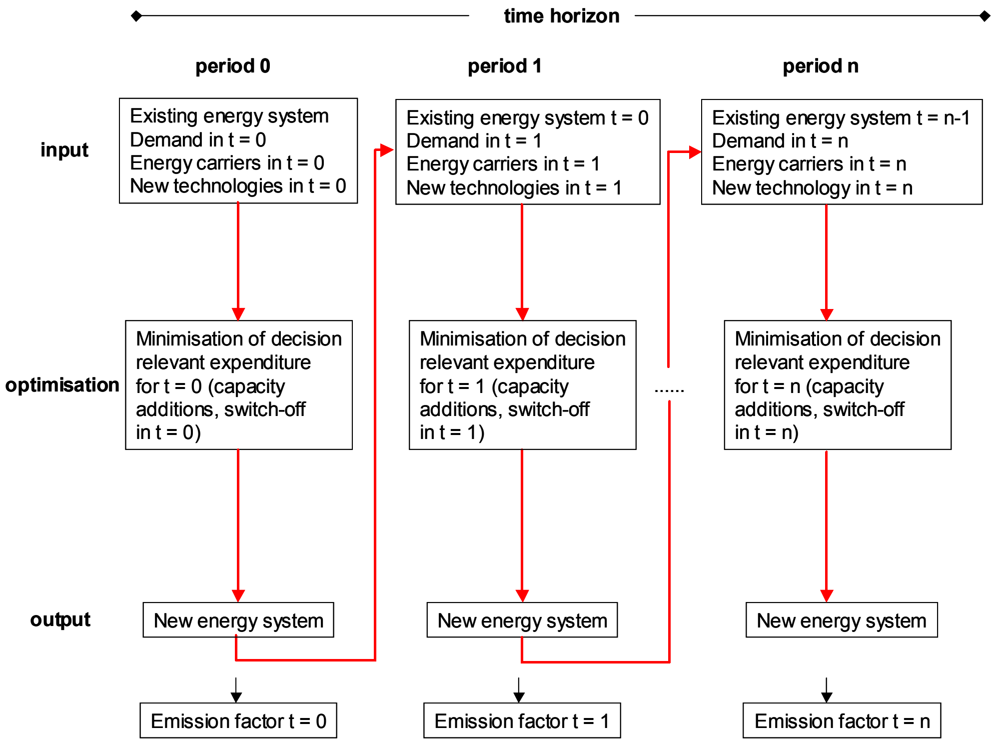

Figure 3.2. Sequential proceeding within Reflex

The model's primary output is the above-mentioned cost-optimal system of generation capacities representing a sector-wide reference scenario. Based on this system, different deductions such as the future implementation of different technologies or a projection of emission factors can be made. In order to keep the model's application as easy as possible and due to the widespread use of *Microsoft Office* products, the model's implementation is realised in *Microsoft Excel* (see Figure 3.3 for an illustration of the Reflex control panel).[87]

[87] Furthermore, Microsoft Excel provides both the possibility to flexibly include additional features by using *Visual Basic* and a solver feature for resolving comparatively small linear optimisation problems.

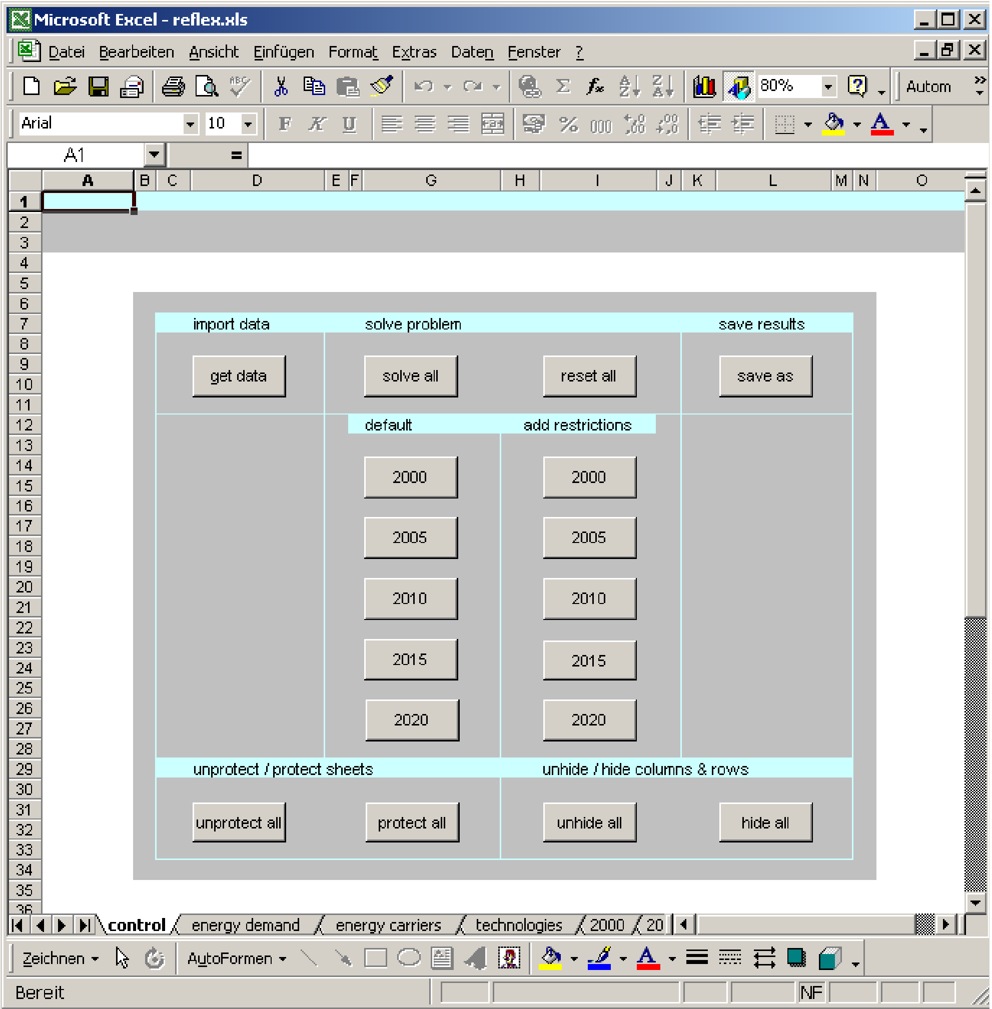

Figure 3.3. Control panel of Reflex

3.3.4 Simplified Baseline Aggregation Tool (SimBAT)

Different aggregation steps can be performed with the results of PERSEUS and Reflex in order to obtain national, regional, sectoral, or load range-specific benchmarks for JI and CDM projects. These have been diversified and implemented in a separate Excel worksheet called *SimBAT* (Simplified Baseline Aggregation Tool). SimBAT uses the output of the PERSEUS and Reflex models (*i.e.* the optimised energy system and the corresponding emissions) to calculate forward-looking average country, sector or load range-specific emissions factors (benchmark values for the baseline). Next to using SimBAT for transforming the PERSEUS/Reflex-optimised future energy systems into dynamic baselines for JI and CDM projects, it can also be used to derive static benchmarks in cases where the detailed data necessary for the sophisticated modelling is not available or where future developments are highly uncertain (see also Section 3.3.1) This is done by leaving out the first optimising modelling step and instead using current or historic overall energy system data and the corresponding emissions as input for the aggregation step (see Figure 3.1).

Below the application of PERSEUS and Reflex to Indonesia and South Africa is described with cross-references to the modelling applied to the Russian Federation (Annex 6 provides details of the modelling exercises for these three countries).

3.3.5 Application of PERSEUS and Reflex to Indonesia

This subsection shows how the above-described models have been used for baseline determination in the Indonesian electricity sector. When determining GHG emission factors for baselines for JI/CDM energy sector projects in Indonesia, it is important to keep in mind that there is no interconnection between the geographical regions of Java-Bali on the one hand and non-Java-Bali on the other. Therefore, PERSEUS delivers specific emission factors for Java-Bali and Non-Java-Bali.[88] Moreover, power generation technologies may differ considerably between sectors. Consequently, different emission factors will need to be derived for *e.g.* industry, central on-grid or rural off-grid electricity production. Finally, projects may be classified according to the load range of the technology under consideration. In the case of Indonesia, such a classification has included using a technology's annual operating hours as a criterion for its affiliation to a load range. Base load includes technologies running more than 6000 hours per year and peak load is characterised by an operation of less than 1500 hours. The remaining plants deliver intermediate load electricity.[89] Following this subdivision procedure (see Figure 3.4) the PERSEUS methodology can be used to determine emission factors for a broad range of potential CDM projects.

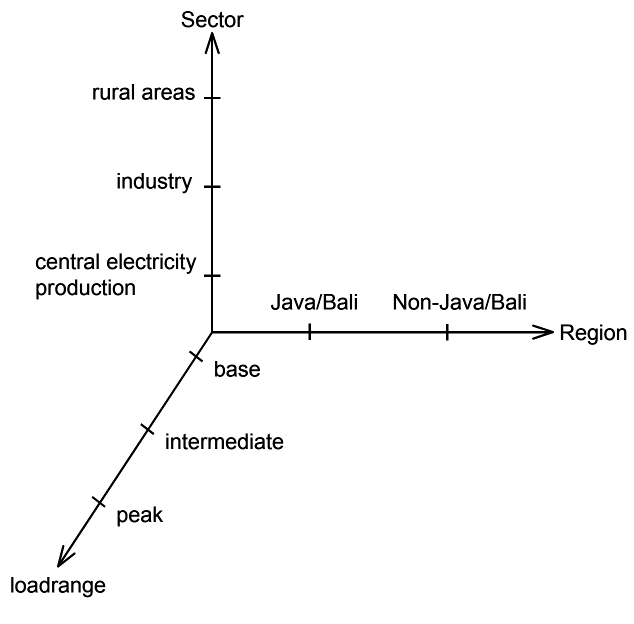

Figure 3.4. Criteria for possible sub-sets of emission factors

A summary of average baseline GHG emission factors for potential CDM projects in Indonesia up to the year 2020 is given in Table 3.2, which includes the classification of projects into different regional areas, sectors and load ranges.

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[88] The power systems of the islands of Java and Bali are connected with each other through a power cable.
[89] This sharp classification into three load ranges is rather arbitrary and not suited equally well for all circumstances. One can also take into account other classifications as will be demonstrated in the case of South Africa.

Table 3.2. Average emission factors for the Indonesian electricity sector in gCO2/kWh						
Region	**Sector**	**Load range**	**2000**	**2005**	**2010**	**2020**
Java-Bali	Central electricity production	Base	615	530	608	659
		Intermediate	408	388	388	388
		Peak	628	727	669	626
	Industry	Base	409	658	744	789
		Intermediate	920	423	404	404
		Peak	697	628	610	629
	Rural		-	-	-	-
Non-Java-Bali	Central electricity production	Base	405	293	349	516
		Intermediate	1212	1149	497	388
		Peak	673	747	763	800
	Industry	Base	526	697	754	788
		Intermediate	920	429	404	404
		Peak	674	643	604	663
	Rural		889	889	889	889
Average emission factors Indonesia			594	572	630	680

The table shows emission factors for the different sectors, regions and load ranges as well as an average emissions factor calculated for the country as a whole. Emission factors of the rural Non-Java-Bali region have not been subdivided into load ranges as only one technology (diesel generators) is added to satisfy demand in all load ranges. In Java-Bali rural electricity demand will exclusively be satisfied by central electricity generation, so no specific emission factors have been calculated for that. The table also indicates that the emission reductions granted to a specific CDM project varies widely depending on the assignment of the project to one of the relevant categories. This fact implies that a standardisation of emission factors may only be justifiable up to a certain level of aggregation and that a sensible differentiation of even standardised emission factors is vital for maintaining the environmental integrity of mitigation activities under the Kyoto Protocol by minimising leakage and free riders while still providing sufficient incentives for investors to take such projects into consideration.

Reflex-Indonesia entails six separate modules for the three load ranges – base, intermediate and peak load – of on-grid electricity generation for the two regions also identified by PERSEUS – Java-Bali and non-Java-Bali. With the model six different annual benchmark emission factors until the year 2020 can be determined using these modules. In order to be able to compare the results of Reflex-Indonesia with those of the PERSEUS model, Reflex uses the same input data as PERSEUS, *i.e.* covering economic, ecological and technological data of existing and future power plants as well as the projection of future energy demand.

According to the Reflex model, generation of base load power of the central electricity production in the Non-Java-Bali region relies on hard coal, gas, geothermal, and hydro power plants. From 2010 onwards, the expected increase in energy demand is mainly satisfied by new coal-fired power plants. Additionally, geothermal power plants will be built beginning in 2005. In order to deliver a realistic picture of the market penetration of geothermal power plants, new geothermal capacities are restricted to the addition of 500 MW per period. From this energy system and the corresponding emissions, baseline emission factors can be derived. Due to the problems connected to the determination of the least-cost technology in a certain subset, average emissions factors are identified, which are presented in Table 3.3 for the non-Java-Bali region.

Table 3.3. Average CO_2 emissions of non-Java-Bali central base load power production (gCO_2/kWh)					
	2000	**2005**	**2010**	**2015**	**2020**
Average CO_2 emissions	502	398	334	452	499

3.3.6 Sample projects evaluated in Indonesia

Eastern Indonesia Hybrid Renewable Energy Systems

The *Eastern Indonesia Hybrid Renewable Energy Systems* project aims at supplying 2800 households in remote areas of Indonesia with renewable electricity by installing 14 solar/diesel hybrid systems in villages in South Sulawesi, which so far have not been connected to the grid. The hybrid systems consist of an 8 kW PV array and a 20 kVA diesel generator with an estimated lifetime of 20 years.

The results of the analysis using PERSEUS show that cost-optimal electricity generation in rural areas of Non-Java-Bali will solely be based on diesel generators up to the year 2020, which implies that the baseline technology/fuel for this project is diesel. Since these generators are the only technology included in the baseline, the average emissions factor are about the same as the emissions factor which corresponds with the least-cost technology found by PERSEUS for this region: about 890 gCO_2 per kWh_{el}. The model analysis shows further that for period considered rural power generation will still be based on local, off-grid plants. In this case, the application of single-project baseline methodologies based on diesel generators will have the same result as the aggregating multi-project approach with energy systems modelling. However, the single-project approach will not give any indication of whether electrification will take place in the future. Apart from electricity produced in by diesel generators, the Eastern Indonesia Hybrid Renewable Energy Systems project will also lead to a replacement of kerosene for lighting. The calculation of the carbon offsets will have to be done on a case-by-case basis since the present PERSEUS-Indonesia model is only tailored for determining GHG emission factors for electricity production.

Renewable Energy Supply System Project

The *Renewable Energy Supply Systems (RESS)* project aims at supplying households and communities in remote areas of Indonesia with renewable electricity through the installation of 1000 Solar Home Systems (SHS), three micro hydro power plants (MHPP) and several PV/hybrid systems (HS). The remote areas are usually not connected to the electricity grid due to high connection costs. Under the RESS, the SHS will supply 50 kW per household with 12V direct current, the micro hydro power plants will supply 46 kW, 64 kW, and 13 kW, while the hybrid PV/wind is a photovoltaic unit with a wind generator and a diesel back-up with about 30 KW. The lifetimes are 15 years for SHS, 30 years for MHPP and 20 years for HS. The results discussed above for the *Eastern Indonesian Hybrid Renewable Energy Systems* are also valid for the RESS project since both projects are located in rural areas of the Non-Java-Bali region. Hence, diesel generators with an emission factor of 890 gCO_2 per kWh_{el} may be applied as baseline technology for electricity production here, too.[90] The substitution of kerosene as lighting fuel has to be evaluated on a case-by-case basis again.

[90] See Betz, 1997.

Sarulla Geothermal Development Project

The *Sarulla Geothermal Development Project* among others entails the construction of a 330 MW geothermal power station in the Sarulla area of North Sumatra.[91] The project has already been in preparation for several years: in 1993 Unocal Geothermal North Sumatra Ltd., Pertamina, and Perusahaan Listrik Negara (PLN, the national Indonesian electric power company) signed a 1,000 MW Joint Operating Contract and Energy Sales Contract. Since then extensive geological and geophysical surveys have been undertaken to identify the primary drilling targets, which led to the recommendation of three primary prospects to be tested by drilling, including the Sibualbuali, Silangkitang and Namora I Langit fields. Due to the economic crisis, the planned construction of electricity generating facilities in Sarulla was halted in 1997. To revive the project, in 2000 preparations started to consider it as a CDM activity. The project aims at a delivery of 2978 GWh electricity per year during the estimated lifetime of at least 20 years. Geothermal power plants typically deliver base load electricity, which implies that, regarding the Sarulla project the adequate baseline technologies are those that deliver base load electricity in the central electricity sector of Non-Java-Bali. In that technology sub-set of the Indonesian power system, PERSEUS identifies coal, gas, and geothermal power plants as the cost-optimal options.

While average emission factors are easy to handle, it is shown below that the determination of a least-cost option can lead to major methodological problems. In the case of the Sarulla project, for instance, according to the model results, geothermal power plants will be the least-cost option up to the year 2020 and thus, with geothermal power being a no-regrets option, basically no emission reduction credits would accrue from CDM geothermal activities in this region. However, the least-cost option may only be identified unambiguously if there is only one technology to be added in every subset of the model, which would imply that the emissions factor of the least-cost option is the same as the average emissions factor. However, in the case of Sarulla the potential of geothermal power plant additions per annum is restricted so that, starting from 2010, further coal power plants will be built in order to satisfy the increasing energy demand. If there is more than one technology to be added in the respective subset, unambiguous determination of one least-cost technology in every subset will not be possible since generation costs depend on the number of full operating hours. Consequently, a technology will usually only qualify as a least-cost option up to a certain range of operating hours. Especially if there are a considerable number of technologies to be implemented within a subset, there does not seem to be a practical way of identifying an appropriate least-cost technology that is valid for the entire subset. Hence, average emission factors are much more practicable.

Reflex identifies geothermal power plants as the least-cost technology for generating base load power in the Non-Java-Bali area in Indonesia, which, again, would at first sight imply that geothermal power is not eligible for crediting under the CDM. However, since Reflex does not take into account investment restrictions, the average emissions factor of the energy system (including geothermal power) will be used as a benchmark. The differences between the emissions factors determined with Reflex and PERSEUS (see Table 3.4) may be explained by the different optimisation methodologies (see Section 3.3.2 and 3.3.3).

[91] According to the Geothermal Resources Council (http://www.geothermal.org/what.html), geothermal energy is heat (thermal) derived from the earth (geo). It is the thermal energy contained in the rock and fluid (that fills the fractures and pores within the rock) in the earth's crust. See also Concise Oxford Dictionary, 9th edition: Geothermal energy -related to, originating from or produced by the internal heat of the Earth.

While PERSEUS includes a simultaneous cost optimisation of the entire energy system over all periods of the time horizon, Reflex performs a sequential optimisation for each period separately. Consequently, the composition of the future energy system determined by the two tools may well differ.[92] It remains to be discussed which methodology is most applicable in giving a comprehensive picture of the actual development of the energy sector in Indonesia.

Table 3.4. Comparison of the benchmarks determined with PERSEUS and REFLEX (gCO_2/kWh)

Non-Java/Bali, base load, central electricity production	2000	2005	2010	2015	2020
PERSEUS benchmark	405	293	349	349	516
Reflex benchmark	502	398	334	452	499

3.3.7 Application of PERSEUS to South Africa

In South Africa the parastatal company Eskom generates nearly all (appr. 95%) of the country's electricity and also owns and operates the national transmission system. The generating capacity (36,500 MW) is primarily coal-fired but also includes: one nuclear power station at Koeberg (1,930 MW), two gas turbine facilities, two conventional hydroelectricity plants, and two hydroelectric pumped-storage stations. In addition to serving the domestic market, Eskom also exports power to Botswana, Lesotho, Mozambique, Namibia, Swaziland and Zimbabwe. In August 2000, the South African Government unveiled plans to restructure Eskom (as well as other state-owned companies) in order to improve efficiency and accountability within the company. Under the plan, many of Eskom's activities, with the notable exception of electricity transmission, will eventually be privatised.

The PERSEUS model for South Africa is divided into a part covering the eastern region and a part covering the western region of the country. This partition allows for taking into consideration the fact that electricity production is mainly concentrated in the eastern provinces of Mpumalanga and Gauteng. In the year 2000 total domestic electricity demand was about 181 GWh of which 76% was consumed in the Eastern provinces while 24% was consumed in the western part. The PERSEUS model assumes this share to remain constant during all periods. Furthermore, a relatively moderate annual energy demand growth of 2.8% was assumed as input into the model. In a cost-optimal development of the South African energy system there will be an important role for domestic hard coal, which will remain dominant far into the future. Existing overcapacities in the electricity sector will be sufficient to provide enough power until around 2010, after which additional capacities will be required, *e.g.* reactivated and new high-efficiency coal-fired stations, nuclear, gas, and water capacities (import).

Figure 3.5 shows the expected CO_2 emissions derived from the modelled electricity output and the fuel sources, which cause the emissions. Table 3.5 shows baseline emission factors per kWh electricity produced for the whole country as well as for the two geographical regions. The high correlation between the national emissions factor and the one of the eastern region is explained by the above-mentioned fact that most of the generation capacities are in the eastern part and close to 90% of the South African power is produced there. The baseline for the western region is significantly lower due to the higher shares of

[92] The difference of emission factors in 2000 is caused by the fact that information on the energy system of Non- Java-Bali was not complete by the time of modelling. Thus, part of the system had to be determined by optimisation.

nuclear and hydro sources. The rise in the western part after 2010 is due to increasing shares of gas and coal-fired capacities.

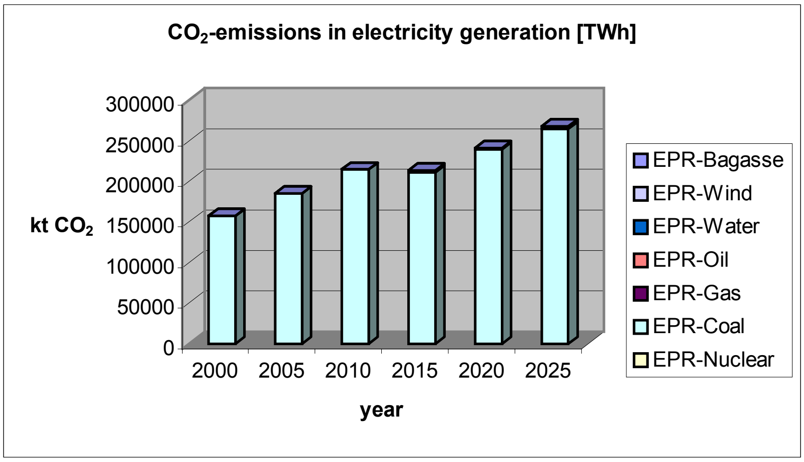

Figure 3.5. CO_2 emissions in the South African power sector

If these regional baselines were officially applied to possible CDM projects, the large difference between them might lead to a situation where project developers prefer implementing projects in the eastern region because of the greater amount of credits to be earned there. In case of energy efficiency or refurbishment measures this would be a desired effect, but if the CDM project aimed at meeting an increase in power demand in the western part of South Africa a biasing effect could occur. If the project were implemented in the western part, the credits would be calculated as a reduction below the relatively low western benchmark (*e.g.* 228 gCO_2/kWh). However, implementing the project in the eastern part and transporting the electricity via the existing transmission system to the western region would result in reductions below the eastern benchmark (*e.g.* 922 gCO_2/kWh). This large difference (about 60%) between the western and the eastern benchmark and the existence of a transmission system between both regions could easily create a bias towards investments in the eastern part so that more emission reductions can be claimed (even if losses from the transmissions were included in the calculations as a leakage factor).

Table 3.5. Emission factors on national, regional, and load-range level (gCO_2/kWh)

	2000	2005	2010	2015	2020	2025
Country-wide	844.17	857.39	876.02	825.35	812.18	795.68
Eastern Part	918.85	922.49	934.63	905.03	888.15	859.76
Western Part	229.39	228.65	227.71	390.42	466.9	465.03
Base load	829.0	852.1	876.1	815.1	793.3	796.6
Intermediate load	933.9	901.7	876.1	845.0	853.3	789.9
Peak load	1025.4	869.3	876.1	877.0	876.7	825.1

Generally, the use of regional baseline emission factors can be very useful as they provide an incentive for plant operators in regions with a high share of carbon-intensive plants to improve the performance of these plants or to implement cleaner technologies. Nevertheless, the example of the South African power system above shows that when the product (*e.g.* power) can be exchanged between the differing regions rather easily, a regional approach to the calculation of multi-project baselines can cause politically and also environmentally questionable incentives as soon as a projects intends to meet new energy demand, *i.e.* when investments for new capacities have to be made.

However, in countries with clearly separated energy systems and limited or no transmission capacities between the grids (*e.g.* Russian Federation or Indonesia) a regional baseline for each grid area will be much less likely to direct new investments to one preferred region with a higher baseline as it will usually be only a demand increase occurring in that very same grid area that is responsible for the addition of new capacities. Furthermore, the spread between regional baseline emissions factors in the Russian Federation and Indonesia (and supposedly in most other countries) is generally not as high as in South Africa.

3.4 Simplified baselines determination with Reflex and SimBAT

Especially in less developed countries the infrastructure of the energy supply sector can be rather inhomogeneous, which often goes hand in hand with great political and economic uncertainties. In countries that have to cope with such a situation, the availability and quality of data necessary for baseline determination can be very poor. This is usually also true for the institutional capacities and the availability of modelling competence. In order to enable the determination of multi-project baselines under these circumstances simplified methodologies must be applied.

As explained in Section 3.3.3, the Reflex modelling tool has been developed in such a way that it can be applied in a modular fashion, *e.g.* only for those regions of a country that have a coherent grid for electricity supply or for generation capacities which belong to a certain load range. However, in some potential host countries even the moderate data requirements for a successful use of the Reflex model may not be fulfilled. In these cases the simplified baseline tool SimBAT, which was basically developed to transform PERSEUS and Reflex modelled energy sector scenarios into baselines (see Section 3.3.4), can be used to determine static benchmark values by using very general historic data and without the prior modelling steps of PERSEUS and Reflex. Below, this application of SimBAT is illustrated for South Africa and Indonesia using historic sector average data.

For the South African power sector a highly aggregated set of capacity and power production data was compiled[93] as an input for SimBAT (Table 3.6). Even with this data set it has turned out to be possible to determine historic sector averages that do not deviate much from those calculated with the advanced models (see Section 3.3.7). This small deviation can be explained by the very homogenous structure of the South African power generation sector, which is mainly coal based. The benchmarks calculated with SimBAT are shown in Table 3.7.

Table 3.6. Accumulated power sector data for South Africa

Technology	Fuel-specific emissions factor [kt CO_2 /PJ]	Capacity [MW]	Power-Production [MWh]	Efficiency (typical) [%]
Nuclear	0.0	1,840	13,009,842	30
Coal fired	94.6	38,873	180,486,668	35
Hydro	0.0	668	1,562,856	100
Bagasse	0.0	105	307,498	26
Pumped storage	0.0	1,580	2,832,639	100
Gas turbines	73.9	662	6,119	26

[93] NER - National Electricity Regulator: Electricity Supply Statistics for South Africa 2000, Corporate Communications, Sandton, South Africa, www.ner.org.za.

Table 3.7. Static benchmarks (gCO_2/kWh) determined with SimBAT for the South African electricity sector

Load-range	Emissions [t CO_2]	Electricity [MWh]	Share of total Production [%]	Emission factor [g CO_2/kWh]
Peak load	6	6,119	0.003	1,023
Intermediate load	26,413	29,809,538	15.040	886
Base load	149,205	168,389,965	84.957	886
Total	172,625	198,205,622	100.000	886

In the case of Indonesia the situation is somewhat different. As the energy system in this country is rather diverse and differs from one region to another, the GHG emission factors calculated from the accumulated electricity data for the whole country (Table 3.8) can deviate significantly from those obtained from using the separated and more sophisticated representation of the energy sector in the models. This can be observed when comparing the SimBAT values in Table 3.9 with those found in Sections 3.3.5. Since accumulated data from the PERSEUS model for the optimised energy system for the year 2000 has been used in the SimBAT calculations, rather accurate values for the average efficiencies could be calculated, but that kind of input may not always be available in other countries. Due to the regionally diversified energy system the load range specific emission factors can different significantly between the regional sectors. An option would be to use them only for small-scale 'greenfields' and demand-side management (DSM) projects.

Table 3.8. Accumulated power sector data for Indonesia (central and rural electricity production 2000 from the PERSEUS model)

Technology	Fuel specific emission factor [kt/PJ]	Capacity [MW]	Power Production [MWh]	Efficiency (average) [%]
Coal	94.6	2,595	17,049,000	36.3
Oil	77.4	1,600	52,000	33.9
Gas	56.1	3367	13,103,000	52.8
Diesel	74.1	1,640	3,981,000	24.7
Geothermal	0.0	580	4,318,000	100.0
Hydro	0.0	2,163	6,429,000	90.0

Table 3.9. Static benchmarks (gCO_2/kWh) determined with SimBAT for the Indonesian electricity sector

Load-range	Emissions [t CO_2]	Electricity [MWh]	Share of total production [%]	Emission factor [g CO_2/kWh]
Peak load	43	52,000	0.1	821.9
Intermediate load	4,299	9,526,880	21.2	451.3
Base load	21,007	35,353,120	78.7	594.2
Total	25,394	44,932,000	100.000	564.2

Below it is examined what the effect on benchmarks is if the data availability is so poor that an even more aggregated set of historic sector data must be compiled. Table 3.10 shows accumulated capacity and power production data from the APEC energy database[94] for the whole Indonesian power sector in 1998

[94] APEC Energy Database: Indonesia (1998), http://www.ieej.or.jp/apec/database/electricity2.html.

(including industrial generation), where all thermal generation technologies are represented in one accumulated value. As neither the average efficiency data, nor the average fuel-specific emission factor of the thermal technologies are given in the database (*i.e.* would have to be best estimates in the absence of further information) they have here been calculated from the efficiencies and emission factors used in the PERSEUS model. The latter factors have been weighted with the share of the respective technologies in the total Indonesian power production. The resulting emission factors calculated with SimBAT are given in Table 3.11.

Table 3.10. Accumulated historic power sector data for Indonesia 1998

Technology	Fuel-specific emission factor [kt/PJ]	Capacity [MW]	Power production [MWh]	Efficiency (average) [%]
Thermal	74.8	16,147	58,604,000	43.5
Geothermal	0.0	363	3,656,000	100.0
Hydro	0.0	3,380	10,452,000	90.0

Table 3.11. Static benchmarks (gCO_2/kWh) determined with SimBAT for the Indonesian electricity sector

Load-range	Emissions [t CO_2]	Electricity [MWh]	Share of total production [%]	Emission factor [g CO_2/kWh]
Peak load	0	0	0.0	n/a
Intermediate load	33,701	54,469,819	74.9	618.7
Base load	2,558	18,242,181	25.1	140.2
Total	36,258	72,712,000	100.0	498.7

While a national average emission factor can still be calculated, this rough set of input data does not allow for the calculation of a peak load emission factor with SimBAT. Furthermore, the shares of base load and intermediate load power, as well as the corresponding emission factors, cannot be regarded as a realistic representation of the situation in the Indonesian electricity sector, let alone that they reasonably represent the different regions. In this case, only the national average could be used for small-scale 'greenfields' and DSM projects without the risk of giving away too many free-rider credits.

In order to take into account changes in the energy sector, these baselines should, while using the most recent available historic data, be updated fairly often. This would imply that the crediting lifetime for projects with baseline determined according to this largely simplified method using historic sector averages should preferably be kept as short as possible (*i.e.* seven years), although for countries with a very homogenous energy system, such as South Africa, a longer crediting lifetime could be possible (*i.e.* 10 years maximum as opted in the *Marrakech Accords*).

3.5 Multiple Benchmark System

3.5.1 Introduction

In order to compare and evaluate different GHG emissions benchmarks and the implications of their possible use for JI/CDM projects, PROBASE developed the Multiple Benchmark System (MBS) as a tool that constructs and compares benchmarks. It embodies three components:

1. Database: The database functions as a pool for collecting, storing and structuring the data to be used by Module 1 and 2 (see below). The information stored in the database comprises of energy generation data, GHG emissions from the energy generation and national and international energy policy information. The Database also stores benchmarks and baselines that are not constructed by the MBS but which are valuable for comparison reasons.

2: Module 1 - construction of benchmarks: Module 1 of the MBS constructs a number of possible multi-project baselines/benchmarks expressed as tonne CO_2 emissions factors per MWh generated by the project for each year of the project's crediting lifetime. Each benchmark assumes a different development path for the country, *e.g.* OECD level, world average level, regional level, *etc*. For example, if the assumption is that the host country would have adopted OECD average techniques in the future, the OECD average benchmark applies. This module uses as input from the Database data for the electricity generation and corresponding emissions and the national and international energy policies relevant for the host country analysed. The outputs, derived after the processing of the input data, are:

- a multi-project benchmark based on an estimate of the business-as-usual situation in the particular region/country/sector (the benchmark),
- the annual emission reductions calculated by taking the annual difference between the benchmark GHG emissions factor and the project's emissions level, multiplied by the project's activity level, and
- the cumulative emission reductions for the whole project lifetime calculated by taking together all annual emission reductions for the project.

The MBS applies different aggregation dimensions to establish benchmarks, such as sectoral, geographical and fuel/technology aggregation paths. Furthermore, benchmarks can be derived, given the aggregation level chosen, from historical, current of projected data samples. Options to define stringency levels of the constructed benchmarks are also incorporated into the MBS. Finally, MBS contains the possibility to construct benchmarks for several time periods.

Another type of benchmark elaborated on in Module 1 is the *Fuel-specific, combined country and regional benchmark*, which determines benchmarks by taking weighted average emission factors of *e.g.* currently operational fossil fuelled power plants in a particular host country, those of power plants in the region in which the country is located, and the emissions factors of plants in the World's best region with the lowest emissions factor. The geographical disaggregation of the International Energy Agency (IEA) *World Energy Regional Breakdown* is used to determine the host country and the region. Electricity generation data and CO_2 emissions from electricity production from each of the fuels are derived from the IEA's *World Energy Outlook 2000*. The methodology for determining *fuel-specific, combined country and regional benchmarks* is explained in further detail in subsection in Annex 6 (see also Section 2.3.6).

3. Module 2 - comparison and testing of benchmarks: Module 2 compares the benchmarks constructed in Module 1 and those stored in the database by applying them to a number of case study projects and by analysing whether and why the GHG emission scenarios derived from the benchmarks differ. The system can be applied to several types of projects such as electricity generation from fossil fuels and renewable sources of energy as well as heat generation and co-generation projects. Schematically, the MBS is presented in Figure 3.6.

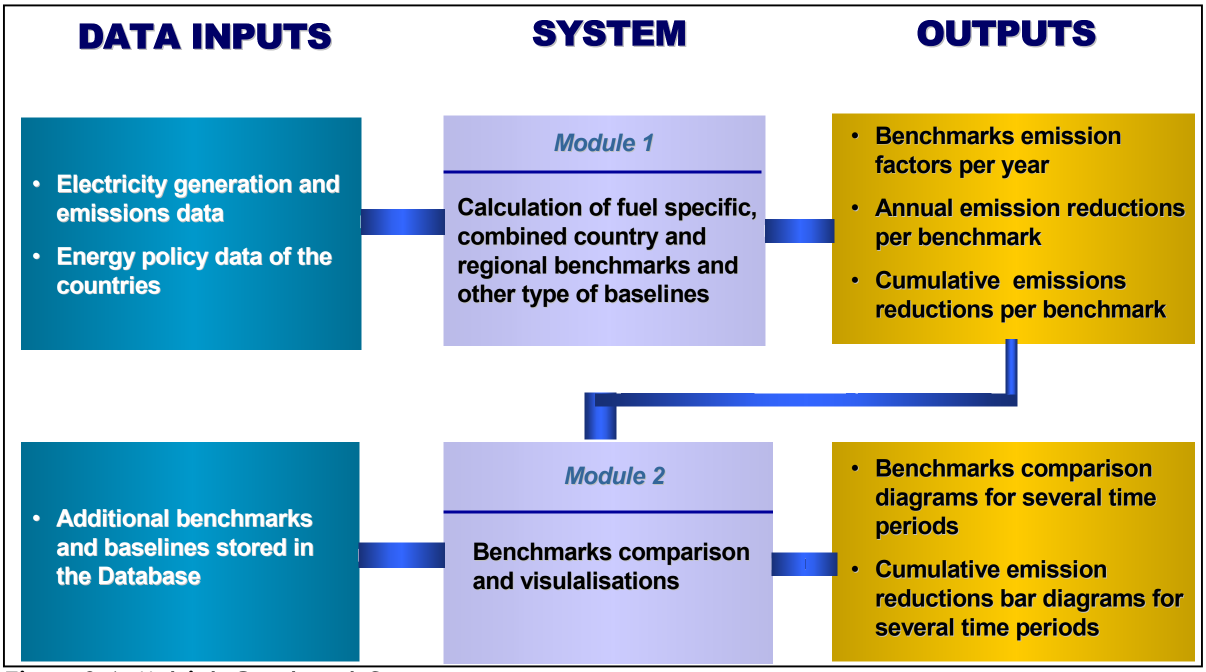

Figure 3.6. Multiple Benchmark System

The MBS has been applied under PROBASE to the following case study projects, which are registered as official AIJ projects or considered as a CDM activity:

- **Sarulla geothermal development** (for a description see Section 3.3.6),
- **Eastern Indonesia hybrid renewable energy systems** (for a description see Section 3.3.6), and
- **Nizhny Novgorod wastewater treatment plant** (for a description see Section 3.5.3).

For these projects the lifetime is considered to range from the year 2000 through 2020 and for this time interval the benchmarks and the emission reductions are calculated.

3.5.2 Application of MBS-constructed benchmarks to Indonesian case study projects

The project developers of the *Sarulla geothermal development* project constructed a baseline for the project based on the assumption that without the project the existing coal power plant (to be replaced by the project), with 36% efficiency fed with sub-bituminous coal, would have continued its operation. This has resulted in an officially reported baseline emissions value of 0.964 tCO_2/MWh, which is assumed to remain constant for the whole project lifetime. Also for the baseline of the *Eastern Indonesian hybrid renewable energy system* the project developers assumed that the pre-project situation would have continued in absence of the project. The resulting single-project baseline assumes that the use of kerosene for electricity generation and lighting would have led to 480 kg CO_2 emissions per household annually, which adds up to 1.3 $ktCO_2$ per year. The emissions factor of this baseline is 0.258 tCO_2/MWh.

For Indonesia, the MBS has constructed several types of benchmarks, which present differences according to their level of geographical and sectoral or fuel/technology aggregation and the data sample used (historical or future-oriented/projected). The *Sarulla geothermal project* and the *Eastern Indonesia hybrid renewable energy systems* are treated by the MBS as renewables projects. Table 3.12 presents the benchmarks derived by the MBS for these two projects.

Table 3.12. MBS benchmarks constructed for Indonesia

Benchmark name	Benchmark short description
B1 World's best region	Benchmark based on the weighted average emissions of all fossil fuel power plants (coal, oil, natural gas) in the world's best region, using historic data. The world's best region has the lowest weighted average emissions[95] of fossil power plants of all the world's regions.
B2 World average	Benchmark based on the weighted average emissions of all fossil fuel power plants (coal, oil, gas plants) in the world, using historic data.
B3 OECD average	Benchmark based on the weighted average emissions of all fossil fuel power plants (coal, oil, gas plants) of all OECD countries, using historic data.
B4 National energy sector average in Indonesia	Benchmark based on the weighted average emissions of all Indonesian power plants (fossil fuelled and renewables) in the year 2000. Its value is 0.54 tCO_2/MWh and is assumed constant for the period 2000-2020[96].
B5 National energy sector projected average in Indonesia	Benchmark based on the projected weighted average emissions of all Indonesian power plants (fossil fuelled and renewables) until the year 2020[97].
B6 National fossil fuel average in Indonesia	Benchmark based on the weighted average emissions of all fossil fuel power plants (coal, oil, gas plants) in 1998. Its value is 0.761 tCO_2/MWh and is assumed to remain constant for the period 2000-2020[98].
B7 Best Available Technology (BAT)	Natural Gas Combined Cycle Advanced is considered the default BAT with an emission factor of 0.36 tCO2/MWh that remains constant for 2000-2020.
B8 Fuel-specific, combined country and regional benchmark for Indonesia	The benchmark is calculated according to the methodology described above.

Figure 3.7 presents the MBS-constructed benchmarks for the period 2000-2020 (in tCO_2/MWh) and compares these with those calculated using the PERSEUS and Reflex models (see Section 3.3) and with the officially reported baselines for the *Sarulla geothermal* (a similar graphical analysis has been done for the *Eastern Indonesia Hybrid Renewable Energy Systems* project, which is shown in Annex 6). The Figure clearly shows that the assumption in the officially reported baseline of a constant annual GHG emission factor of 0.964 tCO_2/MWh for the period 2000-2020 is not supported by the benchmarks found for Indonesia or the non-Java-Bali region in Indonesia.

[95] For all projects the data for B1, B2, B3 and B8 benchmarks is derived from the IEA's World Energy Outlook 2000.
[96] The data for B4 is derived from the National Strategy Study on CDM in Indonesia (State Ministry of Environment, 2001). The benchmark "National energy sector projected average" from Indonesian government, 1999, is derived from the MARKAL model and implies that after 2005 fossil fuels, especially coal, in the use for power generation will be rapidly growing resulting in the increasing trend of the benchmark.
[97] The data for B5 is derived from Indonesian government, 1999.
[98] The data for B6 is based on IEA, 1999.

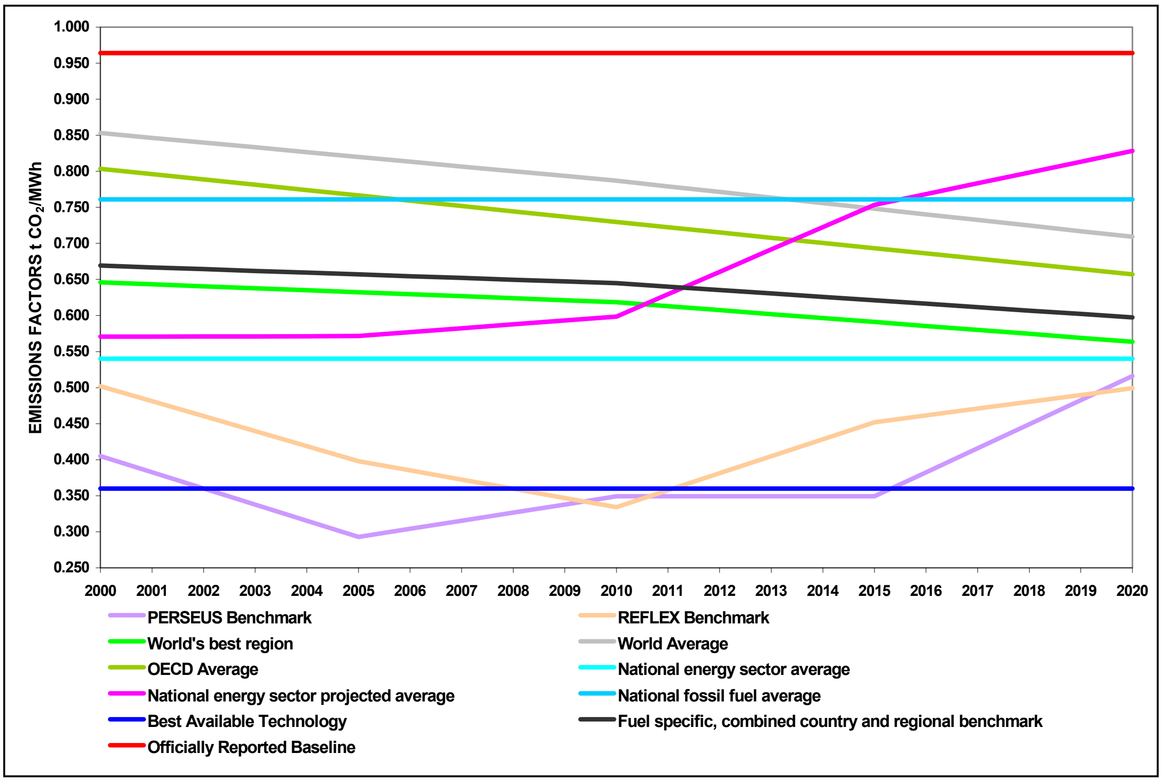

Figure 3.7. Comparison of the benchmarks for the Sarulla geothermal project

As explained in Section 3.3.5 the PERSEUS and Reflex benchmarks for the non-Java-Bali region assume that the *Sarulla geothermal development* project displaces base load capacity in the central electricity production (on-grid), which will be met by coal, gas and geothermal plants until 2010 and from then onwards the gas plants are not part of base load generation any more while the largest part of it will be generated by coal-fired plants (see Figure 3.7). The PERSEUS benchmark for the *Eastern Indonesia Hybrid Renewable Energy Systems* project assumes that without the project off-grid diesel machines would have generated the electricity in the rural area of South Sulawesi. This benchmark faces difficulties to be applied to other than off-grid electrification projects because it incorporates only the special circumstances of the rural areas' electricity supply.

The **National energy sector average** benchmark (B4), based on the year-2000 situation, provides an incentive to upgrade or replace plants with emissions that are already below the national energy sector average. Using this benchmark would generate more credits than the actual GHG emission reductions achieved. On the other hand, the **National energy sector projected average** benchmark (B5) is based on the assumption that as of 2010 mainly coal capacity will be added to the energy sector capacity to meet increased energy demand (see also Section 3.3.5), which is reflected by the increasing slope of the curve in Figure 3.7 after 2010. This benchmark rewards a large number of projects ranging from zero emitting ones to efficient coal technologies (*i.e.* integrated coal gasification combined cycle, IGCC) especially in the years after 2010/2012 when the benchmark level is increasing rapidly. Note that although the slope of this projected national average baseline is more or less the same as the PERSEUS baseline scenario, its benchmark values are much higher than those of PERSEUS are. A likely explanation for this difference is that PERSEUS specifically models the electricity production for the non-Java-Bali region in Indonesia, rather than for Indonesia as a whole.

The **National fossil fuel average** benchmark (B6) is derived from the average emissions factor for power generation from fossil fuels in 1998 and assumes this average to remain constant for the future. Consequently, it does not take into account any changes in the power generation in the future. The benchmark favours all the natural gas and renewables CDM projects[99] and also advanced fuel technologies with high carbon contents could beat the benchmark, even if the fuel is coal. However, since this benchmark is set with no stringency thresholds, it may allow free riders to earn credits.

In terms of spatial aggregation the **World average** (B2) and the **OECD average** (B3) benchmarks are the more aggregated multi-project baselines of Table 3.6. Their trend is descending as the forecast incorporates the evolutionary change of technology in more efficient forms. In case these benchmarks were globally applied there would be no room for investors to prefer one country to another because the baseline for a particular project type would be the same everywhere.[100] However, these benchmarks might not perform well in terms of environmental integrity, possibly allowing a significant number of free riders and leaving room for gaming and overcrediting of particular projects. For Indonesia, World average and OECD benchmarks can be beaten by relatively efficient coal and oil technology projects that are commercially proven and viable, although these (fuel)technologies would probably not generate as many credits as natural-gas plant and renewables projects.

The **World's best region** (B1) benchmark is considerably more conservative that the World average and OECD benchmark and it is likely that only highly efficient coal and oil technologies, as well as the majority of natural gas technologies and renewables will be able to reduce emissions below this multi-project baseline.

The **Best Available Technique (BAT)** (B7) benchmark reflects the most conservative multi-project baseline level for Indonesia.[101] For the Sarulla project (on-grid, non-Java-Bali) the BAT benchmark is in the same range of conservatism as the PERSEUS and Reflex benchmarks, whereas for the *Eastern Indonesia Hybrid Renewable Energy Systems* project BAT is only beaten by, surprisingly, the single-project baseline reported by the project developers. In order to be eligible for crediting a CDM natural gas project should be better than an advanced combined cycle-technology (see table 3.6) or be a renewables project with no emissions at all. Further investigation is needed to explore whether a globally defined BAT could realistically describe the baseline case in a country like Indonesia because sophisticated technologies, such as BAT, need high investments, special skills, human capacity building, *etc.* which may not always be available in CDM host countries and therefore make a BAT assumption under business-as-usual unreasonable.

As explained above, the **Fuel-specific, combined country and regional benchmark** (B8) linearly combines the weighted average emissions factors of all currently operational fossil fuelled power plants of Indonesia, those of the region East Asia and ones of the World's best region. As this benchmark uses

[99] Although natural gas is a fossil fuel too, it has a lower GHG-intensity than coal, so that, taken alone, its emissions-intensity is lower than a fossil fuel average.
[100] For example, applying a national average benchmark globally would still result in different baseline emission levels per country despite the standardised method.
[101] The BAT in this context refers to the internationally existing best available technique, which is different from the BAT application under the EU *Acquis Communautaire*, which defines BAT as what is the best among available techniques in the host country itself.

already available data, its construction is not cumbersome and its development costs can be kept low. The benchmark combines some of the above benchmarks as it takes the present situation of fossil fuel plants in Indonesia as a starting point and adds to that scenario the assumption that Indonesia's development will be in line with that of the East Asian region with the availability of technologies that are currently operational in the World's region with the lowest GHG emissions from fossil fuel plants.

The Fuel-specific, combined country and regional benchmark favours fuel switch to low-carbon fuels like natural gas while investments in high efficiency and advanced coal plants may also reduce emissions below the benchmark, but to a smaller extent. In general it can be argued that the 'Fuel-specific, combined country and regional benchmark' provides a balance between the tighter benchmarks and the more lenient ones described above (see Figure 3.7), which is reflected by the fact that the amount of GHG emissions reduced below the benchmark is exactly in the middle of the emission credits of all the other benchmarks.

3.5.3 Benchmarks constructed by MBS for the Nizhny Novgorod Wastewater Treatment Plant

At aeration stations in the Russian Federation effluents[102] are cleaned biologically with the remaining sludge being treated in an anaerobic reactor. From this process, both biogas and waste heat are produced and emitted into the atmosphere without being used. However, the cleaning of effluents requires a considerable heat input, which is generated nowadays by gas-fired boilers and, additionally, electricity is required from the local grid. The aim of the *Nizhny Novgorod Waste Water Treatment Plant* project is to utilise the biogas produced for power generation and the waste heat for the drying process.[103] The city of Nizhny Novgorod is situated in the Unified Power System (UPS) centre in the European part of the Russian Federation.

Table 3.13 presents the benchmarks derived by MBS for the *Nizhny Novgorod Wastewater Treatment Plant* project. These benchmarks, together with the three PERSEUS model benchmarks and the Reflex benchmark (see Section 3.3) are presented in Figure 3.8.[104]

The two **PERSEUS** benchmarks for the Russian Federation and its European part (PERSEUS benchmarks 1 and 2), which, in fact, are energy sector averages including all power plants and co-generation,[105] show relatively low baseline emission levels. The fact that the benchmark for the European part is lower than for the country as a whole can be explained by the considerable share of nuclear, hydro and CHP plants in the production of electricity in the European part of the Russian Federation. The same conclusions can be inferred from the **Reflex** benchmark. In order to reduce emissions below the relatively conservative PERSEUS and Reflex benchmark projects must implement more advanced technologies, such as fuel switching, natural gas, renewables and demand-side management investments.

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[102] Sewage or industrial waste discharged into open water (*e.g.* river *etc.*).
[103] See PLANAIR/RWB, 2000.
[104] Section 3.3 has not specifically addressed the PERSEUS modelling for the Russian Federation; for a detailed assessment the reader is referred to Annex 6.
[105] The PERSEUS model used for the Russian Federation is not capable of calculating load range-specific emission factors, so sector-specific ones have been used (see for details Annex 6).

Table 3.13. Benchmarks for the Nizhny Novgorod waste water treatment plant project

Benchmark name	*Benchmark short description*
B1 World's best region	Benchmark based on the weighted average emissions of all natural gas fired power plants in the world's best region, using historic data. The world's best region has the lowest weighted average emissions of fossil power plants of all the world's regions.
B2 World average	Benchmark based on the weighted average emissions of all natural gas fired power plants in the world using historical data.
B3 OECD average	Benchmark based on the weighted average emissions of all natural gas fired power plants of all the OECD countries, using historical data.
B4 National energy sector average in Russian Federation	Benchmark based on the weighted average emissions of all Russian power plants (incl. CHP), fossil fuelled, renewables and nuclear in 1997. The benchmark remains constant for the whole project lifetime.[106]
B5 National energy sector projected average in Russian Federation	Benchmark based on projections of the weighted average emissions of all Russian power plants, fossil fuelled, renewables and nuclear, until 2020.[107]
B6 National gas-specific projected average in Russian Federation	Benchmark based on the projected weighted average of all Russian natural gas fuelled power plants until 2020.
B7 Best Available Technology (BAT)	Natural Gas Combined Cycle Advanced is considered to be the default BAT with an emission factor of 0.36 tCO_2/MWh that remains constant for the whole project lifetime.
B8 Fuel-specific, combined country and regional benchmark for Russian Federation	The benchmark is calculated according to the MBS methodology described above.

Another gas-specific benchmark constructed by the MBS is the **World's best region** (B1) benchmark, which is practically a projection of the weighted average emissions factor of all the natural gas power plants in the region of the world with the lowest emissions factor. This firm benchmark appears to 'endanger' some natural gas projects that do not perform as well as the most advanced gas technologies. Furthermore, the advanced technologies of electricity production through natural gas might receive a few credits under this benchmark. In other words, this benchmark encourages in some way the fuel switch to natural gas but the credits accrued might be little. The **OECD average** (B3) benchmark has a slightly higher emissions level than the 'World's best region' benchmark.

The most lenient among the geographically aggregated benchmarks is the **World average** (B2) benchmark, which incorporates the global tendencies for the gas power plants in terms of environmental performance. The 'World average' benchmark allows a larger number of gas project types, including more gas electricity generation technologies, to reduce emissions below the benchmarks. It is also possible for some oil technologies to beat the benchmark although the credits will be limited.

[106] Data for B4 is originated from the UNFCCC 2000 "In-depth review of Second National Communication of Russia".
[107] Data for the B5 and B6 is originated from IEA's World Energy Outlook 2000.

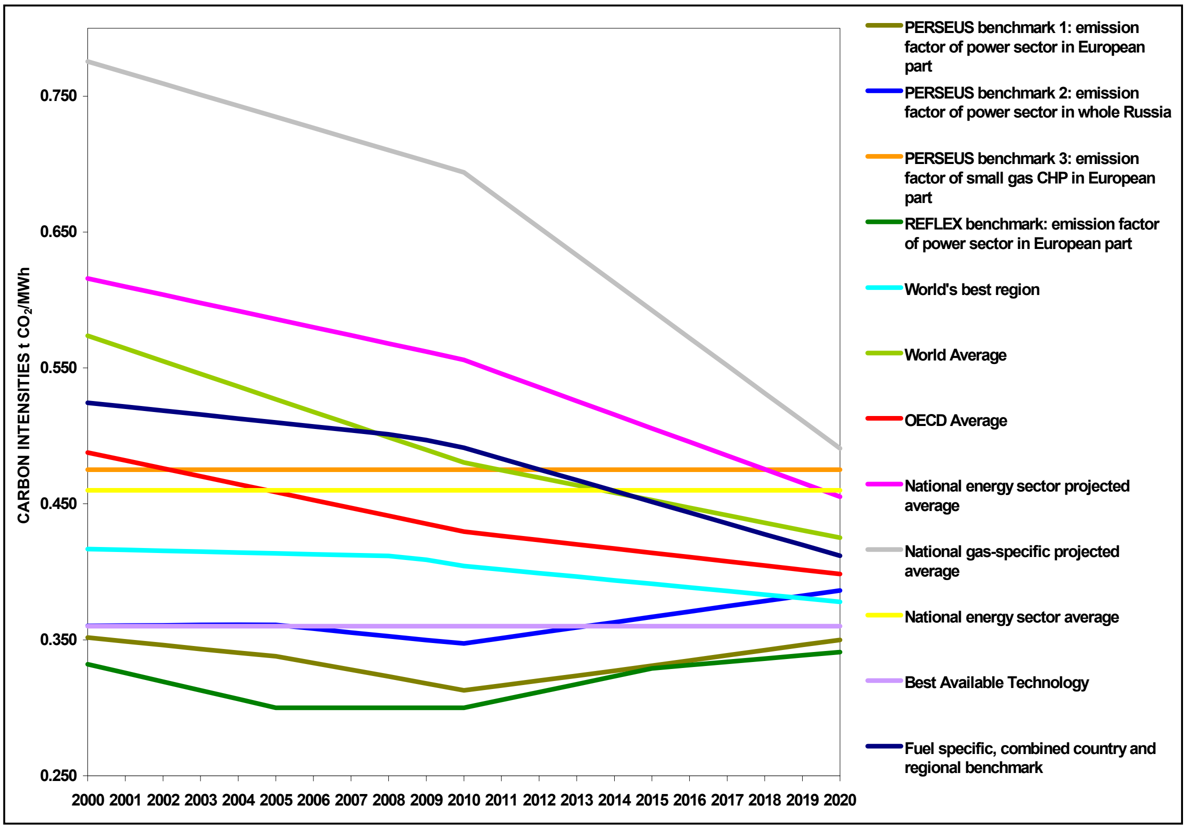

Figure 3.8. Comparison of the benchmarks for the Nizhny Novgorod Wastewater Treatment Plant project

The **National gas-specific projected average** (B6) benchmark includes all the gas plants of the Russian Federation and embodies also all outdated technologies of the existing plants and reflects the poor operational efficiencies and maintenance as well as the obsolete state of the equipment. However, the projected future decline reveals a trend of gradual withdrawal of old plants and technological improvements over the years (see the grey curve in Figure 3.8). Natural gas technologies receive most credits under this benchmark, although almost all natural gas power generation technologies, whether they are advanced or not, would be able to reduce emissions below this benchmark, which might increase the possibility for free riders. This benchmark would also credit advanced coal technologies (*e.g.* pulverised fluidised bed combustion, integrated gasification combined cycle) as well as advanced oil technologies (*e.g.* combined cycle turbines).

The crediting of coal and oil technologies would be impossible under an energy sector-wide benchmark as these technologies have emission levels that are higher than those corresponding with the latter benchmark. All other benchmarks (including CHP) would result in (much) more conservative baselines for natural gas projects, so that only highly efficient natural gas technologies, like combined cycle turbines and CHP plants, can claim credits below the baseline, thereby reducing the risk of overcrediting and free rider ship without abandoning opportunities for natural gas projects. These benchmarks also can credit projects that upgrade the efficiency of existing natural gas installations.

The benchmarks that cover the whole energy sector (including the RERSEUS and Reflex benchmarks) generally hardly encourage coal-to natural gas or oil to natural gas fuel switch. The exception is the **National energy sector projected average** (B5) benchmark, which assumes less CHP plants in its scenario and is therefore less conservative than *e.g.* the **National energy sector average** (B4), which assumes an extensive use of CHP. The low baseline emission levels resulting from **PERSEUS** and **Reflex** enable only the crediting of technologically advanced natural gas plants projects and renewable energy projects.

3.6 Forestry baselines - standardisation of selected baseline aspects

3.6.1 Introduction

So far the specifics of baseline determination for forestry projects under the CDM and JI have not been as thoroughly researched as for *e.g.* energy sector emission reduction projects. Even at present, the discussions on baseline rules in the methodology panel of the CDM Executive Board do not address forestry project issues; these are relegated to the overall discussion on sinks project rules scheduled for later in 2003. The little focus on the modalities of forestry projects under the CDM was for a long period of time caused by the uncertainty about whether sink enhancement projects such as forestry activities would be eligible under the Kyoto mechanisms at all. Only at COP6*bis* (July 2001) it was decided under the *Bonn Agreement* [108] that afforestation and reforestation projects are eligible CDM activities, but that forest conservation/preservation projects can, at least for the time being, not take place under the CDM. This decision implied that about half of the experience with baseline determination for forestry projects under the AIJ pilot phase could not effectively be used anymore for CDM forestry activities. After all, 4 of the AIJ forestry projects deal with afforestation activities, 5 projects aim at reforestation and 9 projects are forest conservation/preservation activities.

The main issues that distinguish sinks projects from emission reduction projects are:

- **Permanence**: how long will carbon taken up in a new forest (afforestation or reforestation) remain sequestered in the trees, which relates to the issues of forest maintenance and forest rotation cycles?
- **Leakage**: although leakage is also an accounting issue for emission reduction projects in *e.g.* the power sector, the risk of carbon benefits being offset by carbon releases elsewhere is generally considered larger for forestry projects.[109]
- The importance of **space** for the forestry project: unlike energy projects where critical factors are the fuel and the activity level while the area covered by project installations generally has no relevance, the size of the area plays a major role for forestry projects.

Next to a detailed analysis of baseline determination for forestry projects, PROBASE Workpackage 8 has analysed in detail the issues of leakage and the importance of space as these have a direct impact on the calculation of carbon sequestration through forestry projects (see Annex 7).

As explained in Annex 7, the baseline for forestry projects and the accounting of the net carbon uptake is influenced by various social factors. These factors, however, might differ strongly between nations or even regions within nations so that a broad aggregation of forestry baselines (by means of standardisation as *e.g.* benchmarking) is difficult if not impossible.

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[108] UNFCCC, 2001a.

[109] It should be noted though that the leakage risk is largest for forest conservation projects where a project halting a deforestation may easily lead to extra deforestation elsewhere.

Instead of developing multi-project baselines for the forestry sector, the analysis has therefore focussed on options for standardising the baseline methodology for forestry project as well as standardising single aspects/parameters of the baseline (see also Introduction to this report).

3.6.2 Standardisation of baseline methodology and baseline parameters

As a first step in the process of standardisation a **template** is developed for baseline setting as well as for the calculation of the leakage and the determination of uncertainty. Such a template would make the quantification of GHG benefits achieved through forestry projects comparable over a broad range of projects. A next phase in the standardisation process involves the identification of those steps in the template, which could be further standardised, *e.g.* by applying default values for certain project types. These standardised default values could help making the baseline determination process for forestry projects more transparent and easier, but could also be applied if for single-project baselines certain minimum data requirements (in terms of data quantity and quality) are not met. Then the default values could be taken instead. Under PROBASE Workpackage 8 (see Annex 7) such a template has been developed and 'tested' on five forestry case studies from potential JI and CDM countries: Brazil, Costa Rica, Romania and the Czech Republic. Insights from these case studies have been used to refine the template in an iterative process. The outcome of this process is a refined multi-project manual for forestry projects, which, although there is still scope for improvement at some points, can be considered a solid basis for the standardisation of the accounting of forestry project carbon sequestration, including baseline determination and leakage estimation. The individual steps in the process of determining GHG benefits of forestry projects are shown in Figure 3.9.

1. Project eligibility

- Standardised LULUCF definitions
- Additionality assessment[110]

2. Definition & description of system boundaries

- Geographical boundaries
- Temporal scope

3. Identification of relevant carbon pools

- Components of forestry systems
- Greenhouse gases

4. Inventory of GHG situation within system boundaries

- Current GHG-stock
- Consideration of pre-project emissions
- Variability over time

5. Estimation of GHG-situation in baseline case within system boundaries

- GHG-stock/carbon removals
- GHG-emissions of human activities
- Variability over time

6. Estimation of GHG-situation in case of project implementation within system boundaries

- GHG-stock/carbon removals
- GHG-emissions due to project activity
- GHG-emissions by human activities
- Trends over time

7. Leakage and uncertainty assessment

→ Results in a subtraction/correction factor, taking into account *i.a.* measurement/monitoring uncertainties and potential leakage effects

8. Determination of credits to be earned by the project

Maximum amount of credits = (GHG situation in baseline case [5] – GHG situation in project case [6]) * correction factor [7]

The maximum amount of credits that can be earned by project also strongly depends on the accounting method chosen

Figure 3.9. Accounting GHG abatement through forestry projects

Within the scope of PROBASE the focus has been on those issues, which directly influence the baseline as well as those related to leakage and uncertainty (relevant steps are indicated by double frames in Figure 3.9). Other aspects of accounting – *e.g.* advantages and disadvantages of the ton-year-approach, the Temporary CER proposal submitted by the EU at COP-8 as an attempt to deal with the permanence issue, *etc.* – are not included in the assessment of PROBASE Workpackage 8 given that this would increase the complexity of the analysis, which main objective is to explore possibilities for standardisation of both baseline procedures and parameters for forestry projects.

3.6.3 Main elements of the proposed template

For the purpose of this study, a two-tired structure was chosen: the template itself describes the individual steps of baseline determination that need to be made by project developers and also provides explanatory information for each step. Subsequently, each step requires answering a number of questions, which guides the project developer through a process of: categorising the project (*e.g.* afforestation, reforestation, forest management), exploring the project's eligibility under JI and the CDM, setting a system boundary for the activity, identifying the relevant carbon pools under the project, quantifying the pre-project carbon stocks, determining the actual baseline scenario, estimating the GHG situation after project implementation, estimating leakage, and considering uncertainties and risks (the questions that need to be answered by the project developers in each steps are explained in detail in Annex 7).

[110] As noted elsewhere in this section, an international debate on whether an additionality check has to be conducted on a mandatory basis or a voluntary is currently still ongoing.

Project eligibility

The very first step in developing a JI/CDM project is to check whether the planned project activity is eligible under the UNFCCC regime – *i.e.* the Kyoto Protocol, the *Marrakech Accords* and the decisions of the CDM Executive Board. In the template an eligibility check is envisaged in terms of checking, in case the project is a CDM activity, whether the project type is indeed a reforestation or afforestation activity, as well as assessing (on a voluntary basis) the project's 'financial' additionality – including both ODA and investment additionality. The latter check (also called 'micro-additionality') is included to prevent that credits are generated from forestry projects that would have happened anyway. However, an international debate on whether an investment additionality check has to be conducted on a mandatory basis or not is currently still ongoing. A two-stage approach is discussed to determine project micro-additionality. First, a qualitative '*incentive-/barrier-based-approach*' is conducted, followed by a quantitative evaluation of the project's internal rate of return (IRR). The final evaluation of a project can then be based on its scoring in the two stages. From the point of view of project developers, it would only make sense to determine a baseline if the intended project passes the eligibility check.

Definition of system boundaries and description of the project site

As mentioned above, the definition of an appropriate project 'area' is much more important and complex for forestry projects than for technical emission reduction projects. In the template for determining baselines and estimating leakage a concept of concentric areas is used (see also Figure 3.10), which consists of:

- The project area (PA),
- The observation area (OA) and the
- The project influence area (PIA).

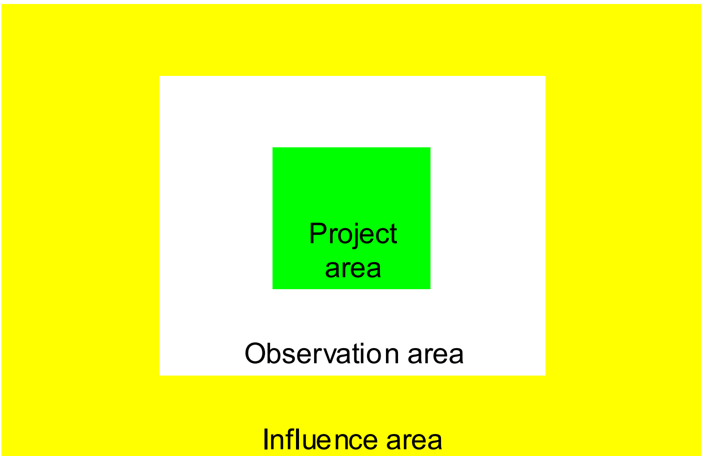

Figure 3.10. Areas for baseline and leakage determination (boundaries)

The *project area* is identical with the geographic boundaries of the project area, *i.e.* the area under direct control of the project developers. The OA shall be a circular area of 5-10 times the project area around the geographic centre of a contiguous project area[111]. Most of the project's indirect effects (leakage) will appear in the OA. The OA will also be relevant for the baseline choice as it helps to adapt the baseline to local/regional conditions. The PIA is generally identical with national borders or boundaries of political influence and is relevant for leakage determination as well (for the institutional implications of determining the OA, see Section 4.2.4).

Next to those geographical aspects, the temporal scope of the project is important – *i.e.* its activity level over time. While the baseline might remain unchanged over the project's crediting lifetime, the project's activity level needs to be considered when calculating GHG benefits. In this section of the template, project developers are asked to identify geographical and temporal project boundaries as the basis for later calculations.

Identification of relevant carbon pools

Calculating the GHG benefits from a forestry project requires that all 'relevant' GHG pools be taken into account. A crucial issue in determining the area's carbon pool is the spatial resolution. As the term 'relevant' is highly subjective and might be differently interpreted by project developers, it is proposed by PROBASE to use a standard definition of relevance: all carbon pools that account for at least 5 percent of the total GHG stock within the project boundaries are considered relevant.

Next to the trees and soils, also wood products (*e.g.* paper and furniture) constitute a major carbon stock. Given the present negotiations and scientific positions, carbon sequestrations in these pools can currently not be accounted for under the CDM. Besides this project type not being eligible for the first commitment period, an accurate quantification of carbon sequestered in wood products requires a lifecycle analysis, including a chain-of-custody analysis, which would monitor the several subsequent stages of the wood once it has left the forests. Obviously, an appropriate number of wood product categories could be defined (*e.g.* differentiated by their lifetime) with 'carbon stock benchmarks' defined per category. The latter, however, would need to be internationally agreed before it could be applied in the context of a future commitment period, which is likely to require further research and negotiations. For this reason the option of considering wood products as a carbon pool has been left out of the PROBASE study.

Initial inventory

The initial inventory supports the quantification of the baseline as it reflects the current situation of carbon stocks and it helps quantifying the project's carbon sequestration. An initial inventory is a prerequisite for development of the monitoring plan and the definition of monitoring requirements. It is conducted by an area-based approach (in contrast to an activity-based approach that might be used to determine the GHG benefits of the project activity) and should consider all relevant carbon pools identified. Table 3.14 gives an illustration of this approach. Depending on the project modality data requirements obviously differ.

[111] Adaptations are necessary in case the OA includes protected areas or crosses national borders.

Table 3.14. Example of an initial inventory

	Biome 1	Biome 2	Biome n	Sum
ha [total]				
Aboveground (live) vegetation	[t $CO_{2\text{-eq}}$ per ha]			
Underwood/debris	[t $CO_{2\text{-eq}}$ per ha]			
Belowground biomass	[t $CO_{2\text{-eq}}$ per ha]			
Topsoil carbon	[t $CO_{2\text{-eq}}$ per ha]			
Mineral soil	[t $CO_{2\text{-eq}}$ per ha]			
Sum				

Carbon stock and GHG emissions in the baseline case

The *Marrakech Accords* offer three approaches for baseline determination: '*current emissions/land use'*, *'top 20% of comparable projects'* and '*economically most attractive land use*',[112] although the *'top 20% of comparable projects'* option does not seem appropriate for forestry projects. Using the '*current emissions/land use*' as a baseline neglects any future land use and thus carbon stock changes. However, in contrast to *e.g.* energy sector projects, the influence of social conditions on a forestry project's GHG benefits is rather large, which requires that future land-use changes must be predicted and incorporated into the baseline. Therefore, it can be concluded that of the three baseline approaches mentioned above showing the economically most attractive land-use alternative would serve best as a baseline for forestry projects.

A determination of the economically most attractive alternative can either be conducted in a 'single-project' approach – *i.e.* reasonably arguing which land-use form is the one to be expected by looking at the determining drivers behind actual land use and land-use change – or in a multi-project form based on recent land-use changes in the observation area (see above). For the standardised multi-project approach, several options exist:

- The land-use option which covers more than 50 percent of the observation area.
- The land-use option whose weighted average of the current share in the observation area and the share in land-use changes of the last five years is the highest of all land-use options.
- The shares of land-use options that exist on the observation area.
- The weighted average of current shares in the observation area and shares in land-use changes of the last five years.

After choosing the most appropriate baseline category the project area's carbon stock needs to be determined, which should be done by direct measurements. An option for standardisation would be to use benchmarks for carbon stocks depending on the expected type of land use, which, however, seems to be surrounded with large uncertainties due to *inter alia:*

- strong differences in soils over short distances that might lead to highly differing carbon contents even for the same type of land use, and
- the importance of landforms such as slopes and riparian areas that may strongly affect the carbon content per hectare.

Only for well managed, even-aged vegetation types, such default values/benchmarks might be appropriate. Therefore, it is currently unclear if such a generalisation would serve the overall goal of

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[112] Para. 48 of Annex to Decision-/CMP.1 (*Article 12*).

standardisation in terms of reducing transaction while maintaining a high level of environmental integrity. Further research and practical experience seems necessary to eventually evaluate the issue.

Carbon stock and GHG emissions in case of project implementation

In order to quantify the GHG benefits of a project, the expected GHG uptake and emissions due to the project activity needs to be calculated. Next to those carbon stocks that have be determined as 'relevant', the following emission sources should be included systematically:

- Emissions from use of fossil fuels, *e.g.* by machinery for agricultural measures,
- Emissions from use of fertilisers,
- Emission due to land preparation,
- Emissions due to road building,
- Indirect effects on the GHG stock inside the project area,
  - *e.g.* change in soil carbon content,
  - benefits from reduced soil erosion (or increase of soil erosion),
- Emissions from tree logging,
  - number of trees cut per year.

Since the determination of project emissions/sequestration is not the focus of PROBASE, only some general aspects that need to be considered are pointed out in the Workpackage 8 report (Annex 7).

Consideration of leakage and uncertainties

Leakage covers the changes in flux/carbon stock outside the system boundaries, resulting from activities within these boundaries, whereas uncertainties mainly result from data quality and data availability[113]. A quantification of leakage effects seems more complex for forestry projects than for energy projects because of the high number of factors influencing people's behaviour and land-use schemes. One approach to assess leakage effects could be to define and monitor key indicators in combination with default leakage factors for each of those indicators. However, due to its complexity and high transaction costs, this concept currently does not yet seem appropriate.

As an alternative approach the above-mentioned concept of concentric areas can be used, which would include the movement of people and of companies away from the project area as well as emissions linked to the provision of material and building of infrastructure for the project. Those parameters are generally easy to monitor and can be coupled to default emissions factors[114]. Thus, the concept seems applicable to all forest projects regardless their location. Figure 3.11 illustrates this process schematically. In order to reduce complexity, leakage caused by private players (in most cases local inhabitants), businesses and 'others' are estimated separately. We also propose to limit quantification efforts to leakage effects that are expected to account for more than 5 percent of the projects GHG benefits.[115]

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[113] Here the measuring method chosen to determine the carbon stock of an area plays an important role.
[114] This can be derived on a regional or a national level.
[115] Next to *negative* leakage effects – carbon sequestration offset by carbon release or GHG emissions elsewhere, which are due to the project – positive leakage effects – extra carbon sequestration or GHG emission reduction elsewhere due to the project – might also be accounted for.

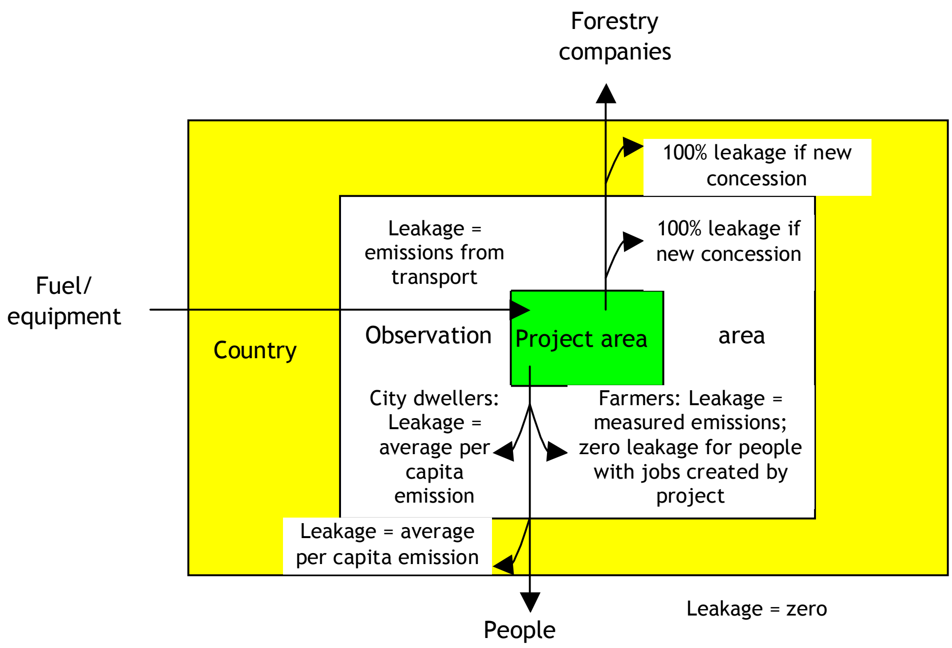

Figure 3.11. Leakage determination for forestry projects

Next to the inherent uncertainties connected to baseline determination itself (*e.g.* counterfactual uncertainty), uncertainties are also associated with the quality of data used. Data availability and data quality may strongly differ for individual projects[116]. When quantifying the amount of credits that may be earned by a project activity, such imperfect conditions should be taken into account (see also Section 4.1). Further to Section 3.2, a distinction can be made between (externally obtained) *data* and *measurements* conducted by project participants. Concerning the former, the application of the NUSAP Pedigree Matrix for Statistical Information (already used Annex 2) is proposed. The results of the NUSAP Pedigree Matrix could be correlated to multi-project *data-quality-correction-factors* in order to quantitatively account for data quality. Uncertainties connected to direct measurement should be determined on a single-project basis. In sum, it is proposed to develop correction factors both for leakage and uncertainties, which are then applied to adapt the amount of credits that can be earned by the forestry activity.

3.6.4 Application of template and manual to the case studies: the example of Krkonose

The developed template methodology of Workpackage 8 has been tested to case studies in Brazil, Costa Rica, Romania and the Czech Republic. Questions, difficulties and insufficiencies that have been encountered during this application have been used to elaborate the methodology. Also, some drawbacks have been identified,[117] which, as far as possible due to time restrictions, have been eliminated. However, theoretical solutions have been found so that a future improvement is possible and advisable. Nevertheless, it was found that the idea of standardising the methodology for baseline determination as well as standardising some further baseline aspects is very suitable for forestry projects, because on the one hand standardisation makes baselines of different projects somewhat more comparable while on the

[116] This was also the experience when working on the subsequent case studies.
[117] For example, how representative is the OA or how to incorporate temporal aspects in the baseline.

other hand there is enough space to incorporate the numerous project-specific aspects of each forestry project in the template method.

Krkonose National Park, Czech Republic


Photo: www.facefoundation.nl

The forest project in the *Krkonose National Park*, conducted by the Dutch FACE Foundation,[118] the Czech National Park Administration and the Czech Ministry of Environment, combines features of reforestation and forest management activities. Although the project is located in an Annex-I country and a financial additionality check therefore is not necessary, the check has been conducted to test the proposed manual (see Annex 7). The results from the analysis clearly indicate that the project can be considered financially additional. The major land use of the project area is spruce forest (with a declining trend in carbon density due to effects of acidification), whereas the observation area is characterised by agricultural use, grazing land, forest area, human infrastructure, *etc.* Due to the fact that the project area is under legal protection, the correct reference case land use would be the existing forest. Again, in order to test the forest baseline template, all standardised options to determine the economically most attractive land use were applied. Results are summarised in Table 3.15.

The Krkonose case study shows that there are significant differences in baselines depending on the selected land use. From an ecological point of view this could be an argument in favour of choosing the most conservative baseline. After having determined the baseline case/reference case land use, the emissions resulting from the selected land use have been estimated: major sources are fuel combustion (transport, plantings), biological degradation of existing vegetation and land preparation as a prerequisite for plantings. Based on those data, the GHG balance of the reference scenario has been determined for the project area at 192,245 t C sequestered (baseline lifetime of 21 years). In a next step, the GHG situation in case of project implementation has been quantified, which, based on the project activity level over time, has shown a sequestration of 2,184,871 t C.

Analysis of leakage shows that private players and forest companies do not cause leakage, while leakage effects due to transportation account for 4.3 t CO_2/year. Positive leakage does not occur. Consequently, overall leakage effects respond to 24.7 t C over the project lifetime.

The data quality evaluation for the Krkonose National Park that has been conducted in Workpackage 2 (see Annex 2, using the NUSAP Pedigree matrix for statistical information) resulted in an overall

[118] The FACE foundation (Forests Absorbing Carbondioxide Emissions) was established in the early 1990s by the Dutch Board of energy generators and distributors SEP. The aim of FACE was to offset the emissions of one 400 MW power plant operational in the Netherlands by planting trees in the Netherlands and abroad.

classification of '3' (on a scale from 1 to 5), which results in a data-quality-correction-factor of 0.96 results. The overall correction factor for data quality and measurement of uncertainty has been determined as 0.92. As a final step, the values determined for leakage as well as correction factors have been applied to quantify the amount of credits that could be earned by the project activity using the PROBASE method developed under Workpackage 8: 2,010,059 t C.

Table 3.15. Baseline options for the Krkonose project

Baseline option	Resulting reference case land use	carbon density of chosen reference case
Land-use option covering more than 50% of the observation area	`Agricultural activity´ (farming plus grazing land)	0 t C/ ha
Land-use option achieving the highest weighted average of its current share in the observation area and its share in land-use changes of the last five years	Farming	0 t C/ ha
Shares of land-use options that exist on the observation area	Farming = 27 % Pasture = 29% Forest = 34 % Wetland = 4 % Human infrastructure = 6%	108 t C/ ha
Weighted average of current shares in the observation area and shares in land-use changes of the last five years	Farming = 51,3 % Pasture = 14,5 % Forest = 17 % Wetland = 2 % Human infrastructure = 15,2%	51 t C/ ha
Project-specific baseline	Existing forest (declining trend of carbon density)	280 t C/ ha (decreasing to a level of about 152 t C/ha in about 30 years)

3.7 Evaluation of multi-project baseline approaches

This section evaluates the standardised, multi-project baseline approaches discussed in this chapter on the basis of the set of criteria described in Section 3.1 (see Table 3.16 for a summary). The evaluation particularly focuses on the application of the models-based benchmarks, the simplified aggregation method using SimBAT and the MBS. An evaluation of standardising baseline procedures for forestry projects is already included in Section 3.6 and is not repeated here.

Table 3.16. Set of criteria for the evaluation of methodologies for baseline setting	
Criterion	**Brief description**
Applicability	Practical feasibility of the methodology for baseline setting (political acceptability and applicability for project types)
Accuracy	Precision achieved taking into account cost of implementation and application of the methodology for baseline setting
Consistency	Comparability of results regarding similar projects as well as ensuring that results are reproducible/environmentally integer
Transaction costs	Level of political and market transaction cost caused by implementation and application and of the methodology
Transparency	Understandability of the approach to baseline setting

3.7.1 Applicability

When analysing the **applicability** of multi-project baseline method in comparison with single-project methods a distinction must be made between *administrative applicability*, which is related to the practical application of baseline methods, and *political applicability*, which observes whether the baseline methods are in line with the baseline approaches defined by the *Marrakech Accords*.[119]

With respect to administrative applicability, it has been argued that multi-project baselines are easier to apply than single-project baselines. For instance, Ardone *et al.* (1997) argue that determining detailed single-project baselines may require almost as much data as needed for the development of aggregate national baselines, especially if the JI/CDM activity is a new power plant for which no project-based benchmark is available and/or when single projects have a synergetic impact on the entire electricity supply system – *e.g.* in a situation where interdependencies of a project with a larger system are strong.[120] The latter data requirements reduce the applicability of single-project baselines. Hence, national benchmarks, which already comprise an analysis of system interdependencies, would be easier to apply in these cases.

The applicability of multi-project baseline methods will, of course, strongly depend on the methodology used. Whereas historic benchmarks can be easily derived from national energy statistics, the calculation of forward-looking benchmarks using energy system models is a rather sophisticated approach. In terms of complexity, the *Fuel-specific combined country and regional benchmarks* (see Section 3.5) are somewhere in the middle of the historic benchmarks approach and the modelling method. Furthermore, the applicability of forward-looking multi-project baseline methods depends strongly on the extent to which future developments in the host country can reasonably be predicted. For instance, a case study analysis of energy data from Zimbabwe within the context of PROBASE has shown that an energy systems model requiring detailed information on the energy systems development for the next 20 years (such as PERSEUS) is not suitable for countries where the future development is highly uncertain due to unstable political circumstances. On the other hand, PERSEUS can be applied relatively easily in Annex I countries where the necessary data for the modelling exercise is generally available and political developments stable. Finally, the PERSEUS approach is also applicable to liberalised electricity markets encompassing more

[119] Para. 48 of Annex to Decision-/CMP.1 (*Article 12*).
[120] This aspect relates to the control issue as defined in para. 52 of the Annex to Decision -/CMP.1: those sources of GHG that are under control of the project participants shall be encompassed in the project boundary.

countries if, at least in the long run, electricity prices will be equal to the marginal costs of electricity generation.

A major restriction to the applicability of multi-project baseline methods is that while they are most useful when applied to on-grid projects, an evaluation of off-grid projects makes little or even no sense (see Section 3.3). The latter is because the off-grid energy consumed cannot be considered as a homogenous product since the pool of generation technologies may differ significantly for energy produced and consumed from location to location. Therefore, single-project baseline determination is more suitable for off-grid projects.[121]

Table 3.17 presents the administrative applicability of the multi-project baseline methodologies for different types of host countries.

Table 3.17. Administrative applicability of multi-project baseline setting

	Developed Countries	Developing Countries	Least Developed Countries
Historic sector averages	+	+	+
Fuel-specific combined country and regional benchmarks	+	+	+
Reflex	+	+	0
PERSEUS	+	0	-

Applicable = +, depends on national conditions = 0, usually not applicable = -

Generally speaking, the multi-project baseline methods described in this chapter are in line with the approaches to baseline setting as defined in the *Marrakech Accords* of COP7. However, the use of *fuel-specific combined country and regional benchmarks* could lead to some problems concerning political applicability/acceptability since investments will not necessarily be made where they are most cost effective (see Section 3.5).

3.7.2 Accuracy

Concerning the **accuracy**[122] of baseline methodologies, single-project methods may seem to be more precise in estimating GHG emissions reductions than aggregate approaches since they specifically take into account site-specific circumstances of projects. However, single-project methods often are insufficiently capable to incorporate factors from outside the project boundary that are not under the control of the project participants (hence, they are excluded from the project system) but which still could have had an influence on the situation on the project area in absence of the project activity.[123]

With regard to the accuracy of multi-project baselines, simplified historic sector average-based benchmarks appear suitable if the crediting lifetime of projects is limited to a few years and only minor

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[121] In the context of off-grid projects PERSEUS may give an indication on whether or not electrification will take place in the future. Additionally, using PERSEUS can identify whether technological changes will take place in rural areas.

[122] Note that, strictly speaking, the term 'accurate' is not applicable for baselines as it assumes that a baseline can, in principle, be precisely determined. The counterfactual character of the baseline, however, prevents this, as it only describes an assumed scenario that will never take place and that can never be fully monitored or verified.

[123] The Dutch ERUPT programme tries to incorporate these external effects into the single-project baselines through the so-called key factor analysis. The key factors refer to both internal and external factors that could have an impact on the baseline for a project. Examples of external key factors are: energy policy of the host countries, international environmental commitment the host country has agreed on, privatisation policies, economic reform policies, *etc.*

changes are expected within the energy sector in the short term. However, in order to reflect baseline emissions more precisely regional disaggregation as well as the consideration of different load ranges might be advantageous. Of the future-oriented modelling approaches, PERSEUS will most likely lead to the highest degree of precision since its representation of the energy sector is most detailed, provided that input data is reliable. On the other hand, the Reflex model comprises only a few restrictions and presents a less detailed representation of the energy system with, consequently, major simplifications. In this context, the *Fuel-specific combined country and regional benchmarks* approach tends to lead to the lowest degree of precision as the baseline emissions are based on national energy data or international benchmarks only. However, it should be noted here that the primary objective of the *Fuel-specific combined country and regional benchmarks* is to avoid rewarding poor environmental performance of countries in the past, rather than to reflect baseline emissions with the highest degree of precision.

3.7.3 Consistency

The AIJ pilot phase has shown that applying single-project baseline methods may lead to large variations in terms of estimating creditable emissions reductions due to different underlying assumptions. For instance, Parkinson *et al.* (2001) have shown that the emissions reduction of projects depends significantly on the assumptions used for project-specific baseline methodologies. They have found that the emissions reduction calculated for the co-generation project in Decin, Czech Republic,[124] could vary, depending on the baseline method applied and the crediting lifetime chosen, between 290,000 tCO_2 and 730,000 tCO_2. This example, as well as the conclusions of the baseline uncertainty assessment in Chapter 4, shows that the application of single-project baselines can lead to large differences in baseline methods chosen by different project developers and consequently calculated emissions reductions.

Applying multi-project baseline methods would properly deal with this inconsistency as these methods use the same underlying assumptions for baselines for a range of similar projects. The consistency of applying multi-project baseline methods would even be higher if one method were applied to a range of host countries. The analysis in this chapter, however, has shown that such a multi-country application (*e.g.* applying a *world best region* benchmark for one project type across a number of host countries) insufficiently deals with country-specific aspects, such as existence of off-grid areas next to on-grid systems, dominance of one particular fossil fuel in the energy sector (*e.g.* coal in South Africa), extent to which differences in load factor influence the emissions in the energy sector, *etc.* With a view on this, a trade off exists between higher consistency (applying a benchmark across a number of host countries) and a higher accuracy (as precisely as possible describing the *e.g.* energy sector in the host country).

3.7.4 Transaction costs

Transaction costs can be divided into market-level transaction costs and transaction costs on a macro-economic or political level. While market transaction costs will be higher for detailed single-project baseline methods, multi-project method may lead to higher transaction costs at a macro level.[125] However, since multi-project baseline methods may be applied to a large number of projects within their areas of validity, the specific cost per project can decrease significantly with the number of projects increasing.

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[124] The Decin co-generation plant utilises natural gas replacing brown coal.
[125] Gustavsson *et al.* 2000.

Additionally, multi-project methodologies ought to be applied by a central organisation (*e.g.* the CDM Executive Board), which could further help reducing the transaction costs of baseline setting due to beneficial learning curve effects.

Since the four multi-project baseline method discussed in this chapter (PERSEUS, Reflex, MBS fuel-specific combined country and region, and SimBAT historic sector averages) all provide standardised emission factors to be used by project developers and validators, their market transaction costs are more or less the same. However, when considering transaction costs at the macro level, the approaches differ considerably. For example, the macro-level transaction costs for the *SimBAT historic sector* average method are generally low, as it requires statistical information about the existing energy system of host countries, which is usually already available. The *MBS fuel-specific combined country and regional benchmarks* method requires an aggregation of the different methods considered in order to derive emission standards for a group of countries, but since this method can also easily be implemented using standard spreadsheet software and the data requirements are in the same order of magnitude as the *historic sector average* method, its macro-level transaction costs are more or less the same as the *SimBAT historic sector average* benchmark method.

The macro-level transaction costs of Reflex and PERSEUS are considerably higher. Apart from data on the existing energy system of host countries, Reflex further needs information on the future development of the energy systems (in PERSEUS this development is projected by the model itself, see Section 3.3.2). For each host country, several optimisation runs will have to be made according to the number of regions, sectors and load ranges. Although implemented in Microsoft Excel (just as the *MBS* benchmark and *SimBAT historic average* benchmark), the use of a tool like Reflex will consequently lead to higher macro-level transaction costs. Finally, the implementation of a complex forecasting and optimisation tool like PERSEUS will lead to the highest macro-level transaction costs, which is mainly due to the highly detailed input data required, but also due to the complex implementation in GAMS being much more sophisticated than using Microsoft Excel.

As an aside it could be argued here that next to the lower transaction costs related to multi-project baseline determination in comparison with single-project baselines, the validation costs of multi-project baselines will be lower too. Their higher consistency and transparency (see below) make validation of baseline scenarios easier as validators do not need to recalculate all the baseline scenarios and the impact of internal and external factors on these baselines.[126] Validation of multi-project baselines basically involves checking whether the multi-project method has been applied correctly to a particular project and checking the project-specific data, such as activity level and the decision regarding setting the project boundary (if the latter is not standardised).

3.7.5 Transparency

During the AIJ pilot phase, it has become clear that single-project baseline determination does not lead to a higher degree of transparency. Multi-project methods could help overcome this drawback by centrally

[126] Note that some currently operational international GHG credit trading programmes such as the World Bank's PCF require project developer to construct more than just one scenario from which to derive a baseline, make a choice from these scenarios and justify the choice. As a consequence, the validation of the baseline must basically repeat these steps.

providing emission factors, so that the procedure of calculating baseline emissions would become standardised and thus more transparent. The discussion of the four aggregate methods in this chapter concerning their transparency basically leads to the same ranking as the one with regard to transaction costs. *SimBAT Historic sector averages* and the *MBS fuel-specific combined country and regional benchmarks* tend to be most transparent followed by Reflex and PERSEUS. Once again, the different levels of complexity may explain this (see above).

Summarising the discussion in this Section, it has to be stated that there is no unambiguously optimal multi-project method to baseline setting. Choosing an appropriate approach will rather depend on the conditions prevailing in the host country (see Table 3.18 for a general, but unweighted ranking).

Table 3.18. Ranking of multi-project approaches based on criteria analysis

	Applicability	Accuracy/ precision (Forward-looking ability)	Consistency (Comparability of projects)	Share of transaction costs	Transparency
Historic sector averages	1	4	3	1	1
Fuel-specific combined country and regional benchmarks	2	3	3 (+/-)	2	2
Reflex	2 (+/-)	2	2 (+/-)	3(+/-)	2
PERSEUS	3	1	2 (+/-)	3(+/-)	3(+/-)
Project specific	+/-	2 (+/-)	4	3 (+/-)	3 (+/-)

Fulfilment of criteria ranked from 1 (very good/easy) to 4 (very poor/difficult), (+/-) indicating that fulfilment depends on national, sectoral, or regional conditions

4. Managing baseline determination: uncertainty, capacity, policy circumstances

In Chapter 3 the application of a number of multi-project baseline methods was analysed and reviewed on the basis of five criteria: applicability, accuracy/precision, consistency, transaction costs and transparency. The analysis has made clear that on the basis of these criteria multi-project baselines generally show better scores than single-project baselines. In that sense Chapter 3 has provided a substantial exploration of the theoretical assessment of multi-project baseline in Chapter 2. Yet, some issues explained in Chapter 2 have not been addressed in detail in the analysis of Chapter 3, which is partly due to the fact that these issues are not specific for multi-project baseline determination.

A first issue which has been touched upon a number of times in Chapter 3, is the uncertainty associated with the baseline given its counterfactual character and sometime large data requirements. Second, baseline determination requires a certain institutional capacity, *i.e.* knowledge of: setting single-project baselines; validation capacity to confirm the validity of a baseline; in case of multi-project baselines, the capacity to set up and maintain a tool (*e.g.* with the centralised body under whose auspices the tool is constructed); and capacity to apply the tools to actual projects, *etc.* Third, as the analysis in Chapter 3 has shown in a number of cases, for baseline determination it is insufficient to only observe a number of key factors within the project boundaries and see what their influence would be on a reference scenario. The baseline may well be determined by external factors such as national government policies, international commitments and energy price developments. An illustrative example of the latter is the pre-Accession process which Central and Eastern European countries have been undergoing as Candidate countries to the EU. In order to be eligible for EU membership, the Candidates must, among other standards, comply with the EU environmental standards; and it is obvious that the latter would have a significant impact on the baselines determined for projects in these countries. In the sections below these three elements are discussed in more detail.

4.1 Uncertainty aspects of baseline determination

4.1.1 Introduction

As explained in Section 2.1, all baselines are counterfactual and there are usually several possible futures or scenarios of what would have happened in the baseline without the project. By exploring these possible futures an indication can be obtained of the size of the uncertainty associated with baseline determination. For example, when possible baselines strongly differ from each other, this could be an indication that baseline determination for that project is surrounded with high uncertainties. Furthermore, analysing a set of possible baselines for a project could reveal factors that would have a major effect on the range of uncertainty associated with baseline determination. Finally, ways can be suggested of managing the uncertainty. Analysing baseline uncertainty is important for environmental integrity as it contributes to minimising the risk of overestimation of emission reductions. This analysis has been carried out by PROBASE in its Workpackage 9 (see Annex 8) in order to:

(a) Assess the level and sources of uncertainty in the estimation of emission reductions, and

(b) Evaluate the suitability of multi-project baselines to be used instead of a detailed scenario single-project approach.

The methods to develop scenario baselines and calculate emission reductions are well established and Parkinson *et al.* (2001) have explored the uncertainty associated with the emission reductions. They distinguish between 4 different types of uncertainty:

- **Project performance** uncertainty: relates to uncertainty about the activity level of the project over the crediting lifetime. For instance, the difference between the anticipated or modelled level of activity and the actual activity level can be large. Parkinson *et al.* (2001) have also examined the difference between feasibility projections and monitored project data and showed that this uncertainty on average contributed ±30% to the overall uncertainty. As a result they recommend that crediting should always be done on the basis of monitored activity levels (*i.e. ex post*).
- **Measurement** uncertainty: relates to uncertainty about the quality of the data, which may impact on the project (*e.g.* how well is output measured?) but also on the baseline when based on information which relates to the pre-project situation (business-as-usual).
- **Counterfactual** uncertainty: in principle, the baseline must represent the situation which would have occurred in the absence of the project. This is a counterfactual situation, which is by definition unknown. Although counterfactual uncertainty is irreducible, establishing the range of probable baselines and selecting a conservative (or even the most conservative) one from that range could reduce this uncertainty.
- **Background** uncertainty: relates to a range of possible external factors such as economic growth, international prices of oil and gas, national politics, policies and legislation and international political developments. Background uncertainty can thus impact on the counterfactual uncertainty and on the project performance uncertainty (see also Section 4.3).

With project performance uncertainty under control through the use of monitored data, and background uncertainty being exogenous, the main focus in this Section is on counterfactual uncertainty and, where possible, on measurement uncertainty.

Because the four types of uncertainty can overlap, they cannot be simply added up to yield the total emission reduction uncertainty. However, with sensitivity analysis the possible impact of measurement uncertainty on the overall level of emission reduction can be assessed. Similarly, those assumptions which contribute most to the divergence of probable baseline scenarios, and thus to the size of the total emission reduction uncertainty, can be identified. Such conflicting assumptions define the counterfactual uncertainty for the project.

The approach also allows examining the effect of the uncertainty in the additionality of a JI/CDM project's emissions reduction. For the projects analysed in this context (see Table 4.1) next to determining a range of possible baselines, one scenario is constructed in which it is assumed that the project's emissions reduction is additional during only the first five years of the assumed 10-year crediting lifetime. Obviously, the latter scenario would result in lower emission reductions, and the extent to which this takes place is an indication of additionality uncertainty.

4.1.2 Methodology

In order to carry out the baseline uncertainty analysis PROBASE has constructed single-project baselines for a series of case studies in a range of potential JI/CDM countries. These are listed in Tables 4.1 and 4.2 below. These case studies and their country contexts have been described in Annex 2 and 3 and are summarised in the analysis of each case study in Sections 2 and 3 of the Workpackage 9 report (see Annex 8).

Table 4.1. Range of countries, technologies and fuels of selected electricity projects (incl. 3 CHP projects and 1 off-grid electricity project)

Country	Technology & fuel	Selected (mini) grid projects
Romania	Run of the river hydro	Surduc-Nehoyasu
Poland	Wind turbines	Skrobotowo
Romania	CHP - gas	STEP
Czech Republic		Celakovice
Russian Federation	CHP - biogas	Nizhny Novgorod
Costa Rica	Wind turbines	Plantas Eolicas
Indonesia	Geothermal	Sarulla
Indonesia -off grid-	MHP/SHS/wind hybrid	RESS (1000+ sub projects)

Table 4.2. The range of countries, technologies and fuels of selected heat-only projects (for CHP projects, see Table 4.1)

Country	Technology	Fuel	Selected heat projects
Czech Republic	Boiler	Coke to Biomass	CHC (1 sub-project)
Czech Republic	Boiler	Coal to Gas	CHC (80 sub-projects)
Czech Republic	Boiler	Oil to gas	CHC (80 sub-projects)
Russian Federation	Boiler	Coal to Gas	Bolshemurashkino

Each case study is taken in turn and the analysis follows a set structure. The analysis starts with a brief description of the project followed by the country context and existing emissions profile of the sector and the project. This background information is vital for the development of assumptions about possible baselines and the subsequent calculations of baselines with the data available. The main assumptions made in the development of single-project scenario baselines are about existing energy demand versus new demand, the default fuel/technology in the sector, and the question of additionality. These assumptions are listed for transparency.

For each case study project a number of the single-project scenario baselines are developed, with a brief description of the sector situation presented by these baselines. Results of the analysis, emission factors, emissions and emission reductions of all the single-project scenario baselines and selected benchmarks are presented in tabular format, while a graph displays the trends in specific output emission factors of baselines and the project over time. The results of the uncertainty analysis are given along with a discussion of the main sources and the size of the uncertainty.

This analysis is followed by a comparison of the most conservative scenario baseline with selected multi-project baselines, which include the *Fuel-specific, combined country and regional benchmark* (CCB; developed under the MBS, see Section 3.5), best region benchmarks, OECD and sector benchmarks (also taken from MBS, see Section 3.5), and the Reflex and PERSEUS results discussed in Chapter 3 and Annex 6. The performance of these multi-project standardised baselines is broadly similar across the projects and the relationship between these baselines and the most appropriate baseline is discussed. To allow comparisons across projects, emission reductions have been calculated over a 10-year crediting lifetime for all projects, which has gained insights into the key uncertainties for this crediting period.

4.1.3 Overall results

The results from all the electricity supply projects analyse are listed in Table 4.3 for the electricity sector and in Table 4.4 for the heat sector (for a detailed description of these results, see Annex 8; below the results for electricity supply projects are summarised). It can be seen that each project has raised different questions relating to uncertainty in the estimates. The range of total uncertainty associated with the projects varied from ±6% to ±46% for the electricity projects and from ±19% to ±57% for the heat and CHP sector projects. The key sources of uncertainty are given in the table and are listed here:

- Background uncertainty in the economic performance of the country and its effect in demand as well as the price of the different fuels. This uncertainty feeds into the counterfactual uncertainty as it affects the technology and fuels applied in the baseline especially for projections of the grid mix or for the selection of a replacement or substituted plant.
- The risk that the project has only accelerated a development which would have happened within the crediting lifetime anyway (its contribution is about ±30% of total uncertainty).
- The project emissions for wind energy projects in a country where there is an energy mix of mainly coal are uncertain as the spinning reserve for the wind energy results in extra emissions.[127] Of the projects analysed this is especially relevant for the *Skrobotowa* project in Poland, where the grid mix is mainly based on coal.
- Data uncertainty. This is explored in more detail in the heat sector analysis in Annex 8 (its contribution is about ±25% of total uncertainty).

For the electricity projects, the counterfactual uncertainty associated with the choice of technology/fuel in the baseline was low (±6-12%) for the projects studied, mainly because in some countries the fossil fuel component to the grid mix is fairly homogeneous or because an average grid mix factor was used.

When the project is substituting for a particular technology/fuel combination in the baseline it is important to distinguish whether the project is substituting for an *existing* plant or demand or, whether it is providing *new* demand. It is clear that for new demand electricity supply baselines must include a particular plant type which would otherwise have been built in the absence of the project in order to meet this new demand. Technology benchmarks (*e.g.* BAT) are more appropriate under these circumstances. If the project were an intermittent source this would not apply, as such a discontinuous source of electricity is more suitable for meeting existing demand. In the case of the substitution of an existing power plant (*i.e.* existing demand) a great deal of detail is required about the energy system to distinguish which type of plant would be substituted over time by the project.[128] Clearly, the *country context* for the grid mix is also important in determining the range of counterfactual uncertainty due to the technology/fuel

[127] The concept of spinning reserve is relevant for situations in which a wind energy park is backed up with a coal-fired plant in times of insufficient wind. As a coal-fired plant needs a relatively long time to be switched on, it must operate in a so-called spinning reserve mode. The emissions resulting from this mode must be subtracted from the gross emission reduction achieved through the wind energy project.

[128] A grid mix baseline could be more conservative if the baseline project were coal. But if a gas plant would have been substituted an average grid mix baseline is usually higher than the emission corresponding with the gas-fired plant and therefore leads to more credits than the emission reductions actually achieved.

developments in the baseline. After all, the country context provides information about whether the electricity sector in a country has an overcapacity or fully utilises its capacity, which helps determining whether a JI/CDM project is likely to meet existing demand (*e.g.* in case of overcapacity) or new demand (*e.g.* in case of full capacity).

For the heat sector and CHP plants the uncertainty does not vary greatly with the original fuel of the boiler. The uncertainty found – between ±40 to 50% – is a combination of additionality and counterfactual uncertainty. The CHP plants have more complex baselines which are a combination of heat and electricity baselines. The total uncertainty for these projects varied from ±19 to 36%, which is again due to a combination of counterfactual and additionality uncertainty.

For the *Bolshemurashkino* heating project in the Russian Federation data uncertainty has been explored, which resulted in a total uncertainty of ±57%. Data uncertainty applies to all projects where the substituted plant data is poor and where a historical baseline is used. Data uncertainty will also apply in collecting the data required for historic averages and performance benchmarks. There is thus opportunity for gaming through data uncertainty. This uncertainty is not included in the range provided for the electricity projects, which implies that the uncertainties shown in Table 4.3 are underestimates. The importance of data uncertainty has been particularly discussed for the heat projects as these projects usually replace a known plant in a district-heating grid.

Generally, the uncertainties for all projects were high even though not all the uncertainties were accounted for in all the projects. Such uncertainties will need to be managed and will become more important the larger the project.

4.1.4 Comparison of baseline uncertainties across plants of the same type

In the small set of electricity projects studied in detail under PROBASE (see Annex 8) only wind energy was analysed in duplicate: for Costa Rica and for Poland. As might be expected for such diverse countries there are entirely different factors to be taken into account and this is reflected in the uncertainties in emission reductions which range from ±12% to ±20%. In the case of *Skrobotowa*, Poland, uncertainty in the timing of introduction of the plant is higher than is the case for the *Plantas Eolicas* wind energy project in Costa Rica. It is also reflected in the recommended baselines for the projects where the most conservative baseline for *Skrobotowa* is the *2020 fossil-fuel grid mix*[129] (plus the correction on the project emissions for spinning reserve) while for the *Plantas Eolicas* case the BAT oil is recommended as the most conservative baseline.

For the heat sector projects the two coal-to-gas conversions examined both show different additionality scenarios and one included the data uncertainty (Bolshemurashkino, Russian Federation). The overall magnitude of the uncertainties was similar but the additionality uncertainty would dominate. It is clear from this that the country-specific conditions in terms of the energy system and fuel base have a strong influence on the most conservative scenarios. The continued additionality of the plant's emissions reduction is the other main factor here, which will also vary across countries.

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[129] This benchmarks estimates what the fossil fuel grid mix for Poland will look like in 2020 and assumes that the GHG emissions factor per MWh in 2020 will be lower than at present.

Table 4.3. Baseline uncertainty results for electricity sector projects			
Project	Major Sources of uncertainty	Most conservative scenario comparison	Total uncertainty
Surduc, Romania • RoR hydro • 55MW • Coal • Gas • Hydro • In roughly equal amounts • Overcapacity • Existing demand	• Continued additionality of project up to ±30% contribution • Background uncertainty in economic performance and fuel prices • Development of grid mix technologies and fuels (counterfactual) ±6% • Data uncertainty, no info	**Most conservative scenario baseline:** Only 5 y additional **Most conservative standardised baseline:** ERUPT, CCB	1,004,767 tCO_2 ±35%.
Skrobotowa, Poland • 60MW 125GWh/y • 92% coal • Overcapacity • Existing demand • Wind intermittent	• Correction for coal spinning reserve on project emissions • Counterfactual ±6% due to homogeneous system development simple coal projection • No uncertainty from additionality as wind investment also avoids perverse incentive from renewables target	**Most conservative scenario baseline:** Mix 2020 with 25% correction factor for project **Most conservative standardised baseline:** ERUPT, Best Region, Poland plus region (CCB)	1,090,511 tCO_2 ±20%
Plantas eolicas, Costa Rica • Wind • 20MW • 76-98GWh/y • New demand but some substitution through hydro • Energy shortage	• Counterfactual 12% • Fully Additional despite policy • Homogenous fossil fuel mix for peak, hydro for base load • Some data uncertainty	**Most conservative scenario baseline:** BAT oil **Most conservative standardised baseline:** CCB and best region	636,410 tCO_2 ±12%
Sarulla, Indonesia • 330MW • Geothermal • Could be New or existing demand	• Background affecting counterfactual uncertainty: ±46% • Additionality under question reduced time • Poor info on actual grid • Do not know if new or existing demand	**Most conservative scenario baseline:** Current mainly coal mix and only 5y additional **Most conservative standardised baseline:** Reflex, BAT gas	11,600,200 tCO_2 ±46%

Table 4.4. Summary of the findings for heat and CHP projects*

Project	Major Sources of uncertainty	Most conservative scenario baseline and standardised baseline	Annual Emission reduction uncertainty
Bolshemurashkino, Russia Conversion of coal-fired heat boilers to gas (99 GWh/y)	• Data uncertainty • Additionality • Fuel options coal/gas	**Conservative scenario baseline:** Only 6y additional **Conservative standardised baseline:** West Russia heat sector benchmark	24 $ktCO_2$ ± 57% (incl. data uncertainty)
CHC coal->gas, Czech Republic Bundled project of 48 boiler conversions (60 GWh/y)	• Additionality • (data uncertainty)	**Conservative scenario baseline:** Only 3y additional **Conservative standardised baseline:** Old gas heat benchmark	131 $ktCO_2$ ± 50%
CHC oil->gas, Czech Republic Bundled project of 10 boiler conversions (10 GWh/y)	• Additionality • (data uncertainty)	**Conservative scenario baseline:** Only 3y additional **Conservative standardised baseline:** None (2/3 of old gas heat benchmark)	12 $ktCO_2$ ± 50%
CHC coke->biomass, Czech Republic Single boiler project (4GWh/y)	• Fuel options gas/biomass • Additionality • (data uncertainty)	**Conservative scenario baseline:** Conversion to natural gas **Conservative standardised baseline:** None (2/3 of old gas heat benchmark)	18 $ktCO_2$ ± 40%
Celakovice, Czech Republic Coal boiler converted to gas CHP (7 GWh/y)	• Tech. options heat/CHP • Additionality • Tech. options gridmix • (data uncertainty)	**Conservative scenario baseline:** New gas heat + cleaner base load electricity **Conservative standardised baseline:** Fossil fuels heat benchmark	32 $ktCO_2$ ± 19%
STEP, Romania Old gas boiler converted to gas CHP, heat network improved (21 GWh/y)	• Tech. option heat/CHP • Additionality (heat only!) • Tech. options gridmix • (data uncertainty)	**Conservative scenario baseline:** New gas heat + cleaner base load electricity **Conservative standardised baseline:** No standardised baselines available	44 $ktCO_2$ ± 36%
Nizhny Novgorod, Russia Methane from waste water treatment captured for CHP	Baseline uncertainty is a minor source of ER uncertainty (additionality not assessed here!)	No scenarios created. The relative impact of even 100% uncertainty in electricity and heat baselines is small compared to the reductions from capture of methane. Max. ER uncertainty: 24 $kgCO_2/kgCH_4$ ± 13%	

* *Note that data uncertainty for the pre-project situation may be high for all heat refurbishments, but it is only assessed for Bolshemurashkino.*

4.1.5 Performance of multi-project baselines

A range of multi-project baselines were investigated for the electricity sector projects: the OECD benchmark, the fuel-specific combined country and regional benchmark (CCB) and the World's best region benchmark taken from the MBS (see Section 3.5), as well as the ERUPT country-based standardised emission coefficients. The results from the analysis show that for the selected multi-project baselines the performance varied across the range of projects.

It was found that of these multi-project baselines the OECD benchmark generally correlates well with the conservative technology-only single-project baseline scenarios of the projects. The latter scenarios assume that in absence of the project a modern technology (*e.g.* similar the one assumed under the OECD benchmark) would have been installed.

However, as can be seen in the cases of *Surduc* and *Sarulla* in Figure 4.1, the OECD benchmark is unable to take account of the uncertainties relating to the timing of the intervention stemming from the country-specific nature of the baselines, *i.e.* while some of the conservative technology-based baseline scenarios assume that the project's emissions reduction is additional for only a part of the 10-year crediting lifetime, the OECD benchmark-based baseline scenario assumes that additionality for the full 10-year period. In these two cases, applying the OECD benchmark results in higher baseline emissions than in case of the single-project conservative technology-only baseline with a timing element for additionality. The picture is different for the Polish *Skrobotowo* wind energy project for which it is assumed, also under the conservative technology-based baseline scenario, that, due to the domination of coal in the Polish grid mix, the investment would not have taken place in absence of the project within the 10-year period (see the bar in Figure 4.1 for *Skrobotowo* below the 0 kg CO_2/MWh/yr line).

In summary, the above-mentioned multi-project baselines tend to be conservative in terms of the counterfactuality of the technology/fuel choice, but OECD and World Best region fail to take account of country-specific grid mix characteristics. None of the multi-project baselines explored here account for uncertainty from continued additionality of the project or the data uncertainties. This means that in some countries they would underestimate reductions and in others overestimate reductions leading to a bias from country to country. Country-specific characteristics are an important element as a starting point for a conservative approach.

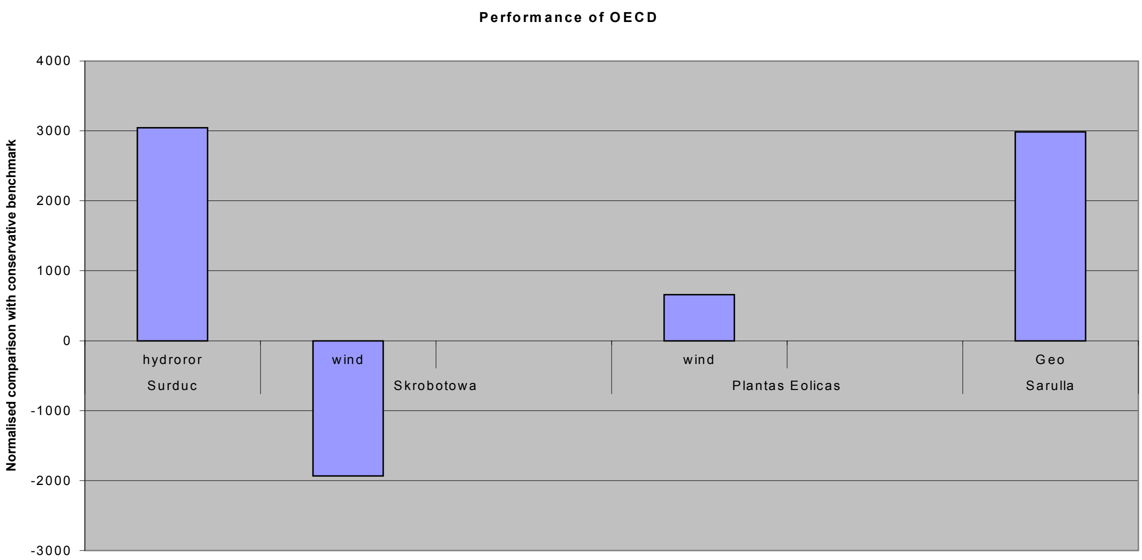

Figure 4.1. Deviation of the OECD benchmark from conservative single-project baselines (Normalised comparison with conservative benchmark (in kgCO2/MWh/yr)

4.1.6 Additionality uncertainty

Additionality has proved a difficult concept to operationalise unambiguously and as a result most of the methods proposed have not been applied in practice (see also Chapter 5). For the projects analysed the continued additionality of the project's emission reductions was explored and the effect that this would have on the range of uncertainty in the emission reductions generated. It was assumed that an evaluation of the initial additionality could be made which would probably be valid for about 5 years into the future. With this the effect of the additionality uncertainty for the years 5 to 10 can be expressed in terms of the uncertainty in the final estimation of reductions. Figure 4.2 explores the sensitivity of the emission reduction estimations to the years of additionality for the *Surduc* project. The contribution of this factor to the total uncertainty is very high, ranging from 35% if it could reasonably be assumed that the project would have been implemented anyway after 5 years to just 6% in year 9. This type of uncertainty is common to many projects. In Chapter 5 the implications of these results are further explored as well as a recommendation on how this particular type of uncertainty can be dealt with.

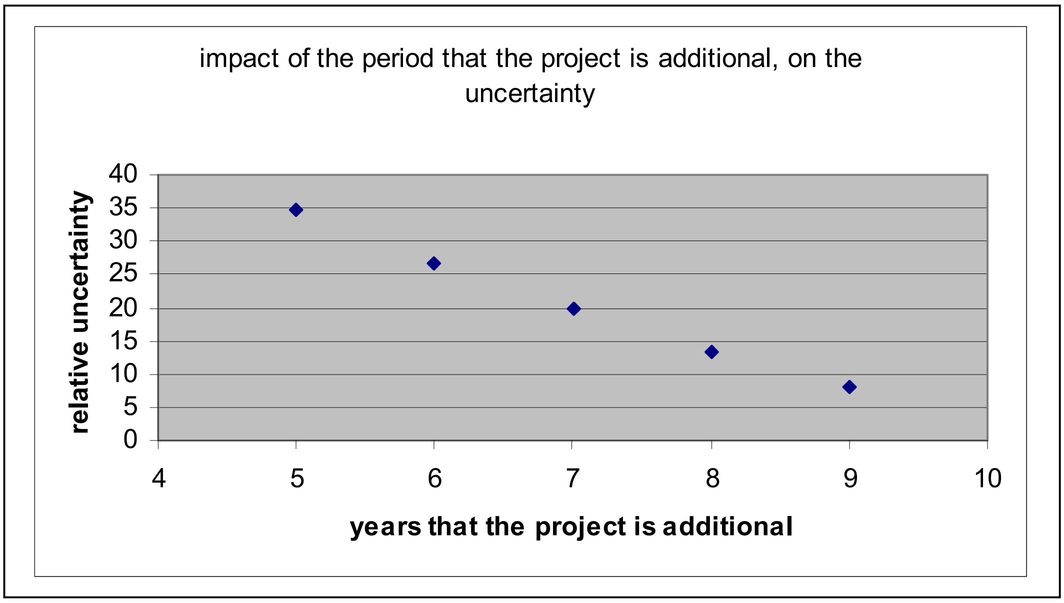

Figure 4.2. Total uncertainty calculated for different lengths of time that the Surduc is additional

4.1.7 Estimating uncertainty: the example of Surduc-Nehoiasu (run of the river hydro), Romania

The Surduc-Nehoiasu project is a run-of-the-river (RoR) hydro project in Romania, expected to come on line in 2005. It will have a capacity of 55MW with 152.7 GWh/y output expected.

Country context and existing emissions profile

In 1999, the output (GWh) of the Romanian electricity sector was produced with the following fuel grid mix: 29% coal and lignite, 16% natural gas, 11% nuclear, and 7% fuel oil. 37% of the electricity output was provided by hydro. 80% of the coal/lignite-fired plants are for electricity production only (*i.e.* 20% is co-generation); for gas/oil-fired plants that figure stands at 45% (*i.e.* 55% is co-generation). The specific output emission factor for the average grid mix (in 1999) is 552 t CO_2/GWh.

60% of current electricity sector capacity in Romania is more than 20 years old and about 10 GW (44% of the capacity) needs to be rehabilitated or replaced by 2010. Currently, Romania has problems with securing the supply of primary fuels, resulting in temporary shortages. Romania is self-sufficient in coal/lignite but has to buy an important amount of its oil and gas on the international market.

General assumptions for baseline selection

- It is assumed that at the time when the project goes live, the present over-capacity in the Romanian grid will still exist, and that the project would therefore address **existing demand**.
- The project is an RoR plant which means that it 'must run' and it is therefore assumed that the plant displaces the **base load fossil fuel grid mix**. Detailed data for the base load component is not available so that two approaches have been used:
- First, it could be argued that the marginal plant substituted may change over time. The costs of maintenance per output are highest for the old coal-fired plants, which may have high outage time due to repairs. However, coal is a relatively cheap and reliable domestic fuel. The gas-fired plants are easier to maintain but the gas is much more expensive to buy and its price can fluctuate considerably on the international market. Thus in one baseline scenario the average fossil-fuel grid mix is used as a surrogate.

  The development of this fossil fuel part of the grid mix during the lifetime of the project depends on a number of factors. It is assumed that the emissions factor of the grid mix is not going to increase during the lifetime of the project and if the economy does not improve, the overcapacity will allow the oldest and most inefficient plants to be closed down, so that the emissions factor of the grid mix will even decrease. However, this effect may be counteracted by high international gas prices so that gas imports will be reduced and the remaining coal-fired plants will be covering more of the output. Therefore, the 'poor economy' scenario, which is reflected in **baseline 1** (see below), has an emissions factor similar to that of the current grid mix (which would be BAU).
- Second, if the economy recovers well, then it can be assumed that the emissions factor of the fossil-fuel component of the grid mix will show a marked decrease. This will be due to the facts that: new plants will be added which are much more efficient; more gas will be imported and used; and old plants will be phased out because more stringent environmental regulations will be enforced as accession to the EU proceeds. This is the basis for **Baseline 2**, which is also called here the mix 2020 scenario.
- As an alternative, the likely substituted base load plant is identified as old coal and this is described in **Baseline 4** (or old coal).
- RoR hydro is a no-regrets option as its running costs are very low. Since there only a few new hydro opportunities in Romania, it can be assumed that in the case of new demand, the project would eventually have happened anyway. It would take a number of years to plan and build the plant so it is assumed that the project could have happened anyway in 5 years' time at the soonest. The building of new hydro plants would be most likely under a high economic growth scenario, which is the basis for **Baseline 3** (or 5y additional).
- The level of seasonality in the hydrological regime of the river is not known. The variability in the specific emission factor of the average grid mix over the year is also unknown, although it could be expected that the seasonal operation of CHP plants would influence the emission factor. But since the available data is aggregated over a whole year, seasonal fluctuations are not taken into account.

Single-project scenario baselines and results

Four single-project scenario baselines have been generated for this project:

- **Baseline 1**: BAU current mix – the emissions factor for the fossil-fuel grid mix remains at the current level. This corresponds with the historic baseline approach of the *Marrakech Accords*.[130]
- **Baseline 2**: Mix 2020 – this is a scenario in which the emissions factor of the fossil-fuel grid mix will decrease over time to a value of 0.6 tCO_2/MWh in 2020, as a result of the phasing out of old plants and building of BAT plants. Under current BAT conditions, and assuming the absence of other fossil fuels, that would require a coal-to-gas output ratio of 11:9 (*i.e.* 55%-45%) in the electricity sector.
- **Baseline 3**: 5y additional – the project would have happened in 5 years' time anyway to provide for possible new demand. In the first 5 years it is assumed that the emissions factor for the grid mix decreases at half the rate of the 'Mix 2020'.
- **Baseline 4**: Old coal – an old coal-fired station is substituted from the base load by the new RoR plant. This scenario baseline assumes that the plant serves existing demand, and that the marginal plant would be an existing coal-fired plant (the average existing Romanian coal is taken as a proxy value for that plant).

The results for the calculation of the emission reductions from the project using the three baseline scenarios described above are given in Table 4.5.

Table 4.5. Emission reductions from scenario baselines for Surduc

Surduc (hydro)	Scenario emissions factor for output (tCO_2/MWh)	Emissions over 10y (tCO_2)	Emission reductions (tCO_2)
Project	0	0	
Baseline 1: current mix	0.887	1,353,975	1,353,975
Baseline 2: mix 2020	0.866-0.705	1,199,968	1,199,968
Baseline 3: 5y additional	0.876-0	655,558	655,558
Baseline 4: old coal	1.145	1,748,415	1,748,415
Emission reductions uncertainty			1,201,987 (±45%)[131]

The table shows that the 'old coal' and 'only 5y additional' are the upper and lower bounds of the four baseline scenarios identified. The size of the uncertainty (45%) over the range of these baselines is primarily due to the possibility that the project could have happened anyway in that timeframe. Without the 5y additionality assumption the 'lower bound' baseline would have been the 'mix 2020' scenario, which would have resulted in an uncertainty percentage of 18.6%. When the project would have happened anyway depends on the economic and political developments within Romania, which fall under the category of background uncertainty. The value of 5 years was taken as a conservative value but obviously other times are possible up to the full 10 year crediting lifetime.[132] Thus where the country circumstances make the project a reasonably likely investment within a few years, this contributes up to 35% to the uncertainty (assuming that 'current mix' is the baseline while the project's emissions reduction is additional). In case the project would not have happened anyway, then the main source of uncertainty would have been due to the possible substitution of the old coal-fired plant rather than the grid mix (13%-19%). The uncertainty relating to the variations in grid mix was small being just ± 6%.

[130] Para. 48a of Annex to Decision -/CMP.1 (*Article 12*).

[131] The uncertainty is calculated as follows: ((1,748,415 – 655,558)/2)/((1,748,415 + 655,558))/2) = 0.45 (45%)

[132] Obviously, the levels of additionality uncertainty are lower for the baselines with 7-year revision periods.

From the single-project baseline uncertainty analysis for this project the following can be concluded:

1. The *counterfactual uncertainty* associated with the range of technology/fuel combinations in the baseline is fairly large at $\pm$19%, while for variations in the energy grid mix (for plants which are not 'must run') it is low at $\pm$6%.
2. The uncertainty associated with the *continued additionality* of the project is high and it may be a relevant uncertainty especially in countries in the EU accession process.
3. In order to correct for this effect the baseline could be set at a level which takes these uncertainties into account: *e.g.* correct the baseline with the corresponding uncertainty-%.
4. Such a stringent level baseline would be set in this case at roughly 65ktCO_2/y, which corresponds to an emissions factor of 0.43 tCO_2/MWh.

Comparison with multi-project baselines

For comparison purposes the following five multi-project baselines and benchmarks have been selected for this project:

1. **Old gas** - representing the average of existing (*i.e.* old) gas plants in Romania. This technology benchmark may be relevant if the price of gas on the international markets increases to such a level that it will make the gas-fired plants more expensive to run than the coal-fired plants (gas-fired thus becoming the marginal plant).
2. **ERUPT** multi-project baseline factors for electricity projects in Romania.
3. This project was submitted to the Dutch ERUPT programme by Ecosecurities who used a **linear extrapolation** from the current grid mix to a grid mix in 30 years time which will be fully based on modern gas-fired plants only, with an emissions factor of 0.388 tCO_2/MWh.
4. **Romania and region** – this is the average grid mix for Romania and all transitional economies excluding the Russian Federation (taken from MBS, Annex 6).
5. **Best region** in the world (taken from MBS, Annex 6)
6. **OECD average** – this is the average grid mix for all OECD countries for the specific time period as described in Annex 6.

The technology benchmark for BAT natural gas is not included here as it is not deemed relevant for a project which covers existing demand (so only the operating margin project is explored, see Kartha *et al.*, 2002).

The specific emissions factors and the emissions reductions resulting from the analysis are listed in Table 4.6. It should be noted that all baselines run for 10 years except ERUPT (8 years only, until the end of 2012) and Ecosecurities (5y only; 2008-2012 covering the Kyoto Protocol commitment period). This means that the emission reductions of the latter two cannot be compared with that of other baselines.

Table 4.6. Comparison of scenario baselines and standardised baselines for Surduc					
Surduc (hydro)	Scenario emissions factor for output (tCO_2/MWh)	Total emissions over 10y (tCO2)		ER (tCO2)	
Project	0	0			
Scenarios					
Baseline 1: current mix	0.887	1,353,975		1,353,975	
Baseline 2: mix 2020	0.866-0.705	1,199,968		1,199,968	
Baseline 3: 5y additional	0.876-0	655,558		655,558	
Baseline 4: old coal	1.145	1,748,415		1,748,415	
Standardised Baselines					
Avg. Rom. Gas	0.499	761,973		761,973	
ERUPT	0.611-0.547	707,459	8y only)	707,459	(8y)
Ecosecurities	0.84-0.76	612,630	(5y only)	612,630	(5y)
Romania+region (CCB)	0.72-0.66	1,062,396		1,062,396	
Best region	0.63-0.60	942,299		942,299	
OECD avg.	0.77-0.7	1,119,994		1,119,994	

The comparison is illustrated in Figure 4.3 below.

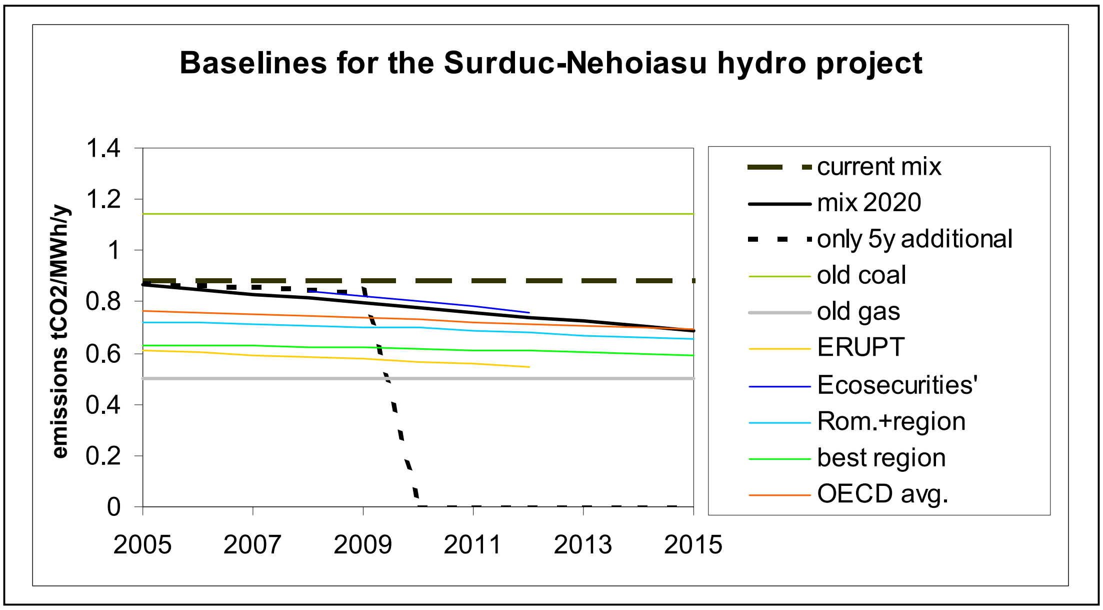

Figure 4.3. Scenario baselines and standardised baselines for Surduc

Conclusions

1. The most conservative scenario in this case is quite stringent as it takes account of a likelihood of non-additionality about halfway the project's lifetime.
2. If additionality was not taken into account the ERUPT, CCB, Best region and OECD benchmarks would be conservative benchmarks in this case.

4.1.8 Summary: Taking account of uncertainty in standardised baselines for large projects

Several important points emerge from comparing single-project baseline scenarios with multi-project baselines for the large projects studied:

➢ The uncertainties associated with each country context can vary from country to country so that to ensure environmental integrity, multi-project baselines, which are not country-specific, should be avoided in order to prevent the same baseline giving one country an advantage over another.[133] This point has also been taken in the description of the MBS-derived benchmarks in Sections 3.5.2 and 3.5.3.

- The uncertainties on data and additionality explored in the scenarios are generally not reflected in the technology or sector average multi-project baselines or in the energy model baselines (*e.g.* PERSEUS).
- To avoid the risk of overestimation of reductions in the electricity sector using a standardised, multi-project baseline, such baselines should be generated with the following characteristics in mind:
  - Country
  - Project type
  - New or existing demand
  - Weighted to account for the uncertainties in additionality, data and technology/fuel.

The *country*, *project type* and *new or existing demand* characteristics affect the choice of the benchmark level of geographical aggregation, the time horizon of the plants used for the benchmark and whether a sector or technology benchmark is appropriate. The *weighting* can be related to the uncertainty range found with these projects, which, though derived from a small set of projects, did show the range of issues likely to be common to many projects. Based on the analysis of the timing of the plant and the data uncertainties a 25% correction factor would be stringent but should not discourage projects while lowering the risk of overestimation for the large plants studied. The counterfactual uncertainty for the choice of technology/fuel or sector average development varies with the country's energy system treated in the consideration of the country, the project type, and the new or existing demand analysis.

In the specific case of wind energy projects where the country electricity system would have spinning reserve (*e.g. Skrobotowo*) a further correction to the project emissions would need to be made in the order of 15% to be added to project emissions (*i.e.* corresponding to extra emissions resulting from keeping a back-up coal plant in a spinning reserve mode). To take account of the data uncertainties some additional checks need to be carried out at the validation phase to make sure that there is no deliberate inflation of the baseline emissions.

For the CDM, the limited crediting lifetime is a good safeguard for minimising the risk of overestimation of emission reductions. But it does not take account of the risk of non-additionality in a 10-year crediting lifetime. For a crediting period of 3 x 7 years the additionality uncertainty will be lower, and an additional weighting of benchmarks beyond the counterfactual uncertainty and additionality uncertainty will not be required. In the case of JI on the other hand, there is no limit to the crediting period. It would therefore be essential for baselines generated for JI projects to take the additionality uncertainty and counterfactual and data uncertainty into account, as described above.

[133] This conclusion underscores the importance of baselines being project-specific as formulated in the Marrakech Accords: para. 45c of Annex to Decision -/CMP.1 (*Article 12*). As argued elsewhere and shown in Annex 8, the condition of baselines being project-specific could be met by both single and multi-project baselines.

4.2 Institutional implications of determining single and multi-project baselines

4.2.1 Introduction

A baseline for a JI/CDM project must be a reasonable description of the situation that would have taken place in absence of the project. This requires first that data is collected about the project circumstances, such as: where to place the project boundary, including an elaboration of those factors that can be controlled by the project participants; an estimate of how the situation would have evolved without the project; whether the characteristics of the project imply that it is only suitable for base load electricity production or could also serve peak load, *etc*. Second, data is needed on the country context for the host country in order to identify what factors could potentially have an impact on the emission sources within the project boundary, *e.g.* whether there is excess energy production capacity, so that a fuel switch would reasonably replace a margin plant, or whether the country's capacity is fully used, so that a project might replace a plant that would otherwise have been built.

Third, a choice must be made how this data can be transformed in a scenario, which requires a decision on whether this scenario would need to be based on historic data as a proxy for future development or be based on future-oriented scenario analysis through modelling, or derived from control groups in other countries or regions. The analysis in Chapter 3 and Section 4.1 has shown that this depends on what the project actually replaces. Finally, the uncertainty related to the baselines for the project must be properly dealt with (see Section 4.1). In case multi-project baselines are used, capacity is needed to determine the corresponding scenario (*e.g.* under the auspices of the CDM Executive Board) and project participants in investor and host countries must be equipped to properly work with these baseline tools.

Definition and administration of rules

In order to understand the information structure of the CDM, Figure 4.4 presents an overview of the actors generally involved in the process.[134]

[134] For JI projects the procedure is similar under the second slower track with the CDM Executive Board being replaced with the JI Supervisory Committee.

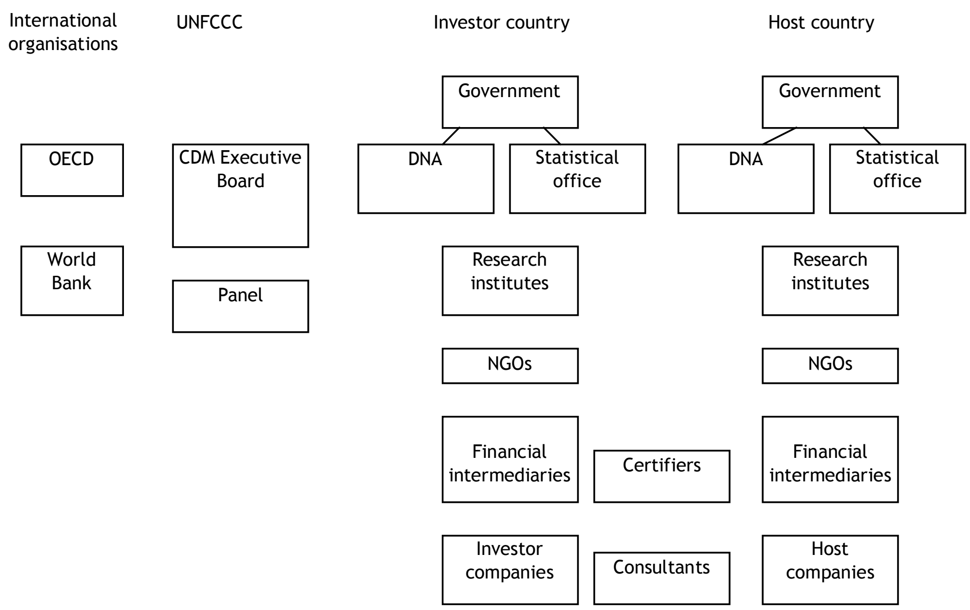

Figure 4.4. Actors and institutions that could be involved in administration of methods and data collection for baseline setting under the CDM

Concerning development and administration of baseline rules, the *Marrakech Accords* have already taken basic decisions, which are to be further worked out by the CDM Executive Board (EB) aided by the baseline methodologies panel. Next to these official rules, certifiers/validators can suggest additional rules when submitting a validation report to the EB should they believe a particular project (type) requires such rules. A similar procedure applies to the second track of JI. Project participants have to describe the baseline according to the procedures laid down in the *Project Design Document*. In the case of first track JI, government agencies can define baseline rules as they like because by complying with Articles 5 and 7 of the Protocol the overall emission reduction accounting for JI projects will be identified under the national GHG inventory assessment of the host country. Public choice theory suggests that institutions that have the power to define baseline rules are likely to make them relatively complex due to the interest to make discretionary decisions. On the other hand, governments have a strong incentive to keep procedures simple in order to keep the project-based mechanisms attractive for private sector investors. Moreover, the way decisions are taken has an influence on the market for service providers such as consultants. Fund managers can bundle functions, especially if they are situated at data-gathering institutions (see for instance the PCF). If discretionary rules are allowed under the CDM, there is a tendency for a low level of environmental integrity as both host and investor have an interest to get lax baselines.

Collection of data for baseline development

Data can be collected from national inventory data, from the field or derived from models, *e.g.* energy sector models estimating future energy demand. In the latter case, research institutions become important unless the models are so user-friendly that their operation can be done without expert assistance (see for instance the difference between the complex PERSEUS model and the more user-friendly Reflex model discussed in Section 3.3).

An important consideration with respect to baseline standardisation is the extent to which data is available in a host country. For example, Kolar *et al.* (2001) conclude that for a country like Poland future and recent capacity additions for the power and heating sector are not reliable sources for determining default values for baselines. They argue that with respect to a future capacity addition approach current data on planned new additions and retrofits are "often unavailable, unreliable, and … prone to gaming by investors". The latter is mainly due to the fact that the Polish power sector is in a process of deregulation (among others with a view to the future Polish membership of the EU, see Section 4.3), which creates a situation where several independent power producers take decisions for themselves about future investments rather than the Polish government doing that for them as was the case in the past. Regarding the application of recent capacity additions as a basis for multi-project baselines, the study felt that the number of recent additions in the power and heating sectors is too small for using this benchmark approach for Poland. Kolar *et al.* (2001) suggest the use of models instead, given that the macro, meso and project-level information have become better available in Poland.

Data collection may be relatively expensive especially if a baseline is determined on a more aggregated scale and if the data is not routinely and systematically collected for other purposes, such as the national inventory of the host country (see also Table 4.7).

Table 4.7. The institutions most likely to give data input for different baseline parameters

Data type	Degree of aggregation	Appropriate institution	Data routinely collected
Project specific			
Internal rate of return/ net present value	• Project basis • National averages	Consultants, Banks, Financial regulatory bodies	No Partly
Project costs	Project basis	Consultants	No
Investment barriers	• Project basis • National averages	Consultants, Regulatory bodies	No
Control groups	• Project basis • National averages	Consultants, Regulatory bodies	No
Scenario analysis	• Project basis • National averages	Consultants, research institutes	Partly
Benchmarks			
Economically most attractive	• Global level • National level	EB DNA	No
Recent comparable	• Global level • National level	EB, OECD, World Bank Sector associations, consultants	No
BAT	• Global level • National level	EB, OECD, World Bank Standardization bodies, regulation bodies	No
Better than average	• Global level • National level	EB, OECD, World Bank Statistical offices, regulation bodies	No
Sector average	• Supranational • National level	OECD, World Bank, Statistical offices	Yes
Modelling	All levels	OECD, World Bank, research institutions	Partly

The role of aggregation

The degree of involvement of institutions depends on the degree of aggregation of data used for baseline determination. Generally, the higher the degree of aggregation the more institutions will be involved in data collection. If a baseline is developed primarily on a single-project basis, most of the data need to be collected by the project developers or by specialised consultants and NGOs familiar with the situation 'on the ground', acting on their behalf and possibly supported by the UNFCCC Designated National

Authority (DNA) in a host country. An important aspect in this respect is that although the data for the baseline is likely to be mainly collected from the project site within the project boundary, there will be a need to also collect data from outside the project boundary, which will be relevant for describing the situation on the project site in the absence of the project, *e.g.* the country context.

Standardising baselines on a sector level requires collection of sector data for which the role of statistical offices becomes more important. Also, the DNA could be made responsible for collecting sector data relevant for the standardised baseline approach. Such data could also be derived from data sets collected by international organizations such as OECD/IEA and the World Bank. Data collection by project developers is then restricted to project activity data, which need to be multiplied by the multi-project baseline emission coefficients derived from the data collection at the sector or national level. In order to determine multi-project baselines such as performance benchmarks, research institutes can be contracted by the government of *e.g.* the host country.[135] The CDM Executive Board or the baseline panel might also try to get a long-term role in developing data gathering and definition competence, which might have the advantage that data collection could become a consistent approach across different host countries and that the risks of gaming and data manipulation could be reduced.

As mentioned above, a higher aggregated data collection for baselines reduces the overall costs for the project participants. However, costs for the national host country governments or the Executive Board are likely to increase with more aggregated baseline determination and consequently data collection, which could be covered by higher fees for registration and issuance of CERs. The costs for governments are likely to be highest if data are aggregated on a national level.

Projects of different scales in the heat and power sector

In the PROBASE analysis of modelling benchmarks in the heat and power sectors (see Chapter 3) the data requirements for the calculation of (standardised) baselines or benchmarks has already been identified (see Table 4.8). Different benchmarks require different data sources and as such require different institutions for the collection. A sector-specific multi-project baseline requires more detailed data than a regional baseline, and the *World Average* benchmark is likely to require more data than the *National Average* benchmark. However, in case of some developing countries the data necessary for the *OECD Average* is probably more readily available than for the *National Average*.

Table 4.8. Data needed for the calculation of baselines

Country-specific data:	Power sector:	Heat sector:
• Energy resources • Energy related environmental issues • CO_2 emissions in energy generation • Energy policy measures	• Electricity generation • Total capacity installed • CO_2 emissions in energy generation • CO_2 emissions in electricity generation • Fuel use for electricity generation • Total electricity demand • Transmission grid characteristics • Forecast electricity demand	• Heat generation • Transmission heat network characteristics

135 An example of where this has been done is the University of Utrecht in the context of benchmarks in energy sectors in the Netherlands.

4.2.3 Implications of modelling multi-project baselines

Chapter 3 examined four different aggregating methods in benchmark modelling:

- the PERSEUS energy systems model in combination with SimBAT,
- the Reflex model in combination with SimBAT,
- a fuel-specific combined country and regional benchmark, and
- a simplified (partly) future-oriented simplified benchmark method based on historic/recent characteristics of the energy sector (in combination with SimBAT).

As shown in Chapter 3, the latter two benchmarks are applicable to a broad range of host countries as the data requirements for these methods are relatively small and the data widely available. The Reflex model, on the other hand, requires more data and is therefore less applicable in least developed countries. This holds even stronger for the PERSEUS model as it requires even more data and is therefore generally not applicable at all in the least developed countries and only applicable, depending on the country-specific situation, in those developing countries where an on-grid power system is in place and sufficient information is available about the parameter values to be modelled (see for a more detailed assessment, Section 3.7)

Cost Implications of modelling with the PERSEUS model

Besides covering a significant share of the total GHG emissions of a country, the use of cost-optimising energy models such as PERSEUS or Reflex, where feasible, brings along a variety of advantages that let their use appear justifiable and desirable in an environmental as well as an economic context. However, the elaboration and application of energy and material flow models requires experience in handling such instruments and is time-intensive, especially in the phase of preparing the model for application in a particular host country. When assessing the cost implications of establishing benchmarks derived from the PERSEUS and Reflex models most transaction costs are related to this preparation phase; the maintenance of the model on a regular basis in order to incorporate the latest data is relatively easy. What is typically needed for the application of models like PERSEUS and Reflex for benchmark determination, are:

- a comprehensive data set for the relevant sector in the host country;
- a detailed country context report;
- a model run to project an optimal energy grid mix for the near future;
- a baseline aggregation tool to transform the scenario calculated by the model into a baseline scenario;
- a number of example projects to test the model results as part of a sensitivity analysis.

Depending on the complexity of the energy system and the level of detail of the available data these steps will require about 6 months of work by a person trained in the application of the PERSEUS model. For an application of Reflex, 3 to 4 months can be considered as a proxy, once again depending on the data availability/quality and the experience of the user. This implies rather high costs up-front on an institutional or political level. However, these costs could at least partly be passed on to project developers that benefit from a drastically simplified baseline determination and validation process. Significant costs reductions could be made since the use of a comprehensive model enables the determination of a set of baselines for different project categories and on various levels of aggregation, as *e.g.* sector, region, or load-range.

To enhance the credibility of forward-looking standardised baselines determined with optimising energy system models a validation step for the input data of the model and the general conditions assumed can be considered. For this step the same is true as for the development of the model as such. Once the initial model has been approved, the later verification would only have to take into account critical changes of model parameters that would be part of a model update. The project developer would only have to prove that his project belongs to one of the categories covered by one of the approved baselines. This would greatly simplify baseline determination for the project developer as well as baseline validation for the project, and thus also cut transaction costs drastically on the operational level. The total amount of transaction costs could thus be lowered due to an economies-of-scale type effect: the more projects (and credits) can be subsumed under those categories for which multi-project baselines are available, the cheaper the share of transaction costs for the individual project.

Once established, maintenance and updates of the models could easily be conducted on an annual basis. The costs for such maintenance would be relatively low, as major structural changes in the model will, if at all, only occur very gradually. Usually, this update would only involve the update of a limited number of values in the database (*e.g.* prices for energy carriers, efficiencies, capacities, *etc.*) with a subsequent model run and the aggregation of the new results to an updated set of baselines.

Table 4.9 summarises the institutional efforts required to implement and maintain multi-project baselines.

Table 4.9. Efforts necessary to implement and maintain multi-project baselines

Multi-project forward-looking baseline using optimising energy models (PERSEUS or Reflex)	
Data collection, model development, definition of reference scenario, model runs, baseline aggregation and determination	4-6 person-months work by a trained individual and infrastructure
Model verification	Thorough examination and verification (e.g. by an independent verifier) of the initial model, later e.g. each year for model update
Baseline validation	Straightforward and cheap verification process. Prove that project belongs to a category for which an approved multi-project baseline is available.
Model maintenance / baseline update	Incorporation of recent changes in economic and technical data easily possible. Updated model, model run and determination of updated baseline could be done on an annual basis at very low costs (1-2 weeks of work by trained individual and infrastructure)
Project-specific baselines (always depending on project size and complexity)	
Data collection, definition of reference scenario	Development of general methodology: (if first project of its kind): 1-3 person-month Applying existing methodology: 1-2 person-month
Baseline validation	Up to 2 person-month
Baseline update	Up to 2 person-month

4.2.4 Institutional implication of standardising baseline procedures in the forestry sector

In contrast to the modelling approaches for energy-related projects, the scope for standardising forestry project baselines is relatively limited due to the high variability of land-use options under the baseline. Standardisation could be applied to the way in which the *observation area* is determined (*e.g.* 5 to 10 times the size of the forest area itself, see Section 3.6) and how land-use options within the observation area are aggregated as a standard parameter for the baseline.

The data collection needed for determining the appropriate size of the observation area for the forestry project will entail costs. It would be preferable to have a database developed by host country authorities that allow calculation of any observation area in the country. The basis can either be cadastral or satellite-image derived data linked to a GIS. In countries that have already GIS-based land use data, additional costs are negligible. Countries that lack such data would have to buy a set of satellite images and to do ground truthing in cases where the satellite data are unclear. Such a process will have costs that are roughly proportional to the land area of the country. The added value of this data set for spatial planning should not be underestimated. Data acquisition costs for satellite data should not surpass € 0.6 per km^2, and personnel costs can be roughly estimated at 5 person-months per 100,000 km^2; *i.e.* € 5000 for a middle-income country. Initial costs will be higher due to the necessity for more ground truthing and related personnel and travel cost.

Under a single-project baseline, detailed land-use data of the area in question as well as trends in economic parameters would have to be used. The detailed definition of a land-use scenario will be more cost-intensive than the use of pre-existing data for the observation area. Given the experiences from development of single-project baselines, such a scenario could cost € 20,000 – 30,000. A country of 500,000 km^2 would thus profit from a standardised baseline method if it hosts more than three new forestry projects every year.

Table 4.10. Cost ranges for initial area inventory

Activities	**Cost range (euro's)**	**Determining factors**
GIS-mapping of the area	Unknown	Accessibility of the area, existence of the appropriate software etc.
Acquisition of satellite imagery	650 – 5,000	Size and homogeneity of the area and subsequently the scale of the pictures
Initial biome stratification	One expert week 2,500	Size
On-the-ground verification and correction of strata	Four expert weeks: 10,000	Size
Determination of statistically relevant number of sample plots within and outside the area	2,500 – unknown	Size, homogeneity of the area, existence of growth tables
Collection of samples	Unknown	Minimum requirements for precision as stipulated by the IPCC. Can be extremely costly, if destructive sampling is needed.
Modelling baseline growth	Unknown	Easy if known species are involved, for which growth tables are available. This should be the rule for afforestation and reforestation projects, but will be difficult for the case of natural forest conservation.

Multi-project baselines for forestry projects will be more attractive to countries that already have good GIS-linked data on land use and that can expect a high number of forestry projects, such as medium-income countries with a well-developed administration. Countries with a lack of administrative capacity and a small number of expected forestry projects should not aim for standardisation of baseline methods. A summary of the efforts necessary for multi-project forestry baselines is given in Table 4.11.

Table 4.11. Efforts necessary to implement and maintain multi-project baselines	
Data collection	Acquisition of satellite images and ground truthing: €10,000-15,000 /100,000 km^2 Use of existing cadastral data: dependent on the degree of computerization of the cadastres.
Additionality determination	Easy multiple choice (1 person day)
Baseline determination	Easy multiplication using GIS-related data (1 person-day)
Baseline verification	Verification of data source necessary, but easy (2 person-days, if governmental data transparent)
Baseline update	Annual collection of new GIS-linked data, see above.

4.3 JI project baselines in the context of the *Acquis Communautaire*

4.3.1 Acquis priority tasks

In order to become eligible as EU Member State, the countries that are candidate for EU membership[136] have to harmonise their national laws with the EU legislation. Successfully passing through this EU-accession process not only requires that the EU legislation (*Acquis Communautaire)* is incorporated in Candidate countries' domestic law but also is fully introduced into practice (implementation). The *Acquis* represents a common level of requirements in different fields of the society, which hold for all EU members as a safeguard to protect the common market. The pre-accession process therefore involves harmonising the national law in Candidate countries with the common legislation in the EU reflected in the *Acquis*.

Part of the *Acquis Communautaire* is a set of common environmental EU standards (hereafter: the environmental *Acquis*). The environmental *Acquis* covers measures mostly in the form of directives, which aim at protecting environmental quality, preventing pollution, adjusting production processes in order to make them more energy efficient, and setting standards for products. Priority areas addressed by the environmental *Acquis* are: nature and biodiversity, environment and health, natural resources and waste and climate change. Incorporating the environmental *Acquis* implies that the Candidates have to fulfil the following priority tasks:

- Incorporate the Community framework legislation (including access to information and environmental impact assessment);
- Carry out measures relating to international conventions to the Community is a Party (*e.g.* the UNFCCC);
- Reduce global and transboundary pollution;
- Safeguard biodiversity by developing nature protection legislation;
- Implementing measures ensuring the functioning of the internal market (*e.g.* product standards).

[136] The Candidate countries in Central and Eastern Europe are: Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. The group of Candidate countries consists of the same countries as the CG-11, with the exception of Croatia, which is a UNFCCC Annex I Party (with quantified emission reduction commitment) but, as per early 2003, not yet an official candidate for EU membership.

4.3.2 The scope for JI under the Acquis

Generally speaking, it can be argued that the scope for JI will be reduced by the environmental standards of the *Acquis*. After all, incorporating these rules improves the environmental standards in the Candidate country and reduces the emissions of GHGs. Due to the stricter *Acquis* environmental standards, the country's business-as-usual emissions level from which the JI project baselines are to be derived becomes (much) lower, thereby lowering the JI emission reduction potential. In other words, part of the potential JI abatement is already obligatory under the *Acquis Communautaire*. The implications of this effect may differ from country to country, but especially for those countries that are expected to be the first ones to enter the EU and that have already begun implementing *Acquis* standards, JI might not be a feasible option anymore or may have lost a considerable part of its initial potential.

The example given in Nondek *et al.* (2001) for the Czech Republic is illustrative in this respect. In their study for the PCF they have (using the MARKAL model) calculated the technical GHG emission reduction potential in the year 2010, *i.e.* emission reduction measures beyond the requirements adopted in the Czech Republic between 1995 and 2000. This potential amounts to a reduction of 62 Mt CO_2-eq. for 2010. Next, adjusting this technical potential with economic effectiveness indicators (*e.g.* different levels of economic viability) results, according to Nondek *et al.* (2001), in a 'real potential' of 24.5 Mt CO_2-eq. emission reduction in the Czech Republic in the same year. Assuming that part of this potential will by 2010 have been carried out anyway because of the economic attractiveness of some of the options and/or because of the requirements of the *Acquis Communautaire*, a 'real JI potential' results of 13 Mt CO_2-eq. Of this potential, assuming that a feasible JI project must at least reduce 1000 t CO_2 per year, Nondek *et al.* (2001) consider only 2.4 Mt CO_2-eq. as the true JI potential in the Czech Republic in 2010 (which is about 4% of the technical potential mentioned above and 10% of the 'real potential').

The *Acquis Communautaire* is likely to affect the GHG emissions in the Candidate countries in a number of ways. The EU environmental legislation varies from prescriptive regulations defining EU-wide minimum environmental standards, such as emission limit values for large combustion plants, to more flexible legislation with *e.g.* site-specific environmental protection rules or voluntary or market-based instruments, such as voluntary agreements between sectors or emissions trading. Although it is required that the Candidate country's environmental legislation is fully harmonised with the EU legislation, there are still reasons why this does not automatically imply that by the time a Candidate becomes an EU member, its environmental protection standards are exactly the same as the common standards of the EU.

A first reason for this could be that the Candidate agrees with the EU on a timeframe for implementing the *Acquis* standards, which could result in a situation in which the Candidate is allowed to complete the full implementation of the *Acquis* measures at a later date. The European Commission does not grant transitional measures on framework legislation (air, waste, water, impact assessment, access to information), nature protection, all product-related legislation that is essential to the internal market, and new installations. Only where measures require a substantial adaptation of the infrastructure in the Candidate country, which needs to be spread over time (*e.g.* upgrading existing power plants to the IPPC Directive standards) a transition period can be considered. The European Commission applies in this context the ground rule that the transition periods allow Candidates to deal with the legacy of the past, but not to attract new investments with lower environmental standards.

Second, EU environmental legislation is often defined in terms of so-called 'Best Available Techniques' (BAT) standards,[137] *i.e.* each EU Member State should introduce domestically BAT for environmental protection (see for a further elaboration on BAT, Section 2.3.3).[138]

In the definition of BAT 'available' is a relative term which needs to be determined for specific situations in the Candidate countries. This implies that BAT can differ between countries, but also within the countries. An important implication of the above definition is that interpreting and defining BAT for environmental standards is to a certain extent a possible topic of negotiation between the EU and the Candidate country. A result of such negotiation could be that for one Candidate country the BAT will become less strict than for another country. Therefore, a strict BAT indirectly reduces the potential for acquiring JI credits in the Candidate country since the improvement of the environmental standards are likely to reduce the emissions of GHGs. The opposite holds for a less strict BAT.[139]

4.3.3 Status of negotiations and transitional arrangements

As explained in more detail in Annex 5, at present the Candidate countries in Central and Eastern Europe are involved in or have completed negotiations with the EU on the incorporation of the *Acquis Communautaire* in their domestic laws. In 2001, the European Commission concluded negotiations with the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. On 9 October 2002, the EU Council agreed on the eligibility of EU membership for these countries as of 2004, which was followed by an approval by the European Council on 13 December 2002.[140] Until then the negotiation outcomes will be considered for ratification by the Candidates' parliaments and in some countries also referenda will be organised. Of the present Eastern European Candidate countries, Romania and Bulgaria are expected to complete the negotiations with the European Commission by 2007, which would enable them to enter the EU, given the ratification process, in 2009 at the earliest (see also Table 4.12).

Table 4.12. Status of negotiations on environmental Acquis

Country	*Chapter opened*	*Status negotiations*
Bulgaria	July 2001	Ongoing; EU expected for 2007
Czech Republic	December 1999	Approval European council in December 2002
Estonia	December 1999	Approval European council in December 2002
Hungary	December 1999	Approval European council in December 2002
Latvia	March 2001	Approval European council in December 2002
Lithuania	November 2000	Approval European council in December 2002
Poland	December 1999	Approval European council in December 2002
Romania	March 2002	Ongoing; EU expected for 2007
Slovakia	March 2001	Approval European council in December 2002
Slovenia	December 1999	Approval European council in December 2002

Source: Annex 5; personal communication with EC officials.

137 EU Council Directive 96/61/EC of 24 September 1996 concerning the Integrated Pollution Prevention and Control (IPPC).

138 Techniques in this context refer to *e.g.* maintenance, choice of raw materials, management practices, monitoring procedures, *etc.* So, the BAT concept does not only refer to technologies.

139 Next to the definition of specific BAT standards for individual installations, Directive 96/61/EC allows for the definition of General Binding Rules (Art. 9(8)) for installations that are regulated by the IPPC. As such, the General Binding Rules allow for a kind of standardization of BAT standards across installations rather than negotiating individual BATs for each installation. The analysis in this section of the interaction between the strictness of BAT and JI baselines to a certain extent also holds for General Binding Rules: a strict General Binding Rule reduces the scope for JI, whereas a less strict General Binding Rule in the Candidate country would provide a larger scope for JI.

140 In addition to these eight Candidate countries, also membership of Malta and Cyprus was approved.

As mentioned above the Candidate countries could be granted transitional measures by the European Commission. Although each of these transitional measures will have an impact on the timing of reducing GHG emissions in the Candidate countries, especially relevant for the topic of this Section is the delay granted for incorporating the IPPC measures, measures reducing air pollution from large combustion plants, and for incorporating the landfill directive. The baseline for a JI retrofit project in Slovakia, Latvia, Poland or Slovenia includes the IPPC standards as of 2010 or 2011 instead of the year 2007 (which is the deadline for the EU). The baseline for the project before 2011 would thus contain standards below the IPPC levels, although it should be kept in mind that incorporating the IPPC is likely to require a gradual process with a year-by-year improvement of the standards up until 2011. Table 4.13 provides an overview of IPPC-specific transitional measures granted to the Candidates. Emission reductions resulting from JI projects aiming at improving the environmental standards of the plants listed in table 4.13 to the level of the *Acquis Communautaire* can only be considered additional until 2010, 2011 or 2012, depending on the transitional arrangement between the Candidates and the European Commission and depending on the Candidates' progress with gradually upgrading the plants towards the *Acquis* standard.

Table 4.13. Transitional arrangements regarding IPPC

Country	Transitional arrangements
Bulgaria	None yet
Czech Republic	Possibly one installation until the end of 2012 (Prerov heating plant)
Estonia	None
Hungary	None
Latvia	8 combustion plants until the end of 2010
Lithuania	None
Poland	Until the end of 2010: • Over 100 municipal heating plants with a thermal input of 50 to 300 MW • 24 combustion plants belonging to main category 1.1 of IPPC • An unknown number of large combustion plants in other industry sectors such as refineries • (Note that these transitional arrangements have been granted on the condition that the plants do not cause a significant transboundary pollution)
Romania	None yet
Slovakia	10 installations (no main cat. 1.1 of IPPC but possibly some large combustion plants in other industrial sectors) until the end of 2011
Slovenia	19 installations (no main cat. 1.1 of IPPC but possibly some large combustion plants in other industrial sectors) until the end of 2011

Source: Annex 5; personal communication with EC official.

In addition to the *Acquis* environmental standards based on which the negotiations have taken or are taking place, the currently drafted EU legislation will also become compulsory for the Candidate countries (in fact, this legislation will eventually become part of the future *Acquis*) and therefore become part of the future business-as-usual scenario. Examples of this draft legislation are (derived from Nondek *et al.*, 2001):

- The Directive for an EU GHG trading scheme
- The bio-fuel Directive
- The Directive for the promotion of renewable energies
- The Directive for energy performance of buildings
- The Directive for energy efficient public procurement
- The amended SAVE Directive 93/76/EEC and
- The framework Directive for fluorinated gases.

4.3.4 The scope for early JI action in the EU accession process

Suppose that a Candidate country enters the EU in 2005 but has arranged with the Commission that a number of large combustion plants be subject to a transitional arrangement (see Table 4.13) which requires these plants to be upgraded towards the *Acquis* standards by the year 2010. If this upgrading operation would be carried out through a JI project in 2008, only additional credits can be derived from the project between 2008 and 2010. In case the JI investor and host had decided to start the project in 2005 already, if the host has the flexibility within its assigned amount to award early action without jeopardising its commitments, the project could earn credits already as of 2005.

Such an arrangement of early action could have the advantage for the investor that more credits can be earned. The host Party needs to make sure that the ERUs transferred to the investor are available as a surplus within the assigned amount. A second advantage could be that the host Party being a Candidate country could implement already in 2005 an environmental measure, which it is required to implement by 2010 only on the basis of a transitional arrangement which states that the Party would not have been able to implement the measure earlier without disrupting the economic situation in the country. There could be a risk of moral hazard here, though. Knowing that it could upgrade a particular large combustion plant as an early JI action project, the Candidate country might have an incentive to negotiate with the Commission a delay in upgrading the plant. By negotiating a transition period and developing an early JI action project, the JI investor would (partly) finance the *Acquis* measure.

In practice, however, this moral hazard does not seem to be a great risk. The experience with the negotiations so far has shown that the Candidates do not seem to negotiate with JI subsidies in the back of their heads. Moreover, for the environmental *Acquis* it would not make much of a difference if the measure were carried out by the Candidate itself or via a JI co-operation with a transfer of emission reductions. For the early JI action project emission reductions, there is no risk of non-additionality, because the analysis of the European Commission, on which the transitional arrangement was based, has shown that the Candidate itself would not have been able to carry out the project by the time of entering the EU.

One implication of rewarding early JI action for baseline setting could be that investments which emission reductions would probably not have been additional during the commitment period could become additional JI emission reductions had such projects been implemented a few years earlier. At first sight, the baseline determination for early action JI projects does not differ from the baselines for JI projects during the first commitment period. However, with a view on the *Marrakech Accords* there is an interesting aspect of baseline determination in relation to early JI action. As explained in Section 1.3.2, the *Marrakech Accords* have identified a two-track approach for JI project development. A Party that meets the eligibility requirements for the (simpler) JI Track-1 approach may "verify reductions in anthropogenic emissions by sources or enhancements of anthropogenic removals by sinks from an Article 6 project as being additional to any that would otherwise occur … Upon such verification, the host Party may issue the appropriate quantity of ERUs in accordance with the relevant provisions of decision -/CMP.1."[141]

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[141] Para. 23 of Annex to Decision -/CMP.1 (*Article 6*).

Two Annex I Parties that consider a JI project to be implemented in 2004 run the risk that one of the (or both) Parties does not meet the JI Track-1 eligibility requirements during the commitment period. In principle, whether or not Parties meet these criteria will at the earliest stage be checked only one year before the start of the commitment period. A direct implication for the early JI action would be that Parties who do not want to run the risk that their project will be rejected by the supervisory committee develop the project as if it were a JI track-2 project. If eventually both Parties qualify for JI track-1, they will not need a verification procedure through the supervisory committee, but if a JI track-2 procedure is required, the early action project must meet the requirements set by the Marrakech text.

Early action and JI Track-1

The biggest difference between early JI action and JI action during the commitment period arises when Parties do not consider the baseline for JI projects as an issue. In case both Parties comply with the JI Track-1 requirements, they are generally free to decide on whether and to what extent the project reduces emissions below a baseline. In theory it could even happen that a host Party, which expects a sufficient surplus within its assigned amount, could agree on a lenient baseline for a JI project in order to transfer more credits. Given its assigned amount surplus, the host Party would not run the risk of not complying with the Protocol Annex B. In such a situation, a JI project becomes in fact an emissions trading transaction where two Parties agree on a transfer of emission reduction units in exchange for an emission reduction investment, in principle irrespective of whether the emissions reduction of this investment is additional.

Next to the more general issue of whether such ERUs represent the same environmental quality as JI Track-2 credits, a significant risk arises for the investor. If both Parties assume that both of them will be in compliance with the JI track-1 requirements during the commitment period and agree in, say 2005, on such an 'emissions trading transfer' via a JI project, they will face a significant problem if at the eve of the commitment period the host Party unexpectedly turns out no to be eligible for JI Track-1. The project would then have to be redesigned along the lines of Track-2. Only completing the project design shortly before the commitment period could cover this risk, but then in 2005 no ERU transfer agreement could be reached.

It remains to be seen, however, to what extent this risk applies to JI projects set up by EU members in co-operation with Candidate countries. Especially those Candidates that are expected to enter the EU well before the first commitment period would have a relatively high chance of meeting eligibility criteria for JI Track-1. Perhaps the pressure will come from a different angle. Currently, the EU Council and the European Commission are preparing the EU emissions trading scheme. There has been a debate within the EU about whether this scheme should be linked with JI/CDM project credits. Recently, the Commission stated that: "Linking the project-based mechanisms, including Joint Implementation (JI) and the Clean Development Mechanism (CDM) with the Community greenhouse gas emissions trading scheme is desirable and therefore the emission credits from these project-based mechanisms will be recognised for their use in this scheme in accordance with modalities proposed by the Commission to the

European Parliament and the Council, which should enter into force in parallel with the Community greenhouse gas emissions trading scheme in 2005."[142]

According to this statement, which basically opens the way to also link early JI action credits to the EU emissions trading scheme, the EU will define modalities for such linking. It seems likely that these modalities will set minimum requirements for the quality of the credits and it may well be possible that in order to be eligible under the EU emissions trading scheme, the EU requires that JI credits are calculated according to the JI Track-2 ('slow track') procedure. A Directive on linking JI/CDM with the emissions trading scheme, which is expected to become available in early 2003, should bring more clarity on this topic.

In the context of the above, early JI action could contribute to speeding up the installation of environmentally sound techniques during the EU (pre-)accession process in Candidate countries. This would have the following implications:

- The Candidate/JI host country can upgrade its environmental standard to the EU level at an earlier date. Furthermore, they could potentially have their EU pre-Accession partly financed through JI credits.
- The new EU members with transitional arrangement would, in absence of early JI action, have had lower environmental standards than the Acquis levels.
- Potential JI investors (either EU members or other Annex I investor countries) interested in JI can still make use of the JI emission reduction potential in Central and Eastern European Annex I Parties.
- For the environmental *Acquis,* it would not make much of a difference if the Candidates carry out the measures themselves or via a JI co-operation with a transfer of emission reductions.
- For the early JI project, there is a limited risk of non-additionality, because the analysis of the European Commission, on which the transitional arrangement was based, has shown that the Candidate itself would not have been able to carry out the project by the time of entering the EU.

4.3.5 Implications for baseline modelling

It is worth to have a closer look at the EU-accession countries in Eastern Europe also in a baseline-modelling context. The expected effects of an implementation of the *Acquis Communautaire* on the energy sector would have to be clarified and modelled in detail for each individual country. When determining forward-looking baselines all relevant legislative regulations in the fields of air pollution control, industrial plant technical and efficiency standards, fuel qualities and so on would have to be considered as they have a direct impact on model input data (plant efficiencies, fuel-specific emission factors, fuel switch options, costs) to the model. In addition to the detailed effects in each country, the timing of implementation of the different measures will be a crucial parameter to be known for an accurate model representation of these coherences.

In general, the implementation of stricter environmental standards can be expected to bring down the GHG emissions when compared to the business-as-usual case. The anticipation of such measures in a forward-looking baseline could thus lead to a new reference scenario with a new, lower baseline when compared to the 'old' business-as-usual one. Thus the implementation of European environmental

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[142] Jepma, 2002.

legislation in the accession countries is likely to lower the baselines in these countries before or during the first commitment period leaving less emission credits to be granted to potential JI projects as emissions in the reference scenario will already have been reduced by the new EU legislation. However, these effects may at least partially be compensated by a growing energy demand due to economic impulses arising from an EU-membership. As already indicated, such complex relations can only be predicted satisfactorily in a model context when all relevant political, technological and economic influences have been determined and can be provided as a comprehensive set of input data to the energy-system-model.

4.3.6 Interaction between EU GHG Trading and Joint Implementation

In the previous Sections, reference has been made to the EU plans to introduce a Directive setting the framework for a mandatory scheme for GHG trading. Moreover, the Commission is to publish the draft of a second directive in spring 2003 regulating the link between this mandatory trading scheme and project-based mechanisms for GHG trading, such as JI and CDM. Both directives will eventually become binding for the Candidate countries under the *Acquis Communautaire*.

Apart from baseline setting, the planned European Emissions Trading Scheme (ETS) raises general questions regarding the interaction with JI. In particular, if the Candidate countries implement the GHG Trading Directive, what will be the influence on the scope for engaging in Article 6 JI activities and how will the GHG Trading Directive affect the demand for the JI instrument?

Below, these questions are briefly addressed in the following steps:

- Firstly, the main elements of the GHG Trading Directive are summarised;
- Secondly, the usefulness of JI for legal entities capped by the GHG Trading Directive is analysed;
- Thirdly, the influence of the GHG Trading Directive on the scope for crediting indirect emissions reductions under JI, particularly in the electricity sector, is analysed.

Overview of GHG Trading Directive

The Commission published its Draft Directive for a European GHG trading scheme in October 2001.[143] The scheme is intended to ensure reduction of GHG emissions from large industrial sources at least cost, as a contribution towards the EU's targets under the Kyoto Protocol. A key objective is to prevent a situation where each Member State introduces its own GHG regulations, which could distort the internal market.

On 9 December 2002, the Council of the European Environmental Ministers reached a political consensus on the Directive which essentially follows the proposal of the Commission.[144] This agreement implies that the Directive is now virtually certain to enter into force. Some minor differences remain, however, relative to the position of the European Parliament who had voted on the Directive in its First Reading in October 2002. This will require a Second Reading by the Parliament and possibly a reconciliation procedure, so that the Directive will likely enter into force in the second half of 2003.

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[143] COM (2001) 581, Proposal for a Directive of the European Parliament and of the Council establishing a scheme for GHG emission allowance trading within the Community and amending Council Directive 96/61/EC.

[144] Council of the European Union, Interinstitutional File: 2001/0245 (COD), Brussels, 11 December 2002.

As proposed by the Commission, the Directive covers about 4,000 – 5,000 installations in the following industries (see Directive for minimum size thresholds):

- Combustion installations with a rated thermal capacity exceeding 20 MW, except waste incineration;
- Mineral oil refineries;
- Coke ovens;
- Metal ore roasting, iron and steel production;
- Cement clinker production;
- Glass manufacturing;
- Ceramic products, including bricks, tiles, and porcelain;
- Pulp, paper and board.

The scheme is to start in 2005, with a pre-commitment period 2005–2007 and a first commitment period 2008-2012. Participation in the scheme is mandatory, and a precondition for the operating permit issued by the Member State. In the period 2005–2007, however, Member States may exempt certain installations or sectors from the scheme, provided that they are subject to comparable emission reduction requirements (opt-out mechanism).

The scheme will cover only CO_2 emissions in the period 2005–2007. From 2008 onwards, the scheme may be extended to other gases, provided that they can be accurately monitored. Similarly, Member States may enter additional activities, such as *e.g.* chemicals or aluminium, into the scheme from 2008 (opt-in mechanism). From 2005 already, Member States may reduce the minimum size thresholds to include smaller installations from the sectors mentioned above.

Member States are responsible for the initial allocation of CO_2 emissions allowances to the capped sources. To this end, they have to develop national allocation plans which are subject to approval by the Commission. The allocation plans must meet several criteria, such as:

- The total cap allocated to the covered industries should be proportionate vis-à-vis the Member State's Kyoto target, and consistent with the Community's progress towards meeting its Kyoto target.
- Initial allocations should be consistent with technological potentials to reduce emissions.
- The plan should be consistent with other EC legislative and policy instruments, for example regarding promotion of electricity generation from renewable sources.

The Directive stipulates that Member States should allocate all allowances for free in the pre-commitment period 2005–2007. In the period 2008-2012, Member States may auction up to 10% of the allowances. Banking of allowances for use in future years is allowed, but not borrowing of future allowances to cover current emissions. Member States are free to apply their own rules regarding banking of allowances from the pre-commitment period into the commitment period (*i.e.* from 2007 into 2008).

Emissions-capped installations under the Directive have to submit allowances equivalent to their emissions by 31 March each year. The penalty for a shortfall in allowances in any year of the period 2005–2007 is €40/t CO_2. In the period 2008–2012, the penalty increases to €100/t CO_2. Those paying the penalty still have to make up the shortfall by delivering the corresponding extra allowances in the next year. Member States are responsible for enforcing the penalties.

Implications for capped emitters

For the emitters that will be covered, the EU GHG Trading Directive essentially represents a shift from a *baseline-and-credit* to a *cap-and-trade* approach for GHG trading:

- The *cap-and-trade* approach involves trading of emission allowances, where the total number of allowances allocated to the covered entities for a specified commitment period (target period) is strictly limited or 'capped'. A regulatory authority establishes the overall cap and allocates the available allowances to the capped sources. At the end of the target period, for example annually, each source must deliver allowances equivalent to its emissions. Trading occurs when a source has excess allowances and sells them to an entity requiring allowances. The planned EU ETS follows a cap-and-trade approach.
- In a *baseline-and-credit* scheme, emitters do not receive any emissions allowances *ex ante*. Instead, they agree (often voluntarily) to an emissions baseline which can be expressed in absolute (tons of CO_2-eq. per year) or relative (tons of CO_2-eq. per unit output) terms. After the target year, emitters beating their baseline are awarded emission credits which can be banked or sold to those who failed to comply with their baseline. JI (as well as the CDM) is a baseline-and-credit instrument.

The key point here is that from the perspective of an individual emitter, *cap-and-trade* and *baseline-and-credit* approaches within the EU are mutually exclusive: emitters covered by the EU GHG Trading Scheme will no longer require the JI instrument. Essentially, the up-front allocation of emissions allowances under the cap-and-trade scheme eliminates the need to credit emissions reductions with ERUs. Capped emitters can monetise any emissions reductions they achieve by selling excess allowances (or by avoiding the cost of buying extra allowances). As a result, the EU GHG Trading Scheme is bound to reduce the scope for JI activities in the Candidate Countries who participate in the scheme considerably.[145]

Implications for crediting indirect emission reductions in the electricity sector

The EU ETS will cover, among other sectors, thermal electricity-generating installations with a rated thermal input >20 MW. This raises questions regarding two important categories of JI activities:

- electricity generation from renewable sources, and
- electricity savings on the consumer side (DSM).

Both DSM and electricity generation from renewables typically reduce GHG emissions *indirectly, i.e.* at some thermal generating installation whose production is displaced. Crediting these indirect emission reductions to the DSM or renewable energy project under JI would create problems of *double-counting* and/or *ownership*:

- *Double-counting* would occur because the ERUs issued to the JI project would effectively increase the total emissions cap, *i.e.* the sum of allowances allocated to the covered industries. More precisely, a host government would likely consider these ERUs an addition to the power sector's initial allocation of emissions allowances (which is effectively an allocation of AAUs).[146] At the same time, the JI

[145] According to Commission estimates, the ETS will cover approx. 46% of CO_2 emissions in 2010 (EU-15 only). This illustrates the scheme's breadth of coverage.
[146] These initial allocations must be defined before the start of each commitment period: Member States must publish their national allocation plans for the period 2005-2007 by 30 September 2004. The allocation plans of the first and subsequent commitment periods must be published one year before the start of the respective period, *i.e.* by 31

project would also contribute to reduced emissions of the thermal generator and hence decrease his need for abatement action.

- *Ownership* problems would likely occur if a host government decided to reserve a portion of its assigned amount for crediting of DSM and renewable energy projects under Article 6 JI, instead of allocating these AAUs to its thermal generators under the cap-and-trade scheme. The same holds true if a government tried to adjust thermal generators' initial allocation retroactively for any ERUs credited to such projects. Either approach would likely meet criticism among thermal generators, because they would conflict with the Trading Directive's fundamental approach of assigning the liability for emissions (and hence ownership of any reductions achieved) to the *direct* emitters.[147]

With these problems in mind, it is plausible to assume that the EU GHG Trading Directive will substantially reduce, if not eliminate, the scope for JI crediting of demand-side electricity savings and generation of electricity from renewables within the countries participating in the ETS. Instead, the Directive will create additional incentives for DSM and renewables indirectly, because electricity prices in Europe are expected to increase due to the internalisation of CO_2 allowance costs under a cap-and-trade mechanism.[148]

Conclusions

In conclusion, the mandatory European ETS for large emitters, planned to start in 2005, will reduce the scope for JI in the Accession Countries substantially in two respects:

- For emitters capped under the Trading Scheme, the need for project-based trading instruments such as JI with countries participating in the scheme will be eliminated altogether, because they will be able to monetise any emissions reductions by selling excess emissions allowances in the European allowance market;
- JI crediting of DSM and renewable energy projects in the power sector is likely to be limited due to problems of double counting and ownership.

As a result, the scope for JI in EU countries having implemented the GHG Trading Directive may in fact be limited to CO_2 emissions reductions in relatively small installations not subject to the Trading Directive (for example, district heating systems <20 MW rated thermal input), and projects reducing GHG other than CO_2. In future years, extension of the ETS to other sources and gases may further reduce this scope. The Directive on the linkages between the European GHG Trading Scheme and project-based mechanisms, announced for spring 2003, is expected to clarify the regulatory scope for JI in the Candidate countries.

With this background, a key question is obviously when the different countries of Central and Eastern Europe will join the EU GHG Trading Scheme. This can at present not be answered with certainty,

December 2006 for the period 2008-2012.

147 It should be noted, however, that the initial allocation of emissions allowances is merely a distributional – and hence political – question. From an economic perspective, there is no need to initially allocate allowances to the capped emitters, as long as the development of an effective market in allowances can be ensured. For example, allowances may initially be allocated to coal miners and consumers of CO_2-intensive products, as a means for compensating them for the costs inferred by the cap-and-trade scheme. For details, see *e.g.* Harrison & Radov (2002).

148 European average wholesale power prices are typically expected to increase by 10% – 20% by 2010 as a result of the GHG Trading Directive, compared to a business as usual scenario. See *e.g.* Karmali & Price-Jones (2002).

because some of the first-wave Candidate countries may negotiate a transition period. However, unofficial information indicates that several larger Accession Countries, including Poland, Slovakia and Hungary, are already preparing to implement the Directive, with a view to joining the scheme from its beginning in 2005.[149]

With regard to baseline setting, it is important to note that the GHG ETS will not make the analyses in this report on interaction between JI baselines and *Acquis Communautaire* obsolete. Rather, the baseline discussion for projects in the countries participating in the scheme will shift to the context of initial allocation of emissions allowances. In particular, the ETS Directive requires that national allocation plans should be consistent with other EC legislative and policy instruments, such as the Renewable Energy Directive or the Landfill Directive. Hence, very similar to JI baselines, initial allocation should account for any GHG emissions reductions that will be required from these policy instruments.

[149] Personal communication, Jos Delbeke, European Commission, January 2003. The first-wave countries acceding the EU in 2004 are: Poland, Czech Republic, Slowakia, Hungary, Slowenia, Estonia, Latvia, Lithuania, Malta and Cyprus. Bulgaria and Romania will probably accede in 2007.

5. Additionality assessment

5.1 Introduction on additionality in the *Marrakech* context

As explained in Section 1.3.1 an additionality assessment is aimed at answering the question whether a JI or CDM project's emission reductions would have taken place without the GHG crediting. Subsequently, with the determination of a baseline it can be calculated to what extent the project reduces GHG emissions in comparison with the situation under business-as-usual. Although the concepts of additionality and baselines are strongly interrelated, they have in the literature and in the several earlier COP negotiation texts often been treated as two separate concepts. In the *Marrakech Accords* additionality is included in the CDM text as a requirement that needs to be addressed by the COP-MOP.

In the literature additionality has been subject to much interpretation and has been disaggregated into various components as people have tried to make sense of the concept and operationalise it. In the practice of operationalising additionality, AIJ/JI/CDM project developers have mostly included the concept in their baseline calculations. The basic assumption in this respect has been that when for a project a baseline scenario has been carefully determined based on the best available information about the business-as-usual situation with regard to the GHG emissions, and if this scenario happens to lie above the project's actual emissions, the emission reduction can be considered additional. According to this practice, the question of how to operationalise additionality implies a question of what parameters are required in order to let a baseline be a reasonable representation of the anthropogenic emissions by sources of GHG that would occur in the absence of the project. A heavily debated topic in this respect has been to what extent the above-mentioned 'best available information' should contain (often confidential) financial/investment information to be disclosed by the project investors.

In actual practice additionality assessment has been dealt with in different ways. Although the World Bank's PCF initially (*i.e.* in 2000) did not request project developers to carry out separate additionality tests, it presently requires project developers who submit JI/CDM proposals to the Fund to specifically show why the project scenario itself could not be baseline, which basically implies an explicit assessment of additionality of the project.[150] In the Dutch ERUPT programme for JI projects project-specific financial and investment information is not required in the baseline document and neither does the programme require project developers to carry out a separate additionality test. The ERUPT approach requires a detailed analysis of the project-specific context as well as of the country context and by taking the best possible information, most reasonable and where necessary conservative baseline parameter values it is assumed that the resulting baseline implicitly reveals the project's additionality.

It is sometimes assumed that the risk of free riders would be smaller when using single-project baselines than with multi-project baselines, as more project-specific information would be included in a single-project baseline. Multi-project baselines, instead, are generally derived from more aggregated and generalised data and therefore might be more sensitive for the risk of free riding. The sections below discuss the difference between single-project baseline determination and applying multi-project baselines

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[150] Next to showing why the project itself is not part of the baseline, the PCF project developers must also submit financial reports on the project. The latter, however, is to make sure that only those projects are supported that are sufficiently financially viable to remain operational after the project's crediting lifetime has ended.

with a view on the assessment of additionality of emission reductions. The discussion is supported with a case study analysis of two actual projects (see Annex 11 for a broader case study analysis).

5.2 Additionality in the negotiating text

The *Marrakech Accords* text contains decisions on the principles, nature and scope of the Kyoto mechanisms, JI, CDM and IET. At the preceding COP sessions there had been discussions on different versions of the negotiating texts relating to the operationalisation of additionality and baselines. For the CDM there were two proposed options.[151] According to the first option, a project must be environmentally additional (*i.e.* produce reductions below a baseline) and show investment additionality by proving that the project's internal rate of return is lower than a threshold level for the host country to be determined by the Executive Board. The second option in the pre-COP-7 negotiating text proposed the use of a performance standard where the project must perform better with respect to reductions than an average performance of current activities in either the investor or host country. The latter is often referred as an Emissions Benchmark Additionality Test (EBAT), which is a type of baseline in effect and would serve to avoid technology dumping. The method would involve an approved quantitative methodology or approved alternative non-quantitative method.

The final text of COP-7 does not contain modalities for carrying out a separate test of such project additionality, *i.e.* the *Marrakech Accords* require emission reductions to be additional to what otherwise would have taken place, but rather than through testing whether the project is additional, the additionality is assessed as part of the baseline study for a CDM project (see Box 5.1). In other words, given that a CDM project baseline must describe what would reasonably have taken place in the absence of the project activity,[152] additionality is shown if the baseline emissions scenario lies above the estimated project emissions level. The word 'reasonably' is obviously crucial here.

Therefore, the clearest message from Marrakech has been that the investment criterion threshold was left out of the *Marrakech Accords* text, so that it seems that that particular option has disappeared from the negotiation table. Several negotiators considered using an investment criterion threshold problematic, among other reasons, because:

- The transparency of an investment criterion threshold may not be high when confidential financial data is required.
- The data can relatively easily be manipulated in order to arrive at a quantified figure which meets the threshold level
- An investment additionality threshold value assumes that investment criteria provide a full picture of an investment decision whereas several other factors (*e.g.* legal and institutional barriers, lack of human capital in the host country) also have an influence on such decisions.

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151 For JI additionality has been included as a project modality in the second track procedure which is to be used in case the host country does not fulfil reporting requirements, but as such does not differ significantly from the CDM project modalities.

152 Para. 44 of the Annex to Draft Decision-/CMP.1 (*Article 12*).

Box 5.1. Additionality in the Marrakech Text on the CDM

Para. 37d Annex on CDM modalities and procedures:
"The project is expected to result in a reduction in … greenhouse gases that are *additional* to any that would occur in the absence of the proposed project activity…"

Para. 43 Annex on CDM modalities and procedures:
"A CDM project activity is additional if…emissions…are reduced below those that would have occurred in absence of the …project."

The phrase "those that … project" refers to the baseline, which implies that additionality is shown if the emissions of the project are below the baseline.

Para. 45b Annex on CDM modalities and procedures:
"[A baseline shall be established] in a transparent and conservative manner regarding the choice of approaches, assumptions… additionality…"

This paragraph clearly includes additionality as a parameter for baseline determination.

Para 2.d, Appendix B – project design document:
"[the project design document shall include a] Description of how the...emissions…are reduced below those that would have occurred in absence of… the project activity"

This requirement has been included in the Project Design Document presented by the Executive Board on 29 August 2002 and requests project developers to explain how and why a project is additional. Given the above paragraphs 37d, 43 and 45b, this implies that project developers need to explain why the baseline for their project is above the project's emissions level. This could be done by identifying barriers that would have prevented the project from being implemented in the business-as-usual case or by identifying which baseline key factor or parameters have caused the baseline to differ from the project's emissions scenario.

Para. a(v), Appendix C – TOR baselines:
"[the Executive Board shall develop and recommend general guidance in order to] address the additionality requirement of Article 12.5.c and paragraph. 43 of the above Annex."

As Article 12.5c of the Kyoto Protocol requires emissions to be additional and paragraph 43 requires emissions to be lower than the baseline, this guidance is likely to contain recommendations to ensure that baseline studies give a reasonable description of what would have happened in absence of the project and as such give a solid basis for the assessing the project's additionality.

5.3 Options for additionality assessment

Determining a project's additionality is not at all straightforward. Principally, the difficulty arises from the *counterfactual* nature of the comparison to be made. What would have happened in the absence of the project is inherently impossible to verify, although it can perhaps be judged, with greater or lesser degrees of reliability, against some kind of assessment of the baseline or reference case. In attempting to operationalise the concept of additionality, a variety of approaches have been suggested in the literature, some of which could be considered to be stricter then the operationalisation of additionality in the *Marrakech Accords*. These include:

1. Policy additionality;
2. Investment additionality using investment criteria;
3. A combined barriers approach;
4. *A priori* additionality;
5. An emissions benchmark additionality test (EBAT)
6. A conservative single-project baseline scenario; and
7. Stringent benchmarks.

Of these approaches, the first five refer to separate additionality tests, whereas the latter two approaches deal with additionality under the baseline. Approaches 4, 5 and 7 are by definition multi-project assessments, whereas approach 1 could be applied both on a single or multi-project basis.

Policy additionality

Policy additionality involves an assessment of whether a particular project would have been carried out anyway as a result of policies that are active in or relevant for the particular country and sector in which the project is to be developed. For example, in case some form of legislation makes a particular (type of) project mandatory (irrespective of the GHG crediting scheme) then it cannot be regarded as additional. In many cases, of course, the policy situation tends to be more ambiguous than this. A recent analysis of policy additionality in the context of emissions trading projects under the UK Emissions Trading Scheme (Begg *et al.*, 2002) has shown that although some potential projects can be ruled out as clearly non-additional, in many cases there will not be sufficient clarity to make a hard and quick decision on the basis of policy additionality alone. For example, rather than specifying mandatory requirements, policies might introduce a variety of incentives to encourage the implementation of desired project types. These incentives will influence investment decisions, and have a variety of implications in terms of determining the additionality of the project.

Important information for the determination of policy additionality can be derived from energy and climate policies at the level of the country where the project takes place, as well as, in case of JI projects in EU Candidate countries, from the relevant Directives set by the EU, *e.g.* the Directive on Integrated Pollution Prevention and Control. For example, due to the strict *Acquis Communautaire* environmental standards, part of the potential JI abatement is already obligatory, thereby making several projects non-additional from a policy additionality perspective. Section 4.3.2 has shown that applying policy additionality reduces the amount of potential JI credits in the Czech Republic by about 50%.

The benchmark modelling activities carried out under PROBASE deal with policy additionality as they have incorporated planned and expected energy policies in the host country.

Investment additionality using investment criteria

The option of investment additionality using investment criteria attempts to reveal the economics of a JI/CDM project in order to find out whether the project would have been carried out without the revenues from the GHG credits. Examples of investment criteria to test additionality are the net present value of an investment or the internal rate of return method, which calculates the real interest rate of the investment and which, contrary to the net present value, is a measure of profitability.

Although as a concept investment additionality is relatively simple, its application in practice, as mentioned earlier, could be difficult, and probably was therefore not included in the *Marrakech Accords* text. First, the data to be acquired from the investors is mainly confidential financial data and might be sensitive for manipulation. Second, it might be difficult to set the threshold for the critical rate of return below which a project would not have been implemented without the credits/subsidies. For projects in developing countries this threshold would be different from the ones in Central Europe and in Eastern Europe. Especially in a market where credit prices are relatively low the share of the emission reduction credit revenue in the investment capital might become too small to 'precisely' determine the difference between whether or not a project would have been implemented without the credits/subsidies. Moreover, adopting threshold profitability parameters may be complicated because profitability expectancies usually differ across companies due to individual internal rate of return requirements and/or degrees of risk aversions.

Barriers approach

The barriers approach to operationalising additionality[153] tries to identify possible barriers that might have prevented the project from being business-as-usual. Examples of such barriers are: technological, institutional/organisational, legal/policy, financial, market, and environmental barriers. According to this approach, a project passes the additionality test if it can be proven that real barriers to its implementation exist and that the project intends to undertake specific activities in order to overcome these barriers.

The difficulty with the barriers approach is that the judgement is to a large extent qualitative and might encompass a high degree of subjectivity. In order to apply this additionality test a distinction needs to be made between, on the one hand, barriers to projects that are likely to be overcome by the project developer for reasons other than carbon credits and, on the other hand, barriers that can only be overcome under the JI/CDM project because of the additional revenues from the carbon credits. If project barriers belong to the second category a project can be considered additional. Again, precisely identifying and accurately and consistently describing this distinction is, due to the counterfactual nature of the analysis, subject to the judgment of the project participants.

In order to operationalise the barriers approach, it has been proposed (*e.g.* by IEA) to weight barriers using values 0, 1, 2 and 3 representing inexistent, small, medium and large barriers, respectively. The additionality of the project is judged in terms of the existence of barriers to the project implementation that are not encountered (or to a lesser extent) by the project developer in the business-as-usual situation. This implies that if project developers under business-as-usual only implement projects with, for instance, a risk factor of 0 or 1, an emissions reduction project can be considered additional if its risk factor is 2 or 3. It should be noted that the risk analysis used here is a relative concept because it depends on the risk aversion of the reference project. If in the baseline case project developers are risk averse and only invests in projects with a risk factor of 0, the project is additional if its risk factor is 1. For a different project where the baseline risk factor is 2, only a project with risk factor 3 is additional.

One of the conclusions of the literature analysis of the barriers option in operationalising additionality is that it should be employed with caution and principally as a secondary criterion only, as it is subject to the judgment and the manipulation of the project developers. As a general guidance, more objectivity to the barriers criteria could be envisaged checking two points: whether any projects of this kind exist in the host country (if there are no projects, barriers are likely to exist), and whether public or private funding supports this type of projects.

A priori additionality

The *a priori* additionality approach considers projects as eligible beforehand and is therefore a multi-project test, which would be applied to project types that are not being implemented on a large scale in potential JI and CDM host countries,[154] such as *e.g.* renewable energy projects. Although the fact that renewables projects in a host country where renewables are only being implemented on a small scale (perhaps supported by a subsidy programme) does not guarantee that the project would not have been

[153] Based on the conclusion of the CDM Executive Board meeting of 20-21 January 2003, this approach is expected to become applicable to small-scale CDM projects.
[154] See Carter, 1997, 6.

implemented anyway, on the whole renewables JI and CDM projects would stimulate a technology shift or energy practice shift in the host countries thereby clearly contributing to GHG abatement in the host country. A clear advantage of *a priori* additionality is that it lowers transaction costs and increases transparency of determining additionality. However, a complication remains with determining which projects should belong to the 'additionality-test-free' projects and which not.

EBAT

The Emissions Benchmark Additionality Tests (EBAT) generally assumes that non-additional projects (free riders) are cheaper and have less technical performance than projects, which are additional to 'what would have happened in the absence of the project'. By setting a performance benchmark at a stringent level it is assumed that the number of free riders would be reduced. This could take place by collecting data from all current or recently installed installations in a sector and take the top X percentile as the performance level which the proposed JI/CDM project must surpass in order to be considered additional. Such a level threshold would imply that proposed projects which perform better than *e.g.* 90% or 80% of all facilities in the sector would automatically be considered additional (see, for example, Sathaye (2001) who has derived stringent emissions based benchmarks to cope with limiting free riders in a study of the energy sectors in developing countries).

A potential problem with an EBAT is that it could create missed opportunities in that there might well be non-additional projects in the range above the performance level. For example, some efficient technologies performing above the EBAT threshold do not necessarily incur extra costs and could be non-additional projects. Furthermore, the EBAT approach assumes that such a performance benchmark is available and is appropriate to the project category, which may not always be the case, *e.g.* due to lack of plants and facilities in host countries and, hence, lack of data. Also, gaming can occur in the process of setting the level of the benchmark (*e.g.* by the government of the host country) but not in its application.

Basically, the EBAT resembles the better-than-average benchmark approach mentioned in Section 2.3.5, which aims at deriving a benchmark baseline scenario on the basis of performance levels. If the better-than-average benchmark approach were selected as a baseline methodology the EBAT would be automatically incorporated in the baseline assessment. In other cases, EBAT could, at least in theory, be used as a stringent filter against free riders after which a more lenient baseline could be determined for those project that have passed the EBAT.

Single-project baselines incorporating additionality considerations

Theoretically, when applying single-project baselines a separate additionality test would not be necessary. If the business-as-usual situation could be accurately described the information needed for the separate additionality test would already be part of the baseline assessment. However, the baseline describes a counterfactual situation and this implies that in reality the business-as-usual situation can never be accurately described and is subject to uncertainty. This is what creates the risk of free riders entering the system of the project-based mechanisms.

In the case of single-project baselines incorporating an additionality assessment it is assumed that determining conservative baselines lowers the chance that a project, which would have taken place anyway, earns credits. A practical example where this approach is applied is the Dutch ERUPT programme. This tender programme does not require project developers to carry out a separate additionality test, but aims at limiting free riders through the selection of conservative values of baseline parameters. The general line followed is that for each project first the recent past and current situation within the project's system boundary is analysed. Extrapolating this situation into the future results in a first draft of the baseline. Subsequently, project developers must identify and analyse a number of key factors which could possibly have affected the business-as-usual situation. Based on the key factor analysis the baseline 'draft' is adjusted upward or downward in order to reflect what would reasonably have taken place within the project's boundary in absence of the project. For example, expected energy price development or planned changes in subsidy policies in the host country – *e.g.* due to a breakdown of coal subsidies – could imply that several coal-fired plants would be retrofitted anyway, possibly including the one planned to be replaced under the project. Therefore, analysis of the key factor energy price development in this example lowers the baseline.

Choosing conservative values for the key factors and hence the baseline would generally reduce the number of free riders. For example, suppose that the majority of energy plants in a host country currently operate at a 30% efficiency level. Assuming that under the baseline these plants would remain in operation for the next 15 years would result in a GHG credit bonus for those investors who would for commercial reasons have upgraded the plants anyway to a level of *e.g.* 35%. Should a more conservative baseline be applied instead, assuming a 40% efficiency level for business-as-usual plants, investments aiming at an efficiency improvement below 40% would not receive credits, which would reduce the number of free riders.

Multi-project baselines and additionality assessment

As explained above, the likelihood of free riders entering the project-based mechanisms is (much) smaller with conservative baselines than with more lenient baselines. The Netherlands' government in its ERUPT programme has therefore taken the position that since due to the counterfactual nature of the baseline/additionality assessment free riders can never be excluded from or identified within the system, the best approach is to reduce the likelihood of their presence. After all, with a conservative baseline, the only investors who can take a free ride on the carbon credits issuance are those who carry out a more environmentally friendly investment than the one under the conservative baseline.

With respect to multi-project baselines the risk of free riders entering the JI/CDM system is generally considered to be larger than with project-specific baselines. The risk of free riders acquiring credits after having beaten a multi-project baseline may indeed be larger if the standard is a benchmark derived from a sector average than if derived from a BAT benchmark (see Section 3.5). Without a separate additionality test, all projects beating the sector average benchmark would in principle be eligible for crediting. With a more conservative BAT benchmark the baseline for projects in a sector in a particular host country would be much lower, which would, similar to single-project baselines, reduce the number of potential free riders.

5.4 Additionality assessment applied to case-study projects

In the sections below, the above-mentioned additionality assessments are applied to two case study projects: the *Sarulla geothermal energy* project in Indonesia (see also Section 3.3 and 3.5), which is a large-scale investment, and the CHC heating project in the Czech Republic, which is a small-scale investment (see also Annex 10, where similar analyses are also shown for the *Surduc hydro energy* project in Romania and the Nizhny Novgorod district heating system project in the Russian Federation). The analysis first assesses whether the project passes a policy additionality test. Subsequently, they are tested using a combined barriers assessment. Also, it is considered whether *a priori* additionality would apply to the project case. Finally, the multi-project benchmarks analysed in Chapter **3** are assessed with the objective to find out whether they result in sufficiently conservative baseline scenarios to minimise free riders entering the JI/CDM system.

5.4.1 Additionality assessment for the Sarulla geothermal development project

Geothermal energy is produced by using natural hot water, usually from depths between 1.5 and 3 km at temperatures between 200 and 350°C. The hot water pumped up from the underground reservoir through production wells is flashed to steam, which subsequently is used to produce electricity in a turbine engine and a coupled generator set. The Sarulla Geothermal Development Project among others entails the construction of a geothermal power station in the Sarulla area, North Sumatra. The goal of the project is to deliver 2,978 GWh of electricity per year from a 330 MW power station with an estimated project lifetime of at least 20 years (for a more detailed description of the project, see Annex 2 and Section 3.3.5).

Policy additionality

In order to judge about the policy additionality of the *Sarulla geothermal development* project it is necessary to analyse whether it is reasonable to assume that current or expected future Indonesian energy sector policies had not provided legislation nor incentives which would have made the development of the plant mandatory or financially viable, without the GHG credits.

On 13 July 1998, Indonesia signed the Kyoto Protocol, which it has not ratified yet. However, Indonesia's commitment to climate change mitigation is displayed by its setting of national GHG mitigation policies, installing mechanisms and procedures for project approval in anticipation of ratification. Within the energy sector, which is the largest contributor to GHG emissions, Indonesian priorities will focus on the following measures:

- Removal of subsidies within energy production,
- Promotion of use of renewable energy,
- Promotion of energy conservation and efficiency,
- Restructuring of pricing regimes.

The national energy policy of the Indonesian government encourages the exploitation of Indonesia's abundant geothermal resources and the Ministry of Environment has identified geothermal energy as a priority CDM activity in the position statement of the Indonesian delegation to COP-6 (November 2000). More than 80 prospective geothermal sites have been identified with an estimated geothermal production potential of 20,000 MW.

The national Indonesian electric power company PLN was established in 1960 and currently has an installed capacity of about 20 GWel. In 1972, the Indonesian government confirmed the status of PLN as Perusahaan Umum (state owned public utility company). Since 1992 PLN faces competition from the private sector within certain business fields. Prior to the Asian financial crisis, Indonesia had plans for a rapid expansion of power generation, based mainly on opening up Indonesia's power market to Independent Power Producers. The crisis led to severe financial strains which made it difficult to pay for all of the power for which PLN had signed contracts with IPPs. Due to both overestimation of demand and a decline in demand attributable to the Asian financial crisis, PLN has an overcapacity on the main Java-Bali power grid of nearly 50%. PLN has over US$5 billion in debt, which has grown markedly in terms of local currency due to the decline in the value of the Rupiah. The Indonesian government has been unwilling to take over the debts of PLN. In 1998, the national government announced to break up PLN into several units which would operate as separate enterprises. This unbundling has taken place in 1999-2000, but will continue. In contrast to central power generation facilities, electrification of remote areas mainly depends on diesel generators. This is why rural electrification does possess major importance in terms of reducing GHG emissions.

Over 80% of the electricity generated in Indonesia is from fossil fuels, 14.5% from hydro and about 5% from geothermal sources. Of the fossil fuels used, 37% are coal, 40% gas, 9% fuel oil and 14% diesel.

Despite the undoubted environmental benefits of geothermal power production and an increased stabilisation of base-load power, the selling price of electricity necessary to make these facilities economically viable currently lies above the average purchasing price of electricity in Indonesia for a large share of geothermal sites, including Sarulla. It is intended to use the generated CERs to bridge this price gap. Only in the long run and with a further exploitation of geothermal reservoirs in the country it is expected that the prices will become lower, eventually leading to a decrease of average electricity production costs.

From the analysis of the current Indonesian energy sector situation and projections for the future it is reasonable to conclude that the Sarulla project is additional to policies or incentives initiated and planned for Indonesia in the short to medium term. Although the Indonesian government politically supports an increased use of renewable energy in the power sector, it seems unlikely to assume that in the short to medium term this will lead to legislation making the development of renewable energy sources mandatory, despite their current cost disadvantages. The tight financial situation of the Southeast Asian economies also makes it unlikely that sufficient subsidies or other financial incentives will be available to make the use of geothermal power financially viable.

For the first part of the project's technical lifetime it is thus reasonable to conclude that the project is politically additional. However, the envisaged project lifetime of 30 years could be considered too long as the currently initiated and proposed legislation as well as the incentives arising from the benefits of exported – or avoided imports of – fossil fuels could be a reason to assume that at least some elements of the project would have been part of Indonesian government policies or incentive packages before the project's end date. Moreover, a decrease in the cost of geothermal electricity can be expected when produced on a large scale, probably making the process financially viable on a long-term basis. A policy additionality revision period of *e.g.* 7 years is therefore recommended.

Combined barriers assessment

The combined barriers approach tries to identify possible barriers that might have prevented the project from being business-as-usual. According to this approach, a project passes the additionality test if real barriers to its implementation exist and that the project intends to undertake specific activities in order to overcome these barriers. The first step in this assessment is to list the main barriers that could hamper the Sarulla project from implementation under business-as-usual circumstances. Table 5.1 lists possible barriers and explores what the project can do to overcome these.

Table 5.1. Possible barriers for the Sarulla geothermal development project	
Risk of technical breakdown or underperformance	Due to existing experience with a similar plant at Salak (Java) and extensive exploration and drilling of the site the risk of technical breakdown or underperformance should be fairly limited. **Barrier under BAU: -**
Lack of technical expertise	PERTAMINA (the national oil and gas company) has conducted extensive testing of possible geothermal sites in co-operation with domestic and foreign partners. More than 80 prospective sites with a production potential of 20,000 MW were identified. However, the operation of a 330 MW geothermal plant will require about 400 workers, a great part of which would have to be trained. The relatively simple technical installations needed and the successful operation of a similar plant let it seem reasonable to assume that the lack of technical expertise will not be a major barrier under BAU conditions. **Barrier under BAU: -**
Lack of adequate supply of equipment	All required equipment can reasonably be assumed to be available as it is also used in the already existing facility at Salak. The only technology still being developed is that for the removal of H_2S to concentrations below 1ppb at reasonable costs, which has been subject of a research effort carried out by UNSG and the government. **Barrier under BAU: -**
High operation and maintenance costs	The selling price of electricity from geothermal sources necessary to make these facilities economically viable lies above the average purchasing price of electricity in Indonesia for a great number of sites, including Sarulla. This is certainly also due to the about 400 workers necessary to be employed on a full-time basis to run the plant. It is intended to use the generated CERs to bridge this price gap. However, benefits from secondary and tertiary activities associated with the plant can also be expected. **Barrier under BAU: +**
Lengthy development process	The first agreement on the development of Sarulla and the sale of geothermal electricity dates back to 1993. In the wake of the Asian financial crisis the project was halted in 1997 and will only be resumed after renegotiation of the energy sales contract with the state electricity company PLN is completed successfully. Substantial project planning and site testing has already been performed. **Barrier under BAU: +**
Poor utility infrastructure	The infrastructure needed for supply and distribution of electricity from a geothermal power station does not significantly differ from that needed for fossil-fuelled plants. In addition, UNSG as the project developer and contractor to PERTAMINA would only be responsible for the exploitation of geothermal electricity, while PLN would buy and distribute the electricity received from the Sarulla project and thus also operate the necessary infrastructure **Barrier under BAU: -**
Lack of capacity building	Extensive well testing and training of personnel are necessary to successfully run a plant like Sarulla. However, personnel trained at sites developed earlier are available. **Barrier under BAU: +**
Inadequate or non-existing institutional setting	As the Indonesian government actively promotes the exploration of geothermal resources as a favourite CDM project type no institutional barriers should be expected in the realisation of the project. **Barrier under BAU: -**
Risk of bureaucracy	See above **Barrier under BAU: -**

Lack of administrative infrastructure and legislative framework (incl. enforcement) related to environmental/ energy efficiency projects	Though the use of renewable energy is a declared target of Indonesian energy policy, there are no direct legal obligations that would prescribe the use of geothermal power instead of conventionally generated power, thus making it an unattractive choice compared to fossil fuels due to the higher costs related to geothermal power produced at Sarulla in the BAU case. **Barrier under BAU: +**
Shortage of capital	The Asian financial crisis led to a halt of the project. Together with the current struggle to get the project off the ground this can be seen as an indicator for the insufficient availability of capital. **Barrier under BAU: +**
Lack of financial incentives to build geothermal power plants	The selling price of electricity from geothermal sources necessary to make these facilities economically viable lies above the average purchasing price of electricity in Indonesia. Though the Indonesian government politically encourages the use of renewable energies, no financial incentives or subsidies exist to make the development of geothermal power plants financially attractive. **Barrier under BAU: +**
Risk of inappropriate provision of fuel and raw materials	Thorough testing of the geothermal site has minimised the risk for potential problems with the reservoir. Experiences with geothermal power plants in the US show that their high availability factors can actually stabilise the supply of base-load power. **Barrier under BAU: -**
Risk of subsidised energy prices	Until the government realises its target to remove subsidies in energy production and until geothermal power is produced on a large scale actually making its production cheaper, the price of geothermally produced electricity at sites like Sarulla will remain above the average price of Indonesian electricity. **Barrier under BAU: +**
Resistance to new ideas or technologies	Not relevant for the Sarulla geothermal development project as the Indonesian government encourages the development of geothermal energy sources as CDM projects. **Barrier under BAU: -**
Low acceptance from the public	Not relevant for the Sarulla geothermal development project. **Barrier under BAU: -**
Risk of unsuccessful drilling / unpredictable behaviour of the well	Risk has been minimised by very intensive exploration and testing of wells and does not seem to be relevant for the Sarulla geothermal development project. **Barrier under BAU: -**

From the analysis in Table 5.1 it can be concluded that several barriers would have existed for project implementation under BAU. The most important ones can be seen in the high operation costs, the lengthy development process, and the lack of financial incentives (coupled to a shortage of capital) to build geothermal power plants. The price difference to conventionally generated power currently makes the installation of geothermal plants financially unattractive under BAU, except maybe for technology development purposes.

A Priori additionality

Being a large-scale CDM project (>15MW), the Sarulla geothermal development project will not be eligible for simplified procedures and neither for *a priori* additionality.

Multi-project additionality assessment

Given that the Indonesian energy system is largely dominated by fossil-fuelled power plants and thus has a relatively high average GHG emissions level it can be concluded that even a very stringent EBAT would be passed by a geothermal power plant such as the Sarulla project.

Conservative multi-project baselines, which require that a project can only be recognised as an additional project if its installed technology is better than the technology or technology mix assumed under the benchmark, have been developed under PROBASE also for Indonesia (see Chapter 3 and Annex 6). Using the PERSEUS and Reflex models in combination with the SimBAT aggregation tool has resulted in conservative multi-project benchmarks for the Indonesian energy sector (divided into the regions of Java-Bali and Non-Java-Bali). The resulting baseline projections describe the expected development of emissions from power demand in the respective region of the country (see Tables 5.2 and 5.3).

Geothermal power plants typically deliver base load electricity. Thus, regarding the Sarulla project, the adequate baseline technologies are those delivering base-load electricity in the central electricity sector of Sumatra (Non-Java Bali). In that technology sub-set of the Indonesian power system, PERSEUS identifies coal, gas, and geothermal power plants leading to minimal expenditure (see Table 5.2). At a first glance the fact that geothermal plants are included in the optimised PERSEUS solution may look confusing. However, the performance and investments for the development of geothermal plants are rather site-specific and thus more or less prone to investment constraints. So only those geothermal potentials are included in the PERSEUS solution that will be economically viable by themselves, *i.e.* without CDM credits. Other geothermal investments that need additional funding, including Sarulla, are not included in the PERSEUS outcome.

Table 5.2. Characteristic features of central electricity production in non-Java-Bali providing base load power determined by PERSEUS

Non-Java-Bali, base load, central electricity production	2000	2005	2010	2020
Electricity generation in PJ	35	48	63	145
Input to coal-fired power plants in PJ	20	20	65	200
Input to gas-fired power plants in PJ	36	36	0	0
Input to geothermal power plants in PJ	5	19	32	46

Table 5.3. Emission factors for the Sarulla project based on average current practice and least cost technology in gCO_2/kWh

Non-Java-Bali, base load, central electricity production	2000	2005	2010	2020
Average current practice	405	293	349	516
Least-cost technology added (Geothermal power plants)	0	0	0	0

Reflex identifies geothermal power plants being the least-cost technology for generating base load power in the Non-Java-Bali area in Indonesia (see Table 5.4). Consequently, it may be argued that geothermal power was not eligible for credits under the CDM. However, since Reflex does not take into account investment restrictions, the average emission factor of the energy system (including geothermal power) will be used as a benchmark. The differences between the emission factors determined from the results of Reflex and PERSEUS may be explained by the different optimisation methodologies. As explained in Chapter 3, PERSEUS includes a simultaneous cost optimisation of the entire energy system over all periods of the time horizon, while Reflex performs a sequential optimisation for each period separately. As a consequence, the composition of the future energy system determined by the two tools may well differ. It remains to be discussed which methodology is most applicable in giving a comprehensive picture of the actual development of the energy sector in Indonesia.

Table 5.4. Comparison of the benchmarks determined with PERSEUS and Reflex						
Non-Java-Bali, base load, central electricity production		**2000**	**2005**	**2010**	**2015**	**2020**
PERSEUS benchmark	(gCO_2/kWh)	405	293	349	349	516
Reflex benchmark	(gCO_2/kWh)	502	398	334	452	499

The application of the benchmark values for base-load in the Non-Java-Bali part leads to a baseline CO_2-eq. emissions level (*e.g.* for the PERSEUS baseline in the year 2000) of 1,171 $ktCO_2$/a for the project. Comparing these values to the coal-only baseline proposed by the project developers themselves, which calculates an annual emissions level of 2,752 $ktCO_2$-eq. for each of the 30 years of the project's proposed lifetime, shows that the single-project baseline derived for the Sarulla project is 2.35 times as high as the benchmark derived from PERSEUS for the Non-Java-Bali region. The PROBASE multi-project benchmark is again much more conservative than the single-project baseline assumed by the project developer, providing an extra additionality safeguard against free riders also in cases like the Sarulla project.

5.4.2 Additionality Assessment for the Czech Heating Centres programme

Sponsored by the Swiss Financial Assistance program, the CHC programme oversaw the rehabilitation of about 70 heating centres in 7 Czech cities.[155] Carried out between 1996 and 1999, the programme entailed the installation of modern gas-fired boilers, thus replacing old boilers (41.6MW in total) which were fuelled with lignite (41% of total consumption), coke (34%), light oil (12%), natural gas (3%) or town gas (10%). This additionality assessment will only focus on old coke/lignite-fired heating plants (75% of the CHC program in terms of fuel consumption). In addition to conversion of these plants to gas, also their potential conversion to biomass (wood) or even a refurbishment without fuel switch can be considered.

The data on the projects are listed in Table 5.5. Pre-project boiler efficiencies were not reported, only an average efficiency of 59% for all the boilers across the fuel types. The efficiency of the new gas-fired boilers is 87%.

Table 5.5. Data of the CHC program				
Heat boiler projects	Lignite -> gas	Coke -> gas	Oil -> gas	Gas -> wood
Number of heating centres	10	48	4	1
Pre-project fuel input MWh/y	54915	46580	16697	7126
Pre-project EF input tCO_2/MWh	0.354	0.370	0.264	0.201
Project fuel input MWh/y *	35876	32214	14754	7381
Project EF input tCO_2/MWh	0.201	0.201	0.201	0
Pre-project emissions tCO_2/y	19439.91	17234.6	4408.008	1432.326
Project emissions tCO_2/y *	7211.076	6475.014	2965.554	0
Estimated ER tCO_2/y	12228.834	10759.59	1442.454	1432.326

**Predicted by the consultants. Where later measurements were available, most predictions proved to be too high.*

The level of emission reductions achieved by the project depends on the efficiency improvement of the boiler and the difference between the emission factors of the old and the new fuel. The price for conversion of 70 old boilers (using various fuels) to modern boilers fired by natural gas amounted to 10.6 m Swiss Franks (7.23 m euro). This was co-financed by the Swiss and the Czech governments, roughly on a 1:2 ratio. Brodmann *et al.* (1999) have calculated the incremental costs and CO_2 abatement costs of the

155 Brodmann *et al*, 1999.

programme. They conclude that the fuel switch to gas is clearly more expensive than BAU, thus suggesting that the coal-to-gas projects under the CHC programme are additional. They also conclude that the CO_2 abatement costs of the coal-to-gas projects are rather high compared to other JI projects. This is due to the low price of domestically produced lignite, in comparison to the price of imported gas. The cost assessment is very sensitive to fluctuations in fuel prices. The coal-mining sector has already been restructured and the cheap price of coal reflects the efficiency gains which have been achieved. In a scenario of continued economic growth, increase in labour costs for domestically produced coal will drive up the price of coal, and make the additionality of switch to gas more questionable.

It should be noted that the use of lignite is particularly competitive in the vicinity of the mines. This is for example reflected in the internationally competitive Czech lignite-fired electricity plants which are located at the site of lignite mining and fed through conveyor belts to minimise transport costs. While these localised production efficiencies are likely to apply to some of the CHP plants, it is not clear to which extent they apply to the heat-only plants under the CHC program.

Policy additionality

The Czech republic has been relatively quick and rigorous in the overhaul of their communist era **energy regulations**. The *1994 Energy Act*, which was largely consistent with the 'Shared Goals' of the IEA and basic policy objectives of the EU, aimed at diversification of energy supply through the development of nuclear energy and new hydrocarbon imports. Uncompetitive units have been phased out, distribution has been unbundled from generation, and environmental damage has been reduced. In January 2000, the Czech government approved a new *Energy Policy* paper, which contained new objectives up to 2020, including the acquisition of reliable, safe and environmentally-acceptable energy supplies to support economic competitiveness. Based on the Energy Policy paper, the government proposed a *new Energy Act*, which came into effect in January 2001 and which includes provisions to transpose the EU electricity and natural gas directives into Czech law.

The Czech republic pursues an active renewables policy, which is supportive of the use of biomass in district heating boilers. However it is not clear if the current levels of subsidies are sufficient to make a coal to biomass conversion economically attractive. These subsidy levels may increase in the near future.

Under the current economic conditions, coal (especially lignite) is cheaper than gas. This would suggest that a refurbishment without a fuel switch might be more economically attractive than a refurbishment with a switch to gas.

While coal dominates in the CHP sector, gas dominates in the heat-only sector which is six times smaller. In households, industry and (smaller scale) district heating, the use of gas has increased significantly over the last decade at the expense of coal. It is not entirely clear how this has come to be, as the economic rationale for the switch to gas is questionable. At current market prices, the use of lignite is cheaper than the use of gas. The emission taxes under the *Clean Air Act* will favour gas over coal, but we do not have the information to assess how this affects the overall comparison of costs of the two competing fuels.

Whether through taxation or though other measures (*e.g.* voluntary agreements), it would appear that the Czech Republic has supported this switch to gas mainly on environmental grounds, which would be consistent with the great efforts they have made to reduce emissions from larger coal and lignite-fired plants. They may have stimulated the switch to gas for smaller installations since installation of gas cleaning equipment on domestic chimneys and the boiler houses of small district heating systems is not a feasible option. The local air quality impacts from small-scale use of coal are greater since district heating boilers have short chimneys and are located in built-up areas.

Despite these conversion efforts, 27% of the heat-only plants are still fuelled by coal or lignite. In the absence of the CHC program, which was not a JI programme, available funding may have gone to other plants (and fewer plants) than the ones selected.

There is no policy requirement for the coal plant to be converted yet, so it is policy additional at the moment. It is likely that environmental legislation will become stricter within 5 to 10 years and this may mean that such a conversion would no longer be policy additional. The fuel switch to gas is a trend which is clearly already taking place in the sector, but it is not sure what the relative importance is of the main drivers for this change. The switch to biomass is an explicitly stated aim of government policy, backed up by specific subsidies. The exact level and preconditions of these subsidies would determine if the switch to biomass is partially or not at all policy additional (see below on *a priory* additionality). This raises questions about the wider additionality of both conversions.

Combined barriers assessment

Table 5.6 shows the results of a combined barrier assessment carried out for the CHC programme. Note that the answers are based on recent developments in the Czech institutional framework, and may not adequately reflect the (fluid) situation at the beginning of the programme.

Table 5.6. Possible barriers for the CHC programme

Risk of technical breakdown or underperformance	This risk is limited. This is proven technology and the privatised utilities have the incentives and obligations to repair and maintain the boilers. **Barrier under BAU: -**
Lack of technical expertise	The technological know-how in the Czech republic is high and modern gas-fired boilers are fairly common in heating centres. **Barrier under BAU: -**
Lack of adequate supply of equipment	The equipment is likely to be of western European origin and there are no import restrictions for this kind of technology. Consequently, the transport costs and supply time would not be a barrier. **Barrier under BAU: -**
High operation and maintenance costs	Operation costs would depend on the cost of gas on the international market. The Czech Republic is one of the richest transitional economies and the privatised utility would be able to pass on higher fuel prices to most of its customers. Maintenance costs are not known but with local technical know-how and short supply lines, it is not expected to be a high cost. **Barrier under BAU: -**
Lengthy development process	The active financial support of the Czech government may have taken some time to materialise but has probably also lead to a smoother implementation phase once the technical agreements had been reached. The considerable reform in the Czech energy sector will have importantly reduced the level of bureaucracy. **Barrier under BAU: -**
Poor utility infrastructure	The CHC program does not indicate of the state of the heating network, but it is likely to have been poor. However the successful privatisation in the heating sector and the low level of non-payment would suggest that the privatised utilities are capable of raising enough capital to maintain and improve the heat network. This probably demands less technical know-how than the installation of a state of the art gas boiler and the investments can be spread over a number of years as parts of the network are upgraded every summer. **Barrier under BAU: -**

Lack of capacity building	The level of purely technical expertise is probably adequate in the Czech Republic. However the will be a training need to manage and operate the plant in accordance with best practice. **Barrier under BAU: +/-**
Inadequate or non-existing institutional setting	The institutional framework in the Czech Republic has been evolving quickly over the last decade. At the moment, the Czech Republic is preparing to join the EU in 2004 and their institutional framework becoming comparable to that of EU countries. It may have been that in the beginning of the project the evolving framework would have been a barrier. **Barrier under BAU: -**
Risk of bureaucracy	Not a barrier, since the sector is well reformed. May have been a limited barrier in the beginning of the projects. **Barrier under BAU: -**
Lack of administrative infrastructure and legislative framework (incl. enforcement) related to environmental or energy efficiency projects	Not a barrier now (see above) **Barrier under BAU: -**
Shortage of capital	This is likely to have been a barrier, as the Swiss paid twice as much as the Czech government. In the absence of the Swiss support, it would have probably taken the Czechs longer to raise the capital. After the successful privatisation, it must have become easier to attract foreign investments. **Barrier under BAU: +/-**
Lack of financial incentives to improve heat-supply plant	There is no evidence that the plants are cheaper to run on gas than on coal. It would have would appear that the program has been implemented primarily for environmental reasons rather than financial. **Barrier under BAU: -**
Risk of inappropriate provision of fuel and raw materials	There are no issues surrounding the quality of the gas. The Czech Republic seems reluctant to become overly dependent on Russian gas, and have made sure that they are connected to the western European gas network so they could also draw from Norwegian gas. **Barrier under BAU: -**
Risk of subsidized energy prices	Not relevant, heat is no longer subsidised. **Barrier under BAU: -**
Resistance to new ideas or technologies	Not relevant, this is not a new idea. **Barrier under BAU: -**
Low acceptance from the public	Quite the opposite; the public will appreciate the improvement of local air quality **Barrier under BAU: -**

A Priori additionality

The coal-to-biomass conversion can be considered as *a priory* additional. In terms of emission reductions, this would be the most preferable of all conversions, and it will not take place at a large scale due to lack of biomass. There are also some barriers in investment funding in the sector, despite the existence of subsidies. To deny crediting to biomass projects because policy additionality is limited would mean that the Czech renewables policy would be treated as a perverse incentive for renewables.

Multi-project additionality assessment

Three different multi-project additionality approaches could be used here:

1. The 7th or 8th percentile of the best performing plants in the sector (*i.e.* the project must perform better than 70% or 80% of the existing plants in the sector).
2. A technology benchmark which the project must out-perform.
3. A sector benchmark weighted to be stringent (as suggested in Section 4.1 and Annex 8).

In the first case, the project would have to perform at least better than half the existing gas-fired boilers in the sector (the 7th percentile). In the second case the technology should be used which is currently implemented in the sector, *i.e.* modern gas-fired plants. In the third case, a standard sector average could be used, such as all fossil fuel plants, and a weighting factor applied.

It is clear that in the first two multi-project additionality approaches, the conversion to gas would not be additional but the conversion to biomass would be. For the third approach, this would depend on the weighting, but even then the biomass project is highly likely to remain additional.

5.5 Conclusions

This chapter has elaborated on the concept of additionality. In the text on the CDM in the *Marrakech Accords* additionality is mainly addressed under the modalities of baseline determination. Basically, baseline determination and additionality assessment are indeed steps in a similar process of providing a reasonable description what would have taken place in absence of the project activity. Yet, an international debate is still ongoing on whether next to calculating how much reduction a project achieves below a baseline, a project must also be analysed in terms of assessing whether the project would have taken place in absence of the GHG crediting.

The points of view in this debate can broadly be categorised as follows. On the one hand, it is argued that determining a reasonable and where necessary conservative baseline along the lines of the *Marrakech Accords* makes a separate additionality assessment redundant. This approach assumes that once a baseline is higher than the project's actual emissions the project can be considered as *implicitly* additional. In practice, this approach has been applied by the Netherlands' Ministry of Economic Affairs when managing the ERUPT programme for tendering JI projects.

On the other hand, it is argued that however precise and reasonable a baseline may be, it will still not be able to filter all free riders (non-additional projects) out of the JI/CDM crediting system. Earlier in this chapter the example was given of a situation where a stringent baseline was used which assumed that the most efficient coal plant would have been installed in a country where coal is traditionally dominant. A project could subsequently only be eligible for crediting if it would install a technology better than (*i.e.* cleaner than) the most efficient coal plant. Generally, cleaner and more efficient technologies are more expensive to install so that a stringent baseline with an efficient technology is assumed to reduce the number of free riders. However, this need not always be the case as for particular reasons the investor might have a commercial interest in investing in a gas-fired plant and would have installed that plant anyway, irrespective of the GHG credits. Proponents of separate investment additionality tests argue that also the latter projects must be filtered out of the system as these, strictly speaking, do not result in additional emission reductions.

An application of a separate additionality assessment next to the baseline can be found in the present approach of the PCF. The Fund requires project developers to show why the proposed project itself would not have been part of the baseline. Therefore, in contrast to the ERUPT approach, the PCF demands from project developers that they explicitly show that the project is additional.

This chapter has discussed a number of options to deal with additionality which have been mentioned in the literature and some of which may be stricter than practically required given the text of the *Marrakech*

Accords. Some of these options require a separate test next to the baseline (policy additionality, a combined barriers approach, *a priori* additionality and an EBAT) and others are additionality assessments as part of a single-project baseline (a conservative baseline scenario *e.g.* ERUPT) or of a multi-project baseline (a stringent benchmark, possibly in combination with an EBAT). From the analysis in this chapter and in Section 4.1 three possible approaches to additionality could be identified (for the option to correct for additionality uncertainty, see Section 4.1):

1. Single-project baselines in combination with a combined barriers assessment;
2. Multi-project baselines in combination with a combined barriers assessment;
3. Multi-project baselines as a stand-alone safeguard against free riders.

Single-project baselines + barriers

It has been illustrated in this chapter that the combined barriers assessment for large-scale projects could reveal several barriers that would have existed for project implementation under BAU: especially, the high operation costs, the lengthy development process, and the lack of financial incentives (coupled to a shortage of capital) to build plants without the GHG reduction credits. Also in some cases (see this chapter and Annex 10) it has turned out that the difference between the price of conventionally generated power and the price of power to be generated by the project's technology may make the project unattractive for installation without JI/CDM support.

Nevertheless, as a stand-alone additionality test the combined barriers approach would probably be an insufficient tool to prevent free riders from entering the JI/CDM system, although some project developers could be discouraged by the work involved with the test and the problems they may have with proving the significance of the barriers. The test has the disadvantage of being of a mainly qualitative nature and although weights could be added to each possible barrier to reflect its importance, the assessment of whether the barrier really exists under BAU remains a qualitative judgment of the project developer. Moreover, as explained in Section 5.3, the interpretation of the weighted results depends on the risk attitude of the project investor (risk averse, risk neutral, *etc.*) and, again, this is sensitive for individual interpretation.

A combined barriers test would, however, be a useful addition to a baseline methodology which already incorporates conservative parameter values, determined in line with the modalities of the *Marrakech Accords*. An advantage of applying such a test in combination with a baseline is that the latter does not need to be overly restrictive. In case of a hydro plant which meets existing energy demand and where the choice for determining the marginal plant is between an old coal plant which burns domestic coal, and a gas-fired plant which needs imported natural gas, a conservative baseline would take the gas plant as the marginal plant because of its lower GHG emissions factor. Carrying out a combined barrier assessment for either coal or gas or both could help exploring whether the gas plant really is the most reasonable scenario, or whether perhaps the coal plant would be more reasonable.

Multi-project baselines + a combined barriers assessment

Carrying out a combined barriers assessment when using multi-project baselines could be one way to make the benchmarks more project-specific. As the analysis in this chapter has shown, the combined barriers assessment helps gathering more qualitative project-specific information about the project than is required with the determination of the multi-project baseline.

The probability that a barriers test reveals non-additionality of the project where the baseline analysis had considered the project as additional becomes higher the less stringent the benchmark has been determined. Leniently specified multi-project baselines (*e.g.* current grid mix with coal-dominance linearly extrapolated into the future) are generally not likely to filter many free riders from the system. Application of the benchmark in combination with a barriers test, however, could gain more insight in the additionality of the project by identifying barriers or by showing that the project is additional indeed.

Multi-project baselines as a stand-alone additionality assessment

Chapter 3 has shown for the case studies analysed that the PERSEUS and Reflex modelling generally leads to relatively stringent baselines, both when compared with the single-project baselines assumed by the project developers and with the fuel-specific and country or regional-specific benchmarks calculated for the case study projects. Thus, the model-based benchmarks, which assume a cost-minimised optimisation when projecting the future energy system of the host country (see Section 3.3), would reduce the scope for non-additional investments precisely because the credits that can be generated from JI and CDM projects with model-based benchmarks are relatively little or even amount to zero if the GHG emissions level under the benchmark is lower than the emissions level of the non-additional project.

Sathaye *et al.* (2001) suggest another approach to use stringent benchmarks as a tool to minimise non-additional JI/CDM projects. Their proposal is to set a multi-project baseline/benchmark at a strict level which could work as an additionality test on its own (EBAT) or used as a baseline incorporating additionality. Sathaye *et al.* (2001) have explored the use of benchmarks in electricity supply and cement production and proposed levels of stringency based on percentiles of the plant performance on emissions, which is similar to the *better-than-average-current-practice* benchmark discussed in Section 2.3.5. Setting a benchmark at a stringent level was suggested as a method of testing additionality as plants would have to perform better than a stringent performance level ensuring high technological standards implying higher costs and consequent additionality of the project.

6. Calculating GHG reductions – Accounting packages & PROBASE decision tool e-SEREM

As explained in the introduction of this report, the main focus of PROBASE has been on standardising baselines procedures. However, the baseline is only part of the overall GHG emission reduction accounting process for JI and CDM projects. This chapter first places baseline determination in the context of the overall cycle of designing a project and the implementation of the project after the design has been validated. It is also shown that the accounting can be carried out along the lines of a strict package (stricter than 'Marrakech') or a less strict or even lenient package (Section 6.1).

Second, this chapter presents a **Smart Emission Reduction Estimation Manual** which is an electronic tool for calculating JI/CDM project emission reductions using multi-project baselines. The manual contains benchmark values calculated by the PROBASE analysis described in Chapter 3 thereby taking into account several different project options (*e.g.* base load projects, on-grid or off-grid electricity supply, large or small scale projects, region, country). The manual guides project developers through a number of steps which automatically takes them through an underlying decision tree. The result of the manual is a baseline scenario for the project as well as a calculation of the project's emission reduction in the form of a printable report (Section 6.2).

6.1 Accounting packages for calculating GHG emission reductions

The calculation of GHG emission reductions achieved via JI or CDM projects requires a number of steps, which have been addressed in more detail in Chapter 2 of this report and in Annex 4. PROBASE identified the following accounting steps:

1. Determine the **system boundary** within which the project activity takes place and which comprise those emission sources that are under direct influence of the project participants (see Section 2.1.1).
2. Describe for the situation within the system boundary what would have happened if the JI/CDM project had not taken place, *i.e.* **assessment of the baseline and additionality**. The exploration and analysis of methodologies for standardising baselines were the main focus of the PROBASE study and have been described in Chapters 2, 3 and 4; Chapter 5 has dealt with additionality. The data used for describing the counterfactual situation that the baseline estimates needs to be checked for quality with the help of data quality methods, such as statistical data, and if not applicable, the NUSAP approach (see Section 3.2.1).
3. Determine the appropriate **crediting lifetime** for a project (either 10 years once, or 3 renewal periods of 7 years each).
4. Determine a **monitoring plan** in order to periodically check the project's actual results.
5. The first three steps (system boundary and determining counterfactual scenario) are followed by a **validation** of the project design, including a validation of the baseline and of a monitoring plan. Once validated, the project's emission reductions are calculated as the extent to which the monitored project emissions are below the validated baseline.
6. Determine **equivalence of service** in combination with the identification of possible **knock-on effects** of the project on factors outside the project boundary that may (partly) offset the GHG emission reduction achieved within the system boundary and are therefore often referred to as leakage. The possible leakage is subtracted from the gross emissions reductions calculated in step 5 (leakage has been described in Annex 4).

7. Finally, along the lines of the proposed CDM Project Design Document (see unfccc.int/cdm), the project's results are **verified and certified** before submission to the responsible UNFCCC bodies (*e.g.* JI Supervisory Committee and CDM Executive Board).

Most of the above steps have been assessed individually in the PROBASE research as part of the literature review and the codification of existing knowledge of each of the issues (see Annex 4 and Section 2.1 for the steps 1, 2, 3, 6 and 7; step 6 has also been addressed in detail in Section 3.6 and in Annex 7). Most attention under PROBASE though was paid to step 2: baseline determination and additionality of emission reductions. Setting up a monitoring plan (step 4), the validation of the baseline and the monitoring plan (step 5) and the verification and certification of the emission reductions (step 7) were beyond the scope of the study.

Going through the steps eventually leads to a number of certified emission reductions credits (either ERUs in case of JI, or CERs in case of the CDM) achieved through a JI or CDM project. However, the amount of emission reductions not only depends on the steps themselves, but also on the strictness applied for each step. For example, in describing the counterfactual situation that would have existed in absence of the project, a baseline for an *e.g.* fuel-switch project in a power plant could be based on single-project historic data assuming that the existing plant would have continued its operation into the future for the duration of the crediting lifetime. Alternatively, the baseline could assume that the existing plant would have been upgraded or replaced anyway by a more efficient technology. The latter baseline is (much) stricter than the first one. Similarly, a multi-project benchmark baseline could be based on average historic data for the sector in the host country, but could also be based on recently added technologies, or derived from a top 20% performance criterion. Similar graduations in strictness can be used when determining leakage resulting from a project, or when selecting the crediting lifetime for the project (*e.g.* the developer can compare a fixed lifetime of 10 years with the costs and risks associated with revisions for a longer crediting lifetime of 3 times 7 years), or setting the project boundaries, or when checking the data quality used for baseline determination (strict statistical tests or qualitative application of NUSAP).

Depending on the level of strictness different GHG accounting packages can be constructed, in which strict steps lead to a strict package and relatively lenient steps towards a lenient package. Implicitly it is assumed that increasing stringency implies a corresponding increase in transaction costs. The aim of the packages is to suggest a balance between environmental integrity, costs and practicality. The particular cases chosen are:

- **A stringent case (package 1)** which requires a separate additionality assessment through a combined barriers assessment and which requires the baseline to be the most conservative one, either single or multi-project. This package is more stringent than the requirements for the CDM as included in the CDM text of the *Marrakech Accords*, which says that baselines must be conservative and where additionality is basically assessed under the baseline (see Chapter 5). Although this stringent case is likely to reduce possible overestimations of GHG emission reductions achieved by the project, the transaction costs for this approach are assumed to be also relatively high.
- **A medium case (package 2)** which requires a similar combined additionality test as in package 1, but where the single or multi-project baseline 'only' needs to be conservative. The separate treatment of additionality and the baseline in this package again can be considered to be stricter than 'Marrakech' requires, but is less strict than package 1. With regard to baselines, the Marrakech text requires baselines to be a reasonable, but conservative description of the situation without the project.

The text does not require project baselines to reflect the most conservative reference scenario. The latter could even be inconsistent with the 'reasonability' criterion of baselines. After all, similar to inflated baselines the most conservative baseline can in several cases hardly be considered a reasonable representation of BAU.

- **The least strict case (package 3)** which assesses additionality as part of the baseline (as in the Marrakech text) and which requires the baseline to be a conservative reference scenario. Furthermore, this case does not deal with an individual leakage assessment.

The assumption in all cases is that the project has had an initial positive screening for eligibility and then for policy additionality.

Package 1. High Environmental Integrity, Transaction costs high case	
Issues	***Option***
Additionality	Combined barrier test
Project boundaries	Assigned boundaries from experts or developer but minimum is one level up and one level down
Baselines	Most conservative baselines (single project or multi-project if available) subject for validation
Leakage	• Proposed is a leakage correction factor (see Begg et al., 2002). • It is important to note that, unlike as expressed in the Marrakech Accords, leakage does not relate to the baseline or to business-as-usual situation but is just a knock-on effect due to the project. Leakage is therefore not part of the project design document and can not be validated; it is part of the monitoring - to the extent measurable - and subject to verification/certification
Crediting lifetime	Limited lifetime of 10 years or 7 years renewable for total of 21 years
Data quality	NUSAP approach
Monitoring of project	• According to good practice guidelines • Environmental assessment Monitoring
Verification of reductions	Reductions to be verified according to JI/CDM requirements
Certification and issuance	Issuance only after reductions verified at intervals to be agreed

Package 2. Medium to High Environmental Integrity Transaction Costs Medium Case	
Issues	***Option***
Additionality	Combined barrier assessment
Project boundaries	One level up and one level downstream
Baselines	Conservative baseline (single project or multi-project if available), but not necessarily most conservative one
Leakage	Proposed is a leakage correction factor (see Begg et al., 2002).
Crediting lifetime	Limited lifetime of 10 years or 7 years renewable for total of 21 years
Data quality	Traditional, less detailed data quality check
Monitoring of project	• According to good practice guidelines (in line with Marrakech) • Environmental assessment Monitoring (in line with Marrakech)
Verification of reductions	Reductions to be verified according to JI/CDM requirements
Certification and issuance	Issuance only after reductions verified at intervals to be agreed

Package 3. Medium Environmental Integrity Transaction Costs Medium Case	
Issues	***Option***
Additionality	Additionality assessment as part of the conservative baseline determination
Project boundaries	One level up and one level downstream
Baselines	Conservative baseline (single project or multi-project if available), but not necessarily most conservative one
Leakage	No leakage correction
Crediting lifetime	Limited lifetime of 10 years or 7 years renewable for total of 21 years
Data quality	Traditional, less detailed data quality check
Monitoring of project	• According to good practice guidelines (in line with Marrakech) • Environmental assessment Monitoring (in line with Marrakech)
Verification of reductions	Reductions to be verified according to JI/CDM requirements
Certification and issuance	Issuance only after reductions verified at intervals to be agreed

As mentioned before, the three packages above are compiled while keeping in mind the minimum requirements of the JI/CDM Text of the *Marrakech Accords* (packages 1 and 2 could be considered to be stricter than 'Marrakech'). The only exception in this respect is the treatment of leakage, which has in some places in the *Marrakech Accords* wrongly been assumed as being a part of the baseline assessment, whereas the counterfactual element of determining leakage outside the project boundary is overlooked. Based on the literature review and an analysis for the UK Government Begg *et al.* (2002) recommend a multi-project correction factor, which is included in package 3 above.

The main difference between the three packages lies in the assessment of additionality of the emission reduction (either separately through *e.g.* a barrier assessment, or in combination with determining a conservative baseline). In the stricter packages 1 and 2 a separate additionality test in combination with the most conservative or just a conservative (multi-project) baseline is proposed, whereas in the least strict package additionality is assessed as part of a conservative baseline, which is not necessarily the most conservative one. For the purpose of illustration, the three packages have been tested on three projects:

- the *Sarulla geothermal energy* project in Indonesia,
- the *Surduc hydro energy* project in Romania, and
- the *Nizhny Novgorod district heating system* project in the Russian Federation.

The results of applying the packages to the three projects are shown in Annex 10. The main finding from the case study analysis is that the conservativeness of the baselines has the biggest impact on the emission reductions achieved through the project. For the projects there turned out to be a large difference between emission reductions achieved with conservative baselines or a conservative benchmark on the one hand, or with some of the single-project baselines without particular conservativeness. The separate additionality test (combined barriers test) does not have a strong impact on the project's emissions reductions if for the same project a conservative single-project baseline is determined or a conservative/strict benchmark.

6.2 PROBASE decision tool: e-SEREM

6.2.1 Introduction

With a view to the objective of PROBASE to operationalise baseline and GHG accounting procedures which lead to a reasonably high environmental integrity (*i.e.* prevent overestimation of baseline emissions) at reasonably low transaction costs, while taking into consideration that the *Marrakech Accords* requests specific guidance into “decision trees and other methodological tools, where appropriate, to guide choices in order to ensure that the most appropriate methodologies are selected, taking into account relevant circumstances,”[156] PROBASE has developed **e-SEREM** (**S**mart **E**mission **R**eduction **E**stimation **M**anual), which is an Internet-based manual for calculating JI/CDM emission reductions. With the help of **e-SEREM** a benchmark for a specific project type in the power or heat sector can easily be selected, and through a decision tree system the annual and cumulative emission reductions accrued by a project can be calculated for the project’s crediting lifetime.

In order to test the applicability and practicality of **e-SEREM** in assisting project developers and evaluators in elaborating on baselines and calculating a project’s emission credits, a pilot version of the manual has been developed. This pilot version was tested on the power sectors of three countries – Indonesia, the Russian Federation, and South Africa – as well as on the heat sector of the Russian Federation. The baselines used for these countries are the ones derived under PROBASE using the PERSEUS, Reflex and SimBAT tools (see Chapter 3). It should be noted that **e-SEREM** is still in a pilot phase and, based on a more extensive testing on all project types, may need to be expanded with further items. However, for the purpose of this report it serves well as a specific illustration of what an electronic manual for JI/CDM project emission reduction accounting looks like.

6.2.2 The system’s structure

The **e-SEREM** Internet home page (see Figure 6.1) contains links to information sources elsewhere on the Internet about the flexibility mechanisms, baselines, and the Kyoto Protocol as well as on PROBASE. The home page contains a link named *Manuals* that directs the user to the *Smart Manual* for power and heat sector projects and the *Forestry Manual*.

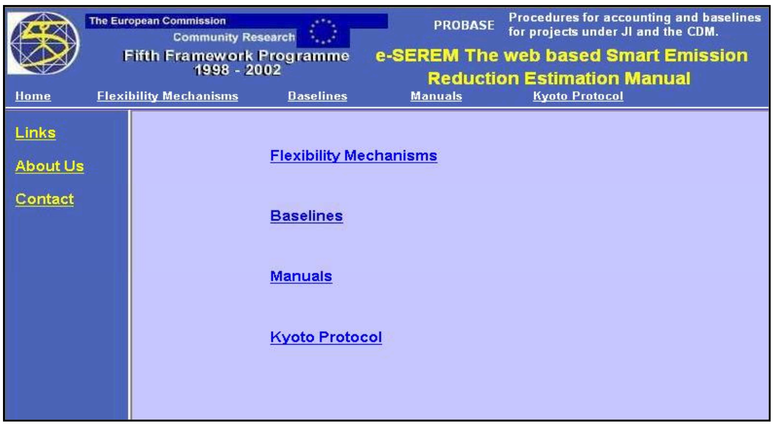


Figure 6.1. e-SEREM homepage

The *Forestry manual*, which is based on the analysis in Section 3.6 and Annex 7, can be downloaded as a PDF document from its link. In the present version of **e-SEREM** the forestry manual contains a hard copy-based standardised accounting procedure for the carbon sequestration achieved by a JI/CDM

[156] Para. b(iv) of Appendix C to Decision -/CMP.1 (*Article 12*).

project. The *Smart Manual* link opens the first page of the electronic manual for baseline selection and emission reduction calculation for power and heat sector projects. **e-SEREM** is structured with the intention to include five functional forms and two final reports, one for the power sector projects and one for the heat sector ones (see Figure 6.2).

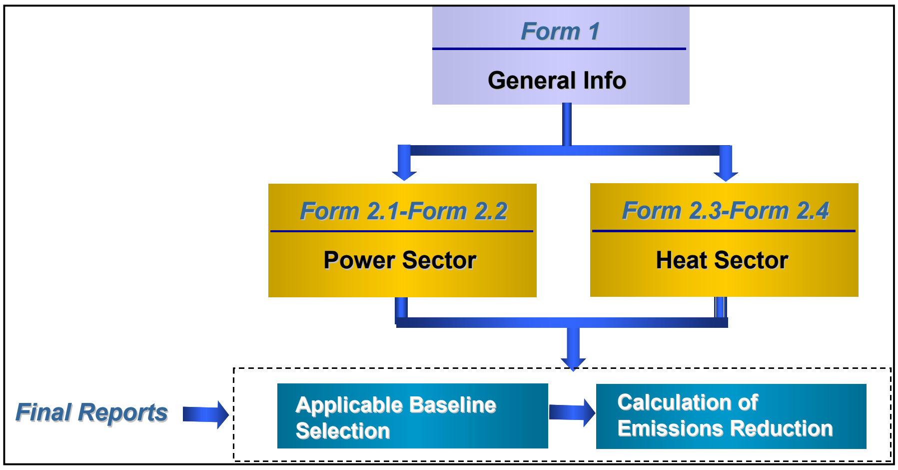


Figure 6.2. e-SEREM structure

The procedure for the selection of the applicable baselines for candidate JI or CDM power and heat sector projects is based on a decision-tree approach. By selecting the host country, region, project sector, project type, scale, grid connection and load profile, the user ends up in a specific branch of the decision tree which leads to the most appropriate baseline for the project in the system. The general structure of the decision tree for power sector projects is presented in Figure 6.3.

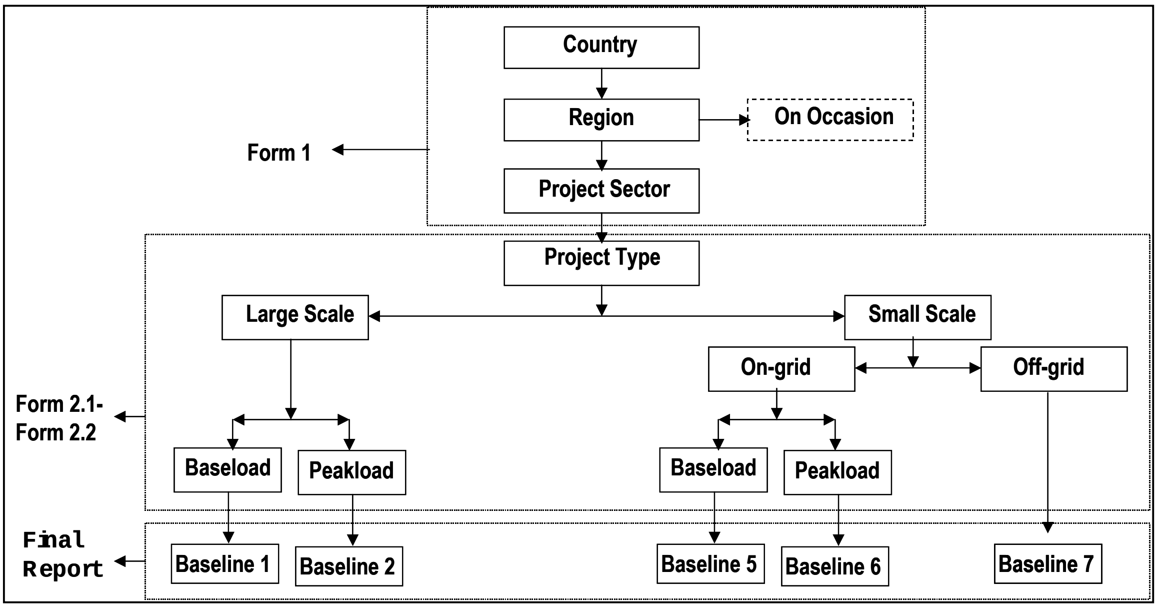


Figure 6.3. e-SEREM electronic decision tree for power sector projects

The decision tree for the heat sector projects is much simpler than for power sector projects, especially because of the small number of project types considered. Only two project types were analysed: *Energy Efficiency Improvement* (supply side) and *Demand-Side Management.* The structure of the decision tree for heat sector projects is shown in Figure 6.4.

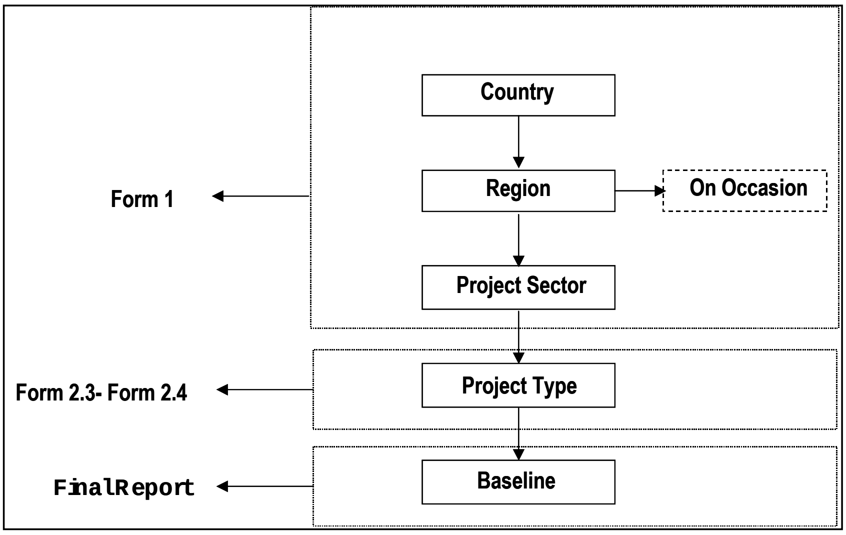


Figure 6.4. e-SEREM electronic decision tree for heat sector projects

The first phase in the decision tree is shown in Figure 6.5. In this phase the project developer must fill in general information about the project, such as project name, project country (the host country), project region (this is an option if the project host country has regions with significant differences in the electricity sector characteristics, power generation mix, separate grids *etc*), and the project sector (the user has to select one among the two options: power sector and heat sector). The information is gathered by **e-SEREM** and systematically saved inside the system so that it serves as automatic input into the next steps. For example, by selecting Indonesia as the project country and Java-Bali as the project region within the country and power as project sector, the non-Java-Bali baselines will be automatically left out of the further steps in the decision tree. The only text needed in Form 1 is the project name. Country, region and sector selection is carried out through dynamic drop-down menus. Based on the sector chosen by the user – power or heat – the system opens Form 2.1 (see Figure 6.6) or Form 2.3, respectively.

The procedure of data submission in Form 2.1 consists of seven steps according to the data fields that should be filled out. Below, these steps are briefly explained for the power sector (for an explanation of these steps for the heat sector part of **e-SEREM** the reader is referred to Annex 10). In step 1, using a dynamic combo-box in the 'Type' field, the user selects the project type from the following possibilities:

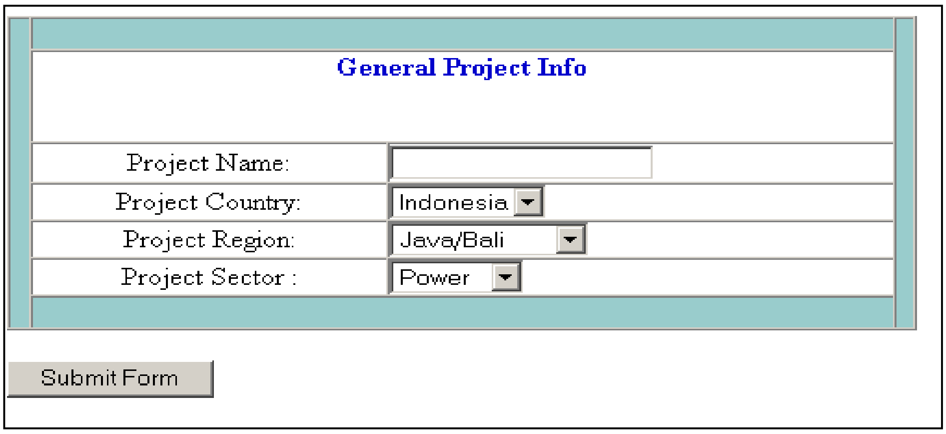
1. Demand side management
2. Fuel switch
3. Greenfield
4. Retrofit
5. Transmission/distribution improvement

In step 2 ('project') a more detailed identification of the project can be given by choosing from the following options:

1. **For project type Demand Side Management,** the user selects one of the following:
   1.1. Reduction of base load

1.2. Levelling of peaks
1.3. Energy saving

2. **For the project type Fuel Switch,** the user selects one of the following:
   2.1. Coal to oil
   2.2. Coal to natural gas
   2.3. Coal to renewables (only geothermal, biogas and biomass)
   2.4. Oil to natural gas
   2.5. Oil to renewables (only geothermal, biogas and biomass)
   2.6. Gas to renewables (only geothermal, biogas and biomass)
3. **For the project type Greenfield,** the user selects one of the following:
   3.1. Coal
   3.2. Oil
   3.3. Natural gas
   3.4. Renewables (wind, hydro, biomass, solar, biogas)
4. **For the project type Retrofit,** the user selects one of the following:
   4.1. Coal
   4.2. Oil
   4.3. Natural gas
5. **For the project type Transmission/Distribution Improvement,** there is no other segmentation into a more detailed project breakdown.


General Project Info

Project Name:	
Project Country:	Indonesia
Project Region:	Java/Bali
Project Sector :	Power

Submit Form

Figure 6.5. Form 1: the first decision tree step

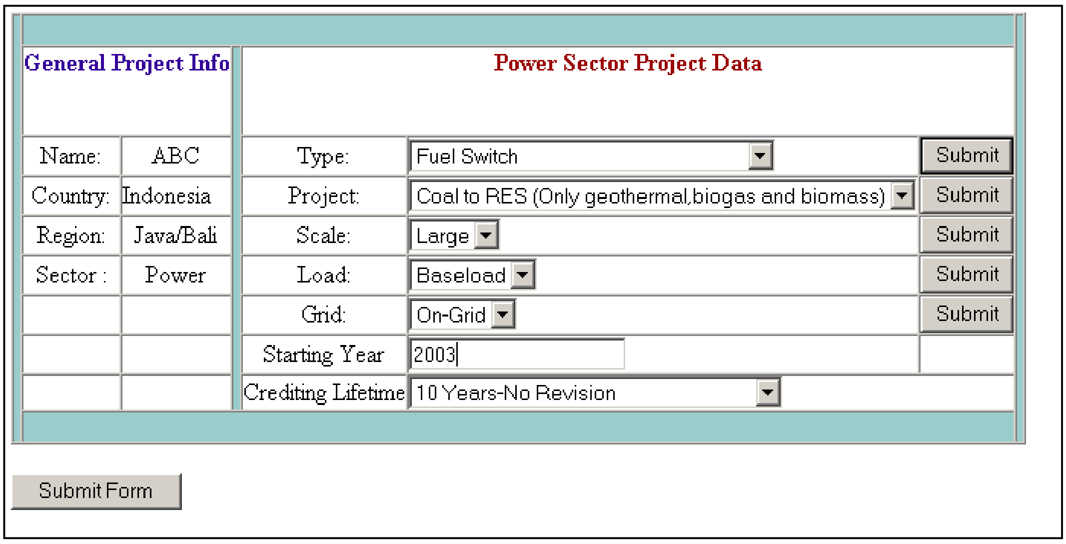


Figure 6.6. Form 2.1 - power sector project data

Step 3 requires a definition of the project scale (based on the large-scale/small-scale distinction for CDM projects in the *Bonn Agreement*).[157] Through a drop-down menu in the 'Scale' field, the user chooses whether the project would be large-scale or small-scale. In step 4 the user must define the load profile of the project by choosing between peak load, average load and base load. Next, the user must identify whether the project aims at feeding electricity into the net (on-grid), or is an off-grid investment. The last two steps in this form deal with the starting year of the project and the crediting lifetime of the project (choice between the options of the *Marrakech Accords*, *i.e.* 10 years or 3 times 7 years).

After having completed Form 2.1 the user is directed to Form 2.2, where data for technical parameters on the power sector project must be submitted (see Figure 6.7). The project parameters that should be entered into the system are:

- Capacity in MW
- Annual Fuel Consumption in GJ/y
- Efficiency of the power plant in %
- Load Factor (utilisation factor) in %
- Electricity Demand Reduction in MWh (only for project type Demand Side Management),
- Losses Reduction in MWh (only for project type Transmission /distribution grid improvement),
- Annual project output in MWh/y. This parameter should be entered for every year of the project's crediting lifetime. The system automatically presents a matrix with the years of the crediting lifetime beginning with the project's starting year. The input of the project output for every year is necessary in case the power generation of the project is not held constant over the crediting lifetime. In order to operate the system all the project output cells should be filled out even if the project output is constant over the crediting lifetime of the project.
- Annual Project Emissions in tCO_2-eq/y. This parameter has to be inserted for each year of the project's crediting lifetime. The system automatically displays a matrix for every year and the user must enter the values of the annual project emissions in the relevant fields.

[157] See unfccc.int.

General Project Info		Power Sector Project Data	
Name:	ABC	Type:	Fuel Switch
Country:	Indonesia	Project:	Coal to RES (Only geothermal,biogas and biomass)
Region:	Java/Bali	Scale:	Large
Sector :	Power	Load:	Baseload
		Grid:	On-Grid
		Starting Year :	2003
		Crediting Lifetime	10 Years

Project Specific Data		
Capacity :	50	MW
Annual Fuel Consumption :	2000	GJ/y
Efficiency (plant) :	40	%
Load Factor (utilisation factor) :	80	%
Electricity Demand Reduction :	0	(MWh) (for project type Demand side management)
Losses Reduction :	0	(MWh) (for project type Transmission /distribution grid improvement.)

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
Annual Project Output	350000	350000	350000	350000	350000	350000	350000	350000	350000	350000	MWh/y
Annual Project Emissions	100	100	100	100	100	100	100	100	100	100	tCO2-eq/y

Submit Form

Figure 6.7. Form 2.2 - project-specific data

After the completion of Form 2.2 **e-SEREM** automatically selects the appropriate baseline for the project and calculates the project's emission reductions. The information about the baseline and the emission reductions of the project are displayed in the *Final Report* of the system for power sector projects (see Figure 6.8). The Final Report can be printed using the printer friendly report option.

General Project Info		Power Sector Project Data	
Name:	ABC	Type:	Fuel Switch
Country:	Indonesia	Project:	Coal to RES (Only geothermal,biogas and biomass)
Region:	Java/Bali	Scale:	Large
Sector :	Power	Load:	Baseload
		Grid:	On-Grid
Starting Year :	2003	Crediting Lifetime	10 Years

Project Specific Data			
Capacity :	50 MW	Efficiency (plant) :	40 %
Annual Fuel Consumption :	2000 GJ/y	Losses Reduction :	0 MWh
Load Factor (utilisation factor) :	80 %	Electricity Demand Reduction :	0 MWh

Project Report

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Sum	
Annual Project Output:	350000	350000	350000	350000	350000	350000	350000	350000	350000	350000	3500000	tCO2-eq
Annual Project Emissions:	100	100	100	100	100	100	100	100	100	350000	350900	tCO2-eq
Annual Baseline Emmisions:	615,24	615,24	530,35	530,35	530,35	530,35	530,35	608,33	608,33	608,33	5707,22	tCO2-eq
Annual Emissions Reductions:	515,24	515,24	430,35	430,35	430,35	430,35	430,35	508,33	508,33	-349391,67	-345192,78	tCO2-eq

Printer Friendly Report

Figure 6.8. Final report: power sector project report

Recommendations

The following recommendations have been formulated on the basis of the PROBASE work. The PROBASE team extensively discussed the recommendations in the form of discussion statements with the PROBASE review board at a meeting on 20 September 2002 in Karlsruhe, Germany.

➢ Purpose of standardisation

Standardisation of baseline procedures, parameters and/or emission factors would contribute to the success of JI and the CDM because of the following benefits of multi-project approaches and methodologies:

- **Transaction costs** in the project design and implementation phase are reduced. Next to providing more structural guidance to project developers in the *project design*, baseline standardisation also makes the *validation* of the baseline easier, more transparent and reliable.
- Standardised baselines with multi-project GHG emission factors reduce the scope for gaming by project developers as the scope for 'talking up' the baseline is minimised.
- Multi-project baseline can correct for perverse incentives, *e.g.* that host countries introducing environmentally benign policies would undermine the scope for crediting CDM projects on their territory, and

Multi-project baseline can provide a simplified alternative for host countries where data availability and insufficient data quality are problematic for single-project baseline determination.

➢ Standardisation and uncertainty

So, standardisation may significantly enhance the credibility of the project-based mechanisms of the Kyoto Protocol, JI and the CDM. Multi-project baseline determination addresses the problem of baseline variability caused by many data uncertainties and other choices made. Such baseline variations can lead to even larger credit fluctuations.

➢ Scope

To the extent feasible, standardisation should not only apply to baseline setting, but also to project proposal procedures (*e.g.* via templates), project boundaries, leakage factors, *etc.* Standardised schemes may evolve in time – *e.g.* also cover projects in sectors with heterogeneous production projects – and thus gradually cover an increasing number of potential JI/CDM projects.

➢ Forms of standardisation

PROBASE has therefore identified three forms of standardisation in relation to baseline determination:

1. **Standardisation of procedures:** this is the weakest form of standardisation because it mainly identifies the steps that need to be taken in the design and implementation of a project. These steps are generally taken from the modalities for CDM projects included in the *Marrakech Accords* and project developers must follow these steps when designing the project and carrying out the investment. The baseline is part of this standardised procedure, but is generally determined on a single-project basis.
2. **Standardisation of baseline parameters:** Standardisation of baselines parameters can imply that a project developer who wants to invest in a renewables project in a particular host country must take a gas-fired plant as the marginal plant, for instance because a project is assumed to meet existing demand and in the host country gas-fired plants are the first plants to be replaced when new power

production capacity becomes available. Other examples of parameters that could be standardised are: the geographical region, whether the baseline must be based on the marginal plant (see the above example) or the best available technique, whether the project in the host country particularly serves base load or peak load, *etc.*

3. **Standardisation of baseline emission factors**: this is the strongest form of standardisation which results in unit-specific GHG emission factors. Project developers basically only need to multiply these factors with the project's activity level in order to determine the baseline (although equivalence of service should be observed). This form standardises all parameters and makes standardisation of procedures easier as it makes a detailed single-project baseline analysis redundant.

PROBASE has explored all three types of standardisation with a particular focus on the standardisation of baseline emissions factors, which have been determined through a modelling exercise with the traditional energy sector model PERSEUS and the simpler model Reflex, which was specifically designed for PROBASE. The models project, based on the assumption of cost minimisation, the future optimal energy mix in a particular host country for a number of subsequent years. Furthermore, information on the energy carriers which are likely to be used in this mix becomes available, so that relatively easily a baseline can be derived.

➢ Homogeneous and heterogeneous production processes

The PROBASE study project has elaborated on operationalising procedures for baselines and accounting for JI and CDM projects. The main focus has been on ways to standardise baseline determination for power, heat and forestry projects. The power and heat sectors were chosen because of their homogenous products (heat and power) and production processes which enable expressing baseline emission factors in units of output in these sectors (*e.g.* $kgCO_2/kWh$). When a baseline is assumed to be a coal plant with a 35% efficiency rate, it is known how much fuel is needed to produce one unit of power. Heterogeneous production processes, on the other hand, are more complicated in terms of baseline determination, because *e.g.* one bicycle could be produced in different ways depending on the type, so that from the output itself it is complicated to determine on a multi-project basis how much energy is needed per unit of output. Standardisation of baseline determination in the heterogeneous sectors would be topic of further research. Finally, forestry has been included in the analysis to explore the special characteristics of this project type and see to what extent procedures for baseline could be standardised.

➢ Environmental integrity

Securing environmental integrity with regard to the JI/CDM procedure is imperative to its long-term acceptability. This not only calls for conservative and regularly updated benchmarks (especially in the absence of a separate project additionality test), but also for a range of other safeguards, such as limited crediting lifetimes, high data quality and validation/verification standards, careful consideration of leakage factors, *etc.* The integrity has to come from the whole package.

When choosing between options of equal integrity consideration should be given to investors' preferences/the project's attractiveness from an investor's point of view.

➢ Organisation of multi-project baselines under the Kyoto Protocol

It is recommended that multi-project baselines (benchmarks) when considered appropriate under the three baseline approaches included in the *Marrakech Accords* are mandatory for all projects in the project categories and JI/CDM host countries for which they have been determined. The benchmarks would have to be managed under the auspices of the CDM Executive Board (or the JI Supervisory Committee) by independent experts who determine benchmarks on behalf of the Executive Board and carry out the maintenance of the scenarios. The benchmark type (*e.g.* country or sector averages, fuel-specific averages or modelled scenarios) selected for a host country depends on the characteristics of that country. For example, a modelling approach could be applied for countries where energy sector characteristics and data availability and quality are well suited for the application of energy models. However, for country where data is limitedly available a less country-specific benchmark could be chosen based on the average emissions in the region, *etc.*

- **Possibility of appeal with mandatory benchmarks and the systemic bias it could create**

It could be considered that in a situation with mandatory benchmarks for JI/CDM projects under the Kyoto Protocol the project developers are provided with an opportunity to appeal against the application of the official accepted benchmark. A reason for such an appeal could be that the project developer believes that the benchmark insufficiently or not all reflects the specific circumstances for his project. Such an appeal would need to be judged by the CDM Executive Board. If the appeal fails, application of the benchmark is mandatory.

However, should an appeal procedure be allowed, there could be a risk of a system bias. One advantage of having mandatory benchmarks is that, provided that the benchmarks are set reasonably, there is no systematic bias, as some project developers would gain from the benchmark whereas for others the benchmark would be stricter than the single-project baseline they would have determined otherwise. With an appeal procedure it is likely that only those project developers will appeal who feel that the benchmark is stricter than their single-project baselines; those who benefit from the benchmark would not appeal. This could introduce a systematic bias in the JI/CDM system, which needs to be taken into consideration.

- **Choice of benchmarks**

Even if the official acceptance of benchmarks for specific project categories/regions may have political implications, such decisions should be based on a selection by an independent panel of experts preferably from a number of well-documented alternatives that specify sensitivity to key uncertainty factors. Benchmarks should in any case be based on sound technical methodological frameworks. This procedure requires regular update, also – if necessary – of the underlying models, to further guarantee the benchmark's environmental integrity.

- **Benchmark type and level of aggregation**

The benchmark type and level of aggregation, both with regard to the project category and the regional scope, may have an impact on the overall environmental integrity of the system. Decisions on this should be based on experts' views, based on a mix of principles (transaction costs, integrity), technical factors (grid, substitution possibilities) and practical considerations (data availability). Benchmarks may apply to regions, but also to countries lumped together; the regional scope may vary depending on the project category benchmark.

- **Leakage**

Since leakage on the whole is rather difficult to determine (in fact, its determination is based on a counterfactual assessment as well), if not impossible to quantify, a standardised test could be designed to assess if leakage is, for instance, material, slightly material or immaterial. This categorisation can then be translated in fixed percentages to be subtracted from the credits.

- **Forestry**

Forestry projects have many characteristics that make them different from other climate projects. Generic benchmarks do not seem suitable. Yet, there seems to be scope to introduce standardization, *e.g.* by standardising the process to get to a baseline and a leakage factor (templates). Applications of such approaches look promising.

- **Electronic manual**

Standardising the project design and implementation procedure of JI and CDM, including a multi-project baseline, can greatly benefit from electronic manuals that are freely available. Such manuals should ideally provide a decision tree automatically guiding project developers through the overall process, that may, if applicable, lead them to the benchmark, and subsequently automatically calculates the amount of credits that one can expect. Although the manual should be as simple as possible, for the purpose of transparency it is recommended that the underlying data and considerations for *e.g.* regional aggregation, time horizon applied, fuel technology chosen, *etc.* are linked to the manual as electronic *Portable Document Formats*.

It is recommended that an electronic manual will be posted on the UNFCCC Internet site under the auspices of the JI Supervisory Committee and the CDM Executive Board.

- **Political considerations behind the choice of benchmark**

For host countries the choice of the benchmark could be crucial for the JI or CDM potential in their countries. For example, the PROBASE analysis of applying models for the electricity sector in Indonesia has shown that the PERSEUS and Reflex model benchmarks are considerably stricter than that national energy projected benchmark found in the PROBASE Multiple Benchmark System analysis. Should the CDM Executive Board decide to apply a PERSEUS/Reflex-like benchmark to power sector projects in Indonesia, then the Indonesian government could argue that it would become less attractive as a CDM host country. For the political acceptability of benchmarks for potential host countries it is therefore recommended that the expert teams which determine benchmarks under the auspices of the CDM Executive Board consist of sufficient experts from host countries as well.

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