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STANDARDISED BASELINES
FOR
SMALL-SCALE CDM ACTIVITIES

A proposal for the CDM programme of the Netherlands

DISCUSSION PAPER

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In order to establish this challenging task within the short time frame, the chapters have been divided over selected group of experts, each responsible for their own chapter:
- Chapter 1: *Introduction,* J.W. Martens, H.J. Wijnants.
- Chapter 2: G*rid-connected small-scale renewable energy and energy efficiency projects*, V. Bovee, M. Lazarus, J.W. Martens, H.J. Wijnants, S.N.M. van Rooijen.
- Chapter 3: *Standardised approaches for small-scale end-use energy Efficiency projects – the case of residential CFL projects*, M.T. van Wees, D. Violette.
- Chapter 4: O*ff grid renewable electricity projects*, F.D.J. Nieuwenhout, S.L. Kaufman.
- Chapter 5: *Streamlined procedures for small-scale CDM projects*, J.W. Martens, A.P.H. Dankers, D. Violette.
- Chapter 6: *Conclusions and recommendations*, All authors.

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Abstract

According to the Marrakesh Accords, small-scale project activities under CDM can use standardised baselines and simplified procedures to kick start their development (UNFCCC, 2001). The Netherlands Ministry of Housing, Spatial Planning and the Environment is developing a Dutch CDM programme. This programme can support small-scale project activities under CDM.

In order to facilitate the submission of small-scale projects under the CDM programme, this study has developed standardised baselines and streamlined procedures for selected small project categories. These categories included:
- Standardising baselines for on grid renewable energy projects and energy efficiency projects.
- Standardising baselines for energy efficient lighting projects.
- Standardising baselines for off grid renewable energy projects.
- Streamlined procedures for the above project categories.

Chapter 6 provides an elaborate overview of the conclusions and recommendations of this study.

CONTENTS

1. INTRODUCTION

1.1 Background for the study

In its Climate White Papers I and II the Government of the Netherlands has outlined its strategy on how it wants to fulfil its obligations under the Kyoto Protocol. In principle, 50% of the emission reductions will be achieved through domestic policy and 50% via the flexible mechanisms identified in the Kyoto Protocol: Joint Implementation and Clean Development Mechanism (CDM). The purchasing of emission reduction units through the flexibility mechanism is equally divided over the options: 25% via JI and 25% via CDM.

The Ministry of Housing, Spatial Planning and the Environment[1] is responsible for the CDM programme. In order to spend this budget cost-effectively, the programme considers various channels. The channels currently under consideration are:
- A tender procedure, carried out by a Dutch implementing agency, Senter, that started on November 1, 2001.
- Contracts with multilateral financial and development institutions, such as the World Bank, IFC, EBRD, ADB, UNDP, etc.
- Contracts with private financial institutions, such as development banks or commercial banks.
- Bilateral agreements between the Government of the Netherlands and non-Annex 1 host countries.

The ministry has prepared a background paper that sets out a framework for this programme (VROM, 2001). Under this framework general guidelines for baselines have been developed and available for use by the various intermediaries and ultimately by project developers. The ministry has assigned a consortium of ECN, DHV Group and Ecosecurities to also develop standardised baselines for small scale projects in order to facilitate the submission of small scale CDM project activities in the various CDM purchase channels of the Ministry, including C-ERUPT (see Senter, 2001).

The Marakesh Accords (the agreement reached in November 2001 at CoP-7 in Marrakesh) has introduced small scale project activities for CDM as project activities that are:
- Renewable energy project activities with a maximum output capacity equivalent of up to 15 MW.
- Energy efficiency improvement project activities which reduce energy consumption by up to the equivalent of 15 GWh per year.
- Other project activities that both reduce anthropogenic emissions by sources and directly emit less than 15 kton GHG per year.

The Marrakesh Accords asks for simplified procedures for the above small-scale projects (UNFCCC, 2001). Standardised baselines and streamlined monitoring procedures are important components of such simplified procedures. Standardised baselines are attractive since they will lower the costs of baseline preparation. Project developers of small scale projects will especially benefit from lower transaction costs, since the typical investment size of these projects does not allow high transaction costs.

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[1] Dutch acronym is VROM.

Streamlined monitoring and verification procedures are potentially another important category for reducing transaction costs for small projects. The Bonn Agreement stresses also the development and adaptation of simplified modalities and procedures as part of the work plan of the executive board, which is installed after CoP-7 in November 2001. A Panel of Experts is probably not installed before 2002. Hence, to further kick-start small-scale projects under the tender of November 2001, the ministry has asked the project team to prepare simplified procedures for the selected small-scale project categories.

The objective of this study is to provide the ministry with standardised baselines and streamlined procedures for selected small-scale projects. The standardised baselines will be provided for the C-ERUPT tender for CDM projects that started on November 1, 2001. The results will be communicated to the relevant project developers via the Internet in a separate format (see Senter, 2001), in addition to the C-ERUPT guidelines. The recommendations for small projects have been uploaded on 21 December 2001. This discussion paper provides an overview of the selected baselines and streamlined procedures and provides a description of why and how choices have been made.

Running ahead of the crowd, as the Government of the Netherlands is doing, entails certain risks. In the case of small projects, the risk is that standardised baselines are developed for countries or technologies following methodologies, which are in the end not acceptable to the CDM Executive Board. To anticipate this risk the project team has aimed to follow as closely as possible the Bonn and Marrakesh Agreements, as well as the recommendations of the OECD/IEA/UNEP Expert Workshop on Baselines. As another measure, an international team of expert has acted as reviewers to look at the recommendations made by the project team and advice on the acceptability of the recommendations.

1.2 Scope of the study

Selection of project categories

Given the short turnaround for this study, the ministry has selected specific categories within the small-scale projects to develop standardised baselines for. This selection was based on high potential project categories during the phase of Activities Implemented Jointly in developing countries. The selected categories are project activities in the field of:

- Grid-connected small-scale renewable energy and electricity reducing energy efficiency projects[2].
- Efficient lighting projects.
- Off-grid electricity generating renewable energy projects.

Geographical coverage and incorporation of country specific elements

Ideally, methodologies for standardised baselines are a combination of two key aspects. Elements, which relate to the nature of the project or the technology and which should be commonly treated across countries. For instance, the supply of wind for grid connected wind power projects is in most cases intermittent and unpredictable, a factor which should be treated equally in baselines regardless of the country the project is based in. On the other hand, specific national circumstances and national policies are an important component, which may influence baselines for a project in a specific country. Examples of such components are the size of the national grid and specific expansion plans for electrification.

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[2] Renewables are defined here as all electricity generation technologies, excluding nuclear, that do not use fossil fuels. Most relevant are the following commercially available technologies: solar, wind, biomass and small hydropower. Geothermal is mainly relevant for large-scale grid-connected generation. Small wave energy generators exists, but are not yet commercially available.

Incorporating country specific elements into the baseline selection is likely to take considerable effort: it is data intensive, ‘capacity-building’ intensive, time-consuming and may be costly if assistance is required from international consultants. Hence, waiting until host countries come up with their baselines may hinder a prompt start of small projects in the C-Erupt tender and is likely to disproportional affect small and underdeveloped countries. An important restriction of this study was the short lead-time before the start of the first C-ERUPT tender, which precluded the option to involve potential host countries of C-ERUPT projects extensively into the discussion. To avoid that the developed baselines would only be applicable to a limited selection of countries, the project team has chosen to come up with conservative standardised baselines based upon international data, which would be applicable for most of the potential C-ERUPT countries. In the course of time when host countries come up with their own baselines, these baselines can be replaced with more realistic country-specific baselines.

1.3 This Report

Chapter 2 provides an overview of issues related to developing standardised baselines for small-scale grid connected electricity projects both renewable and energy efficiency projects. It also suggests a standardised approach for incorporating the environmental benefits of avoided T&D losses of such projects.

Energy efficiency projects come in all sorts and types. It may require detailed industry studies to recommend appropriate standardised approaches for such projects. Chapter 3 focuses on one particular type of energy efficiency projects: efficient lighting and recommends a standardised approach for this type of projects.

In Chapter 4 an analysis for off-grid renewables is given. Standardised baselines are developed for different off-grid electricity generating renewable energy technologies.

Besides standardised baselines, also other streamlined procedures can assist in reducing transaction costs. Chapter 5 discusses and recommends possible streamlined procedures for the above project categories.

Based on the considerations and conclusions of the different chapters, Chapter 6 will provide an overview of the recommendations as submitted to the Dutch C-ERUPT Programme.

2. GRID CONNECTED SMALL-SCALE RENEWABLE ENERGY AND ENERGY EFFICIENCY PROJECTS

By: V. Bovee, M. Lazarus, J.W. Martens, H.J. Wijnants, S. N. M. van Rooijen, M. T. van Wees

The objective of this chapter is to assess the options for standardising baselines for the electricity displaced by grid connected small-scale renewable energy (as well as small scale energy efficiency) projects and to come up with practical recommendations for the C-ERUPT programme.

The main part of this chapter outlines a methodology and provides an algorithm for calculating a standard emissions factor for ‘displaced’ electricity generation. A carbon emission factor (CEF) indicates the amount of CO_2 emitted for each unit of fuel consumed, energy produced, or electricity output. CEFs are thus a measure of the 'carbon intensity' of different activities. This chapter focuses on defining the emissions factor for electricity generation, where the CEF will be expressed in units of tons of CO_2 per MWh of electricity produced.

The key issue for selecting the baseline method is to answer the question what a new project will be displacing. Section 2.2 deals with this question in detail by analysing the elements of existing baseline methods where Section 2.3 goes into more detail on the aspect of defining system boundaries. Section 2.4 describes how the selected baseline method has been defined and how to calculate the standardised emissions rate. Finally, the various steps of the selected baseline method are illustrated by some case studies.

The defined standard will be applicable for:

- all grid-connected wind, hydro, solar, biomass and geothermal electricity generating projects with an equivalent capacity below 15 MW,
- within a specific country (i.e. baseline is set at country level).

The developed standard can also be applied for energy efficiency projects that reduce demand by less than 15 GWh/yr. Chapter 3 further discusses the steps and methods for baseline development for energy efficiency projects. This chapter will further focus on the baseline standardisation for electricity generation projects.

The last part of this chapter analyses, and proposes a standard methodology for calculating additional benefits where a project reduces electricity transmission and distribution losses (Section 2.6).

2.1 Introduction and background

The most accurate way of developing a baseline would be to develop a project specific baseline. The aim of this study is to develop a baseline method that can be applicable to all non-Annex I countries that would like to participate with a small scale project under the C-ERUPT programme. Subsequently, the method developed will be a generic baseline method, which can not take into account country-specific conditions and parameters.

Also, the method that can rely on relatively aggregate national data. Data which can be obtained from international institutions (e.g. the International Energy Agency, IEA) where local data are lacking. As noted above, the baselines recommended and calculated in this study can be replaced in due course with more detailed baselines based on local factors, data and analysis.

Using aggregated data means that limited possibilities exist to take into account country specific data that may have an impact on the baseline as well. To find out the difference between a generic standard baseline based on aggregated data and a baseline taking into account country specific data, also several baselines based on country specific data will be developed.

Standardising baselines is a simplification compared to the complex and detailed methodologies for creating project specific baselines. The main simplification is that the standardised baseline is applicable to all projects within the region for which the baseline is defined. This implies that the project developer does not have to develop its own project specific baseline and that as such the standardised approach does not include a project specific environmental additionality test. In other words it *assumes* that the selected categories of project activities result in less GHG emissions than the situation in absence of the project.

This assumption is obviously not strictly accurate, since it is clear that some small-scale renewables activity could be occurring even without CDM. Such a project could under a standardised approach earn CERs as CDM project. As a consequence, it is recommended to accompany the use of standardised baselines with a separate additionality test to assess whether the project is additional. Under the C-ERUPT guidelines project developers of small-scale projects are also required to prove that is additional and would not have occurred in the absence of the CDM (Senter, 2001).

2.2 What will a small-scale project be displacing?

Similar to developing a baseline for a project the key question for developing a standard baseline for grid connected small scale energy projects is: *What will the project be displacing?* In this section we will try to find the answer to this key question by discussing the various options for answering this question.

2.2.1 Basic options for displacement

The basic answers to this question are[3]:

a. The project displaces part of the electricity generated by the currently existing park/electricity sector.
b. The project displaces or delays (a mix of) new additions, in other words the project is assumed to have an impact on whether and when new plants will be build.
c. The project displaces a combination of option (a) and (b).

In general it can be assumed that small-scale energy projects with a capacity of 15 MW or lower will not displace capacity. In other words, they will not have any impact on investment decisions of new facilities, as the amount of electricity they will be producing is marginal compared to the total park. However, this assumption is not necessarily true for all countries, especially for those countries with a small installed capacity. What is important, is whether a project is relatively small compared to the national installed capacity. In countries where a project of 10 or 15 MW is relatively big compared to the national grid it may well be that a new small-scale renewable energy project delays other investments. This means that the key question can be answered differently, depending on each individual situation.

To answer the question ‘what does the small scale project displace?’ properly, an accurate and detailed study of the situation in every individual host country would need to be carried out. This requires a field visit, analysis of the electricity expansion plans, dispatch rules, marginal

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[3] It should be noted that this just represents the basic options. For each of these options different variations are possible. For example, the average of the currently existing power mix can be based on the average of all units or the average of only fossil fuel units. Or rather than looking at the total operational mix, only those power plants operating at the margin could be included.

costs per plant, information about peak and base load cycles, interviews with the appropriate organisations in the host country, etc. This would increase transaction costs substantially, whereas the aim of this study is to reduce transaction costs for small-scale projects to facilitate their participation under the Dutch CDM programme (C-ERUPT).

So the real challenge is to develop a standard method that can be applied at low costs and time, and to provide a satisfactory answer to the key question, guaranteeing conservatism and accuracy of the baseline.

2.2.2 Existing methods for determining what the project will be displacing

Literature and baseline research recently carried out (see Rooijen et. al., 2001/Bosi, 2001/Lazarus et. al. ,2001/UNEP/OECD/IEA, 2001) discusses a broad range of possible baseline methodologies. The range of the main baseline methodologies that are considered is included in Box 1 below.

Box 1. Baseline Methods

The methods described below are four plausible and widely analysed baseline scenarios dealing with the issue 'what will be displaced', including:

a. System -average; under this approach it is assumed that the project will be displacing the average electricity mix for a country based on historic data, extended into the future. Options for variations on System-average approach are:
    - Projected system-average; account the planned extension and subtracts the technologies that are phased out.
    - System-average excluding hydro from the mix.

b. Built Margin; this baseline method presumes that the project will be affecting other electricity generation investments, by altering whether or when a new plant is built or will be build. It can be approximated using information on recent and/or planned future capacity additions. A conservative variant of the built margin approach is the BAT, or the future emission profile of the Best Available Technologies. It should be defined clearly how the BAT will be determined.

c. Hybrid method; in order to answer the question what will be displaced by the project, the hybrid method combines elements of the system average method with the built margin method. The ERUPT method for electricity projects (Vol. 2B1 of Senter, 2000) is an example of a hybrid method. The ERUPT methodology (specifically developed for countries in Central and Eastern Europe) is based on connecting;
    i. the emissions factor (based on weighted average grid mix) for the year 2000 (or any other year for which most recent data are available) with
    ii. the emissions factor for the BAT for combined cycle natural gas through a straight line.

Operating margin; the basis of this method is similar to the system average method, but in order to define what the project is displacing a more detailed analysis of operating conditions of the existing operational mix is carried out. In contract to the system average approach, the operating margin approaches use data from existing operational plants but require information on the relative operation costs of different plants types and/or the number of hours they operate a given year. An example of an operating margin method is the *weighted average marginal emissions rate* (WAMER) approach. The WAMER methodology involves the determination of which plant type is operating at the highest cost, or most likely to be turned down in the event that new generation is added or load is reduced, during different hours or periods of the year. It has been used for several GHG mitigation projects (Lazarus et. al., 2001).

2.2.3 System-average approach

The simplest approach for developing a standard baseline is to use the system average method, where the weighted average emissions rate of all currently operating plants for a specific year (year x) forms the baseline. Preferably, year x is the year for which the most recent and complete data are available. The advantages are that the data used are reliable, observable and verifiable and that no assumptions or projections have to be made.

The next question is how to use the system average method, should it be assumed that the situation as defined for year x remains static during the baseline period or not. And if not, how should it be adjusted? For CDM projects, the baseline can be defined for a period of three times seven or one time ten years (Marrakesh Accords, -/CMP.1 (article 12), Annex G, para 49; UNFCCC, 2001). In case a project developer selects the option of defining the baseline for three times seven years, the baseline has to be revised after the first seven years and thus the baseline can be fixed for a period of 7 years. It is unlikely that the grid mix, as defined and calculated for year x, will still be identical in 2012.[4] Firstly, because plants will have been retired or refurbished between 2000 and 2012 and secondly because new plants will have been added to the grid, most likely introducing new and more efficient technologies.

From this, it can be concluded that the system average approach could serve as the starting point of the baseline, but the overall baseline should incorporate projected improvements. For a more accurate representation of the business as usual case it is recommended to develop a more complex baseline, taking into account factors like increased efficiency and new additions.

2.2.4 Operating margin approach

The system average methodology could further be sophisticated by comparing the potential CDM project with that type of plant, which generation would most likely be pushed out of operation. This method is called the operating margin approach. However, the application of the operating margin method requires considerable data and analysis, which is time consuming and leads to high transaction costs. The required data (running costs, dispatch order, etc.) are often difficult to collect, and are increasingly viewed as proprietary, especially in those countries where the electric sector is opening to competition. While the operating margin methodology seeks to determine more precisely what generation is avoided by a new project or load reduction, it is often also based on either subjective judgement or sophisticated modelling.

Given the amount of data needs and expert judgement, the operating margin method seems most appropriate for country specific methodologies. Because of the wide scope and applications of baselines in this study (using a generic baseline method rather than a country specific), the operating margin method is not further considered in this study.

2.2.5 Project displaced additions (built margin)

As briefly discussed above, in most non-Annex I countries it is unlikely that new small scale renewable energy projects will have a major impact on investment decisions of other facilities or accelerate the retirement of existing plants. However, new and recent additions can provide a reasonable basis for making projections on the business as usual case.

The built margin method poses a fundamental definitional challenge. For example, should built margin be based on new or recent additions, over the next 5 or 10 years? Should all new or re-

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[4] The standardised baseline for C-ERUPT will be developed for a 10-year period from 2002-2012. The reasoning behind this is that the CoP-7 text allows two options for selecting the crediting period, being a) a fixed period of 10 years or b) a fixed period of 7 years with the options of two times renewing. Subsequently, 10 years is the maximum period for which a *fixed* baseline can be developed. Please note that it is still up to the project developer which of the two options to select for his specific project.

cent additions be included or just the best or last 25% etc.? We recommend to define built margin based on a predefined quantity of power plants to be included rather than on a period. For example, the 5 most recent or planned plants should be included in built margin, or the most recent 20% of new additions, rather than all additions in a 5-year period. This because in some countries no new additions (or only one) have been added for the last 5 years. By making a selection based on a quantity of plants, situations where only one power plant forms the built margin will be avoided.

2.2.6 Conclusion

Since CDM projects will affect some combination of the operating mix as well as new additions, the baseline method should ideally reflect both. One option is to use a hybrid approach that includes elements of:

- The weighted average existing grid system, as an approximation of the operating margin.
- The built margin, as reflected in recently built, under construction, or planned facilities.

We propose this hybrid approach, for adoption under C-ERUPT. The method will be called the Hybrid Average Margin method. It is described in more detail in Section 2.4 below. Before elaborating on the proposed hybrid approach, the system boundaries and level of aggregation will be defined in 2.3.

2.3 System boundaries

System boundaries are the notional margins around a project, within which the project's impact (in terms of GHG emission reductions) will be assessed, and within which the baseline will be developed. Setting a system boundary will take into account a number of factors, including:

a. Geographic factors; for example should a wind farm in China be compared against the current electricity generating mix within the whole country (i.e. at a national level) or a more disaggregated level?
b. Activity level; in other words, the emission of which activities have to be included in the baseline. For example, should emissions related to the construction of a facility be included or not, to what extent upstream and downstream emissions, etc.[5]

2.3.1 Aggregation level

For defining a *generic* baseline method for non-Annex I countries the study considers the size of the project compared to size of the national grid is not to be a decisive factor. Since using a generic baseline method implies that no country specific factors will be taken into account. Subsequently, the question of what a small scale project is actually displacing should be answered equally for all non-Annex I countries included in this study, regardless of the size of their national grid, in terms of total amount of generated electricity. Additional reasons for not differentiating between relatively small and large countries are:

1. The threshold defining what is a small and what is a large project compared to the country's grid size would be arbitrary. Appendix A presents the results of an analysis that was carried out to assess in how many countries a 15 MW project, assuming a 50% load factor, would be qualified as relatively big compared to the total grid size.
2. There is no guarantee that applying different methodologies actually presents a more accurate baseline within a country. It could for example still be the case that a small scale project within a country with a relatively large capacity does have an impact on an investment decision whereas it does not in a country with a relatively small capacity.

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[5] In literature on baselines when discussing system boundaries this in general refers to the issue we are discussing as 'activity level' in this study. The issue here referred to as 'geographical level' is more referred to as aggregation level. Both issues have an impact on the level at which data should be included.

3. Grid/power pool size is more important than country size with respect to the impact of a new project. Small countries can be in a large power pool (Botswana/SADC), whereas some large countries may contain several smaller grids (Indonesia). See also Appendix B.
4. Investment in capacity expansion normally focus on the expansion of the capacity to meet peak demand (peak load capacity). Intermittent renewable resources, such as wind, PV, run-off-the-river mini hydro's and some biomass) have unreliable power supply and are therefore typically base load generating options which do not influence such future capacity expansions.

Size of the power pool
The size of the grid/power pool is a more accurate factor for defining the scope of the effect of the project than the size of the national capacity. The preferred option is to define the system boundary at the grid/power pool level, rather than at a country level. The baseline should then be developed for the grid to which the project is connected. In defining the project boundary two dimensions for the grid level can be distinguished being:

- more than one grid within a country, or,
- several countries connected to one grid.

The development of different baselines for different grid systems *within* a country relies heavily on the national data that are available and possible to retrieve. Within the scope of this study for the C-ERUPT tender it is not possible to provide this information for all countries included in the study, because of insufficient data. This implies that for those countries with more than one grid system, only a grid factor for the main grid will be provided. For the priority countries for which data are available, also the grid factors for the smaller grids within one country will be calculated.

The second option is that grid systems are beyond national borders and that countries share a grid together. In these situations it is even more complicated to distinguish between a common grid. There are many situations where the grid systems between countries are connected with each other via inter-connectors. However, we believe that this is by itself not a sufficient criterion to consider this as one grid system and thus not enough basis to calculate a joint carbon emissions grid factor for the countries that are interconnected. Instead, we propose to use 'joint dispatch' as the distinguishing criterion, where joint dispatch refers to a system managed and regulated by one and the same system operator. So we will only calculate a joint grid factor for those countries with a joint dispatch.

Imports and exports in non-Annex-1 countries
It can be signalled if a country takes part in an international co-operation -without having to carry out a country specific study- by analysing the import/export ratio's of the non-Annex I countries included in this study. Appendix B presents the results of this analysis, by providing the percentage of import and export of electricity for several Non-Annex-1 countries. The results were obtained from the IEA database, including data for the year 1999 (IEA, 2001a).

The main interconnected power systems identified from the analysis are:

- SIEPAC (Sistema de Interconexion Electrica Para America Central) includes El Salvador, Guatemala, Honduras, Nicaragua, Costa Rica, Panama.
- WAPP (West African Power Pool) to be installed, including Côte d'Ivoire, Benin, Ghana, Togo, Burkina Faso (under construction), Mali (in study), Guinea (in study).
- SAPP (South African Power Pool) includes: Namibia, Botswana, Zimbabwe, Lesotho, Swaziland, South Africa, Mozambique, Zambia.
- ERRA (Regional Association of Energy Regulators) includes Albania, Armenia, Bulgaria, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Poland, Romania, Russia and Ukraine. The group in this region, which is important for CDM, consists of Tajikistan, Kyrgyzstan, Uzbekistan, Turkmenistan and Kazakhstan.

- Bilateral agreements are made between Paraguay, a major exporter of hydropower, and Brazil and Argentina, and between Congo (Brazzaville) (importer) and Congo (Kinshasa) (exporter).

It should be noted that the results only give an indication of whether a grid could be shared, and do not provide information about the presence of a joint dispatch. Although the issues are related, it cannot be concluded that countries with a high import/export ratio also have a joint dispatch. For example, the countries in the SAPP pool all have contracts on import/export of electricity, but there is no common dispatch. Another example is Paraguay, which exports about eight times its electricity generation to Brazil and Argentina. However, not via a joint dispatch, but via bilateral agreements.

The results of this preliminary analysis are considered too basic and general to support as evidence for the existence of a joint dispatch. It is recommended to revisit this issue by doing more research based on region and country specific parameters, before drawing any further conclusions regarding the selection of a regional or country emissions factor. Due to the lack of further evidence, the CEFs determined at the country level will serve as the standardised emissions baseline for countries with an active import/export relation.

2.3.2 Activity level

Another issue, related to defining system boundaries, is which project related activities should be included in the calculation of emissions. For example, should upstream and downstream emissions related to the project activity be included in the calculations or not? The general guidance for selecting the system boundary at the activity level is to include the emissions of those activities that are still within control of the project developer. These are at minimum the emissions related to the production of electricity; the direct emissions, e.g. emissions connected with electricity produced by the project that replaces off-site electricity generation (Volume 2a of Senter, 2001). This involves emissions from displaced fuel use at power plants. In accordance with the conclusions at the Roskilde workshop in May 2001 (UNEP/OECD/IEA, 2001) only these direct emissions will be included in the baseline method. This implies that for the generation of electricity only the emission that are accounted for in the baseline are the CO_2 emissions and that the other GHG are not included in the baseline.

One step upstream emissions related to production, transport and distribution of the *fuel used* for the power plants are not included. The emissions related to the transport and distribution of *electricity* might be included where relevant (see Section 2.6).

This implies that the emission factors used for calculation should not include the carbon intensity measurement of any upstream (e.g., in natural gas extraction and processing) and/or downstream (e.g., in transmission and delivery) emissions or output losses. So called point-of use emission factors, which measure the carbon intensity of direct emission from fuel use at the power plant, should be applied.

2.4 Hybrid Average Margin method

This section describes the key factors of the Hybrid Average Margin baseline method. The method is based on a combination of elements from the system-average (as an approximation of the operating margin) and built margin baseline approaches.

The hybrid approach is based on the ERUPT method that has been used for JI projects in the electricity sector in Central and Eastern Europe. This hybrid method for ERUPT makes a linear relation between the average system approach defining the emissions rate for the starting point (year x) and the load that is assumed to be displaced in the year 2020; a built margin approach (ERUPT Volume 2b, Senter 2000).

The Hybrid Average Margin method for small-scale projects under C-ERUPT draws a line between the existing operational power mix (year x, which is the year for which the most recent data are available) and the mix projected for the year 2012.[6] Figure 2.1 illustrates the concept of the Hybrid average margin graphically. It should be noted though that the emissions baseline defined in 2012 based on the built margin method does not necessarily always have to be lower than the system average. Moreover, the figure assumes that the parameters of the System Average and Built Margin (BM) baseline are hold constant.

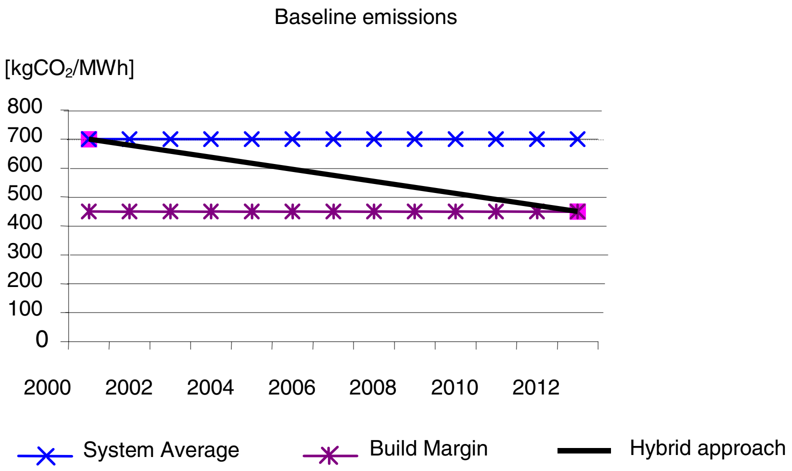

Figure 2.1 *Principle of Hybrid Method, combining a static System Average and BM*

Elements of the Hybrid Average Margin methodology

The main characteristics of the Hybrid Average Margin method are:

For the first year value, a proxy for the operating margin is step by step calculated:

a. The existing operational power mix at a country level or grid level forms the starting point of the methodology. Data for the year x (year for which the most recent data is available) will be collected from the host country.
b. The weighted average power mix will be determined by defining the proportional contribution of generated electric output of each power plant or power plant type in the total power mix.
c. Per plant (or fuel, if plant type unavailable) the appropriate emissions factor for currently operational technologies will be applied. Country specific technology CEFs will be used. If these are not available, default CEFs for current technologies (as provided by Öko Institute, 1998) will be applied.

For the 2012 baseline value, a proxy for the built margin is step by step calculated:

d. Data on recently built and likely to be build power plants form the mix for 2012, and information will be collected on their generated output or capacity under construction or planned.
e. Performance characteristics for the plants to be build (emission rates) will be based on projected levels in 2012.
f. The final step is to multiply the determined weighted average proportions of the mix in 2012 with the respective defined emissions rates.

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[6] The year 2012 is selected, because the baseline will be developed for a 10-year period, which is the maximum period for which a baseline can be developed without having to be revised. Under C-ERUPT projects can start claiming credits from the year 2002 onwards.

The baseline for intervening years will be formed by connecting emission rate for the first year (year ×) and 2012 values as shown in Figure 2.1.

The section below discusses the various options that have been identified for the above characteristics in our baseline method.

2.4.1 Operational power mix for the starting point

The starting point for developing the baseline will be to determine the grid mix of currently operational plants. The preferred option is to define the grid mix based on country specific data on electricity production from power plants connected to the grid in year x. Moreover, only those plants that generate electricity as their core activity should be included in the baseline. Finally, no corrections for electricity import and/or export have to be made, unless the country is part of a joint dispatch system (see Section 2.3.1).

In case no country specific data is available, IEA data can be used.[7] In both cases (i.e. country specific data or more aggregated IEA data) the power mix can be determined based on:

a. Total grid mix, including fossil fuels, hydro, nuclear and renewables.
b. Mix based on fossil fuels only, assuming that fossil fuels in general operate at higher costs and are thus more likely to operate at the margin.
c. Mix based on total grid mix, but excluding hydro and other zero fuel cost technologies (e.g. wind and solar).

Option c) has been selected as the best option because the operating cost will be the criterion that decides which generation will not occur as a result of the CDM project. Facilities operated by resources that are obtained at zero costs should be excluded from the baseline, on the basis that these by default will not be displaced by a new CDM project, unless spilled or wasted as a result.[8]

2.4.2 Carbon emissions factor for year x

Once the proportions of the mix have been determined the next step is to combine the proportions with the respective emission factors. In case the actual emission factors of the operational plants are available, these should be applied. In case this information is not available, there are two options. One option is that country specific data on fuel consumption for electricity generation is available, in which case emission rates per fuel as provided by the IPCC can be applied (see table below). The other possibility is that the country specific data are provided in terms of electric output per technology. In this case default emission factors expressed in tons of CO_2 per MWh can be used.

The Environmental Manual for Power Development (EM model) of the Öko institute is a good source providing default technology based emission factors (Öko, 1998). The EM model is a model developed for decision making of developing energy projects in developing countries. The development of the manual was managed by the German GTZ with technical assistance from the German Öko-Institute. The EM model is also supported by the World Bank, and data

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[7] For the purpose of this study the most recent data are for 1999 (and this year would thus be year x and used as the starting point).

[8] Electricity generated from hydropower is unique in the sense that its resources (water) are obtained at zero costs and that water can also be stored. This storage is important because it means that on a momentarily basis it may be replaced by the small scale CDM project, but it still can be used at another time. Since the marginal costs of hydro are zero, it is very likely that the stored hydropower will be the preferred option over fossil fuel based power plants. In short, hydropower will never be wasted by an operator and thus never be replaced by small-scale investments as long as there are other alternatives in the system. There is one important exemption to this rule, in which case water in hydropower reservoirs are being ‘spilled’ is when it is used for irrigation. However, the amount of water spilled on irrigation is likely to be determined by irrigation needs and is similar for both baseline and project situation.

are collected from energy projects from GTZ, DGIS, World Bank and other projects sponsored by ODA money. The EM model links a specific technology for burning fossil fuels to a specific CEF, expressed in CO_2 equivalents. The CEFs provided through the EM model are similar to those made available by the US Energy Information Agency (EIA) for voluntary reporting of GHG emissions. The emission factors from the EM model are presented in the table below.

Table 2.1 *Emission factors per technology from the EM Model*

Fuel	Technology	Carbon Intensity [t CO_2/GWh]	Carbon Intensity [t CO_2/MWh]
Natural Gas	Simple Gas Turbine	644	0.644
	Combined Cycle	406	0.406
Diesel Oil	Combined Cycle	650	0.605
	Gas Turbine	895	0.895
	Steam Turbine	735	0.735
	Combustion Turbine	854	0.845
Coal	Conventional Steam	987	0.987

As indicated these factors from the EM model are based on the assumption that plants are operating under good conditions and are applicable at a global level. The EM model does not take into account that conditions under which the plants are operating in developing countries are in general worse and at much lower efficiency. Therefore, using the CEFs from the EM model is per definition conservative. For example, from a research on carbon emission factors per plant in Venezuela carried out by Tellus Institute, it was found that natural gas combustion turbines had CEF of 0.81 t CO_2/MWh (when operating at base load) and 1.17 t CO_2/MWh for those operating at peak load. In both cases the older turbine technologies are much less efficient than the 0.644 t CO_2/MWh CEF for natural gas turbines as provided by the EM model!

The next question is whether the use of the CEFs from the EM model are not too conservative. Therefore, it is recommended to try and find country specific data on fuel consumption for electricity generation and use the CEFs per fuel as provided by the IPCC.

In case country specific data on electric output lack and IEA data have been used, the proportions of fuel consumption used to generate electricity in year x will be available. The baseline emissions factor can then be calculated by multiplying the determined proportion of each fuel in the mix with the IPCC default emissions factor for the respective fuel. The IPCC emission factors are expressed in tons of carbon per TJ. The C-ERUPT guidelines provide emission factors, taken from the IPCC publication expressed in ktonne CO_2 per TJ fuel input. These are copied in Table 2.2.

Table 2.2 *CO_2 emission factors for fuels*

		Energy carrier	[Ktonne CO_2/TJ]
Solid Fossil			
	Primary fuels	Anthracite	0.0983
		Coking Coal	0.0946
		Other bituminous coal	0.0946
		Sub-bituminous coal	0.0961
		Lignite	0.1012
		Oil Shale	0.1067
		Peat	0.1060
	Secondary fuel/products	Coke oven/Gas coke	0.1082
		Coke oven gas	0.0477
		Blast furnace gas	0.2420
		Patent fuel and BKB	0.0946
Liquid Fossil			
	Primary fuels	Crude oil	0.0733
		Orimulsion	0.0807
		Liquefied natural gas (LNG)	0.0631
	Secondary fuel/products	Gasoline	0.0693
		Jet kerosine	0.0715
		Other kerosine	0.0719
		Shale oil	0.0733
		Gas/diesel oil	0.0741
		Residual fuel oil	0.0774
		LPG	0.0631
		Ethane	0.0616
		Naphtha	0.0733
		Bitumen	0.0807
		Lubricants	0.0807
		Petroleum coke	0.1008
		Refinery feedstocks	0.0807
		Refinery gas	0.0667
		Other oil	0.0733
Gaseous fossil			
		Natural gas	0.0561
		Methane	0.0551

Appendix D presents the carbon emission factors for year x (which is 1999) calculated for all Annex I countries for which IEA data were available. Calculations are based on the IEA data and the IPCC emission rates.

2.4.3 Built margin for 2012

When using the Hybrid Average margin method, where the existing mix will be connected with the projected mix for 2012 through a linear line between the two points, the grid mix and carbon emission factor for the year 2012 have to be determined. In general the most conservative way for defining the 'grid mix' for the year 2012 would be to use the BAT for natural combined cycle plants, although this will not be the case in those countries where hydro or other renewable energy sources are on the built margin. However, in those situations where no data exist, using the BAT for natural gas seems to be the most plausible and safe option. This option may not always be a realistic one, as many countries do not have an infrastructure for natural gas. Alternative options identified to determine the grid mix for 2012 are:

a. Mix in 2012 is based on the mix of planned facilities.
b. Mix of both recently and planned facilities.

c. Mix of 5 most recently added facilities.
d. Based on BAT for combined cycle natural gas.

We propose to use a kind of ranking system here, where option a) is our preferred option, but if trustworthy data are not available option b) would be applied. In practice this implies that option b) is preferred over option a) in case trustworthy data on new plants is available for less than 3 plants. Then option c) is considered the third best option.

If in a specific country no plant specific data can be found for recent additions either, then option d) will apply, assuming that there is no significant economic potential for hydro or other renewables. This can be considered as an incentive for the host countries to co-operate in collecting data (see Figure 2.2). If there is significant hydro potential however, option (d) will not be considered a viable option, since it would potentially provide an inflated baseline. Moreover, option d) is a way to deal with the issue of lack of data availability.

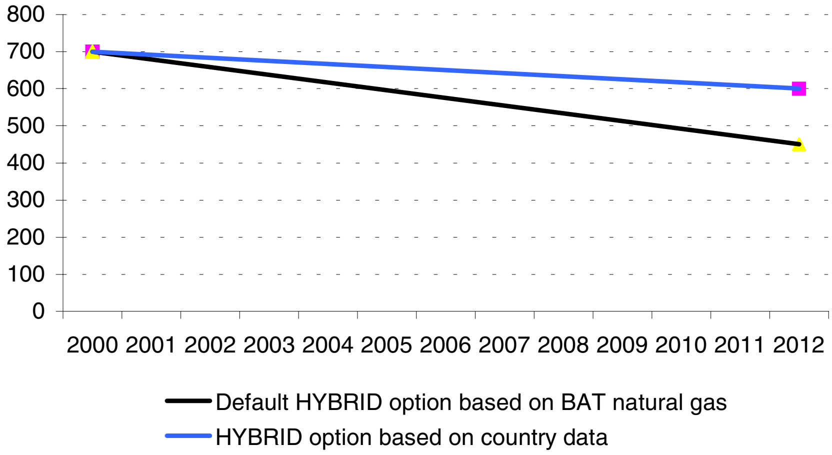

Figure 2.2 *Expected difference between IEA/Nat.gas BAT and country specific data*

2.4.4 Use of CEFs (Carbon Emission Factors) for year 2012

For our baseline method we will be using CEFs, which measure the carbon intensity of the production of a unit of electricity. Emissions of other GHG or other activities in the lifecycle of generating electricity are not included (see also Section 2.2.2. on system boundaries).

This section discusses the CEFs per technology to be applied for the year 2012 baseline (i.e. step E in Section 2.4.1). These technology CEFs are then used to determine the weighted average grid mix for year 2012. The options are:
a. Use CEFs based on performance and emissions profile of current technologies (thus same as CEFs that have been used for starting point in year x).
b. Use the projected emission factors as provided by the U.S. Energy Information Agency (EIA) for advanced technologies (BAT). This would be the most conservative option.
c. Apply the today's BAT in non-Annex I countries.

We suggest to use option c. Technology improvements should be taken into account as power plant technologies and markets are rapidly converging and thus there is limited basis to assume that current technologies will persist. Applying the BAT for new to be developed plants in the future that is determined for the United States for non-Annex I countries is unrealistic given various market and institutional barriers for introducing these technologies at the same time in developing.

An independent source providing default emission factors is the EM model from the Öko Institute. These factors have been defined with the purpose of being applied to new to be build energy projects in developing countries. Table 2.1 includes the emission factors that can be applied as CEF for 2012.[9]

2.4.5 Plant Factor

The project team's preferred option for determining the grid mix for the year 2012 is to use plant specific data for plants that have recently been added or will be added to the grid within the period 2000-2012. In general, for facilities that are not yet operational only information on installed capacity is available. In order to work with the same reference and to present the situation more accurately, the mix for the year 2012 should also be based on generated output by plants. Therefore, assumptions have to be made on the plant (or load) factor for each of the planned facilities.

Options are:

a. Determine the plant factor by combining the data for the year x on installed capacity and generated output.
b. Define regional plant factors based on regional reference scenarios for 2010 as provided in the World Energy Outlook (IEA, 2000).
c. Define plant factor based on reference scenario for all developing countries in 2010 as provided in the World Energy Outlook. (IEA, 2000).

For calculating the plant factor in all above options the following formulae will be used:

$$\textit{Plant factor (\%)} = \textit{Total generated output}_{\textit{country x,}} / (8{,}760 \times \textit{Total installed capacity}_{\textit{country x}})$$

For our baseline method we use option b). Method a) is based on current technologies, which are likely to include some very old and inefficient plants or ones in repair and unlikely to include much combined cycle. New plants are generally built under the expectation they will operate with a higher load factor than existing plants.

Table 2.3 presents the regional plant factors that have been calculated, based on the reference scenario for 2010 in the World Energy Outlook data (WEO), as well as the plant factor for all developing countries. WEO provides an analysis of the energy demand and power generation using a world energy model that analyses global energy prospects. The data provided for 2010 is for all capacity on the system and the plant factors calculated thus also represent the plant factor of all capacity for a specific fuel on the system as projected for the year 2010. It should be noted that WEO does not differentiate for technologies. Due to lack of technology specific plant factors, the plant factors given can also be used for all technologies fuelled by that specific fuel source.

The table below indicates that the differences in plant factor for a region and the plant factor for all developing countries are marginal. However, the plant factors per region are considered to give a more accurate reflection of developments in a region and thus it is recommended to use these.

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[9] It has been recommended to use the same factors as the CEF for the year x, due to lack of independent data sources that provide a more accurate estimate for existing emission levels. It is also recognised that these values are very conservative as an emissions rate in a developing country, considering the existing performance level and standards of power plants in developing countries. The CEFs are considered to be more realistic for representing emission rates for the year 2012, but due to lack of better data can be used for year x as well.

Table 2.3 *Plant factors for 2010 from the IEA -World Energy Outlook 2000*

	Plant Factor [%]					
Region	Coal	Oil	Gas	Nuclear	Hydro	Renewables
Africa	70	30	50	74	35	46
East Asia	71	40	43	84	35	57
Latin America	65	40	49	86	55	53
Middle East	73	42	49	80	39	n.a.
South Asia	59	42	50	68	40	31
All developing countries	61	40	47	82	46	48

2.4.6 Conclusion on the grid factor

Applying our preferred options would result in the following characteristics of the Hybrid Average Margin for small-scale grid connected renewable energy projects:

The proposed Hybrid method consists of the following steps:

Step 1:
Determine current weighted average power mix, excluding hydro, wind, solar, and other zero fuel cost technologies, for the year x, where year x is the year for which most recent data are available. If no country specific data are available, IEA data will serve as the basis.

Step 2:
Apply country specific CEFs based on the performance of existing operating technologies in year x. If such country specific emission factors are not available, the CEFs per technology as provided by the Öko Institute can be applied (Table 2.1). Note that these factors are in general more conservative compared to country specific factors.

In those cases where data (IEA or country specific) on fuel consumption are available the fuel specific emission factors of IPCC should be applied (Table 2.2).

Step 3:
Determine the weighted average CEF for the starting point by multiplying the defined proportion per fuel with the appropriate CEF for that fuel.

Step 4:
Ranking system for the built margin:

- *New additions*. The key objective in setting any emissions baseline for 2012 based on the built margin approach is to represent changes in the business as usual for the future. Based on this principle, the preferred data for determining the built margin in 2012 are planned future capacity additions, since theoretically, these data best reflect 'what would have otherwise occurred.' However, in practice, reliable data on planned new additions are often unavailable in developing countries. Therefore, it is recommended to include only those plants that already started construction or have received a regulatory approval (e.g. a concession) in the built margin. We propose to include the earliest 5 plants that are expected to become operational. Note that data on planned hydropower will be included in the mix!
- *Recent addition.* If no regulatory approval for new additions has been received, then data on recent capacity additions should be used as the built margin. Recent capacity additions provide a reasonable basis for estimating future trends, assuming the technical and economic conditions for choosing capacity do not change significantly. The average of the most recently built plants determines the mix for 2012. Data on recently built hydropower plants will be included.

- *BAT natural gas*. If no data on recently built plants are available, then the BAT for natural gas combined cycle plants serves as the grid mix for 2012. In this study and for the C-ERUPT programme, this option will apply for all non-Annex I countries for which no country specific data were available, and for which IEA data have been used to determine the emissions baseline for year x.

Step 5:
Calculate the weighted average CEF for the year 2012 by combining the fuel proportion of the mix calculated as step 4 with the appropriate CEFs.

Step 6:
Connecting the grid factors calculated for year x and the year 2012 through a straight line, to be presented in a graph.

2.5 Standardisation of electricity transport and distribution losses

By: M. T. van Wees

2.5.1 Objectives, scope and applicability

Small-scale end-use energy efficiency projects that reduce electricity consumption also reduce electricity transport and distribution (T&D) losses. The same applies to small scale decentralised electricity producing renewable energy projects if the amount of electricity that is transported and distributed is reduced. For both end-use energy efficiency projects as well as small-scale renewable electricity production, the reduction of T&D losses can be an important benefit compared to centralised electricity production. Incorporating T&D losses in the estimation of GHG emission reduction can substantially increase the number of CERs generated by the CDM project. It is expected therefore that baseline developers will include these in the baseline studies. Project specific assessment of avoided T&D losses in baseline studies is in most cases difficult because of the lack of reliable data. Standardisation of T&D losses therefore would substantially decrease transaction costs.

The objective of standardisation of T&D losses is therefore to:

1. reduce the transaction costs in estimating avoided T&D losses for small projects in the CDM,
2. increase consistency in the estimation of avoided T&D losses, compared to the situation where no guidelines are available,
3. secure a conservative estimation of avoided T&D losses.

This section develops a conservative standardised approach for incorporating T&D losses into the C-ERUPT guidelines. Standardised national values for have been developed for all non-Annex 1 countries (see Section 2.5.2). In addition, guidelines for project specific assessment of T&D losses are provided in case the standard values can not be applied or in case the baseline developer decides to use a project specific approach (Section 2.5.3).

Whether small-scale energy-efficiency and renewable energy projects are allowed to use the standard values for T&D losses of Section 2.5.2 depends on the following conditions:

1. Small scale end-use energy efficiency projects that reduce electricity use and that draw electricity from the low-voltage grid can use the standard values.
2. Small-scale grid connected renewable electricity production that feeds into the low-voltage distribution grid can also use the standard values.

3. In case of grid connection to the medium voltage grid (for both energy efficiency and renewable energy projects) no T&D losses should be accounted for, unless the baseline developer can show T&D losses are significant through a project specific assessment using the guidelines from Section 2.5.3.
4. In case the baseline developer can argue that the standard national values for T&D losses are a significant underestimation of the T&D losses relevant to a specific CDM project, a specific project specific assessment should be made using the guidelines from Section 2.5.3. This could, for instance, be relevant for certain remote areas in a country, where T&D losses are significantly higher than the national average.

2.5.2 Standard values for T&D losses

As a starting point in developing a methodology for standardisation of T&D losses, the operational guidelines for electricity grid factors and T&D losses for JI projects for the Dutch tender ERU-PT were used (Ybema and Volkers, 2001). In this case, national average T&D losses were set as standard values for JI host countries in Central and Eastern Europe. These were calculated from the 1999 Energy Balances of the IEA (IEA, 2001a/2001b). The T&D losses range from 5% (Slovenia) to 18% (Ukraine). To consider the improvement of transport and distribution systems in the future it is assumed that in 2030 all countries will have reduced the average T&D losses to the level of the OECD-Europe (7%), apart from those countries with already lower T&D losses, which remain constant.

For the standardisation of T&D losses in CDM host countries, the following has been considered:

1. Electricity sector statistics, including the statistics on T&D losses, are on average less reliable than for Central and Eastern Europe.
2. In many countries non-technical losses are significant in terms of share of total T&D losses. Non-technical losses are a measure of unmetered consumption of electricity, which may indicate the existence of illegal connections, inadequate metering, billing, and collection, or lack of enforcement and ability to disconnect delinquent customers. Non-technical losses, contrary to technical losses, will not decrease if electricity consumption is reduced by means of CDM activities and should not be credited. Correcting T&D statistics for such non-technical losses is quite difficult, as data on non-technical losses is in general scarce.
3. For most CDM host countries, the improvement of the T&D system and the resulting reduction of technical losses will probably take longer than for most JI host countries. Therefore, there is less need to incorporate such improvements in the baseline, as their impact within the expected crediting time for small-scale CDM projects would not be significant.

Accounting for these issues, the following approach was adopted in setting standard baseline values for T&D losses in CDM host countries:
National average T&D losses were calculated for *non-Annex 1 countries* using the IEA statistics (IEA, 2001, year 1999). These values range from 5 to 50% (Haiti), excluding the obviously unreliable data.

1. The national average T&D losses for *OECD Europe countries* were calculated. OECD Europe includes Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey and the United Kingdom These range from 3 to 10% (Spain), not considering Luxembourg, Turkey and the Economies in Transition. See Table 2.15.
2. The T&D losses in OECD countries are fully technical and can therefore by used as a reference. The upper range for OECD Europe countries of 10% (Spain) is adopted as the standard value for technical T&D losses in non-Annex-1-countries. This is certainly a conservative estimate, because the technical condition of transport and distribution networks most of the non-Annex 1 countries is lower than in Spain.

3. The standard value for T&D losses is set as follows: for those non-Annex-1-countries that have T&D losses according to the IEA statistics higher than 10%, the default value of 10% is valid. For countries that have T&D losses lower than 10% according to the IEA statistics, the IEA values are valid.
4. These values do not change over time. It is assumed that the crediting of small-scale projects is less than the time period over which significant improvements of the T&D system are implemented. Therefore, the approach to standardising T&D losses remains conservative.

Table 2.15 *Average technical electricity T&D losses for OECD Europe member countries (IEA, 2001b; year 1999)*

Country	T&D losses [%]	Country	T&D losses [%]
Austria	8	Luxembourg	36
Belgium	5	The Netherlands	5
The Czech Republic	8	Norway	8
Denmark	5	Poland	10
Finland	4	Portugal	9
France	6	The Slovak Republic	7
Germany	4	*Spain*	*10*
Greece	7	Sweden	7
Hungary	13	Switzerland	6
Iceland	5	Turkey	19
Ireland	8	United Kingdom	8
Italy	7		

2.5.3 Guidelines for the project specific estimation of avoided technical T&D losses

The guidelines in this section can be used in the following cases:
1. The baseline developer would like to include avoided T&D losses in the baseline study but does not meet the criteria for use of the standard values (see Section 2.5.1).
2. The baseline developer expects that avoided T&D losses for a specific project will be higher than the standard value (see Section 2.5.1).

Only technical T&D losses can be included, which depend on:
1. quality of the T&D network,
2. technical characteristics of the T&D network (voltage level, topographic conditions etc.),
3. density of the grid,
4. location of the project in relation to other electricity production units,
5. in case of small-scale decentralised production, the distance between the production site and the end-users,
6. voltage level of the grid connection of the project or end-user.

The project-specific assessment of avoided technical T&D losses should therefore:
- Include reasons why the project’s technical T&D losses are higher than the national average T&D losses.
- Include estimates of total T&D losses based on the sum of losses of individual components of the system, based on feed-in/grid connection characteristics, voltage level, topography, technical components and technical quality and age of the system.
- Consider the location of the project to production sites or end-users.
- Use data from officially published references by the government/relevant distribution companies/utilities/independent research institutions.
- Exclude commercial or non-technical losses.

3. STANDARDISED APPROACHES FOR SMALL-SCALE END USE ENERGY EFFICIENCY PROJECTS – THE CASE OF RESIDENTIAL CFL PROJECTS

By: M. T. van Wees and D. Violette

3.1 Scope of standardisation

Improvement of end-use energy efficiency leads to reduction of greenhouse gas emissions and, in many cases also contributes to sustainable development. Projects in this category therefore are suitable candidates for CDM. Often these projects are small-scale in accordance with the Marrakesh Accords and could benefit from standardised baselines and streamlined procedures. The Marrakesh Accords define small-scale energy efficiency projects as projects reducing energy, in this case electricity, up to the equivalent of 15 GWh per year (UNFCCC, 2001).

When developing standardised baselines and streamlined procedures for small-scale end-use energy efficiency projects, the main difficulty is the heterogeneity of the projects. End-use energy efficiency projects can be categorised according to sector, application, technology, size, and type of end-use energy carrier that is saved. Take e.g. the differences between an energy efficient light programme in the residential sector, where millions of compact fluorescent lamps (CFL) are distributed, and a project in the steel industry. Therefore, most of the work on standardised baselines and streamlined procedures will have to address specific categories of energy efficiency projects. There is therefore, first of all, a need for a systematic categorisation of energy efficiency projects on the basis of project characteristics and the resulting conditions for baseline and monitoring (Van Wees, 2001). For example, now some preliminary work on energy efficiency projects has been done, it is now necessary to clearly distinguish between e.g. energy efficient lighting (CFL) projects and energy efficiency projects in industry and not to tackle a category 'energy efficiency' as a whole. For end-use energy efficiency projects, this would probably imply about 10 to 20 different categories.

In this study, it was impossible to develop guidelines for all project categories. Therefore it was decided to develop specific guidelines for energy efficient lighting projects in the residential sector, i.e. the replacement of a large number of existing incandescent lamps with CFL lamps ('CFL-projects'). This selection is based on the following arguments:
1. Given the low efficiency of electricity production in CDM host countries, projects that increase end-use efficiency of electricity use often have high benefits in terms of GHG emission reduction.
2. In many non-Annex I countries, a large potential for efficiency improvements in lighting exists.
3. Efficient lighting provides collateral economic and social benefits.

The standardised baselines for small-scale electricity energy efficiency projects comprise two parts:
1. Standardisation of the GHG grid factor of distributed electricity.
2. Standardisation of the estimation of saved electricity for CFL projects.

3.2 Standardisation of the grid factor

In Chapter 2 standardised baseline values for the GHG grid factor for` electricity production have been established in terms of kg CO_{2eq}/kWh. See also Appendix D. These standardised emission factors can be used for electricity saving small-scale energy efficiency projects, in this case in terms of kg $CO_{2\ eq}/kWh_{saved}$.

In Section 2.6, standardised baseline values for losses in electricity transport and distribution have been elaborated. Under certain conditions, they can be used for small-scale energy efficiency projects. For reduced electricity consumption, the total standard grid factor including T&D losses can be calculated by dividing the standard electricity emission factor for electricity production (ex. T&D losses) with (1 - standard T&D losses). See Appendix E.

3.3 Standardised baselines for CFL projects

3.3.1 Definition of CFL projects

CFL projects are energy efficient lighting projects in the residential sector aimed at replacing a large number of existing incandescent lamps with CFL lamps. In many non-Annex I countries, these projects have been implemented in the past. The projects show a variety of design characteristics, particularly in the (financial) incentives used and implementation mechanisms as well in scale, e.g. the number of replaced lamps, and scope (municipal versus national projects). The standardised baselines can be applied if the projects comply with the following conditions:

1. The 2001 Bonn Agreement defines small-scale energy efficiency projects in this category as projects reducing electricity to a maximum of 15 GWh per year. However, clustering of smaller projects could be possible. See the ToR of C-ERUPT (Senter, 2001).
2. It should be possible to track and register participants in the project. This is required for the sampling procedure for baseline establishment and monitoring.

3.3.2 Approach to baseline standardisation

The following steps have to be taken in the baseline study for CFL projects in households. The approach is based on (Violette et. al., 2000). See Table 3.1.

Table 3.1 *Steps in the elaboration of a baseline study for CFL projects*

A. Define characteristics of project

1. Define project participation criteria.
2. Define target regions and household categories.
3. Define characteristics of the energy efficiency measures, in this case replacing incandescent lamps by CFLs.
4. Describe programme (incentives, promotion etc.).

B. Estimate electricity saving per CFL lamp installed

1. Estimate power and operational and performance factors of incandescent lamps to be replaced.
2. Define power and operational and performance factors of CFLs.
3. Calculate electricity savings per CFL lamp replacing an incandescent lamp.

C. Estimate electricity savings of the total project

1. Estimate expected number of project participants and CFL sold over time.
2. Estimate lamp lifetime.
3. Estimate total direct electricity savings over time.
4. Estimate share of free riders.
5. Estimate indirect effects (rebound, market transformation).
6. Estimate fall-out (lamps out of operation).
7. Calculate total electricity savings corrected for free riders, indirect effects and fall-out.
8. Determine crediting period.
9. Calculate total electricity savings in crediting period.

D. Calculate GHG emission reduction over crediting period

1. Estimate emission factor of electricity production in crediting period.
2. Estimate avoided transport and distribution losses in crediting period.
3. Calculate GHG emission reduction from total electricity savings, grid factor and avoided T&D losses in crediting period.

The characterisation of the project is not subject to standardisation, therefore the standardised guidelines for energy efficient lighting project in households ('CFL projects') cover the following four steps:

1. Standardisation of the estimation of electricity savings per lamp.
2. Standardisation of the estimation of the total electricity savings of the project.
3. Standardisation of the estimation of the total GHG savings of the project.
4. Simplified procedures for field auditing for baseline assessment and monitoring (see Chapter 5 for more details).

3.3.3 Estimation of electricity saving per CFL lamp installed

Electricity savings per installed CFL lamp per year and over the lifetime of the lamp are calculated as follows under the assumption that the service level (amount of light) is the same for incandescents and CFLs:

$$Electricity\_Savings\_Lamp\_Year =$$
$$(Watts_{incandescent} - Watts_{CFL}) \times Operating\_Hours$$

and

$$Electricity\_Savings\_Lamp\_Lifetime =$$
$$(Watts_{incandescent} - Watts_{CFL}) \times Operating\_Hours\ x\ Lifetime$$

The Watts $_{\text{incandescent}}$ of the lamps to be replaced and the operating hours per year are the key baseline determinants and should be estimated through auditing a sample of residential households to determine the baseline current lighting efficiency (wattage) and usage patterns (hours of operation). In Section 5.5 a simplified auditing procedure has been developed as part of these guidelines. The wattage of the CFL lamp is a project design parameter and doesn't have to be standardised.

The lifetime of the CFL lamps (in terms of years) can be determined from the operating hours per year and the maximum burning hours of the CFL lamps. The latter is a product characteristic and should be based on product tests (not standardised).

3.3.4 Estimation of total electricity savings of the project

The size of the CFL project could be expressed in the total number of CFL lamps installed over the duration of the project. The total electricity savings of the CFL project over the lifetime of the lamps can be calculated as follows:

$$
\begin{aligned}
&Total\_Electricity\_Savings\_Lifetime = \\
&Energy\_Savings\_Lamp\_Lifetime \times (Total\_Number\_Lamps\_Installed - Fallout)
\end{aligned}
$$

Fallout

Fallout is the share of installed lamps that are not operational any more (broken, removed etc.). Correcting for fallout in this way is conservative because it assumes no electricity is saved by the fallout CFLs before they are removed, broken etc. This key parameter needs to be estimated in the baseline study and monitored in the monitoring study. Standard values are not possible because of the strong dependence on local conditions and programme design. A standardised and simplified approach can be found in Section 5.5.

In CFL projects, three additional effects can influence the total project impact: free riders, market transformation, and the take-back effect. The way these effects are treated in baseline guidelines can significantly influence the level of conservatism of the baseline.

Free riders

Free riders are the participants in the CFL projects that would have installed the CFL lamp even without the project. A high share of free riders reduces the net impacts of the project. The share is also dependent among others on the socio-demographic characteristics of the project. If the income level of participants is low, free riders are likely to be less. The expected share of free riders should be considered in the baseline study and monitored. No standard values can be established because of the strong dependence on local conditions and programme design. A standardised and simplified approach can be found in Section 55.

Market transformation effects

The market transformation effect is the increased sales of CFL lamps outside the CFL project that can be attributed to the indirect impact of the project (e.g. increased awareness and improved availability on the market). For instance, the chance that a user replaces a CFL purchased through a CFL project with another one will be higher than without the CFL project. Incorporating market transformation effects increases the impact of the project. These effects are difficult to estimate. Furthermore, standardised baselines should tend to conservative estimates of emission reduction. Baseline developers can always include project specific estimates of market transformation effect in the baseline studies and monitoring procedures. In the proposal for streamlined procedures limited guidelines on the baseline assessment and monitoring of market transformation are given (See Section 5.5.4) However, substantially more work needs to be done in this field.

Take-back effect

The take-back effect is the increase in the use of energy services as a result of the decrease in energy costs. With CFL projects, one can distinguish two effects. The first type of take-back effect can occur in the form of an increase of lighting hours (increased level of the same service). This effect should be considered in the baseline study and be monitored (by field measuring operating hours before and after implementation)[10]. No standardised values can be used given the uncertainty involved. The second type of take-back effect can occur in the form of an increase of the level of other energy services resulting from the increase of the household budget. This effect does not have to be considered, because it can be considered as a sustainability and development benefit of CDM.

3.3.5 Estimation of total GHG emission reduction

The total GHG emission reduction can be calculated as follows:

$$\begin{aligned}&Total\_GHG\_Emission\_Reduction =\\&Total\_Electricity\_Savings\_Lifetime\\&\times Standard\_Emission\_Factor\_Electricity\\&\times (1/(1-Standard\_T\&D\_Losses))\end{aligned}$$

Standard emission reduction factors for electricity production as well as standard values for transport and distribution losses (T&D losses) are provided in these guidelines (See Appendix E).

The crediting time is the period during which the project can generate CERs. The crediting time for CFL lamps can be set equal to the lifetime of the CFL lamps (typically five years). In this case, the total emission reduction over the lifetime of the CFL lamps equals the amount of CERs generated. In case the installation of lamps takes a substantial period (for instance in the case that a rebate programme runs for two years) the baseline developer can decide to include the installation period in the crediting period accounting for the fact that some lamps are installed during the second year of a two-year project. In this example the crediting period is 7 years. .

3.3.6 Simplified procedures for CFL field measurements

In the development of standardised guidelines for CFL projects, an important issue is whether or not to allow the use of engineering estimates partly based on standard values derived from past experiences, in replacing field measurements. This is relevant for the estimation of key parameters, such as the wattage of the replaced lamps, operation hours, fallout and free ridership, both in the baseline study and in monitoring. In general, reducing requirements for field measurements reduces costs.

In the case of CFL projects, an intermediate approach is selected. One should consider that for any CFL project some field measurements are always necessary for programme development and evaluation and that only field measurements are able to reduce the level of uncertainties in key parameters to an acceptable level. Especially, when one considers that the conditions for CFL projects in non-Annex I countries will be more diverse than those for CFL projects in a single country, for instance, the USA. Therefore, a simplified procedure for field measurements (in baseline and monitoring auditing) is proposed, which will lead to very limited additional costs, but will increase the reliability in the estimation and monitoring of key parameters substantially. By and large, this approach to standardisation is much simplified compared to the

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[10] Some experts hold the view that that increased levels of the same service (in this case amount of lighting) should be considered and that credit should be given against a higher activity level, not against the pre-project activity level. This will require separate methodological work ('suppressed demand baselines') (Winkler, 2001).

extensive evaluation protocols, which have been applied, for instance in the USA in the evaluation of DSM programmes. (See Section 5.4.4).

4. STANDARDISED BASELINES FOR OFF-GRID RENEWABLE ELECTRICITY PROJECTS

By: F.D.J. Nieuwenhout, S. L. Kaufman

4.1 Introduction

This chapter discusses the establishment of standardised baselines for small-scale renewable energy applications that provide 'off-grid' electricity. In this context, 'off-grid' means not connected to a national or regional electricity grid. The applications addressed include stand-alone electricity provision to individual households and for productive uses (such as water pumping and power for workshops) as well as mini-grids. There is a continuum in mini-grid size from extremely small (a solar home system with an extra 6 Watt connection to a neighbour) to multi-MW systems distributing electricity to a town and neighbouring areas. There are several justifiable options for defining the border between grid and mini-grid (e.g., based on distribution voltages, number of power plants, etc.). For CDM purposes we suggest defining a mini-grid as a grid having a total generating capacity of up to 15 MW, because this corresponds with the definition in Decision 5/CP.6 of small-scale CDM projects involving renewable energy.

All activities discussed in this chapter involve the use of renewable energy to replace part or all of previous fossil fuel sources used to provide equal energy services. The emission reductions thus relate to fuel substitution. The chapter covers a range of application categories, however, representing different baseline and project circumstances. In some cases, for example, the renewable energy projects involve stand-alone systems that supply 100% of the electricity while in other cases they supply supplemental power for mini-grids. Given the different conditions that apply, we discuss baseline standardisation by application category.

Categories of baselines

For renewable energy projects supplying off-grid electric service, one of two baseline situations will most commonly apply: diesel electric generators or traditional household fuels (i.e., kerosene for lighting and batteries to power small appliances).

Diesel generators are commonly used to provide electricity for stand-alone and mini-grid applications in developing countries and are thus a broadly applicable benchmark for off-grid electricity provision. One source in the CDM baseline literature recommends that 'off-grid small CDM power projects generally be assessed against a diesel-based baseline' (Bosi, 2001); another suggests that 'a benchmark based on diesel generators, the world's most common source of off-grid electricity … might offer a reasonable baseline that could be applied in non-Annex-I countries' (Larazus et. al., 2000). We recommend using a diesel baseline for off-grid renewable energy projects that provide power for mini-grids (except where the energy supplied to end users is limited, as discussed below) and for productive uses.

Traditional household fuels, including kerosene and candles for lighting and batteries to power small appliances, are widely used across the developing world by households that are not connected to a source of readily available electricity (i.e., a grid, mini-grid, or generator). A baseline of traditional household fuels is therefore applicable for small-scale stand-alone renewable energy systems used for household electrification.

To distinguish the applicable baseline and recommended emission reduction calculation methodology, we have divided off-grid renewable energy projects into five categories, based on expected differences in baseline and project emissions:

a. Stand-alone application of renewables for household use (Section 4.2).

b. Mini-grids where renewable energy systems provide 100% of the power (Section 4.3.2).
c. Mini-grids with renewables, a diesel generator and storage. The diesel generator is used to reduce required size of the storage capacity and to increase reliability and is run mainly at full load (Section 4.3.3).
d. Mini-grids with renewables, a diesel generator, but without storage. Application of renewables results in fuel savings. Diesel load is not constant (Section 4.3.4).
e. Renewables for water pumping and productive appliances (Section 4.4).

4.2 Stand-alone single household electricity production

4.2.1 Overview

A number of renewable energy technologies exist that can supply an individual household with a small quantity of electricity, sufficient to meet basic needs. These include solar home systems (about 1.5 million units have been installed already world-wide), wind battery chargers (in the order of 100,000 units mainly in China and Mongolia) and pico-hydro installations (a few hundred thousand units, mainly in Vietnam and China).

Households that use these small stand-alone renewable systems all have in common that they previously used conventional fuels for providing equal energy services. Generally, the introduction of these renewable technologies implies first use of readily available electricity by the household. The baseline that most closely corresponds with the actual savings of greenhouse gases is the previous use of fossil fuels, providing equal energy services. In most cases, this includes kerosene use for lighting and the use of car batteries that are charged elsewhere. Savings in candles and dry cell batteries are also possible, but they turn out to be of limited significance in terms of GHG reductions.

In a previous project, ECN, Sunrise Technologies and IT Power proposed a methodology for establishing baselines for solar home systems (Martens et. al., 2001). A global baseline was proposed based on a number of studies that quantified the substitution of conventional fuels with solar home systems. Similar studies have not been identified for other renewable energy technologies at the household scale. Furthermore there is no reason to expect households that substitute other small-scale renewables for conventional fuels would be much different from households that use solar energy. Therefore we propose to use the same baseline for all renewable energy technologies at the individual household scale to facilitate the fast-tracking of such technologies until more detailed studies per technology or per country become available. However, it is proposed to limit this to a range in renewable electricity generation of 50 to 500 Wh per day. Above 500 Wh per day the more likely baseline situation would involve the use of an individual diesel or gasoline generator.

4.2.2 Solar home systems

In the case of solar home systems it was found that smaller systems result in relatively higher savings per unit of installed capacity. Based on limited empirical data the following relation was inferred for the global baseline: annual emission reduction is: 75 $kgCO_2$ per system per year plus 4 $kgCO_2$ per year for each Wp of installed capacity with a minimum of 10 Wp (Martens et. al., 2001; Ybema, et. al., 2000).

$$CER(PV) = 75\ kg/y + 4 \times Power\ kg/y/Wp\ [kg\ CO_2/y]$$

With Power equalling the PV-module capacity in Wp.

To convert the formula for solar home systems to other technologies one has to calculate first how much electricity is generated. At a typical irradiation level of 5 $kWh/m^2/day$, each Wp of PV-power generates 5Wh electricity per day. The global baseline figure then becomes (with Energy the energy consumption in Wh/d in the range of 50-500 Wh/d):

$CER(ren) = 75\ kg/y + 0.8 \times Energy\ kg/y/Wh/d\ [kg\ CO_2/y]$

4.2.3 Hydropower

Small, ‘family-hydro’ units are popular in Vietnam and China, where a few hundred thousand units have been installed. These are typically 200 W AC units, selling in the market place for as low as US$25 for the cheapest, inefficient and generally short-lived units.[11] With a small run-of-river pico-hydro generator, electricity can be produced for 24 hours a day, and 365 days per year, provided of course that the stream does not dry up in the dry season. For small hydropower, the daily electricity yield can be calculated by multiplying the generator capacity by the number of hours of use. In a small run-of river hydropower system there is no incentive at all to save electricity provided that the load can be met by the installed capacity. It is safe to assume that the equivalent number of hours of use is equal to the actual number of hours per day (which is equivalent to assuming a capacity factor of 100% during use).

For example, with an assumed 4 hours of use per day, a 200 watt pico-hydropower installation with a capacity factor of 50% generates 400 Wh per day. Annual carbon credits will amount to 75 kg CO_2/y + 400 Wh/d×0.8kg CO_2/y/Wh/d = 395 kg CO_2/yr. The general formula for pico-hydro power becomes: 75 + 0.4×capacity (in W) × equivalent number of hours of use per day.

$CER(hydro) = 75\ kg/y + 0.4 \times Energy\ kg/y/Wh\ [kg\ CO_2/y]$

With Energy the power of the turbine in watts multiplied by the equivalent numbers of hours of use.

Most systems will be able to deliver power for 24 hours. Equivalent number of hours can be calculated by dividing the useful daily electricity consumption by the capacity. One can expect a range in the order of 3-12 hours per day. A default value of 5 hours is recommended (typical use of electricity by households is about one hour during the day and 4 hours during the evening[12]), which makes: 75 kg/y+ 2 kg/y CO_2 per W installed capacity.

4.2.4 Wind power

Power generation with wind turbines is more difficult to calculate compared to solar and hydro. The energy content of wind is proportional to the third power of the wind speed. Average wind speed figures and the distribution are usually unknown for the exact location of the turbine. Wind speeds are very site dependent. Rotor diameters are more important for determining annual electricity generation than rated power. It is possible that replacing a generator with one with a smaller capacity rating will result in an increase in annual generation. The combined uncertainty due to lack of wind speed data and turbine characteristics is large and requires an extra conservative approach.

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[11] Personal communication with John Green, IT Power, 3-12-2001.

[12] These are results from monitoring of solar home systems in Indonesia and China. See: M. Djamin et al, ‘Performance Evaluation and Analysis of Solar Home Systems in Kolaka, South East Sulawesi, Indonesia’, presented at ISES 2001 Solar World Congress in Adelaide, and F.D.J. Nieuwenhout et al. ‘Monitoring of solar home systems in China: first year results’, 17th European Photovoltaic Solar Energy Conference, Munich, October 2001.

Using actual wind speed data for a large number of small wind battery chargers to set GHG baselines would be impractical and extremely costly. A practical approach is only possible using factors other than the actual wind speeds at the locations of the turbines. We assume that wind battery chargers are only installed in locations that have a favourable wind climate and no shielding by buildings or trees. To render wind power financially viable, the average wind speed at 10m should be at least 5 meters per second. (Hulscher and Fraenkel, 1994). Small turbines are often installed at too low a height in an environment causing a lot of turbulence in which yawing takes place inefficiently. Furthermore, wearing is fast due to the high speed of the blades, causing faults to develop more often than in larger turbines. Not all generated electricity can be used due to a mismatch of supply and demand, and there will be losses in the batteries due to storage (as with solar home systems). All these aspects cause the annual electricity generation to be much lower than what is common with larger turbines. A well-chosen small wind battery charger in a good location in the Netherlands will generate in the order of 250 kWh of useful energy per year per m^2 over rotor area[13]. Different wind regimes will result in different values. In tropical areas the electricity generated per square meter of rotor area would be lower in general.

As a conservative value, 200 kWh per year per m^2 of swept rotor area is proposed as a conservative standardised figure. Using the convention to characterise wind generators with their rotor diameter D in meters, the annual carbon savings will amount to 75 kg/y CO_2 + $0.8 \times (200{,}000/365) \times 0.25 \times \pi \times D^2$. This is equivalent to:

$CER(wind) = 75\ kg/y + 350 \times D^2\ kg/y/m^2\ [kg\ CO_2/y]$

4.2.5 Conclusions for stand-alone household electricity production

The general formula for calculating annual carbon savings is derived from household fuel savings that occurred when people substituted a solar home system for their conventional fuels. With the lack of similar data for other renewable energy sources, the carbon savings are assumed to be the same per unit of electricity generated. Using this assumption we arrive at the global values shown in Table 4.1. Empirical data from households using solar home systems were obtained in the range from 10 to 75 Wp. To allow for some future growth in PV-module capacities, it is proposed to extend the range over which this formula can be used to 10-100 Wp. The resulting equivalent carbon emissions are in the range of 115 to 475 kg CO_2 per year, and energy generation in the range of 50 to 500 Wh/day.

Table 4.1 *Global annual carbon emission reduction figures in kg CO_2 per year*

Technology	Carbon savings in kg CO_2/year
General, small renewables for household electrification	75 kg/y + 0.8×Energy kg/y/Wh/d
Solar home systems	75 kg/y + 4×Power kg/y/Wp. [kg CO_2/y]
Pico hydropower	75 kg/y + 2 kg/y/W installed capacity
Wind battery chargers	75 kg/y + 350×D^2 kg/y/m^2 (with D = rotor diameter)

4.3 Minigrids

Across the developing world and in industrialised countries as well, mini-grids are used to supply electricity for households, public facilities, and commercial applications in areas that are isolated from interconnected national or regional electric grid systems. The emissions baselines for such systems depend on the fuel consumption characteristics of the diesel generators that supply them with electricity. While several factors can influence the rate of diesel fuel con-

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[13] Private communication: Frans van Hulle, ECN, 5-12-2001.

sumption per kWh (e.g., generator age, technology, and maintenance), generator size and load factor appear to have the greatest influence.

4.3.1 Data collection

To obtain information on the impact of generator size and operating load on fuel consumption, the authors conducted a brief literature review, identified and compiled manufacturers' specifications, and posted requests for information on the Climate-L and Village Power electronic list services operated by the International Institute for Sustainable Development and the National Renewable Energy Laboratory (NREL), respectively, and posted an information request in NREL's Village Power electronic newsletter. This was supplemented by a review of baseline calculation methodologies used for AIJ, GEF, and PCF projects (current and proposed) involving renewable energy technology deployment where diesel generation was used as the baseline.

While the data collection effort found that information on diesel generator performance in rural areas is generally not readily available, the project's data collection efforts did provide information showing that fuel efficiency increases with generator size and with operating load. Based on a combination of manufacturers' specifications and empirical data, the following graph shows the general correlation between generator size and fuel consumption. The graph displays figures for the highest reported load factor.

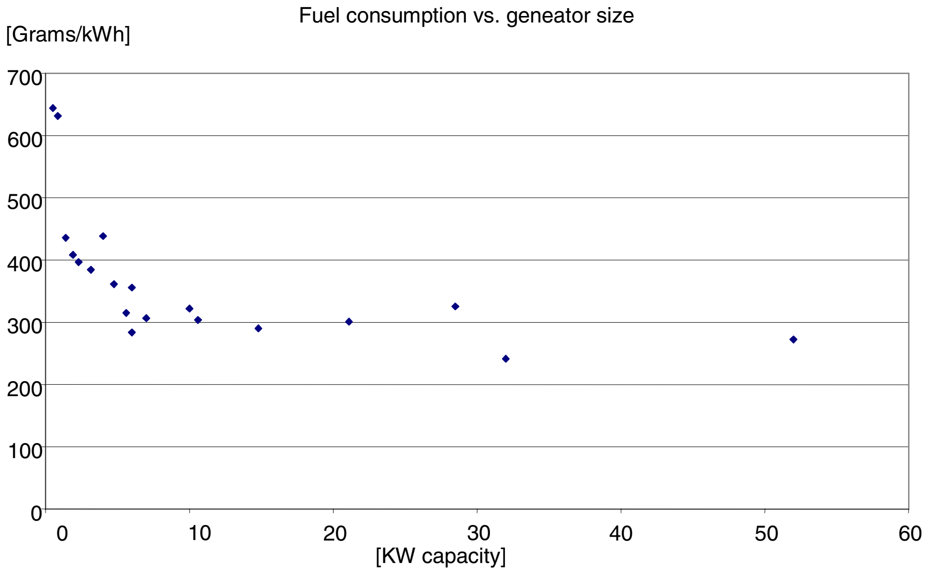

Figure 4.1 *Correlation between generator size and fuel consumption, Source: manufacturers' specifications and empirical data. For conversion from grams diesel per kWh to grams CO_2 per kWh, multiply by 3.2*

Information in the literature and empirical data also indicate that fuel efficiency decreases as diesel generators operate at a lower percentage of their capacity. As the graph below indicates, fuel efficiency begins to decline rapidly when generators are operated below about 30 or 40% of their capacity.

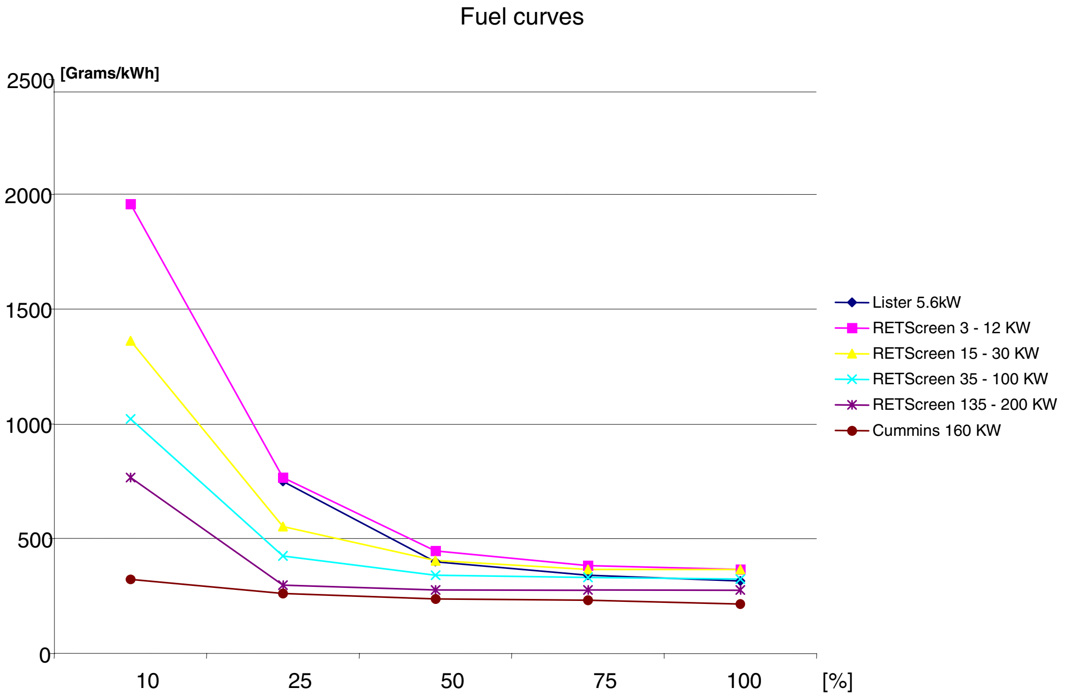

Figure 4.2 *Correlation between fuel efficiency and load factor. Source: Online manual, RETScreen International PV 2000 model, downloadable from http://retscreen.gc.ca/, and empirical data provided by Glynn Morris of AGAMA Energy (Lister) and Tony Jimenez of the National Renewable Energy Laboratory (Cummins)*

While information on diesel generator operational performance in rural areas is generally not very well documented, it is evident that the load factor is very important in determining the emissions, especially for smaller capacities. In cases where diesel replacement is the appropriate baseline (i.e., except where energy service to end-users is limited, as explained below), we therefore propose to use benchmark diesel emissions factors that vary depending on the applicable generator size and pre-project load factor characteristics.

4.3.2 Mini-grid without diesel

There are two options in choosing a suitable baseline for mini-grid systems where 100% of the electricity is supplied by renewable sources. In cases where the available energy per household connection is small (e.g. less then 500 Wh/day) the situation is similar to that of a solar home system user, both having a restricted supply. In that case one can use the general formula for stand alone renewables per connection: 75 + 0.8 kg CO_2/y per Wh/d, and multiply this by the total number of connections, using the average energy consumption per connection to determine Wh per day.

If the load per connection is more than 500Wh/day then the approach using the general formula described above will overestimate savings. In that case, the proposed baseline will be based on a diesel generator that powers a mini grid for household applications. Household electricity use is known to vary over time and peaks during a few hours per day. Diesel mini-grids fall into two general categories: ones providing full 24 hour per day service and ones providing partial service. In the latter case, usually 4-6 hours of service is provided in the evening. These different service types correspond with different load factors. Further research is required to determine typical load factors for these two cases using actual field experiences. For the time being a load factor of 25% is assumed for the full service diesels and 50% for the partial service diesels.[14] The resulting emissions factors strongly depend on the percentage of capacity at which diesel generators are operated (see Table 4.2).

In cases where renewables replace electricity generation from one or more diesel generators to supply an existing mini-grid, the benchmark emissions figures should be selected from Table 4.2 based on the type of service and generator capacity that preceded the introduction of renewable energy. In the case where a renewable energy system is supplying a wholly new service, the benchmark selected from Table 4.2 should be based on the service type and capacity of the renewable energy system.

4.3.3 Mini-grid with a diesel and storage

With the availability of energy storage there is an opportunity to run the diesel generator more efficiently. It is possible to run the diesel generator only part of the time at a 100% capacity factor. When the load is smaller or renewable energy supply is absent, the batteries will provide the required power. When a diesel generator is operated in this way it will produce less carbon per kWh generated than a diesel that supplies the full load. Therefore one cannot use the actual measured specific fuel consumption of the back-up diesel as a baseline for the avoided emissions; instead, one could use a benchmark figure for a diesel supplying the full load. For the resulting diesel emissions factors, see table 4.2 in the columns of 25% and 50% load, depending on the type of service provided by the mini grid before the introduction of renewable energy.

4.3.4 Mini-grid with a diesel, but without storage

In this case the application of renewables is meant to lead to savings of diesel fuel. However, due to variability in supply of most renewable energy sources, the resulting load factor will be lower with the application of renewables than without it. Especially with smaller diesel generation sets in the range from 3 - 12 kW, the electricity savings caused by the application of renewables can be almost completely wiped out by the decreased efficiency of the diesel under partial load (see Table 4.2). This occurs when the application of renewables leads to a decrease in load factor from 50% to 25%. As in the previous case, one can not use the actual diesel consumption figures (i.e., during the project case, after the implementation of renewables) as the baseline, since they differ from the situation where the full load is supplied by the diesel. Monitoring of project emissions will have to establish the extent to which the project actually reduces emissions compared to the benchmark.

4.3.5 Conclusions regarding mini grids

In nearly all cases with mini grids, actual diesel consumption figures for the diesel generator as applied after the implementation of renewables will not necessarily reflect the baseline emissions situation. A diesel generator in a hybrid system will usually run differently compared to one that has to supply the full electric load. The diesel generator can be either more or less efficient depending on whether battery storage is incorporated into the system. In both cases it is proposed to use a benchmark emissions factor for a diesel generator that has to supply the full load on its own; in the absence of actual pre-project fuel consumption records, this is probably a reasonable reflection of the baseline situation. To calculate emission reductions, one must monitor the emissions of the total hybrid system, including diesel emissions.

The emissions factors in Table 4.2 are suggested as benchmarks for off-grid renewable energy projects where energy supplied by diesel generators represent the project baseline. The applicable benchmark should be selected based on the size of the diesel generator and its pre-project

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[14] Mini-grids supplied by larger generators and by more than one generator typically operate at higher load factors.

operating conditions. The 25% load factor applies where electricity was previously supplied 24 hours per day by a mini-grid system without storage. The 50% factor is applicable where electricity was previously supplied for part of the day by a system that had no storage. It is recommended that the 100% factor should apply where electricity had already been supplied by a mini-grid system that included storage.

Table 4.2 *Emissions factors in kg CO_2/kWh for diesel generators in five size categories at different levels of load*

Cases:	Mini grid with 24 hr service	a. Mini grid with temporary service (4-6 hr/day) b. productive applications c. Water pumps	Mini grid with storage
Load factor [%]	25	50	100
3-12 kW	2.4	1.4	1.2
15-30 kW	1.9	1.3	1.1
35-100 kW	1.3	1.0	1.0
135-200 kW	0.9	0.8	0.8
> 200 kW[1]	0.8	0.8	0.8

[1] Recommended default values.

Source: Derived from fuel consumption information in the online user manual of RETScreen International‘s PV 2000 model, downloadable from http://retscreen.gc.ca/. Note: This source presents fuel curves plotting typical average fuel consumption versus capacity used for the first four generator size categories above, up to 200 kW, and presents figures in litres of diesel per kWh. Here we assume a diesel fuel weighing 850 kg per litre and apply a conversion factor of 3.2kg CO_2 per kg of diesel.

To calculate emission reductions attributable to a project, actual emissions during the project case (if any, based on fuel consumption) must be subtracted from kWh generated during the project’s operation multiplied by the applicable benchmark emissions factor.

4.4 Off-grid electricity provision for productive applications

Diesel baselines are suggested for off-grid renewable energy systems used for water pumping and other productive applications.

In the range from about 100 W to a few tens of kW renewable energy systems are a well-suited alternative for water pumping. Renewable energy systems are less suitable for driving large water pumps with a large head and/or large flow. Very small water pumps can be powered manually or by animal power. Small-scale applications usually apply submersible electric pumps. If head and flow are not too large, diesel electricity generation is suitable for comparison. Given the sizing of the renewable energy system, one can calculate the amount of electricity generated. Renewable energy used to power other electric appliances will have the same considerations.

Where diesel generators run electric motors, the generators will tend to be oversized and run at a lower percentage of their load capacity since substantially more energy is needed to start electric motors than to keep them running. This was argued by GEET (2001):

> ‘**Important Consideration: Motor starting is another consideration, depending on the efficiency of the motor, it will require up to 2 times the running watts to start, or up to 4-7 times the running watts for motors with a load on them during the start, for Air Conditioners, Air Compressors, Pumps, Refrigerator/Freezers, etc.’*

This leads us to conclude that the baseline should be based on an equivalent fuel consumption of sub-optimally operated diesel gen-set; hence we propose using the figures for diesel generators operating at 50% load in Table 4.2.

5. STREAMLINED PROCEDURES FOR SMALL SCALE CDM PROJECTS

By: J.W. Martens, A.P.H. Dankers and D. Violette.

5.1 Introduction

The Marrakesh Accords recommends simplified modalities and procedures to promote the fast-tracking of small projects[15] (UNFCCC, 2001). Apart from standardised baselines, simplified procedures are generally thought to include the development of streamlined procedures for validation, monitoring, verification and certification for small-scale CDM projects. Different stages of the cycle can be streamlined for small-scale projects. By looking at project/industry specific characteristics, costs for validation, monitoring, verification and certification can often be reduced greatly, while keeping the credibility of the reduced credits at an acceptable level.

5.1.1 The CDM project cycle

Figure 5.1 shows the major steps in the CDM project cycle potentially subject to streamlining. In the project design phase the project developer has to prepare the project design document (PDD). The major components of the PDD include (UNFCCC, 2001[16]):

a. A description of the project.
b. Proposed baseline methodology.
c. Statement of the estimated operational lifetime of the project.
d. Description of the additionality of the project.
e. Environmental impacts of the project.
f. Information on sources of public funding from the involved Annex I Parties.
g. Stakeholders comments received on the project.
h. Monitoring plan.
i. Calculations of the net GHG emission reductions of the project.
j. References to support the above.

The project is validated by an independent Operating Entity (OE) and requires written approval of the host country, including confirmation that the project contributes to the host Party's sustainable development. The OE forwards a validation report to the Executive Board (EB), and if approved, will be registered as a CDM project.

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[15] In this chapter we distinguish the following terminology:
Simplified procedures = standardised baselines, streamlined M&V procedures plus other beneficial arrangements.
Streamlined procedures = streamlined procedures for project design, validation, monitoring, verification and certification stages of the project cycle.
Streamlined M&V procedures = Streamlined monitoring and verification procedures.

[16] See Marrakesh Accords, draft decision -/CMP.1 (article 12), Appendix B.

	CDM Project Cycle	*Responsibility*
Project Design	Project design documents, baseline study, monitoring plan	Project developer
	Validation of project design, baseline study and monitoring plan, host country approval, stakeholder comment	Operating Entity (or validation, verification & certification [V,V&C} bodies recognised by Dutch Government[17])
	Registration	Executive Board (or Dutch Government)
Project Implementation	Project monitoring & reporting	Project developer
	Verification of monitoring report (resulting in verification report)	Operating Entity (or V,V&C bodies recognised by Dutch Government)
	Certification (based on certification report OE)	Operating Entity (or V,V&C bodies recognised by Dutch Government) + Executive Board (or Dutch Government)

Figure 5.1 *Major steps and responsibilities in CDM project cycle*

In the case of the C-ERUPT programme, projects first need to qualify before they are allowed to submit a PDD. In the selection phase, suppliers will have to submit an Expression of Interest to Senter, including a Project Idea Note (PIN) in which the project is described. Amongst others, the PIN should describe the estimated total amount of CERs to be delivered and the estimated price per CER offered, on the basis of which the projects will be selected.

The provision of simplified procedures in this stage include standardised baselines (see previous chapters), the manuals to guide project developers in developing the project design document and pre-designed project forms. Such forms are common practice to facilitate project formulation and are used by for instance by C-ERUPT (see Senter, 2001).

The next stage in the project cycle is the implementation of the project. To receive the CERs produced by the project, the project owner needs to demonstrate the reduced GHG savings in its monitoring reports. The monitoring results will be verified and certified by the OE, which leads, upon approval by the EB, to issuance of CERs equal to the project's certified emission reductions.

5.1.2 Previous literature on streamlining M&V procedures

As opposed to the discussion on baseline methodologies and standardisation of baselines very little literature exists on streamlining CDM procedures for small projects. On the other hand, small-scale clean energy technologies have been implemented as part of GEF and AIJ projects.

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[17] Pending the entry into operation of the Executive Board and the accreditation of Designated Operating Entities, the Dutch government, being the investor party in the C-ERUPT programme, is taking the responsibility for approval of baselines study, recognition of Verification and Validation Bodies and certification of C-ERUPT credits.

This paragraph provides an overview of available literature and a brief analysis of available sources for streamlining CDM procedures.

Private sector GHG accounting initiatives
After the Bonn Agreement, new initiatives for developing monitoring protocols for GHG emission savings are emerging. Such initiatives include the GHG Protocol Initiative of the World Resource Institute (WRI) and the World Business Council on Sustainable Development and the Guidelines for GHG Accounting organised by IETA (WRI/WBCSD, 2001/IETA, 2001). Such initiatives discuss the monitoring protocols for CDM projects in general and do not focus in detail on streamlining monitoring procedures for small projects.

Annex I Expert Group on the UNFCCC (OECD/IEA)
The Annex I Expert Group on the UNFCCC prepares analytical papers in anticipation of upcoming issues in the climate change negotiations and has been spearheading the international discussions on both standardised baselines and streamlined procedures (OECD/IEA, 2000; Bosi, 2001). Bosi's paper on fast-tracking small CDM projects presents an overview of the literature on transaction costs which indicates the need for simplified procedures to overcome transaction costs for such projects. Bosi suggests a number of measures for fast-tracking CDM procedures (see box below).

Bosi presents interesting ideas, some of which are already included in the C-ERUPT programme (the Standardised baselines and Standardised Project Description Format). The Environmental Impact Assessment (EIA) process is taken over in the recommendations of Section 5.2. The suggestion to have the validation done by the host country instead of the Operating Entity is potentially a very useful one to bring down transaction costs, but also may open the opportunity for gaming by the host country and investors. We believe that it is too revolutionary to be included in the C-ERUPT programme at this stage, however it would be a good option to be considered by the EB.

Possible features of a CDM fast-tracking procedure (Bosi, 2001)

1. PRE-REQUISITES: STANDARDISED BASELINES AND STANDARDISED PROJECT DESCRIPTION FORMAT

- These two pieces (i.e. standardised baselines and project description format) are necessary elements of a CDM fast-tracking procedure. These can be reviewed periodically, as greater experience is gained, but should not affect retroactively small CDM projects already implemented.
- They will likely need to be developed under the authority of, and receive the approval from, the CDM Executive Board.
- They would need to be widely accessible, e.g. via internet. Designated national CDM authorities would also have them on hand.

2. PROJECT VALIDATION

- Project proponents fill-in a brief project description (in a standardised format).
- Approval is sought from the host country CDM authority:
  - Normal EIA process applies.
  - Host country checks that the project description is complete and the calculations are correct, based on agreed standardised baseline values.
  - There is no need for 3rd Party validation, as CERs would be based on a standardised baseline.

3. PROJECT REGISTRATION

- Host country would report annually to the CDM Executive Board on the projects it has provided its CDM approval, providing relevant EIA documentation.
- The project is registered by the CDM Executive Board as a CDM project.

4. PROJECT VERIFICATION AND CERTIFICATION

- An Operational Entity (OE) would verify and certify that the project is in place and operating.
  (If baseline is based on a kWh basis, the project proponent would need to submit records of operations and output).
- Building on existing administrative auditing procedures.
- The OE's findings are communicated to the host country and the CDM Executive Board.

5. ISSUANCE OF CERS

The CDM Executive Board receives the verification and certification reports and issues the CERs.

Activities Implemented Jointly projects in the pilot phase
Review studies of AIJ projects and other reviews of potential CDM projects focus mostly on baseline setting, additionality and sustainable development impacts (see for example Begg, 1999/Begg et. al., 2000/Dixon, 1999/Ellis, 1999/Jepma and Eisma, 1999). Although the category 'Modalities for measurement, reporting and assessment' has been included in the indicative list of methodological issues related to activities implemented jointly, no thorough review study of the monitoring methodologies of AIJ projects has been undertaken.

A quick scan of 26 AIJ renewable projects listed on the UNFCCC website which follow the Uniform Reporting Format revealed that such projects do briefly indicate the monitoring methodology to be used but do not provide information about the transaction costs associated with such projects nor the experience in practice with the methodology. Hence, the potentially large experience gained by project participants in monitoring which could be relevant for streamlining CDM procedures has yet to be documented, analysed and transformed into monitoring guidelines.

UNDP-GEF projects

UNDP/GEF Climate Change projects that are being funded under operational programmes 5 and 6: ‘Removal of Barriers to Energy Efficiency and Energy Conservation’ and ‘Promoting the Adoption of Renewable Energy by Removing Barriers and Reducing Incremental Costs’ respectively are being monitored and evaluated using mainly the standard UNDP procedures on monitoring and evaluation. In addition to this, UNDP/GEF projects are subject to the GEF-wide Project Implementation Review process. Despite of the fact that emission baseline situations are important in determining incremental costs for which GEF assistance is requested they are often poorly defined in quantitative terms and changes are seldom monitored throughout the project life.

The direct and indirect GHG impacts of UNDP/GEF projects are supposed to be monitored by the project itself. The local UNDP offices focus mainly on monitoring the project implementation progress; i.e. are outputs as specified in the project document achieved in a timely manner. Linking the project implementation results to GHG impacts is however rarely done, mainly as a result of the lack of clear procedures that give guidance on how this should be done and second the lack of (technical) expertise at local UNDP offices.

In this context it needs to be understood that GEF focuses mainly on barrier removal for climate change mitigation and thereby creates the basis for GHG reduction. Consequently monitoring and evaluation (M&E) procedures focus on measuring and assessing achievements in terms of barrier removal instead of monitoring GHG impacts directly.

Nevertheless, the monitoring and evaluation unit of the UNDP/GEF core unit in New York is looking into improving the above situation and works towards the development of standardised baselines and more practical GHG monitoring and evaluation procedures. This is a work in progress and tailored to UNDP/GEF projects that are less strict in the baseline setting, validation, monitoring and verification than CDM projects.

In summary, the existing procedures currently in use for monitoring GHG impacts of UNDP/GEF projects are yet of little value to (streamlining) procedures to be used for CDM projects. No experience was retrieved from GEF projects executed by other implementing agencies (such as the World Bank), but given the lack of clear GHG monitoring protocols at the GEF Secretariat level, it is likely to be similar to the UNDP’s experience.

Energy efficiency projects

According to Vine and Sathaye (1999) standardised guidelines could have a number of advantages for energy efficiency projects:

1. Increase the reliability of data for estimating GHG impacts.
2. Provide real-time data so programs and plans can be revised mid-course.
3. Introduce consistency and transparency across project types, sectors and reporters.
4. Enhance the credibility of the projects with stakeholders.
5. Reduce costs by providing an international, industry consensus approach and methodologies.
6. Reduce financing costs, allowing project bundling and pooled project financing.

The body of literature and experience on M&V of energy efficiency projects not related to JI and CDM is at the moment much larger than existing JI/CDM related experiences. Important are the recent efforts in developing internationally accepted guidelines and protocols for M&V of energy efficiency projects. Particularly, the guidelines of the International Performance Measurement and Verification Protocol (IPMVP) for measuring and verifying energy savings (see www.ipmvp.org) should be mentioned (see also Vine and Sathaye, 1999 for a discussion of the use of IPMVP). However, further research is required on the best way to use these existing protocols for CDM.

Conclusion

Experience with and literature on streamlining GHG monitoring for project based activities on the international level seems to be limited so far. Given the limited time provided for this study it seems over-ambitious to develop extensive streamlined procedures to be included in the first C-ERUPT tender.

Nevertheless, a number of simplified procedures are more specific to the CDM process and they have been further worked out in Section 5.2. Monitoring of kWh produced by electricity generation projects seems straightforward and opportunities for streamlining have been worked out in Section 5.3, including:

- grid-connected renewable energy projects,
- mini-grid with renewables and large diesel,
- mini-grid with a renewable energy system,
- small stand-alone household installations.

On the contrary, given the industry or sector specificity of many energy efficiency projects, working out streamlined monitoring procedures for such projects is much more difficult. In Section 5.4 we briefly discuss the key issues involved in energy efficiency and in line with the selected categories for baseline development, we have elaborated on streamlined procedures for efficient lighting projects.

5.2 Streamlined procedures for small-scale renewable energy projects

A number of options to facilitate the fast-tracking of small projects in the CDM measures would apply to all small-scale project category. In this section we will briefly discuss them. Table 5.1 provides an overview of such streamlined procedures.

Table 5.1 *Streamlined procedures for all small projects*

Category	Subject of streamlining	Proposed streamlining measure
Project design document	Project size and categories	Allow bundling of similar small projects (maximum size of bundled projects in accordance with size definition of small project in Bonn Agreement).
Validation	Use of Operational Entity (OE)	Require only one OE in the whole process, instead of a separate OE for validation and verification/certification.
Validation	Environmental Impact Assessment	No additional requirements beyond host country's EIA processes.
Verification	Verification period	Require periodic instead of annual verification and certification reports.

5.2.1 Bundling of projects

Given that transaction costs are often not strongly related to the size of a project, bundling small projects together could potentially reduce this cost. Apart from the evident case of economies of scale, the central project promoter could play an important role in project development and execution, focused around four main tasks:

1. Raise awareness of CDM and engage industries in CDM, most of which might have never heard of CDM.
2. Develop the project according the requirements of the CDM and assist companies in seeking approval from the host government.
3. Organise the administrative CDM procedures for these industries. The central project developer could develop special administrative procedures understandable to small industries and instruct these industries regarding the actions they need to undertake to receive credits. The central project developer could help them through the process.
4. Sell the approved CERs on the international carbon market, either by approaching carbon investors (private sector, bilateral or multilateral) or by selling CERs in international carbon exchanges or via tenders.

Organisations functioning as such central project developers could be multilateral development banks and organisations, commercial CDM project developers, industry associations, technology intermediaries, or consultants. Basically any organisation with a wide network among small industry and the capacity to develop CDM projects could play this role.

With regard to the C-ERUPT programme the bundling of small projects is allowed. There is a chance that by bundling small projects, their total size will become larger than the small CDM projects limits defined in the Bonn Agreement. It is yet undecided whether such bundled projects would be allowed to make use of the simplified procedures for small projects. To prevent potential gaming with project boundaries in order for projects to gain from the preferential treatment for small projects, it is recommended to keep the small CDM projects definition as the limit for projects to benefit from the fast-track procedures.

5.2.2 Only one Operational Entity

Involving more than one Operational Entity (i.e. a separate one for validation and verification) has considerable impact on the transaction costs (over 45%), according to one study on transaction costs (PWC, 2000). Given that small projects would mostly use standardised baselines and streamlined monitoring procedures, there is little risk of gaming. Consequently, the potential risk for gaming by allowing one OE both validating and verifying one project does not seem to be high.

5.2.3 Environmental Impact Assessment

Many non-Annex I countries already require Environmental Impact Assessments for infrastructure projects such as electricity generation. At the same time, it is not uncommon to have certain exemptions for small projects given the minimal environmental risk of such projects (Bosi, 2001). To benefit from less regulatory barriers and up-front costs, we recommend that the only EIA requirements for small CDM projects are the ones imposed by the host government.

5.2.4 Flexible verification periods

To further reduce expenses on hiring an Operational Entity, projects should be allowed to choose a flexible period for verification. Obviously, if an OE only needs to verify and certify the reductions once every two years the costs will be lower than for certification every year. Annual verification is not an official requirement in the CDM modalities and procedures, but is open for negotiation between the project, host country and investors. As such this point does not have to be an explicit part of the simplified procedures for small projects. In the C-ERUPT programme verification and certification is required every 2 year by the Dutch Government.

5.3 Streamlined procedures for grid connected renewable energy projects

Grid-connected renewable energy projects (such as wind, solar[18], hydro, geothermal and biomass projects) come in a wide variety of sizes and are developed by different types of project owners. In general they are owned by:
- Utilities or distribution companies which deliver the produced electricity to their own consumers.
- Independent power producers delivering the electricity under contract to the electricity distribution companies or to third parties/consumers.
- Auto-producers - industrial facilities such as sugar mills which produce renewable electricity from biomass, use the generated electricity for their own demand and supply the remainder to the grid (as IPPs).
- Community based projects.

Of the above categories auto-producers are the most challenging group to monitor the produced electricity as they often also produce part of their electricity with fossil fuels (coal). As the electricity production of auto-producers is very sector, seasonal and plant specific, project specific monitoring methodologies are recommended for such projects. Or further research is required to establish a monitoring protocol on the basis of detailed industry specific study.

Table 5.2 *Grid-connected RE projects*

Category	Subject of streamlining	Proposed streamlining measure
Validation	Estimation of kWh	Allow use estimated kWh in Power Purchase Agreement (PPA) as basis of kWh use (Access to PPA for validator is required). In case a load sensitive project baseline is used, the estimated sales in different load cycle tariff classes of the PPA can be used to estimate specific emissions per load cycle.
Monitoring	Monitoring of kWhs produced	A copy of the sales reports indicating the produced electricity to the client of the electricity is allowed. In the case of load sensitive cycles, the delivered kWhs per load cycle indicated in the sales reports can be used for the estimation of emissions per load cycle.
Verification	Verification of kWh produced	To prove the actual sales of the reported electricity, the project can send a written declaration of an external accountant/auditor that sales reports of the produced electricity has been verified and audited. (Only officially registered accountants: check with auditors on standards for that).

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[18] Because of their small scale, grid-connected solar projects face more challenges than other type of grid-connected renewable energy projects and should as such be treated separately. However, the electricity costs of such projects are such that very few of them are actually implemented in developing countries. We feel therefore safe to ignore them here.

These procedures consider also streamlined procedures for project baselines. This is to facilitate those projects, which prefer not to use a standardised baseline, but which would like to use streamlined procedures.

Transaction costs and simplicity

The proposed streamlined procedures for this category are all aimed at avoiding separate CDM monitoring and verification activities. The relevant monitoring parameter, kWh produced, is in most cases likely to be monitored as part of the contract between supplier and purchaser of the electricity. Hence, there is no need to set up a separate monitoring process provided that the sales reports are audited by an independent external party (normally local accountants/auditors). The project can thus realise important savings on the transaction costs as compared to the situation where the OE has to travel to his project location.

Some renewable energy projects do not sell electricity to third parties, for instance when they are owned by a distribution company or the national utility, in which case there may not be a an official PPA and thus no externally audited sales reports. In those cases the project owner would have to ask an external auditor to audit its sales report to benefit from the above procedures.

Credibility:

The credibility of using auditor or accountant declarations was discussed with experts as part of the study by Martens et al (2001). The following arguments were made:

> ‘Since this verification procedure makes use of the existing auditing structure in the host country, its credibility is as good as the credibility of that structure. Most respondents interviewed thought that the credibility of financial auditors is generally high and certainly higher than other administrative structures such as tax collection. Most respondents thought this procedure was suitable for CDM verification purposes. As one participant noted: ‘It is hardly imaginable that any CDM auditing and verification system would be more fraud proof than the existing financial auditing standards in a country.’ There are a number of observations in this regard:
>
> - Since CER revenues per system are likely to be relatively small there is less incentive for cheating as compared, for instance, to GEF subsidies on SHSs, which are generally much higher.
> - Cheating in auditing reports is in most counties a criminal offence and can be dealt with by the courts.
> - Auditors are not likely to accept bribes since their reputation for independence is crucial to their core business.’

5.3.1 Streamlined procedures for renewable energy systems connected to a mini-grid

Renewable energy based mini-grids can roughly be divided in systems that are 100% renewable energy based such as most small-hydro schemes and hybrid systems as is the case with wind/diesel, solar/diesel systems and wind/solar/diesel systems.

These categories can be characterised as small systems; i.e. hydro schemes ranging from 50 kW to a few MW and hybrid systems in the range of 50-500 kW. Project developers are often also the project owners and especially in the smaller ranges (up to 500 kW) these are community-based organisations and/or rural electricity co-operatives. Developing and implementing CDM projects with all validation, monitoring and verification requirements is an extra burden for this category of project developers. Their capacity for getting involved in these additional project activities is very limited and the projects are relatively small in terms of CER revenues so hiring expensive capacity to assist them is not a realistic option. This situation creates a realistic barrier for this group of developers to get involved in CDM activities, although streamlined procedures and the possibility of bundling similar projects are expected to contribute in decreasing this extra burden.

For both categories a summary of streamlined procedures are presented in the tables that follow.

Table 5.3 *Mini-grids using hybrid renewable/diesel*

Category	Subject of streamlining	Proposed streamlining measure
Validation	Estimation of system capacity	Feasibility and financial reports used for technical and financial due diligence by the investors/developers.
Monitoring	Monitoring of kWhs produced	A kWh meter is required to measure the renewable kWhs. Monitor of diesel consumption could be done on basis of the invoices of purchased diesel. A system specification of the supplier should be sent with the monitoring data to double-check the claimed emission reductions.
Verification	Verification of kWh produced	Written statement to OE by local accountant/auditor that reported kWhs meter of renewable component has been verified (also fuel consumption invoices).

Transaction costs and simplicity

As for this category not all electricity is produced by a renewable energy source also the fuel consumption invoices and the average efficiency of the diesel gen-set have to be kept/monitored by the project owner and made available to the local accountants/auditors. In case such information is not provided no use can be made of the above streamlined procedures.

Credibility

Especially with community based organisations, accounting procedures are often based on locally accepted practice, which is not per definition in line with national accounting procedures. Therefore such organisations are to be provided with the required minimum accounting procedures and trained in the use thereof to ensure an acceptable standard of CER accounting. Although the responsibility for the above lies with the project developer, it is anticipated that support from national CDM committees (possibly supported by Annex-1 countries) will be made available.

Table 5.4 *Mini-grids using renewable energy sources or 100% stand-alone renewable electricity generating applications*

Category	Subject of streamlining	Proposed streamlining measure
Validation	Estimation of kWh	Feasibility and financial reports used for technical and financial due diligence by the investors/developers.
Monitoring	Monitoring of kWhs produced	A kWh meter specific for the renewable component is required to measure the renewable kWhs. In case battery storage is used, the kWhs reported should be corrected for the battery losses; In case of multiple installations in the project and each installation is smaller than 15 kW, the kWh meter need only be installed in a sample of the systems.
Verification	Verification of kWh produced	Written statement to OE by local accountant/auditor that reported kWhs meter of renewable component has been verified.

Credibility

Similar to the situation described above the project developer is responsible for ensuring an acceptable level of the CER accounting procedures. As project developers for this category are often larger and more capable it is still advisable to assess their accounting procedures and also provide them with the required minimum accounting procedures and train them in the use thereof if that turns out to be necessary.

5.3.2 Streamlined procedures for small stand-alone household installations

The recommendations below are adopted from a detailed case study for Solar Home Systems (see Martens et. al., 2001). As such they mostly apply for solar home systems. Other renewable individual household technologies (such as wind battery chargers or pico-hydro) for which no detailed study has been carried out might follow the proposed procedures where appropriate.

Solar Home systems are normally distributed through various channels:
- Private sector companies selling the technologies on a commercial or semi-commercial basis (i.e. with partly a government subsidy) to households.
- Pilot activities carried out by NGOs often financed by development assistance.
- Government programmes delivering mostly subsidised systems to deprived communities.

The proposed procedures in this section would mainly apply for the first category. The costs for the two other categories are normally covered by non-commercial sources (such as GEF, ODA or government subsidies) and would not qualify for CDM.

Table 5.5 *Small stand-alone household installations*

Category	Subject of streamlining	Proposed streamlining measure
	Reporting of system sales	Copies of company's financial records indicating the sales of the systems can be used for reporting the system sales. To prevent double-counting of PV panels, the serial number used in the project can be verified with the financial records of the PV panel producer.
Monitoring	Monitoring of system performance	Appropriate maintenance records on the client's system performance are allowed to be used. In case no maintenance records are available, a household survey can be used to show the availability (meaning physical in place and still functional). To reduce transaction costs, such a survey could be implemented by an independent third party in co-ordination with the OE to prevent a separate field trip by an OE.
Verification	Verification of system sales	Written statement to OE by local accountant/auditor that reported items have been verified.

5.4 Simplified procedures for the baseline assessment and monitoring of CFL projects

By Dan Violette

In this study, one example of a sector specific energy efficiency case has been elaborated: efficient lighting projects in the residential sector (see Chapter 3).

5.4.1 Using a statistical sampling approach

This section addresses simplified procedures in the form of a protocol for baseline determination and ongoing monitoring of energy efficient lighting (CFL). These projects are designed to replace a large number of existing incandescent lamps with CFL lamps. Unlike other JI or CDM projects, energy efficiency projects pose challenges because project impacts tend to be dispersed across a number of sites. A fuel switching project at a single large energy using site (e.g., a steam plant) allows the baseline estimation and on-going monitoring to be focused on a single location. A lighting project will typically involve the replacement of a large number of lamps spread across a large number of residential sites.

Given the dispersed nature of these projects, it is assumed that a sampling approach can be used to produce baseline estimates and also that a sample can be used for ongoing monitoring and tracking. The experience in the ILUMEX project was used as the main reference for the use of statistical baselines for energy efficient lighting projects (World Bank, 1999a; 1999b).

The proposed procedures for baseline and monitoring are simplified in comparison to the commonly used evaluation procedures for CFL projects. For instance, the suggested World Bank protocols for CFL projects are much more complex (World Bank, 1999b). The main simplifications are:

1. The sampling size is limited to 60 and the number of strata to three, regardless of size of the project.
2. The procedure does not require to establish the wattage before and after (e.g., spot-watt measurements are not required for determining the wattage reduction due to the installation of CFLs). The baseline developer can use either accepted tables or use manufacturers' ratings. Also, no laboratory testing of wattage of the CFL lamps is necessary. In comparison, the suggested World Bank protocols recommend laboratory testing. However, the ILUMEX data shows that the deviation between the manufacturers' ratings versus the test results is only 10%, which is small compared to the difference in wattage between incandescent and CFL lamps.
3. The estimation of free riders is simplified. In comparison, the suggested World Bank protocols include extensive work to get free riders, and other indirect effects.
4. Monitoring is only required every 18 months, not annually, for the duration of the crediting period.
5. Finally, the suggested procedures as a whole provide certainty to the baseline developer that a baseline and monitoring study developed according to these procedures will be accepted.

5.4.2 Key parameters in baseline study and monitoring

Electricity savings per CFL lamp installed comes from the following equation:

$$Electricity\_Savings\_Lamp\_Year = (\overset{(Term\ 1)}{Watts_{incandescent}} - \overset{(Term\ 2)}{Watts_{CFL}}) \times \overset{(Term\ 3)}{Annual\_Operating\_Hours}$$

(See Section 3.3.3.)

Thus, all estimates of savings require three pieces of information:

1. Watts Before (Term 1) - An estimate of the Watts of the lamp being replaced.
2. Watts After (Term 2) - An estimate of the Wattage of CFL lamp being installed.
3. Hours (Term 3) - An estimate of the hours of operation of the lamp to produce Watt_Hours of savings for each lamp.

As discussed in the report, there are other factors that may need to be taken into account, including fallout (due to failure, breakage, removal), free riders, market transformation, and take-back effects. These factors are defined in Section 3.3.5 of this report.

All lighting projects must have some procedures in place for developing these three information elements - Watts Before, Watts After, and Hours of operation. While the baseline calculation only involves Watts Before and Hours of operation, any approach to energy savings calculations must address the process for developing all three pieces of information. The procedures available for collecting these information elements will depend on the design of the project. Two types of project designs are discussed below.

5.4.3 Two types of lighting projects - Market Delivery and Direct Install

Residential energy efficiency lighting projects have typically used two types of delivery mechanisms: direct install where contractors perform the replacements, and other approaches that use market channels to deliver the CFLs to participants (e.g., rebates redeemed at stores, mail order, neighbourhood groups such as churches or schools).

Project Type #1: Market Delivery Projects

Market delivery project designs try to reduce the costs of implementation by eliminating the need to have a contractor visit each participant. These approaches may use rebates that can then be redeemed at a local store or through the mail.[19] Other approaches have used neighbourhood entities (e.g., churches or schools). In some cases, CFLs have been mailed to project participants. All of these approaches seek to reduce costs per CFL installed by finding a less expensive delivery approach than having contractors visit a participant.[20]

While these market approaches may lower the cost per CFL delivered, they also make the savings estimates less certain. Direct install programs have a contractor on site that installs the CFLs and records the three key pieces of information (Watts Before, Watts After, and Hours). How should these key information elements be produced when there is no contractor site visit? Lamp wattage and hours of operation can vary substantially by application in a residence. If a contractor is not doing the replacement, CFLs may be placed in areas where operating hours are low and the replacement CFL wattage may be inappropriate for the location in which it is installed (i.e., it may be too high or too low). This can lead to dissatisfaction with the lighting levels and quality, and the CFLs may be removed prematurely.

The most difficult piece of information to collect with market delivery programs is reliable estimates of ‘Watts Before.’ Once the CFLs are installed and the replaced lamps taken out, it is difficult (if not impossible) to track what was taken out. As a result, many assessments require market delivery projects to identify participants as they participate. This allows some direct observation of the lamps being removed establish an actual ‘Watts Before’ value. The simplified protocol recommended here does not go that far, but it does require the tracking of program participants so that a sample can be contacted for a follow-up monitoring survey.

Project Type #2: Direct Install Projects

Direct install projects have customers signup to participate, then and a contractor visits the residence, performs quick assessment of which lamps are used a sufficient number of hours to warrant a retrofit. This contractor replaces these incandescent lamps with CFLs. For direct install projects, the three required pieces of information are collected for each participating residence by the contractor, i.e., the contractor should:

- Record the Watts of the lamp being removed.
- Record the Watts of the new CFL being installed.
- Develop an estimate of the hours of operation based on location of lamp and discussion with people at the home. When making these initial estimates of operating hours, seasonal effects should be considered. The estimated hours of operation may change as the length of the day changes, i.e., the hours of daylight changes.

These three pieces of information are included in the project database, and as project participants are added, the project database tracks the accrued estimates of savings using these data. In this case, it is important to recognise that this information is available on all the project participants, i.e., this information is available for the population of project participants. At this point, there are two key uncertainties in the estimates of savings – the estimated hours of operation may be in error and the fact that some CFLs may break or be removed.[21] The wattage ratings that are listed by the manufacturer (or available from a wide number of accepted industry sources) are viewed as sufficiently accurate for this calculation.

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[19] There are many pros and cons to each method of delivery. Some advocates of using rebates for CFLs that can be redeemed at qualified stores believe that his helps keep local shop owners happy since they are not bypassed.

[20] An often overlooked advantage of having a contractor visit the site is that they can come with a variety of CFLs that will fit the fixtures and needs of the residence. As a result, a larger number of CFLs may be installed per residence and they are installed in a way that produces the maximum benefit.

[21] The issues of free riders, take back and market transformation are ignored for the moment.

Monitoring and verification of the project savings estimates should focus on reducing these two uncertainties - fallout and hours of operation. This can be done using a monitoring protocol that selects a sample of participants for a follow-up visit. At this visit, all installed CFLs are inspected to see if they are still operational, and inexpensive runtime meters (several types are available) are used to measure the hours of operation of the lamps. These runtime meters are left in place for several weeks and they measure the number of hours that lighting fixture is either on or off. After this period, the meters are either removed or, if appropriate, they can be mailed by the customer back to the monitoring company. These verified hours of operation from the runtime meters are compared against the initial estimate of hours of operation and an adjustment factor is calculated. Using a sample of sites, average adjustment factors for all project sites are estimated. For example, if the initial estimates of operating hours were found to be 10 percent too high, on average, an adjustment factor of 0.9 would be used to reduce the estimate of hours of operation when producing estimates of program savings. To capture seasonal variation in hours of operation, the sample of runtime meters should be spread across seasons.

Performing this monitoring function on a sample of project sites periodically (annually or every 18 months) would provide updated estimates of the key information elements required for estimating electricity savings.

Most programs that use the direct install method of delivery offer more than one type of energy efficiency improvement to warrant the costs of having a contractor visit a site. Measures such as weatherisation and window treatments can all be addressed during a single visit. For the CFL lighting projects, a direct install program would provide the highest certainty that impacts are being accurately estimated.

5.4.4 Baseline and monitoring approach

This section describes an approach for establishing a project baseline that can be used by any energy efficiency CFL lighting project. For Direct-Install projects, in theory, this baseline assessment step is not needed since the data collected on each project participant effectively establishes the baseline for that participant. The project baseline is then the sum of each participant's baseline. Since Watts Before and Hours of operation will be collected on every project participant, the information will be available for the population of participants. This provides for the most accurate assessment of project impacts. However, if a baseline is needed prior to the project being approved and delivered into the field, which is the case in CDM, the same baseline procedure presented below is needed. This also depends on the status of development of the Direct Install project at the time of baseline development for a CDM proposal.

However, Market-Delivery projects (delivering to numerous participants) do not collect this information on each participant. As a result, an alternate method is needed for baseline development. The planning stage of most energy efficiency projects will require information on the size of the target market, and ancillary information on the characteristics of customers and their willingness to participate in a lighting project will also improve program plans. The baseline assessment can provide project planners with needed information that can improve the overall efficiency of the project delivery.

Establishing the Project Baseline

The project baseline will establish baseline usage levels for lighting among the target group of project participants. Six steps are proposed for baseline assessment for CFL projects. Each is described below.

Step One - Specify the area targeted by the project. This might be a specific city, several cities or a region.

Step Two - Draw a sample of 100 sites that represent the target market for the project. These sites are expected to be residences that will have a number of lamps present. The adequacy of this sample will be judged based on its representativeness of the target market, e.g., income levels, family size, and house size should be similar to the target market.

The reason for a sample size of 100 residences is that for most projects, regardless of project size, it is a robust sample size. In case of extremely small programs with installations at less than 500 residences, then this recommended sample size is a 20% sample of the population and a smaller baseline might be warranted (i.e., the finite population correction factor could become important). However, for any projects that hope to reach more than 500 sites, this sample size is believed to be needed. In addition, the sampling for the project baseline is not drawn from a well-defined population of participants, but is carried out in advance of installation so a sample size is needed that covers the spectrum of sites that might participate. Also, if the baseline sample is used to produce an initial estimate of free-ridership, the sample size should be large enough too provide a reasonable chance of finding installed CFLs, if CFLs are already being installed in this region without the program being implemented. The fraction of times in which this occurs will be the initial estimate of free-ridership.

To help ensure representativeness, it is strongly recommended that the sample be drawn using three strata. While the specific stratification scheme is left up to the project developer, the default stratification should be three geographic areas each representing approximately one third of the target market. Three is selected as the minimum number of strata to be used because a large number of statistical studies show gains in estimation efficiency for most any population when up to three strata are used.[22] In the ILUMEX report, four strata were used (World Bank, 1999a).

Step Three - Each site in the sample would be visited by a contractor. The contractor would conduct a simplified lighting survey of the residence. This would involve the following activities:

1. A count of the number of lamps (e.g., number of 60 Watt lamps, 100 watt lamps, etc.). The wattage ratings of lamps do not need to be metered. Ratings from manufacturer's specifications for incandescent lamps or from lighting tables that have been approved for use will be deemed accurate for this purpose.
2. Initial estimate of daily operating hours for each lamp (week-day and week-end days). This estimate would be based on the experience of the contractor and information obtained from the customers regarding which lamps they use most. These would all be recorded in a lighting survey form. These initial estimates of hours of operation must take into account seasonal effects, i.e., a best guess of winter versus summer operating hours under different daylight assumptions with an extrapolation for the months in between.
3. Based on these initial estimates, the auditor would identify those lamps that are candidates for replacement by CFLs under the conditions of the project.
4. As a check on the initial hours of operation estimates for those lamps identified as candidates for replacement by CFLs, runtime meters would be installed and left behind on a minimum of two and a maximum of four lamps. These runtime meters would be recovered by the project developer after two weeks of operation. The operating hours obtained from these runtime meters would be compared to the initial estimates. An adjustment factor comparing initial estimates to runtime metered hours would be developed for that site, and recorded on that site's lamp survey form.

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[22] The gains in estimation efficiency that result from stratification will depend upon the properties of the population from which sample is being drawn. This protocol proposes the use of three strata since a wide range of statistical applications show gains in estimation efficiency up through three strata and then a leveling off of benefits as stratification exceeds three strata. As a result, the use of three strata almost always improves estimation efficiency where higher levels of stratification provide less certain benefits.

Step Four - Average Watts Before and Operating Hours will be determined for the target market. This will be calculated *only* using information from those lamps that were determined to be candidates for cost-effective CFL replacement. An average baseline 'Watts Before' will be calculated using all the lamps that were viewed as candidate for replacement by CFLs.

Average operating hours will be calculated by:

(Estimated operating hours for all candidate replacement lamps)t
(Project adjustment factor for operating hours)

Where the project adjustment factor is the actual operating hours from runtime meters divided by the estimated hours for each lamp on which a runtime meter was installed.

Step Five - Use the average Watts estimates and average Hours estimates for lamps that are candidates for CFL replacement to calculate the project wide baseline using the projected total number of sites and CFLs installed.

In planning their projects, developers will need information on the average number and wattage of lamps that might be replaced by CFLs before they can evaluate the economics of their own project. This baseline assessment procedure would provide that information and also allow project developers to assess customer response to various incentive, rebates, delivery and marketing methods. As a result, the cost of the baseline is not viewed as excessive given the opportunity provided for improved programs design.

Step Six - Assess the importance of other factors: free riders, market transformation, free riders, and fallout.

Free riders will be assumed to be zero unless the baseline study shows that some residences have already installed CFLs. If the number of CFLs installed is so low that none turn up in the 100 site survey, an assumption of zero free ridership is likely reasonable.

Take back is assumed to be zero per the argument included in the main document which reflects the fact that take back represents the customer receiving higher levels of service (see also Section 3.3.5).

Market transformation is also assumed to be zero but, if the monitoring study can demonstrate the existence of market transformation effects, it can be added on to the net savings estimates to a maximum of 15%. This figure is based on US experience.

Two guidelines for market transformation can be given:

1. One guideline that could be used to for establishing market transformation and also free riders would be for each project to conduct samples of non-participants with a minimum sample size of 100 to see if CFLs have non-participants may have installed CFLs. If it can be established that they would not have installed these CFLs if the program had not existed, e.g., they heard about CFLs from their neighbours, or attained availability through the program but did not apply for the rebate; then it can be argued that market transformation in the form of non-participant project spillover has occurred - residences outside the boundary of program participants have benefited from the program.
2. A second type of market transformation occurs when participants buy additional CFLS, but not through the project. They experienced energy savings from CFLs and therefore bought more without participating in the direct install program or applying for rebates. This is termed participant project spillover and can be found through the periodic studies that are examining Fallout.

Estimates of fallout, i.e., the share of installed lamps that are not operational any more (broken, removed, failed etc.), cannot be developed from a baseline study. The monitoring study will develop the fallout numbers. However, as a starting point for, fallout number of 5% first year, 2% second year, and 3% thereafter will serve as the baseline values. Thus, one year after installation 95% of the lamps are assumed to be in working condition, 93% after two years, 90% after three years, and 87% after four years. Experience has shown that first year breakage and takeout is relatively high. If the equipment survives in-place the first year without being removed, then it is likely to last several years. Some people find that the CFL lamps produce lower quality light, or not enough light for the space, or do not fit new lighting fixtures. These dissatisfied 'customers' tend to take the lamps out in the first year. After the first year, this dissatisfaction effect is lower. However, a program could be designed to reduce this effect if it is a direct install program since the people in the house can be shown the lighting of the CFL and CFLs can be better sized. Low initial year estimates may be appropriate for 'direct install programs'. The initial estimates proposed here are probably best for market-based programs. It should be noted that these are only interim figures. They will be replaced with actual information from the monitoring study.

Monitoring protocol
The baseline provides a starting point regarding the assumptions needed to calculate net project savings. Monitoring is required for both Direct Install and Market Delivery programs. The purpose of the monitoring is to verify the accuracy of the initial estimates developed in the baseline study. The procedure to be used for monitoring is the same as was conducted to produce the baseline assessment, with the additional task of assessing fallout. However, if the project developer wants to claim credit for market transformation, a different sampling design and study protocol will likely be appropriate.

The monitoring study will include periodic onsite visits to a sample of project participants. The estimates to be verified include:

- Watts Before: Based best estimate and comparison to standard practice.
- Watts After: Based on inspection of CFL lamps installed.
- Hours of operation (with seasonality addressed): Based on additional runtime meters of two-week intervals.
- Fallout: Based on inspection of CFLs to see if they are all still installed and working.
- Other effects: If a measure of market transformation is proposed by the project developer, this can be addressed in the monitoring study.

The recommended procedure for the selecting sites for monitoring is:

- Phase 1: After 18 months: 25 sites but not more than 10% of the total participating sites. During this first year and half's assessment, each sample site should have run-time data collected during summer and winter seasons. This seasonal requirement for each site does not continue through subsequent years' monitoring efforts. In subsequent years, the larger sample sizes should produce sites that have runtime measurements made during different seasons. This information will be used to develop an adjustment factor for seasonal operating hours that can be applied to initial estimates.
- Phase 2: After 36 months: 50 sites but not more than 10% of the total participating sites, with 25 sites coming from first phase (18 months) participants and 25 coming from second phase participants.
- Phase 3: After 54 months: 60 sites but not more that 10% of total, with 20 sites coming from phase 1, 20 from phase 2, and 20 from phase 3, etc.
- Phase 4 and 5 (depending on selected crediting period): After 72 and 90 months: 60 sites are required for each with strata of 20 sites selected to represent the first one third of the par-

ticipants (based on length of time in the project), 20 sites from the second third of participants, and 20 participants from the last third (i.e., the most recent participants).[23]

5.5 Summary of streamlined M&V procedures for small-scale renewable energy projects

Category	Subject of streamlining	Proposed streamlining measure
All small projects		
Project design document	Project size and categories	Allow bundling of similar small projects (maximum size of bundled projects in accordance with size definition of small project in Bonn Agreement).
Validation	Use of OE	Require only one OE in the whole process, instead of a separate OE for validation and verification/certification.
Validation	Environmental Impact Assessment	No additional requirements beyond host country's EIA processes.
Verification	Crediting time	Require periodical in stead of annual verification and certification reports.
Grid-connected RE projects		
Validation	Estimation of kWh	Allow use estimated kWh in PPA as basis of kWh use (Access to PPA for validator is required). In case a load sensitive project baseline is used, the estimated sales in different load cycle tariff classes of the PPA can be used to estimate specific emissions per load cycle.
Monitoring	Monitoring of kWhs produced	A copy of the sales reports indicating the produced electricity to the client of the electricity is allowed. In the case of load sensitive cycles, the delivered kWhs per load cycle indicated in the sales reports can be used for the estimation of emissions per load cycle.
Verification	Verification of kWh produced	To prove the actual sales of the reported electricity, the project can send a written declaration of an external accountant/auditor that sales reports of the produced electricity has been verified and audited. (Only officially registered accountants: check with auditors on standards for that.)

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[23] The rationale for having the monitoring sample level off at 60 sites in Phase 4 and 5 is predicated on the fact that this sample is building on information collected in prior samples, i.e., it only has to confirm previously found results. It also uses the general rule of thumb that three strata are quite certain to produce benefits in terms of the efficiency of the estimate, and the sample size of 20 is selected since the test statistics used to establish confidence intervals (t-values or z-values) level off in magnitude at around a strata sample size of 20 even for large populations. The overall sample size of 60 across three strata drawn from a well-defined population of participants would have a t-value of 1.296 with an alpha equal to.10 (i.e., a ten-percent tail to the sampling distribution). A sample size of 120 would require a t-value of 1.289 to attain the same precision. In the extreme, as the sample approaches infinity, the required t-value approaches 1.282. As a result, this sample size is judged reasonable for this purpose. One can also consider sample sizes based on the power of the test, i.e., the likelihood of accepting a false positive. The power of the test similarly levels off for sample sizes of 20 per strata and 60 total, regardless of the size of the population (i.e., the total number of project participants).

Mini-grids using hybrid renewable/diesel		
Validation	Estimation of system capacity	-
Monitoring	Monitoring of kWhs produced	A kWh meter specific for the renewable component is required to measure the renewable kWhs. In case battery storage is used, the kWh meter should be placed after battery to incorporate possible battery losses; Diesel baseline: 1. Copy of system specifications of the supplier indicating the GHG emissions per kWh or efficiency of the engine. 2. In case of measuring actual efficiency of the engine: Monitor electricity generation by using a kWh meter and monitor fuel consumption on basis of invoices.
Verification	Verification of kWh produced	Written statement to OE by local accountant/auditor that reported kWhs meter of renewable component has been verified (in case of diesel baseline option 2: also fuel consumption invoices).
Mini-grids using renewable energy sources or 100% stand-alone renewable electricity generating applications		
Validation	Estimation of kWh	-
Monitoring	Monitoring of kWhs produced	A kWh meter specific for the renewable component is required to measure the renewable kWhs. In case battery storage is used, the kWhs reported should be corrected for the battery losses. In case of multiple installations in the project and each installations is smaller than a certain size in kW, the kWh meter need only be installed in a sample of the systems.
Verification	Verification of kWh produced	Written statement to OE by local accountant/auditor that reported kWhs meter of renewable component has been verified.
Individual household technologies (SHSs, wind battery chargers, pico-hydro)		
Monitoring	Reporting of system sales	Copies of company's financial records indicating the sales of the systems can be used for reporting the system sales. To prevent double-counting of PV panels, the serial number used in the project can be verified with the financial records of the PV panel producer.
	Monitoring of system performance	Appropriate maintenance records on the client's system performance are allowed to be used. In case no maintenance records are available, a household survey can be used to show the availability. To reduce transaction costs, such a survey could be implemented by an independent third party in co-ordination with the OE in order to prevent a separate field trip by an OE.
Verification	Verification of system sales	Written statement to OE by local accountant/auditor that reported items have been verified.

With regard to CFL lighting projects, there are three elements of information which need to be retrieved:

1. Watts Before - An estimate of the Watts of the lamp being replaced.
2. Watts After - An estimate of the Wattage of CFL lamp being installed.
3. Hours - An estimate of the hours of operation of the lamp to produce Watt_Hours of savings for each lamp.

Streamlined procedures available for collecting these information elements have been developed for two types of project designs (see Section 5.4):
- Market delivery projects.
- Direct install projects.

The various aspects of baseline assessment, monitoring and verification vary according to these two market types and have been further detailed in Section 5.4.

6. CONCLUSIONS AND RECOMMENDATIONS

It is the objective of this study to examine possible standardised baselines and streamlined procedures for selected small-scale CDM activities, including grid-connected renewable energy and energy efficiency projects, CFL lighting projects and off-grid renewable energy projects. In the previous 4 chapters we have examined in detail the key issues related to standardised baselines and streamlined procedures for each of these project categories and selected the methodologies that we think are most suitable.

In this final concluding chapter, we have summarised the recommendations for each of the selected project category:
- Grid-connected small-scale renewable electricity supply projects (6.1).
- Small-scale electricity demand reducing projects (6.2).
- Energy efficient lighting projects in the residential sector (6.3).
- Off-grid renewable electricity projects (6.4).

For each of the sections, we have discussed the eligible project categories, geographical coverage, the developed methodology and possible ways to streamline the monitoring methodologies.

6.1 Grid-connected small-scale renewable electricity supply projects

6.1.1 Eligible project categories

The standardised baseline is expressed as a fixed carbon dioxide (CO_2) emission factor (CEF) for electricity production for each of the relevant years. The standard is expressed in t CO_2/MWh and is applicable for the following grid-connected renewable electricity projects with a capacity below 15 MW equivalent:
- wind
- hydro
- biomass[24]
- solar
- geothermal power projects.

Using the standard baseline of this section exempts eligible projects from filling out Section 2 until 5 of Appendix A of Vol. 2a, as far as the replacement of grid electricity is concerned.

6.1.2 Geographical coverage

The countries for which these baselines apply should first meet the general participation requirements as outlined in Section 2.3.4 of the ToR for C-ERUPT. The countries for which a standardised grid factor for grid connected renewable energy and energy efficiency projects has been developed are listed with their respective emission factors in Appendix D.

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[24] Please note that for biomass projects the standardised CEF can only be used to calculate the avoided CO2 emissions related to electricity generation. To determine other CO2 emission reductions related to the project (for example related to heat production) a project specific baseline (as described in Volumes 2.a and 2.b) should be developed.

6.1.3 Standardised CO_2 emission factors

The standardised CO_2 emission factors have been calculated on basis of the Hybrid Average-Margin baseline methodology[25]. The baseline for each country has been determined for the period 2000 – 2012 based on this hybrid method, which includes the following steps:

Determination of 2000 point:
The baseline for the year 2000 has been determined by calculating the weighted average CO_2 emission factor. First the weighted average power mix, excluding hydro, has been determined for the year 1999 (the most recent data in the IEA database. Next the weighted average CEF could be calculated by multiplying the defined proportion per fuel with the appropriate CEF for that fuel.)[26]. CO_2 emission factors for fossil fuels are taken from IPCC[27].

The emissions baseline for the year 2012 is based on the CEF for Best Available Technology (BAT) for natural gas combined cycle plants.[28] The final baseline is formed by connecting the two points for the year 2000 and the year 2012 through a straight line. Appendix D presents the CEF values per country for the year 1999 as a proxy for the year 2000. The standard is expressed in t CO_2/MWh.

For Caribbean Island States included in the benchmark study for the Caribbean executed by the Centre for Clean Air Policy, a regional CEF benchmark has been adopted. For countries located in the Caribbean the benchmark serves as the standard baselines. The results are also included in Appendix D.

Countries not included in Appendix D
For projects based in countries not included in Appendix D, a project specific baseline will have to be developed. They could adopt the Hybrid Average-Margin Methodology using country specific data by following the Step 1 to 6 below.

Step 1:
Determine the current weighted average power mix, excluding hydro, for the year for which most recent data are available, preferably the year 2000.

Step 2:
Apply CEFs for existing technologies. If country specific emission factors are not available, the CEFs per technology as provided by the Öko Institute can be applied. It should be noted that these factors are in general more conservative compared to country specific factors. In case country specific data on fuel consumption is available, the CO_2 emission factors for fuels from the IPCC can be applied (see Section 6 of Volume 1 of the C-ERUPT guidelines).

Step 3:
Determine the weighted average CEF for the starting point by multiplying the defined proportion per fuel with the appropriate CEF for that fuel.

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[25] See Martens et al, 2001, ‘Standardised Baselines for Small-scale CDM Activities: A proposal for the CDM programme of the Netherlands’, ECN-C--01-098.

[26] IEA, 2001a: Energy Balances of Non-OECD Countries. IEA 2001 Edition. OECD/IEA, Paris.

[27] See Volume 1 of Senter 2001 .

[28] Öko Institute, 1998: *Environmental Manual for Power Development (EM Model)*, see also http://www.climatetech.net/conferences/ostritz/proceed/partIII/GEMIS.PDF.

Step 4:

- Determine the weighted average mix for 2012 based on data of planned future capacity additions. It is recommended to include only those plants that already started construction or have received a regulatory approval (e.g. a concession) in the built margin. Which of these new additions should be included should be defined based on the number plants to be included. It is suggested to include the earliest 5 plants that are expected to become operational. Data on planned hydropower should be included in the mix.
- If no new projects are under construction or no regulatory approval for new additions has been received, then data on recent capacity additions should be used to determine the mix for 2012. Recent capacity additions provide a reasonable basis for estimating future trends, assuming the technical and economic conditions for choosing capacity do not change significantly. The average of the five last most recently built plants determine the mix for 2012. Data on recently built hydropower plants will be included.
- If no data on recently built plants are available, then the BAT for natural gas combined cycle plants can serve as the grid mix for 2012.

Step 5:
Calculate the weighted average CEF for the year 2012 by combining the fuel proportion in the mix calculated for 2012 with the appropriate CEFs.

Step 6:
Connecting the grid factors calculated for year 2000 and the year 2012 through a straight line, to be presented in a graph.

6.1.4 Calculating electricity transmission & distribution losses

Standardised country specific values for electricity transport and distribution (T&D) losses are listed in Appendix E. The above mentioned small-scale renewable energy projects are allowed to make use of these standardised T&D losses if they supply electricity to the low-voltage electricity grid. The total standard grid factors as listed in Appendix E have been calculated by dividing the standard carbon emission factor for electricity production (ex. T&D losses) from Appendix D with (1 - standard T&D losses).

Guidelines for the project specific estimation of avoided technical T&D losses

The standard values can not be used in the following cases. Instead the guidelines in this section can be used to make a project specific estimation of avoided T&D losses:

1. In case a project is connected to a medium voltage grid no T&D losses should be accounted for, unless the baseline developer can show T&D losses are significant using a project specific assessment according to the guidelines listed below.
2. In case the baseline developer can argue that the standard national values for T&D losses are a significant underestimation of the T&D losses relevant to a specific CDM project, a project specific assessment could be made.

The project-specific assessment of avoided technical T&D losses should:

- Include argumentation why the project's technical T&D losses are higher than the national average T&D losses.
- Include estimates of total T&D losses based on the sum of losses of individual components of the system, based on feed-in/grid connection characteristics, voltage level, topography, technical components and technical quality and age of the system.
- Consider the location of the project to production sites or end-users.
- Use data from officially published references by the government/relevant distribution companies/utilities/independent research institutions.

- Exclude commercial or non-technical losses. Only technical T&D losses can be included, which depend on:
  - quality of the T&D networks,
  - technical characteristics of the T&D network (voltage level, topographics etc.),
  - density of the grid,
  - the location of the project in relation to other electricity production units,
  - in case of small-scale decentralised production, the distance between the production site and the end-users,
  - voltage level of the grid connection of the project or end-user.

6.1.5 Streamlined monitoring and verification procedures

Table 6.1 *Streamlined monitoring and verification procedures for grid-connected renewable electricity projects*

Category	Subject of streamlining	Proposed streamlining measure
Validation	Estimation of kWh	Use estimated kWh in Power Purchase Agreement (PPA) as basis of kWh use (Access to PPA for validator is required). In case a load sensitive project specific baseline is used, the estimated sales in different load cycle tariff classes of the PPA can be used to estimate specific emissions per load cycle.
Monitoring	Monitoring of kWhs produced	A copy of the sales reports indicating the produced electricity to the client of the electricity is allowed. In the case of load sensitive cycles, the delivered kWhs per load cycle indicated in the sales reports can be used for the estimation of emissions per load cycle.
Verification	Verification of kWh produced	To prove the actual sales of the reported electricity, the project can send a written declaration of an independent third party such as an external accountant/auditor that sales reports of the produced electricity has been verified and audited.

6.2 Small-scale electricity demand reducing projects

6.2.1 Eligible project categories

All end-use energy efficiency projects that reduce electricity demand from the grid leading to an annual electricity demand reduction of less than 15 GWh.

The standardised CEF for these project categories can only be used to replace the calculation of the CO_2 emission factor of the grid. The determination of energy savings should be established on a project specific basis.

6.2.2 Geographical coverage

The countries for which these baselines apply should first meet the general participation requirements as outlined in Section 2.3.4 of the ToR for C-ERUPT. The countries for which a standardised grid factor for grid connected efficiency projects has been developed are listed in Appendix D.

6.2.3 Standardised CO_2 emission factors

The standardised CO_2 emission factors have also been calculated on basis of the Hybrid Average-Margin methodology for the period 2000 - 2012 and can be found in Appendix A (see Chapter 2 for background).

6.2.4 Calculating electricity transmission & distribution losses

Standardised country specific values for electricity transport and distribution (T&D) losses are listed in Appendix E. The above mentioned small-scale energy efficiency projects are allowed to make use of these standardised T&D losses if they reduce electricity demand provided by the low-voltage electricity grid The total standard grid factor can be calculated by dividing the standard carbon emission factor for electricity production (ex. T&D losses) from Appendix D with (1 - standard T&D losses).

Guidelines for the project specific estimation of avoided technical T&D losses

1. If a project is connected to a medium voltage grid no T&D losses should be accounted for, unless the baseline developer can show T&D losses are significant using a project specific assessment according to the guidelines listed below.
2. In case the baseline developer can argue that the standard national values for T&D losses are a significant underestimation of the T&D losses relevant to a specific CDM project, a specific project specific assessment could be made.

The project-specific assessment of avoided technical T&D losses should:

- Include argumentation why the project's technical T&D losses are higher than the national average T&D losses.
- Include estimates of total T&D losses based on the sum of losses of individual components of the system, based on feed-in/grid connection characteristics, voltage level, topography, technical components and technical quality and age of the system.
- Consider the location of the project to production sites or end-users.
- Use data from officially published references by the government/relevant distribution companies/utilities/independent research institutions.
- Exclude commercial or non-technical losses. Only technical T&D losses can be included, which depend on:
  - quality of the T&D networks,
  - technical characteristics of the T&D network (voltage level, topography etc.),
  - density of the grid,
  - the location of the project in relation to other electricity production units,
  - voltage level of the grid connection of the project or end-user.

6.3 Standardised approaches for energy efficient lighting projects in the residential sector

6.3.1 Eligible project categories

Energy efficient lighting projects in the residential sector are eligible that lead to an annual electricity demand reduction from the grid of less than 15 GWh.

CFL projects are energy efficient lighting projects in the residential sector aimed at replacing a large number of existing incandescent lamps with CFL lamps. In many non-Annex I countries, these projects have been implemented in the past. The projects show a variety of design characteristics, particularly in the (financial) incentives used and implementation mechanisms as well in scale, e.g. the number of replaced lamps, and scope (municipal versus national projects). Two types of residential energy efficiency lighting projects qualify:

1. *Direct Install* where contractors perform the replacements.
2. *Market Delivery* that use market channels to deliver the CFL's to participants (e.g., rebates redeemed at stores, mail order, neighbourhood groups such as churches or schools).

6.3.2 Geographical coverage

The countries for which these baselines apply should first meet the general participation requirements as outlined in Section 2.3.4 of the ToR for C-ERUPT.

6.3.3 Standardised approach for CFL projects

Steps to be taken in the baseline study

Table 6.2 presents the steps that have to be taken in the baseline study for CFL projects.

Table 6.2 *Steps in the elaboration of a baseline study for CFL projects*

A. Define characteristics of project	
1.	Define project participation criteria.
2.	Define target regions and household categories.
3.	Define characteristics of the energy efficiency measures, in this case replacing incandescent lamps by CFLs.
4.	Describe programme (incentives, promotion etc.)
B. Estimate electricity saving per CFL lamp installed	
1.	Estimate power and operational and performance factors of incandescent lamps to be replaced.
2.	Define power and operational and performance factors of CFLs.
3.	Calculate electricity savings per CFL lamp replacing an incandescent lamp.
C. Estimate electricity savings of the total project	
1.	Estimate expected number of project participants and CFL sold over time.
2.	Estimate lamp lifetime.
3.	Estimate total direct electricity savings over time.
4.	Estimate share of free riders.
5.	Estimate indirect effects (rebound, market transformation).
6.	Estimate fall-out (lamps out of operation).
7.	Calculate total electricity savings corrected for free riders, indirect effects and fall-out.
8.	Determine crediting period.
9.	Calculate total electricity savings in crediting period.
D. Calculate GHG emission reduction over crediting period	
1.	Estimate emission factor of electricity production in crediting period.
2.	Estimate avoided transport and distribution losses in crediting period.
3.	Calculate GHG emission reduction from total electricity savings, grid factor and avoided T&D losses in crediting period.

The characterisation of the project is not subject to standardisation, therefore the standardised guidelines for energy efficient lighting project in households ('CFL projects') cover the following four steps:

1. Standardisation of the estimation of electricity savings per lamp.
2. Standardisation of the estimation of the total electricity savings of the project.
3. Standardisation of the estimation of the total GHG savings of the project.
4. Simplified procedures for field auditing for baseline assessment and monitoring.

Estimation of electricity saving per CFL lamp installed
Electricity savings per installed CFL lamp per year and over the lifetime of the lamp are calculated as follows under the assumption that the service level (amount of light) is the same for incandescent lamps and CFLs:

$$Electricity\_Savings\_Lamp\_Year = (Watts_{incandescent} - Watts_{CFL}) \times Operating\_Hours$$

and

$$Electricity\_Savings\_Lamp\_Lifetime = (Watts_{incandescent} - Watts_{CFL}) \times Operating\_Hours \times Lifetime$$

The $Watts_{incandescent}$ of the lamps to be replaced and the operation hours per year are the key baseline determinants and should be estimated through auditing a sample of residential households to determine the baseline current lighting efficiency (wattage) and usage patterns (hours of operation). See section below on simplified auditing procedures for CFL projects. Finally, the wattage of the CFL lamp is a project design parameter and doesn't have to be standardised.

The lifetime of the CFL lamps (in terms of years) can be determined from the operating hours per year and the maximum burning hours of the CFL lamps. The latter is a product characteristic and should be based on product tests and manufacturers' ratings (not standardised).

Estimation of total electricity savings of the project
The size of the CFL project could be expressed in the total number of CFL lamps installed over the duration of the project. The total electricity savings of the CFL project over the lifetime of the lamps can be calculated as follows:

$$Total\_Electricity\_Savings\_Lifetime = Energy\_Savings\_Lamp\_Lifetime \times (Total\_Number\_Lamps\_Installed - Fallout)$$

Fallout
Fallout is the share of installed lamps that are not operational any more (broken, removed etc.). Correcting for fallout in this way is conservative because it assumes no electricity is saved by the fallout CFLs before they are removed, broken etc. This key parameter needs to be estimated in the baseline study and monitored in the monitoring study. Standard values are not possible because of the strong dependence on local conditions and programme design. A standardised and simplified approach can be found below.

In CFL projects, three additional effects can influence the total project impact: free riders, market transformation, and the take-back effect.

Free riders
Free riders are the participants in the CFL projects that would have installed the CFL lamp even without the project. A high share of free riders reduces the net impacts of the project. The share is also dependent among others on the socio-demographic characteristics of the project. If the income level of participants is low, free drivers are likely to be less. The expected share of free riders should be considered in the baseline study and monitored. No standard values can be established because of the strong dependence on local conditions and programme design. A standardised and simplified approach can be found below.

Market transformation effects
The market transformation effect is the increased sales of CFL lamps outside the CFL project that can be attributed to the indirect impact of the project (e.g. increased awareness and improved availability on the market). For instance, the chance that a user replaces a CFL pur-

chased through a CFL project with another one will be higher than without the CFL project. Incorporating market transformation effects increases the impact of the project. These effects are difficult to estimate. Furthermore, standardised baselines should tend to conservative estimates of emission reduction. Baseline developers can always include project specific estimates of market transformation effect in the baseline studies and monitoring procedures.

Take-back effect
The take-back effect is the increase in the use of energy services as a result of the decrease in energy costs. With CFL projects, one can distinguish two effects. The first type of take-back effect can occur in the form of an increase of lighting hours (increased level of the same service). This effect should be considered in the baseline study and be monitored (by field measuring operating hours before and after implementation). No standardised values can be used given the uncertainty involved. The second type of take-back effect can occur in the form of an increase of the level of other energy services resulting from the increase of the household budget. This effect does not have to be considered, because it can be considered as a sustainability and development benefit of CDM.

Estimation of total GHG emission reduction
The total GHG emission reduction can be calculated as follows:

$$\begin{aligned}&\mathit{Total\_GHG\_Emission\_Reduction} = \\ &\mathit{Total\_Electricity\_Savings\_Lifetime} \\ &\times \mathit{Standard\_Emission\_Factor\_Electricity} \\ &\times (1/(1\text{-}\mathit{Standard\_T\&D\_Losses}))\end{aligned}$$

In Appendix D standardised baseline values for the GHG emission factor for electricity production were established in terms of $t\,CO_{2\ eq}/MWh$. These standardised emission factors can be used for electricity saving small-scale energy efficiency projects, including CFL projects, in this case in terms of $t\,CO_{2\ eq}/MWh_{saved}$. In Appendix E standardised baseline values for losses in electricity transport and distribution have been elaborated.

The total standard grid factor has been calculated by dividing the standard emission factor for electricity production (ex. T&D losses) with (1 - standard T&D losses).

Crediting period
The crediting time is the period during which the project can generate CERs. The crediting time for CFL lamps can be set equal to the lifetime of the CFL lamps (typically five years). In this case, the total emission reduction over the lifetime of the CFL lamps equals the amount of CERs generated. In case the installation of lamps takes a substantial period (for instance in the case that a rebate programme runs for two years) the baseline developer can decide to include the installation period in the crediting period accounting for the fact that some lamps are installed during the second year of a two-year project. In this example the crediting period is 7 years.

6.4 Off-grid renewable electricity projects

Off-grid means not connected to a national or regional electricity grid. Instead electricity generation takes place in stand-alone applications without the need for a distribution grid, or uses a mini-grid. There is a continuum in grid size from extremely small (a solar home system with an extra 6 watt connection to a neighbour) to a multi-MW powered grid for a town and neighbouring areas. There are some options for defining the borderline between grid and mini-grid based on distribution voltages (LV versus MV/HV); number of power plants (one for a mini-grid and more than one for a grid) and size of the generator. Proposed is the following practical rule: off-grid includes all mini-grids with total generating capacity up to 15 MW, which corresponds with the definition in Decision 5/CP.6 of small-scale CDM projects involving renewable energy.

Categories of baselines

In most cases, diesel is an appropriate benchmark for off-grid electricity provision in rural areas of developing countries. This category applies to off-grid projects providing power to rural communities and to electric appliances for productive use (such as water pumps, refrigerators, and power for workshops). There is one exemption: very small household technologies are more likely to replace historic household fuels, like kerosene, candles and dry cell batteries. In summary, off grid renewable projects have been divided into five categories:

a. Stand-alone application of renewables for household use.
b. Mini-grids where renewable energy systems provide 100% of the power.
c. Mini-grids with renewables, a diesel generator and storage. The diesel generator is used to reduce required size of the storage capacity and to increase reliability and is run mainly at full load.
d. Mini-grids with renewables, a diesel generator, but without storage. Application of renewables results in fuel savings. Diesel load is not constant.
e. Renewables for water pumping and productive appliances.

6.4.1 Eligible project categories

Off-grid renewable electricity projects smaller than 15 MW eq. qualify to use the standardised baselines in this section if they use the following technologies:

1. Stand-alone household applications with daily energy consumption in the range of 50-500 Wh/d:

- solar home systems,
- pico hydropower,
- wind battery chargers.

2. Mini-grids:

- 100% renewable,
- hybrid systems with storage capacity,
- hybrid systems without storage capacity.

3. Productive appliances (water pumping, milling, etc.)

By ‘hybrid’ systems we mean a system that uses more than one energy source. In the context of off-grid electricity projects this often is a combination of one renewable energy source with diesel, such as a wind-diesel hybrid or solar PV - diesel hybrid. Another possibility would involve more than one renewable energy source, for example a solar-wind hybrid or a solar wind diesel hybrid.

Using the standard baseline of this section exempts eligible projects from filling out Sections 2 to 5 of Appendix A of Vol. 2a.

6.4.2 Geographical coverage

The countries for which these baselines apply should first meet the general participation requirements as outlined in Section 2.3.4 of the ToR for C-ERUPT.

6.4.3 Standardised emission reduction factors for off-grid renewable electricity projects

Stand-alone household applications

This category includes stand-alone household applications with daily energy consumption in the range of 50-500 Wh/d:

- solar home systems
- pico hydropower
- wind battery chargers.

Because of their small size and difficult accessibility, for these projects a standardised emission reduction factor has been calculated. This is the expected baseline emissions minus the expected project emissions.

For small-scale stand alone application of renewables with daily energy consumption in the range of 50-500 Wh/d, annual CO_2 emission reduction figures are given in Table 6.3.

Table 6.3 *Global annual carbon emission reduction figures in kg CO_2 per year for small-scale stand-alone application of renewables*

Technology	Carbon savings [kg CO_2/year]
General: small renewables for household electrification.	75 kg/y + 0.8×Energy kg/y/Wh/d (with Energy = daily load in Wh/d)
solar home systems	75 kg/y + 4×Power kg/y/Wp. [kg CO_2/y]
pico hydropower	75 kg/y + 2 kg/y/W installed capacity
wind battery chargers	75 kg/y + 350×D^2 kg/y/m^2 (with D = rotor diameter)

Mini-grids; 100% renewables and hybrid applications

Four different cases of mini-grids require only two different baseline cases: using a load factor of 25% when the default energy service would be available for 24 hours a day, and 50% when the comparison is based on a limited service level of 4-6 hours per day (see Table 6.4). With a known load factor and diesel generator capacity the resulting diesel emissions factors are shown in Table 6.5.

Table 6.4 *Summary of the mini-grid cases*

Category of mini-grid	Load factor in baselines [%]
100% renewable	25 or 50%[1]
with storage	25 or 50%[1]
without storage[2]	25 or 50%[1]
Productive applications	50%

[1] 25% for 24-hour service and 50% for limited service of 4-6 hours/day.

[2] Please note that for hybrid systems without storage empirical evidence shows that CO_2 emissions per kWh is expected to be higher than the base case. Hence such projects are not likely to qualify as CDM projects. The use of energy storage in the case of hybrid systems is thus highly recommended if GHG savings is an objective of the project.

Table 6.5 *Emissions factors for diesel generator systems [kg CO_2/kWh[1]] for three different levels of load factor[2]*

Cases:	Mini grid with 24 hr service	i) Mini grid with temporary service (4-6 hr/day) ii) Productive applications iii) Water pumps	Mini grid with storage
Load factor [%]	25	50	100
3-12 kW	2.4	1.4	1.2
15-30 kW	1.9	1.3	1.1
35-100 kW	1.3	1.0	1.0
135-200 kW	0.9	0.8	0.8
> 200 kW[3]	0.8	0.8	0.8

[1] A conversion factor of 3.2kg CO_2 per kg of diesel has been used (following IPCC guidelines).

[2] Figures are derived from fuel curves in the online manual of RETScreen International's PV 2000 model, downloadable from http://retscreen.gc.ca/.

[3] Default values.

6.4.4 Streamlined M&V Procedures

Table 6.6 *Small stand-alone household installations*

Category	Subject of streamlining	Proposed streamlining measure
Monitoring	Reporting of system sales	Copies of company's financial records indicating the sales of the systems can be used for reporting the system sales. To prevent double-counting of PV panels, the serial number used in the project can be verified with the financial records of the PV panel producer.
	Monitoring of system performance	Appropriate maintenance records on the client's system performance are allowed to be used. In case no maintenance records are available, a household survey can be used to show the availability (meaning physical in place and still functional). To reduce transaction costs, such a survey could be implemented by an independent third party in co-ordination with the OE to prevent a separate field trip by an OE.
Verification	Verification of system sales	Written statement to OE by local accountant/auditor that reported items have been verified.

Table 6.7 *Mini-grids using hybrid renewable/diesel*

Category	Subject of streamlining	Proposed streamlining measure
Validation	Estimation of system capacity	Feasibility and financial reports used for technical and financial due diligence by the investors/developers.
Monitoring	Monitoring of kWhs produced	A kWh meter is required to measure the renewable kWhs. Monitor of diesel consumption could be done on basis of the invoices of purchased diesel. A system specification of the supplier should be sent with the monitoring data to double-check the claimed emission reductions.
Verification	Verification of kWh produced	Written statement to OE by local accountant/auditor that reported kWhs meter of renewable component has been verified (this could apply also fuel consumption invoices).

Table 6.8 *Mini-grids using renewable energy sources or 100% stand-alone renewable electricity generating applications*

Category	Subject of streamlining	Proposed streamlining measure
Validation	Estimation of kWh	Feasibility and financial reports used for technical and financial due diligence by the investors/developers.
Monitoring	Monitoring of kWhs produced	A kWh meter specific for the renewable component is required to measure the renewable kWhs. In case battery storage is used, the kWhs reported should be corrected for the battery losses. In case of multiple installations in the project and each installation is smaller than 15 kW, the kWh meter need only be installed in a sample of the systems.
Verification	Verification of kWh produced	Written statement to OE by local accountant/auditor that reported kWhs meter of renewable component has been verified.

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APPENDIX A RELATIVE SIZE OF THE PROJECT COMPARED TO NATIONAL GRID

In order to assess in how may countries a project would be qualified as relatively big compared to the volume of electricity of the total grid, a brief analysis of 87 non-Annex I countries has been carried out. The analysis was based on IEA data on total annual generated output per country for the year 1998.

The IEA data provides data for total generated electricity per year, not installed capacity in a country. Hence, the first question is how much electricity could a small CDM project potentially generate? Given the maximum capacity of 15 MW, the type of projects to generate the most kWh are the ones, which could exploit that capacity load factor. Assuming a load factor of 50%[29] (operating hours of 4,380 hours per year), than the amount of electricity generated by the project is 66 GWh.

The next step is to identify how many countries a CDM project could possibly qualify as relatively big as compared to the total installed capacity of the country. For ease of reference these countries have also been referred to as ‘small’ in this study.

The different definitions that were examined for defining small countries in this context are:
1. CDM project are big if they generate more than 1% of the total electricity output. Assuming the CDM project generates 100GWh per year, this implies that the country would qualify as ‘small’ if the country has an annual output of 10TWh or less (hence cut-off rate is 10 TWh).
2. CDM project is big if it generates more than 2% of the total electricity output. (cut-off rate is 5 TWh).
3. CDM project is big if it generates more than 10% of the total electricity output. (cut-off rate is 1 TWh).

In total a number of 87 countries have been included in analysis.

Criterion	Number of countries where a project qualifies as relatively large (= small country)	Number of countries where project is relatively large and country small [%]
1	33	38
2	16	18
3	4	5

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[29] This 50% load factor can be considered as an average load factor for small scale projects considering that it concerns geothermal, biomass and hydro plants which can operate at a high load factor as well as wind power projects which in general operate at a 30-35% load factor.

APPENDIX B INTERCONNECTION OF GRID SYSTEMS

The table below presents the results for those countries that have an import or export larger than 20%. The analysis indicates that there are several electricity interconnections between countries, although in Africa, many are in the design phase. It seems that hydropower is very suitable for export, since the major exporters of electricity rely mainly on this type of power generation. The table also lists the country-specific CO_2 emission factors (CEF). The country-specific remarks in the table below gives insight in the electricity flows between countries.

Table B.1 *Percentage of import and export for the countries importing or exporting more than 20% for 1999. CO_2 emission factor for each country is based on the year 2000 (data source IEA, 2001)*

Country	Annual electricity consumption [GWh/yr]	Of which imports are [%]	CEF for domestic generation [t CO_2/MWh]	Country-specific remarks
Benin	372	88	1.086	Imports via WAPP (from Côte d'Ivoire?).
Congo (Brazzaville)	283	66	1.593	Imports much from Congo (Kinshasa); high but unused hydro potential.
Kyrgyzstan	11264	57	0,410	connected to ERRA, exports hydropower to Kazakhstan and Uzbekistan.
Moldova	5384	29	0.523	connected to ERRA.
Mozambique	1537	23	0.330	From South Africa and Congo (Kinshasa), Joint Dispatch: SAPP.
Namibia	2245	49	0.879	From South Africa, Joint Dispatch: SAPP.
Tajikistan	15611	23	0.519	Imports from Uzbekistan, Kyrgyzstan.
Togo	528	81	1.375	Imports via WAPP (from Côte d'Ivoire?)
Zimbabwe	12359	43	1.392	From South Africa, Joint Dispatch: SAPP.
Congo (Kinshasa)	4666	23	1.115	Exports to Congo (Brazzaville) and via SAPP.
Côte d'Ivoire	3752		0.897	Much hydro, exports via WAPP to Benin, Togo, Ghana.
Kyrgyzstan	11264		0.410	connected to ERRA.
Mozambique	1537		0.330	Joint Dispatch (SAPP).
Paraguay	6008		0.437	Major exporter of hydro-power to Brazil and Argentina (binational projects).
Tajikistan	15611		0.519	Exports much of its hydropower to Kazakhstan.
Zambia	6530		0.903	Joint Dispatch (SAPP).

SIEPAC (Sistema de Interconexion Electrica para America Central) includes El Salvador, Guatemala, Honduras, Nicaragua, Costa Rica, Panama.

SAPP= South African Power Pool, includes: Namibia, Botswana, Zimbabwe, Lesotho, Swaziland, South Africa, Mozambique, Zambia.

WAPP (West African Power Pool) to be installed, including Côte d'Ivoire, Benin, Ghana, Togo, Burkina Faso (under construction), Mali (in study), Guinea (in study).

ERRA (Regional Association of Energy Regulators) includes Albania, Armenia, Bulgaria, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Poland, Romania, Russia and Ukraine.

By looking at the information in the tables, more information can be obtained about countries possibly working together in a joint dispatch or sharing electricity. If the grid, to which the country is connected, is taken as the CEF, the baseline of a project may change considerably. Table B.2 lists the different groups that were identified in Table B.1. For each of the multiple grid systems the regional CEF is presented.

Table B.2 *CEF per possible grid. By looking at the country-specific CEF and comparing it to the grid-specific CEF, it can be shown whether a standard baseline should be developed per country or rather per grid (data source IEA, 2001)*

Pool	Countries	Group-CEF
SAPP[1]	South-Africa, Zambia, Zimbabwe, Mozambique, Namibia.	0.921
SIEPAC	Panama, Costa Rica, Nicaragua, Honduras, Guatemala, El Salvador.	0.635
WAPP	Ghana, Togo, Benin.	0.877
Stan-group without Kazakhstan	Tajikistan, Kyrgyzstan, Uzbekistan, Turkmenistan.	0.621
Stan-group with Kazakhstan	Tajikistan, Kyrgyzstan, Uzbekistan, Turkmenistan, Kazakhstan.	0.954

[1] No data on Swaziland, Lesotho and Botswana

The comparison between Table B.1 and B.2 indicates that within a grid or power pool, CEFs can vary considerably. In the SAPP for instance, Zimbabwe has a low CO_2 efficiency of 1.4 t CO_2/MWh, whereas Mozambique is very efficient with a CEF of 0.3 t CO_2/MWh. It is recommended to do some more research on whether the countries are really interconnected in a shared electricity net, before taking any further conclusion on which CEF should be applied as the emissions baseline for a CDM project.

APPENDIX C PRACTICAL CASE STUDIES FOR COUNTRY CEFS

The idea at the beginning of this study was to test the methodology, by applying it for 10 different priority countries. The 10 countries were selected by the Ministry of VROM and include Bolivia, China, El Salvador, Guatemala, Honduras, Indonesia, Nicaragua, Peru, Philippines and South Africa. The country specific data had to be collected based on a desk study.

Beginning of October this year the project team started to contact the 10 selected host countries with the request to assist us in collecting the following data:
- Data on generated electricity by fuel sources (i.e. hydro, nuclear, coal, gas etc.) for the year 1999 or 2000.
- Emissions factors.
- Electricity expansion plan(s) for the future; i.e. which plants are expected to become operational in the next 5 to 10 years or so.
- Information on the most recent additions (i.e. year at which plants were commissioned).
- Information about the electricity grid system in the country, is there one national grid or multiple regional grid systems?

The data on generated output are also available at for example IEA, but host countries tend to have more accurate data that are also plant specific. The IEA data are at a higher aggregated level and do not provide an insight in technologies used, date of commissioning of the plants, information on the most recent additions, etc.

For Peru and the Philippines the data were already available, because a member of the project team had already been working on developing a baseline in these countries. In both countries data were collected from the national power institutes during a field visit. By the beginning of November, we had only received a response from Bolivia and South Africa. For the other 6 countries no data were received. For South Africa, we did receive the data for defining the system average, but no data on recent additions or future plans were received. For all countries, the data collected does not include data on electricity import or export. None of the countries provided data on emission factors of currently operational plants.

So we could only test the methodology for the 3 countries for which we received all the data (for year x as well as year 2012), being Bolivia, Peru and the Philippines. Below we will discuss our approach per country for each step in the baseline method (i.e. step 1 to 6).

C.1 Determining the system average

This section discussed how the system average for each of the three countries has been determined.

Bolivia

For Bolivia data were collected at the national level. Data were received from the 'Superintendencia Electricidad', which is the authority responsible for regulating the activities of the electricity sector (SE, 2001). The current fuel mix consists for hydropower plants, natural gas fired gas turbine plants and oil fired internal combustion power plants. The results are included in the Table C.1 below.

The next step was excluding hydro from the total mix and determine the proportion of natural gas fired and oil fired plants as a proportion of the total mix, minus hydropower. Proportions of the mix are 86% gas fired plants and 14% oil fired plants.

Table C.1 *Grid mix Bolivia for the year 2000*

Generated Output for 2000 [GWh]				
Utility	Hydro	Gas (GT)	Oil (IC)	Total
Corani	773.77			773.77
COBEE	1043.04	23.72		1066.76
EGSA		918.07	3.31	921.38
Valle Hermoso		361.18	215.59	576.77
Rio Electrico	56.28			56.28
H. Boliviana	6.92			6.92
Synergia	22.65			22.65
CECBB		78.06		78.06
Total	1902.66	1381.03	218.9	3502.59

Peru

Since recently, Peru has one national grid system and data were collected at the country level. Data were provided by the 'Ministerio de Energia y Minas, Anuario Electricidad estadistico 1999'. Data on electric output per power plant is provided, including the technology used for each of the power plants. The existing fuel mix consists of the same sources as for Bolivia, being hydro, natural gas and oil fired power plants. The results are presented in Table C.2 below. Proportion of the mix excluding hydro are presented as well.

Table C.2 *Grid mix Peru for the year 1999*

Fuel	Technology	Output [GWh]	[%] Mix
Hydro		15948108	
Natural Gas	Simple Gas Turbine	825198	0.24
Oil fired	Combined Cycle	56947	0.02
	Gas Turbine	678840	0.20
	Internal Combusion	728047	0.21
	Steam Turbine	1099848	0.32
Total Output		19336988	
Total Thermal		3388880	

Philippines

For the Philippines data for the country as well as for the different grid systems were collected from the Annual report of the National Power Corporation for 1999. Luzon is the main grid system in the Philippines and therefore only data on the grid system for Luzon have been calculated. For comparison, we also made calculations for the country as a whole. Data from public as well as independent power producers are included in the calculations. The data does not provide information on technologies used and only subdivides per fuel source. The results are presented in Table C.3 and C.4 below.

Table C.3 *Grid mix for Luzon*

	NPC	IPP	Total excluding hydro
LUZON	*14381*	*16351*	*27446*
Oil-Basel	2799	6178	8977
Hydro	2631	655	3288
Geothermal	4136	3215	7351
Coal	4815	6303	11118

Table C.4 *Grid mix for Philippines at national level*

	NPC	IPP	Total excluding hydro
Philippines	*21068*	*18609*	*32112*
Oil-Based	3251	6835	10086
Geothermal	6092	4556	10648
Coal	4815	6563	11378

South Africa

For South Africa data were collected from the statistic for 1999 from the National Electricity regulator (www.ner.org.za). Similar to the Philippines, the data are collected from the national power corporation Eskom, as well as from municipalities and independent power producers. Data from all three sources have been added and the grid mix is calculated at the national level. The data are subdivided per fuel source and do not provide information about technologies used. The results, including proportions of the mix excluding hydropower, are presented in Table C.5 on the next page.

Table C.5 *Grid mix for South Africa for 1999*

Total for the country	Output [GWh]	[%] Mix
Coal	173339	0.93
Hydro	1057	
Nuclear	12837	0.07
Bagasse/Coal	196	0.00
Oil fired GT	4	0.00
Total	187433	
Total excluding hydro	186376	

C.2 CEFs for existing technologies

For none of the 10 countries we have been able to collect country specific emission factors. Therefore, the technology emission factors provided by the Environmental Manual for Power Development (EM model) of the Öko institute have been used (see Table 2.2). For those countries for which no information about technologies used was available, the average CEF per of all technologies for a specific fuel has been used. The factors calculated for oil and natural gas are 0.784 t CO_2/MWh and 0.525 t CO_2/MWh respectively.

C.3 Calculation of the emission factor for starting point

The emissions factor for year x can now be calculated by multiplying the proportions of each fuel (or technology if available) in the mix, with the respective carbon emissions factor as included in Table C.5. This resulted in the following emission factors:

- Bolivia 0.673 t of CO_2/MWh for the year 2000.
- Peru 0.769 t of CO_2/MWh for 1999.
- Philippines 0.563 t of CO_2/MWh for 1999 and 0.656 t/MWh of CO_2 in Luzon.
- South Africa 0.918 per ton of CO_2/MWh for 1999.

C.4 Calculation of the grid mix for 2012

The grid mix for 2012 based on built margin has only been calculated for Bolivia, Peru and the Philippines.

All data provided on recent and/or future additions were provided in installed capacity and thus the plant factor had to be calculated. The plant factors have been calculated using data from the World Energy Outlook from the International Energy Agency (IEA). We used the data on projected installed capacity and generated output for the year 2010, provided in regional reference scenario's. For Bolivia and Peru data from the reference scenario for Latin America were used, for the Philippines data from the reference scenario for South Asia. See also Table 2.3.

Bolivia

For Bolivia, data on recent additions as well as future additions were provided. The grid mix for 2012 was calculated by determining the proportion of each fuel compared to the total installed capacity of additions.

We made two different calculations. For the first calculations (further referred to as BM1) data on additions were selected, based on a time period (results in Table C.6). Built Margin in the table below, refers to the fact that data on recent additions have been used where Build Margin refers to the use of projected or new additions only. Finally, we also calculated the Build Margin by including the plants added in the period 1998 - 2003. The results of the Build Margin defined based on a quantity of plants are also presented in Table C.6.

Table C.6 *BM 1 for Bolivia in 2012 - selection based on time period*

Built Margin	Corrected with plant factor Output [GWh]	[%] Mix
Hydro	229460	0.12
Gas	1697232	0.88
Total	1926692	
Built Margin	Corrected with plant factor Output [GWh]	[%] Mix
Hydro	3786872	0.77
NG GT	1107826	0.23
Oil	8	0
Total	4894706	
Recent and new additions	Installed capacity [MW]	[%] Mix
Hydro	125.12	0.28
Gas	359	0.72
Total	484.12	

For the second calculations (BM2), data on additions were selected based on the quantity of plants. In Table C.7 Built Margin was defined by including the 5 most recently built plants. Build Margin is defined by including the three plants that are at the moment under construction.

Table C.7 *BM-2 based on selection of quantity of plants*

Built Margin last 5 plants	Installed capacity [MW]	Corrected with plant factor Output [GWh]	[%] Mix
Hydro	23.6	114730	0.11
Gas	209	890522	0.89
Total	232.6	1005252	
Build Margin under construction	Installed capacity [MW]	Corrected with plant factor Output [GWh]	[%] Mix
Hydro	101.52	493534	0.44
Gas	150	639130	0.56
Total	251.52	1132664	

Peru

For Peru, data from the national expansion plan until 2012 have been included. It is projected that between 2004 and 2012 ten new power plants will be build with a total installed capacity of 2186 MW. No data on recently built power plants were available.

Table C.8 *Build margin mix for Peru*

Built	Corrected with plant factor	
Margin	Output [GWh]	[%] Mix
Hydro	655248	0.08
CC diesel	4.80000	0.54
Diesel ST	1752000	0.22
NG CC	1287720	0.16
Total	8074968	

Philippines

For the Philippines, data on future additions are available up to the year 2006. Most of the 6 projected plants will be added to the Luzon grid. However, a new coal plant will be built on one of the other islands. This plant is included in the built margin grid mix that was determined at the country level for the Philippines.

Table C.9 *Build margin for 2012 in Philippines*

Philippines National level	Corrected with Plant factor	[%] Mix
Hydro	3196383	0.296119
Natural Gas	6562600	0.607962
Coal	1035385	0.09592
Luzon	Corrected with Plant factor	[%] Mix
Hydro	3196383	0.33
NG	6562500	0.67
Total	9758883	

C.5 Calculation of the grid factor for 2012

In order to calculate the weighted average CEF for the year 2012, the fuel proportion calculated has to be multiplied with the respective carbon emission factors for 2012. The emission factors depend on the efficiency of the plants to be installed. Since the plants are still to be build, it is difficult to assess what the efficiency of the new plants will be. It is assumed that new plants will at least have a higher efficiency than the existing plants. The following factors will be used as CEFs for 2012:

- For new to be built natural gas plants it is assumed that all plants will use the combined cycle technology. The emission factor provided by the Öko Institute for NGCC is 0.406 t CO_2 per MWh.
- For oil and diesel fired plants it is assumed that all new plants will be using combined cycle technology, with an emission factor of 0.650 t CO_2/MWh (Öko).
- For coal fired power plants, the CEF for advanced coal technology, as provided by the EIA will be used. The factor is 0.722 tons of CO_2/MWh.
- For those plants for which information on technology used is known, the following data will be used:
  - Natural gas turbine fired by natural gas; the CEF as provided for advanced natural gas turbine from EIA will be applied (0.464 t CO_2/MWh).
  - Combustion turbines fired by diesel or oil: 0.735 t CO_2/MWh.

When multiplying these emission factors with the proportions calculated in Section C.5 we come to the results presented in Table C.10.

Table C.10 *Grid factors Bolivia, Peru and Philippines for 2012*

Country	Grid Factor 2012 [t CO_2/GWh]
Bolivia Build Margin	105
Bolivia Built Margin	409
Peru	577
Philippines Country	316
Luzon grid	273

C.6 Development of the baseline

The baseline has been developed by connecting the grid factors calculated for year x and the year 2012 through a straight line. The results are presented in the Figure C.1.

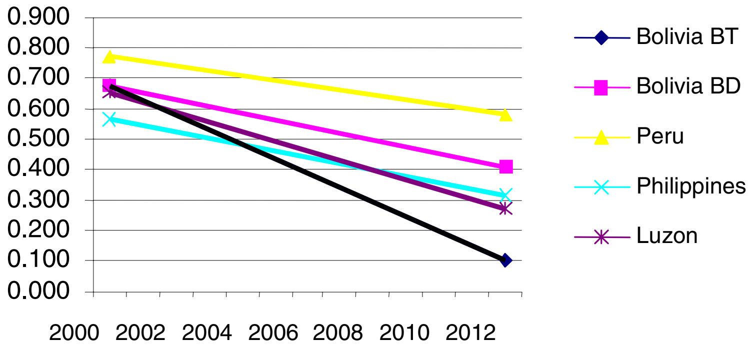

Figure C.1 *Country specific grid factors for the selected case studies*

Table C.11 *Final results per country*

Country	Grid factor [t CO_2/MWh] Grid factor 2000	Grid factor 2012
Bolivia BT	0.673	0.105
Bolivia BD		0.409
Peru	0.769	0.577
Philippines	0.563	0.316
Luzon	0.656	0.273

For the other countries the 2000 figures are given in Appendix D on basis of the IEA data. The 2012 figure is the CEF for the Natural gas BAT: 0.406 t CO_2/kWh.

Comparison of the country specific figures and the IEA data

Figures C.2 to C.5 show the emission factors for the selected countries on basis of the IEA data and compare them with the emission factors of the country specific (CS) analysis. For CDM projects located in the Caribbean, the CEF as calculated by the Centre for Clean Air Policy (CCAP) is applicable (see Appendix D). For Peru and the Caribbean are the results in line with the expectations of Figure 2.2, because the other countries' grid factors for 2012 include hydro-power.

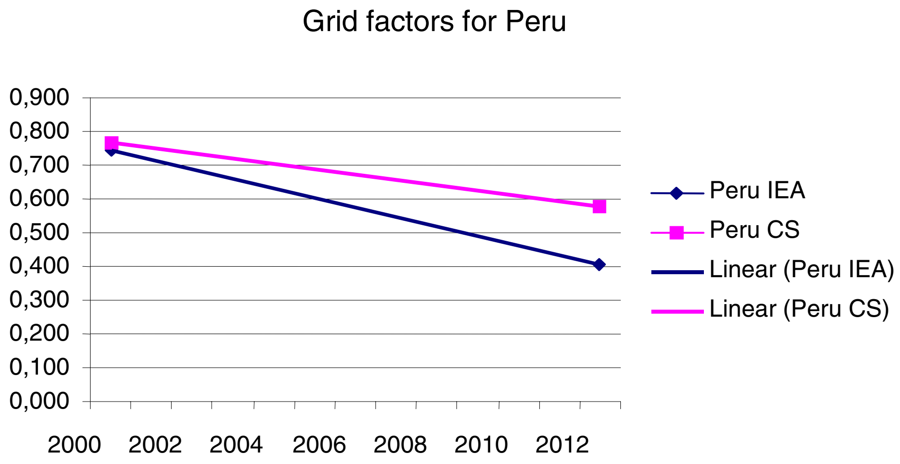

Figure C.2 *Grid factors for Peru*

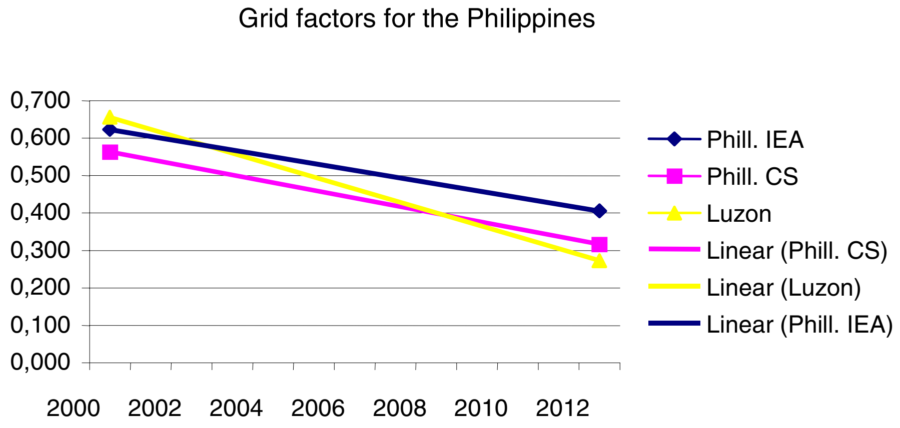

Figure C.3 *Grid factors for the Philippines*

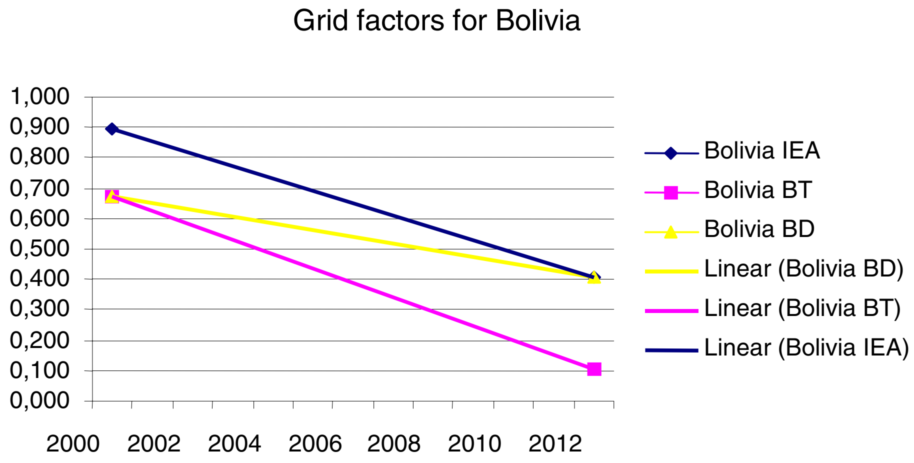

Figure C.4 *Grid factors for Bolivia*

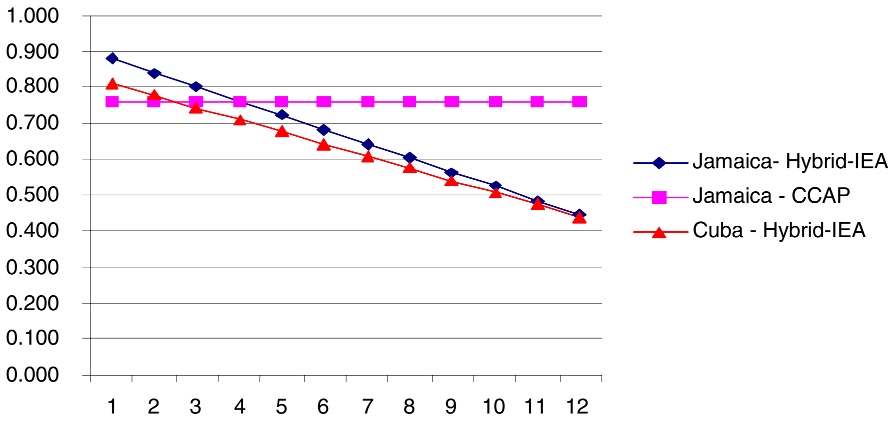

Figure C.5 *Comparison CCAP benchmark and Hybrid method*

APPENDIX D STANDARD VALUES FOR ELECTRICITY GRID FACTORS

Country	Grid CEF excl. T&D losses	Country	Grid CEF excl. T&D losses	Country	Grid CEF excl. T&D losses
Algeria	0.731	Guatemala	0.820	Peru	0.747
Angola	1.048	Guyana	0.759	Philippines	0.623
Antigua	0.759	Haiti	0.689	Qatar	1.123
Argentina	0.494	Honduras	0.662	Republic of Moldova	0.523
Armenia	0.251	India	1.055	Saudi Arabia	0.491
Azerbaijan	0.632	Indonesia	0.710	Senegal	0.922
Bahamas	0.759	Iraq	0.562	Singapore	0.927
Bahrain	0.856	Islamic Republic of Iran	0.612	South Africa	0.911
Bangladesh	0.634	Israel	0.832	Sri Lanka	0.656
Barbados	0.759	Jamaica	0.759	St. Kitts	0.759
Belize	0.759	Jordan	0.747	St. Lucia	0.759
Benin	1.086	Kazakhstan	1.356	St. Vincent	0.759
Bolivia	0.892	Kenya	1.045	Sudan	0.962
Brazil	0.642	Korea. DPR	2.860	Suriname	0.759
Cameroon	0.910	Kuwait	0.690	Syria	1.004
Chile	0.737	Kyrgyzstan	0.410	Tajikistan	0.519
Colombia	0.490	Lebanon	0.860	Thailand	0.611
Congo	1.593	Libya	0.636	Togo	1.375
Costa Rica	0.128	Malaysia	0.510	Trinidad and Tobago	0.705
Cote d'Ivoire	0.897	Malta	0.964	Tunisia	0.603
Cuba	0.759	Morocco	0.819	Turkmenistan	0.795
Democratic Republic of Congo	1.115	Mozambique	0.330	Turks & Caicos	0.759
Dominica	0.759	Myanmar	0.667	Ukraine	0.586
Dominican Republic	1.029	Namibia	0.879	United Arab Emirates	0.768
Ecuador	0.763	Nepal	0.743	United Republic of Tanzania	1.075
Egypt	0.619	Nicaragua	0.739	Uruguay	0.799
El Salvador	0.515	Nigeria	0.562	Uzbekistan	0.588
Eritrea	0.778	Oman	0.754	Venezuela	0.895
Ethiopia	0.920	Pakistan	0.624	Vietnam	0.835
Gabon	0.924	Panama	0.688	Yemen	0.566
Georgia	1.059	Paraguay	0.437	Zambia	0.903
Ghana	0.831	People’s Republic of China	1.027	Zimbabwe	1.392
Grenada	0.759				

APPENDIX E   STANDARD VALUES FOR T&D LOSSES

The table does not include all NA1 countries yet, but is presented anyway to provide an indication of the range in standard T&D losses values. In the final report the data on NA1 countries will be included. See Section 2.

Country	Transport and distribution losses [%]	Country	Transport and distribution losses [%]	Country	Transport and distribution losses [%]
Albania	10	Gabon	10	Nigeria	10
Algeria	10	Georgia	10	Oman	10
Angola	10	Ghana	1	Pakistan	10
Argentina	10	Gibraltar	0	Panama	10
Armenia	10	Guatemala	10	Paraguay	3
Azerbaijan	10	Haiti	10	People’s Republic of China	7
Bahrain	7	Honduras	10	Peru	10
Bangladesh	10	Hong Kong, Chin	10	Philippines	10
Belarus	10	India	10	Qatar	6
Benin	10	Indonesia	10	Republic of Moldova	10
Bolivia	10	Iraq	0	Saudi Arabia	8
Bosnia and Herzegovina	10	Islamic Republic of Iran	10	Senegal	10
Brazil	10	Israel	3	Singapore	4
Brunei	1	Jamaica	10	South Africa	8
Bulgaria	10	Jordan	10	Sri Lanka	10
Cameroon	10	Kazakhstan	10	Sudan	10
Chile	5	Kenya	10	Syria	0
Chinese Taipei	5	Korea	4	Tajikistan	10
Colombia	10	Korea, DPR	10	Thailand	8
Congo	10	Kuwait	0	Togo	10
Costa Rica	8	Kyrgyzstan	10	Trinidad and Tobago	8
Cote d'Ivoire	10	Latvia	10	Tunisia	10
Croatia	10	Lebanon	10	Turkmenistan	10
Cuba	10	Libya	0	United Arab Emirates	9
Cyprus	6	Malaysia	8	United Republic of Tanzania	10
Democratic Republic of Congo	3	Malta	10	Uruguay	10
Dominican Republic	10	Mexico	10	Uzbekistan	9
Ecuador	10	Morocco	4	Venezuela	10
Egypt	10	Mozambique	10	Vietnam	10
El Salvador	10	Myanmar	10	Yemen	10
Eritrea	10	Namibia	10	Zambia	10
Estonia	10	Nepal	10	Zimbabwe	10
Ethiopia	10	Netherlands Antilles	10		
Federal Republic of Yugoslavia	5	Nicaragua	10		
Former Yugoslav Republic of Macedonia	10				
Former Yugoslavia	9				

APPENDIX F GLOSSARY OF TERMS

Base load	That minimum level of electricity demand which is relative constant from day to day.
Built/build margin	This baseline method is based on recent and future additions to the grid into account.
CER	Certified Emission Reduction.
CDM	Clean Development Mechanism.
C-ERUPT	Certified Emission Reduction Procurement Tender .
Crediting period	The period during which a CDM project generates CERs.
CEF	Carbon Emission Factor, distinguished between fuel based and technology based factors. Fuel based CEFs specify the carbon emissions per unit fuel consumed. Technology based CEFs give average carbon emissions for a specific technology. In this report T&D losses are not included in the CEFs.
CFL	Compact Fluorescent Lamps.
Dispatch order	The order in which in an electricity grid's electricity generating units are commissioned to make sure that supply meets demand.
Emission factor	In this study the emission factor refers to the carbon emission factor CEF.
ERU-PT	Emission Reduction Unit Procurement Tender.
Free-rider	1. Someone who would have implemented a project anyway but who enjoys the benefits of a CDM project. Or in other words: whose project would not be additional. 2. For CFL projects, those participants to a programme, e.g. in receiving a rebate that would have bought a CFL lamp anyway.
GHG	Greenhouse gases.
Grid factor	The carbon intensity of grid-delivered electricity (CO_2/kWh). If electricity T&D losses are included, it is specified.
Grid	The lay out of an electrical transport and distribution system. In this study a multiple country grid is defined as one grid if it operates under a joint dispatch.
JI	Joint Implementation.
kW	kilo Watt, 1000 watts.
kWh	KiloWatthour.
GWh	GigaWatthour.
Load factor	The percentage of the total capacity that a technology is operating (in the report sometimes also referred to as plant factor).
Market transformation effect	Indirect impact on the CDM project due to changing market conditions outside its project boundary.
Mini-grid	An independent grid with a power capacity of less than 15 MW.
NA1	Non-Annex 1 countries.
Operating in the margin	Technologies serving the peak load with high marginal costs.
Peak load	Operating hours during (daily, seasonal) peak demand.
Power pool	Mix of technologies providing electricity to one grid.
Take-back effect	Increase in demand for services, due to higher efficiency of services and a resulting lower costs, e.g. the increase in lighting hours as a result of the energy savings.
T&D losses	Losses occurred during transmission and distribution of electricity from the generating facility to the user.
M&V	Monitoring and verification.