3.2　他の国際機関のガイドライン

本研究で収集した主要な国際的な援助機関のガイドラインのうち、技術協力プロジェクトにおける GHG 定量化の考え方を参照した以下の２機関のガイドラインを、電子ファイルで、本プロジェクト研究完了報告書の CD－ROM 内に添付する。

① **GEF（Global Environment Facility）**
“Manual for Calculating GHG Benefits of GEF Projects: Energy Efficiency and Renewable Energy Projects, GEF/C.33/Inf.18, April 16, 2008”

② **GTZ(Deutsche Gesellschaft für Technische Zusammenarbeit GmbH)**
“Mitigating Climate Change with Energy-related TC projects
Guidelines for Calculating GHG Emission Impact (DRAFT),2008”

注）GTZ のガイドラインはドラフトであり改訂される可能性があるため、その引用には注意が必要である。

Global Environment Facility

GEF/C.33/Inf.18
April 16, 2008

GEF Council
April 22-2, 2008

MANUAL FOR CALCULATING GHG BENEFITS OF GEF PROJECTS: ENERGY EFFICIENCY AND RENEWABLE ENERGY PROJECTS

Table of Contents

List of Abbreviations

BIPV	Building-integrated Photovoltaic
BU	Bottom-up
CDM	Clean Development Mechanism
CF	causality factor
CO_2	Carbon dioxide
DP	Direct Project
DPP	Direct post-project
E	Energy
ESCO	Energy Service Company
GEF	Global Environment Facility
GHG	Greenhouse Gas
GWP	Global warming potential
IFF	Investment Facilitation Fund
IPCC	Intergovernmental Panel on Climate Change
kt or ktonnes	kilo-tonnes or 103 metric tonnes
kWh	Kilowatt hours
M&E	Monitoring and evaluation
MW	Megawatt
MWh	Megawatt hour
RF	replication factor
tf	turnover factor
TAR	IPCC Third Assessment Report
TD	Top-down
t or tonnes	103 kg or one metric tonne
UNFCCC	UN Framework Convention on Climate Change

I. INTRODUCTION, CONCEPTS, AND DEFINITIONS

Why this Manual?

1. All Global Environment Facility's (GEF) climate change project briefs have to supply an assessment of how much CO_2 eq emissions the projects are expected to save. In addition, as part of the GEF Replenishment Agreement for GEF-4, a performance target for greenhouse gas (GHG) emissions impacts was established as an indicator of programming effectiveness in the climate change focal areas. The performance target stated that in the climate change focal area, "projects projected to avoid or sequester at least 200 million tonnes of greenhouse gas (carbon dioxide equivalents) emissions will be approved." At the midpoint review in GEF-3, this target had been met, and a review of agency project briefs shows this is also the case for the second half of GEF-3. GEF-4 targets another 400 million tonnes of $CO_{2\ eq}$ to be avoided through GEF-sponsored mitigation projects.

2. To assess this indicator in a robust, fair, and consistent manner, a methodology for estimating GHG savings was developed. This document describes this methodology, which is particularly appropriate given the unique nature of GEF projects. Project proposals are asked to apply this methodology in their project briefs.

3. Further methodological developments will be necessary in the future. The next step will be to develop CO_2 quantification guidelines for GEF projects in transportation, land use, land-use change, and forestry. Although these areas have GHG impacts, they have not yet been report to the Council, given methodological uncertainty. However, the methodologies reported in this manual for renewable energy and energy efficiency projects must be applied for all future projects.

What is Different about this Scheme Compared to Standard Schemes for CO2 Accounting?

4. Most of the methodologies for measuring the CO_2 impacts of projects focus on the emissions savings from a specific investment. Projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol, for example, have to specify the technical characteristics of the hardware, location, ownership, and operating hours, in order to calculate the expected amount of emissions reductions to be produced from an investment. The methodologies for assessing the baselines and additional impacts of CDM projects are constantly under review by the relevant bodies of the United Nations Framework Convention on Climate Change Convention (UNFCCC). They can serve as helpful tools to analyze GEF projects' impacts.

5. Nevertheless, GEF projects differ from CDM projects in important ways, which need to be reflected in the impact calculations. GEF projects under the operational programs have a long-term and strategic market development approach. That means that their starting baseline is the overall state of the market in a country or region, not simply the business-as-usual scenario for a single investment. A second difference lies in the types of activities supported by the GEF as compared to the CDM. Typical GEF projects range from demonstration projects and direct

investments, to financing mechanisms that leverage local private sector financing, to capacity building and technical assistance, to the development and implementation of government policies supporting climate-friendly investments in energy and other sectors. Many project activities do not have direct GHG impacts, yet are necessary preconditions for effectively avoiding emissions in the long run. Therefore, an adequate assessment methodology of the CO_2 emission reduction effects of GEF projects needs to take into account the direct mitigation effect of cofinanced investments, as well as the indirect mitigation effects of investments for which the GEF intervention has created the enabling environment. The proposed methodology accounts explicitly for this situation. As the estimates for direct and indirect effects are fundamentally different in their accuracy and degree of certainty, the methodology used here reports separately on direct and indirect effects.

6. GEF projects typically focus on facilitating future market development, removing barriers, and putting the right conditions in place so that emissions and energy needs will not rise in the future. These projects are necessarily risky, their outcomes uncertain, and they vary in their degree of uncertainty both between and within projects. In addition, a GEF method for GHG accounting needs to take into account the investments that can happen after the actual GEF intervention.

7. Therefore, a different, larger set of uncertainties for GEF projects than for CDM projects compromises the quality of a GHG impact assessment. In addition, GEF projects typically are exposed to a larger number of implementation uncertainties, which decrease the probability that the expected positive outcomes of a project will be achieved in the given amount of time. While CDM project proponents receive the funding for CO_2 emissions reductions only upon delivery of the Certified Emission Reductions, GEF project proponents receive the funding up front.

8. It is important to note that no methodology that quantifies GHG emission reduction effects for GEF projects can fulfill all purposes. In particular, no methodology that results in one aggregate number for the portfolio can provide meaningful and comparable values for GHG abatement costs (US$/tonnes) because of the following:

(a) The GHG emission reductions are achieved using many different avenues in GEF projects.

(b) The weights of these avenues vary greatly among different projects.

(c) In the interest of sustainability and replicability, the GEF-sponsored part of the project often focuses on interventions that have long-term cost-reduction effects (e.g., through capacity building or enabling environments), but by themselves do not have impacts on GHG emissions.

9. The methodology accounts for this by estimating separate figures with different uncertainties attached: it does not recommend totaling these figures. As is described in more detail in what follows, a GEF project has direct CO_2 emission reductions achieved by investments that are directly part of the results of the projects; direct post-project emission reductions through those investments that are supported by GEF-sponsored financial

mechanisms still active after the projects' supervised duration; and a range of indirect impacts through market facilitation and development. The methodology employs conservative assumptions to account for the uncertainties in the assessment of the scale of their impacts, as well as the causality of the GEF intervention and shifting baselines.

Table 1: Three Types of GHG Emission Reductions in GEF Projects

Type of GHG emission reduction	**Direct**	**Direct post-project**	**Indirect**
Example component of a GEF intervention that can cause this type of GHG emission reduction	Demonstration projects and investments leveraged during the projects' supervised implementation	Investments supported by mechanisms (e.g., revolving funds) that continue operating after the end of the project	Policy framework, standards, and labels
Logframe level	Output	Not corresponding to a specific logframe level	Outcome/impact on level of global environmental objective
Quantification method	Similar to CDM projects	Similar to CDM projects, based on assumptions of functioning post-project mechanisms	Bottom-up or top-down
Quality of assessment	Highest level of certainty and accuracy	Reasonable level of accuracy, medium level of certainty	Low levels of accuracy and certainty

What Is Direct GHG Impact?

10. In most GEF projects, energy efficiency or renewable energy investments are parts of the projects' outputs and lead directly to reductions in GHG emissions. Direct emission reductions are calculated by assessing the fuel savings attributable to the investments made during the project's supervised implementation period. These are then projected for, and totaled over, the respective lifetime of the investments both during and post implementation. All CO_2 savings resulting from investments made within the boundaries of a project—as defined by the logframe, either using GEF resources or the resources contributed by cofinanciers and tracked through monitoring and evaluation (M&E) systems—will be counted toward a project's direct effects.

What Is Direct Post-Project GHG Impact?

11. GEF projects frequently put in place (financial) mechanisms that will still be operational after the project ends, such as partial credit guarantee facilities, risk mitigation facilities, or revolving funds. Such mechanisms facilitate investments yielding CO_2 reductions, which can, in turn, be quantified with the same methodology as the direct investments. However, these effects fall outside the framework of normal project monitoring systems. To account for these savings, the methodology calculates them separately as "direct post-project" emission reductions. Although the same assumptions for investment lifetimes and emission factors are used as in the case of direct emission reductions, the nature of direct post-project emissions dictates that conservative assumptions be used with reference to leakage rates and financial instruments' effectiveness.

What Are Indirect GHG Emission Savings?

12. Because GEF projects emphasize capacity building, innovation, and catalytic action for replication, their largest impacts typically lie in the long-term GHG savings achieved after the GEF project's completion. These investments are strongly affected by the long-term outcomes of the GEF activities that remove barriers; for example, those that build capacity, improve the enabling environment, and stimulate replication. Their GHG emission reductions are referred to as "indirect" GHG savings. To estimate the indirect impact, one must rely heavily upon assumptions and expert judgment. As their level of uncertainty and accuracy is different from direct or direct post-project savings, it is not appropriate to aggregate the two types of savings.

13. There are two different approaches for estimating indirect effects, resulting in a range of likely indirect effects. The first one—referred to as "bottom-up"—requires an expert judgment on the likely effectiveness of a project's demonstration and triggering effects. The direct and direct post-project impacts of a project are simply multiplied by the number of times that a successful investment under the project might be replicated after the project's activities have ended.

14. The second—or "top-down" —approach assesses indirect impacts by estimating the combined technical and economic market potential for the technology within the 10 years after the project's lifetime. Most of the time, this is not purely the technical potential of a technology, because during those 10 years, additional market barriers may emerge and prevent achieving the total potential. Using the maximum realizable market size further implies that there would be no baseline changes over considerable periods of time, and that all emission reductions in that sector or market can be attributed entirely to the GEF intervention. Clearly, both of these assumptions are unlikely to hold in reality. Therefore, the assessment contains a correction factor, the "GEF causality factor," which expresses the degree to which the GEF intervention can take credit for these improvements. This causality factor is used to finalize the "top-down" estimate for the indirect benefits, which can be viewed as providing the upper limit of the range of indirect GHG benefits.

II. STEP-BY-STEP GUIDE FOR ALL TYPES OF PROJECTS

15. Calculating CO_2 emission reductions from GEF projects is a process with several steps, depending on the project's complexity (in particular, how many different technologies and applications are affected) and components. Some project components contain investments as an output; these lead to direct GHG emission reductions. Other components (e.g., revolving funds) typically lead to direct as well as to indirect GHG emission reductions. A third group might lead—first and foremost, if not exclusively—to indirect GHG emission reductions.

16. The typical sequence in calculating CO_2 emission reductions:

(a) Calculate the baseline emissions of the scenario without a GEF contribution to the project.

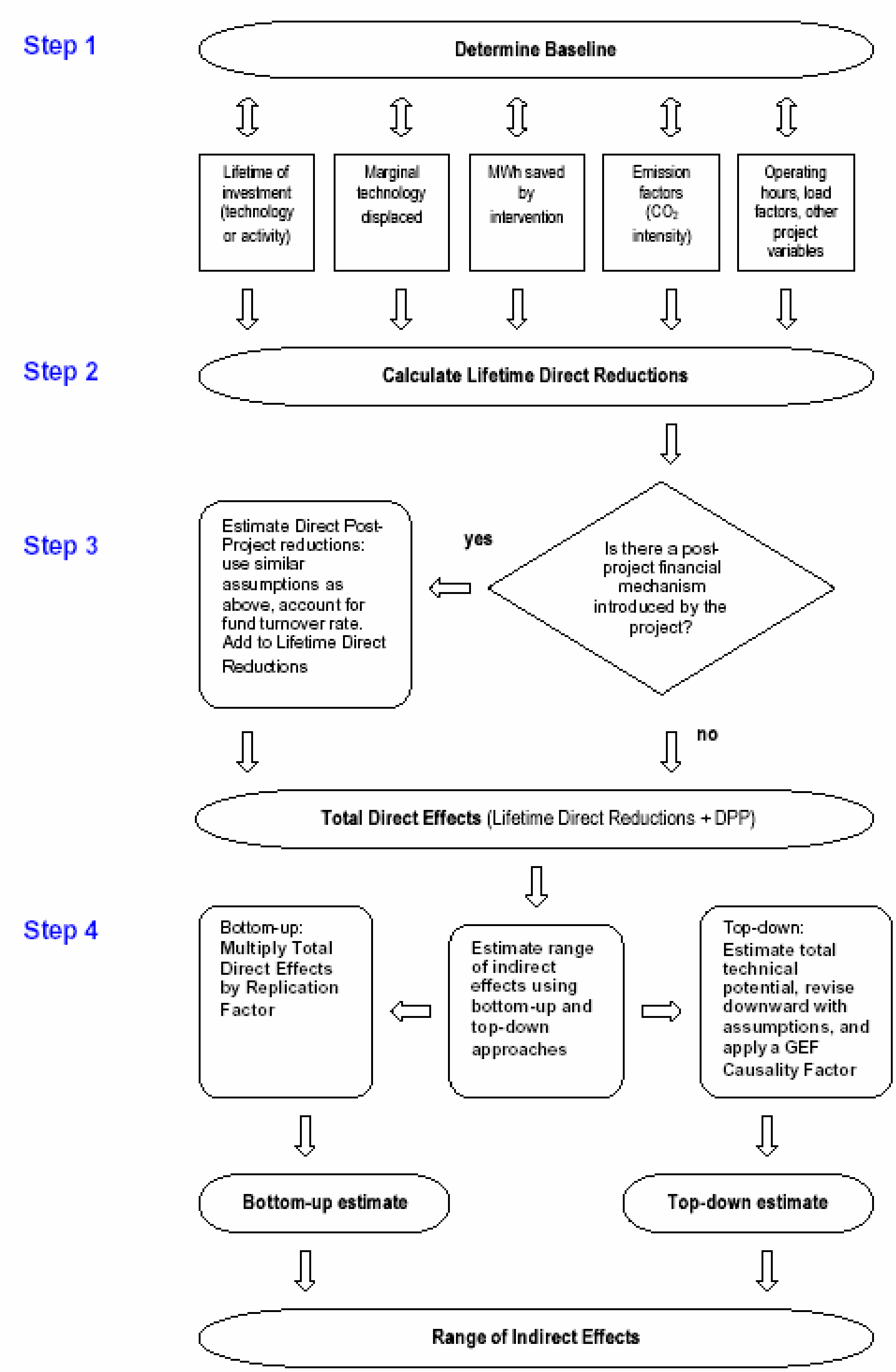
(b) For the GEF alternative, calculate the emissions, including investments that are tracked in the logframe during the project's implementation. The difference between this number and the baseline emissions equals the direct emission reductions of the project.

(c) If, for the post-project period, a project-sponsored (financial) mechanism will remain in place and keep providing support for GHG-reducing investments, which would not happen in the baseline case, estimate the direct post-project emission reductions for these investments.

(d) Estimate what emission reductions in the post-project period will have a causal link to the GEF intervention. For these, calculate the indirect emission reductions. If the data permit it, and if it is appropriate for the situation, use both methods: the bottom-up and the top-down. In some cases, only the bottom-up method will make sense.

(e) Each of these steps will be discussed in more detail in the following sections. Figure 1 contains a flowchart that also indicates the data requirements for all steps.

Figure 1: Four Steps to Calculate GHG Impacts



Assumptions and Data Requirements

17. The data and assumptions necessary for the CO_2 emissions reduction assessment are normally highly project specific. They are researched and documented during the preparatory phase of the projects and should be contained in the project document.

18. Some general assumptions are important in all steps of the GHG emission reductions assessment:

(a) All analyses are conducted in tonnes of $CO_{2\ eq}$.

(b) The CO_2 reductions reported are cumulative reductions, calculated for the lifetimes of the investments.

(c) No discounting for future GHG emission reductions.

19. As a general rule when applying this methodology, the project proponent should rather err on the side of transparency, and generally be cautious and conservative when making assumptions on GHG emission reductions.

Table 2: Global Warming Potentials as Given in Table 3 of the Technical Summary of Working Group I for the Third Assessment Report (TAR) of IPCC, 2001

Gas	Lifetime (Years)	Global Warming Potential (Time Horizon in Years)		
		20	100	500
Carbon Dioxide (CO_2)		1	1	1
Methane[a] (CH_4)	12[b]	62	23	7

Note: a) The methane global warming potentials include an indirect contribution from stratospheric H20 and O3. b) The value for methane is an adjustment time, which incorporates the indirect effects of emissions of the gas on its own lifetime.

(Source: http://www.ipcc.ch/pub/wg1TARtechsum.pdf)

20. In order to put these assumptions into practice, it is important that the database is good. In particular, the following data need to be gathered for the assessment:

(a) Global warming potentials of non-CO_2 greenhouse gases: Table 2 reproduces the Intergovernmental Panel on Climate Change (IPCC) figures, which should be used for all purposes in GEF projects. Typically, the 100-year figures are used.

(b) Baseline scenarios: It is very important for the analysis of the non-GEF baseline to factor in the likely expansion for the specific market (e.g., market for energy-using equipment, market for a specific energy service) without GEF intervention. The approaches here are different for each operational program, and will be discussed in more detail in the next section, as well as in separate sections for each operational program. In any case, the baseline scenario also contains the baseline technologies, i.e., which technology would be deployed next under a scenario without GEF intervention.

(c) Emission factors: For the baseline technologies, as well as for the technologies to be deployed under the GEF Alternative Scenario, the proposal needs to contain the expected emissions factors, i.e., how many kilograms of $CO_{2\ eq}$ are going to be emitted for each kilowatt-hour (kWh) of energy, or every energy service provided. In exceptional cases, i.e., if no baseline technology can be specified, the average emission factor of the respective economy can be used.

(d) Lifetimes of investments: The second investment-specific parameter that needs to be determined is the lifetime of the investment. For the various operational programs, different technologies, investment conditions, and assumptions are appropriate. The methodology actually specifies preapproved default values for the lifetimes of the relevant technologies, and proponents are encouraged to utilize these default values. They will be discussed in the respective sections on direct emission reductions of the operational programs below.

Calculating Baseline CO_2 Emissions

21. The baseline is part of the project proposal. It should contain a full description of the country's development without the GEF intervention, but with engagement of the respective implementing agency, if that would happen without the GEF. Please note, the Incremental Cost Analysis only relates to the incremental costs imposed as a result of caring for the global environment, not to those incremental costs that are caused by developmental additionalities. The baseline scenario includes developmental activities of national governments and implementing agencies.[1]

22. The baseline scenario is typically used to identify marginal (power-generation or energy-using) technology and its emission factor. These are the bases for the baseline GHG emissions. In the baseline scenario, projects should describe the characteristics of the power sector, the emission factors, the markets to be transformed, and the lifetime of the investments. All of this information needs to be collected in the project preparation phase. In exceptional cases where data on marginal technology are absolutely unavailable, the average emission factors can be used to calculate the CO_2 savings. In these cases, the proposal should discuss the impact of this change in assumptions on the overall assessment in a qualitative manner.

Calculating Direct Emission Reduction Effects

[1] During the finalization of this manual, the incremental cost guidelines for GEF projects are being revisited. Please note that this methodology should not impose unnecessary bureaucracy above and beyond the revised guidelines.

23. Direct emission reductions are achieved in GEF projects where these projects lead to less GHG-emitting investments than a no-project situation would achieve. The development of voluntary carbon funds, voluntary markets for certified emission reductions, obligatory markets for carbon emissions, and the methodological progress in the Clean Development Mechanism have all stimulated efforts to refine the methodologies for carbon emission reduction accounting and baseline definition in the context of direct GHG abatement from investment projects. All of these certification mechanisms target the same emission reductions from specific investment projects that can be counted under "direct emission reductions" for GEF projects. Several methodologies have been published to analyze the direct emission reduction effects of CDM projects. One can apply their main ideas for calculations of direct emission reductions, which are achieved by investments that are facilitated in the GEF project and analyzed as part of the project proposal.

24. Almost all GEF projects leverage referring to tangible investments into cleaner energy or transportation systems. In some cases, these investments are not part of the project itself, and follow only indirectly from the project activities. When this is the case, the emission reductions should not be included in the direct emissions, but subsumed under the category "indirect emission reductions," discussed below. The most clear-cut criterion to decide whether investments should be counted toward direct or indirect emission reductions is the inclusion of the investment in the logframe of the GEF project, and the question whether it is monitored as part of the project's success indicators.

25. To quantify the GHG direct impacts of GEF projects, the approach chosen for the GEF projects is derived from international best practices, but also kept simple. All investments responsible for direct effects are evaluated in terms of the energy produced / (fossil) energy avoided over the lifetime of the respective investments. Different technologies have different assumed lifetimes. For example, solar home systems have shorter assumed lifetimes than village hydro systems.[2] The saved fuel or energy is then multiplied by the marginal CO_2 intensity of the energy supply. The formula is

$CO_{2\ direct} = E * c = e * l * c;$ with

$CO_{2\ direct}$ = direct GHG emission savings of successful project implementation
in $CO_{2\ eq}$, in tonnes
E = cumulative energy saved or substituted, e.g., in megawatt hours (MWh); $E = \Sigma_l\ e$
c = CO_2 intensity of the marginal technology, e.g., in t/MWh
e = annual energy replaced, e.g., in MWh
l = average useful lifetime of equipment in years

26. Please note that the lifetime of the equipment determines the duration over which the GHG savings may occur and count toward this sum. That means that the impact of all

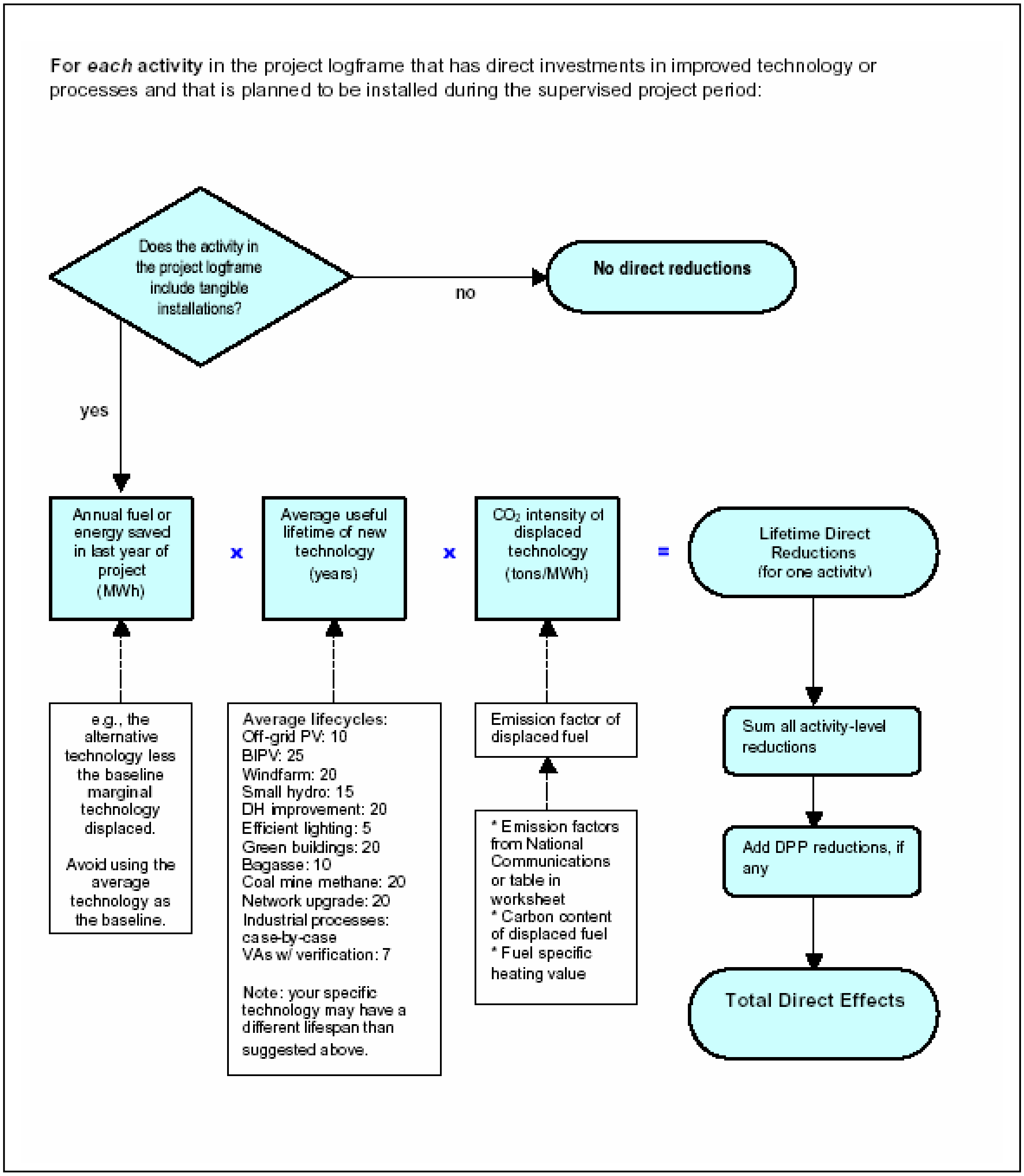
[2] For the default lifetimes to be used in the calculations, please refer to the chapters on energy efficiency, renewable energy, and transportation.

investments that are made during the project is the same, irrespective of whether they are undertaken in year one or five of project implementation. However, they must be made during the project's supervised operations to count as "direct" GHG emission reductions.

27. Because of the setup of GEF projects (and a conservative interpretation of the GEF cofinancing rules), investments are counted toward this sum irrespective of whether they are financed by GEF support or by cofinancing. The decisive criterion for the question of whether to include or exclude an investment is whether it is included in the M&E framework proposed in the logframe.

28. Figure 2 illustrates how to calculate the direct GHG impact of GEF projects.

Figure 2: Flowchart for Direct GHG Emission Reductions



Calculating Direct Post-project Emission Reduction Effects

29. In some cases, GEF projects implement a GEF-supported financing mechanism that will continue to support direct investments after the implementation or supervision period of the project. An example is a revolving fund for up-front financing of energy investments, which is refinanced from user fees, loan repayments, or a partial credit guarantee facility that might be

fully exposed at the end of the project, but then reduces its credit risk exposure and thus keeps looking for new investments. Depending on the leakage rate, facilities of this type can lead to a multiple of the original direct investment, which in turn can lead to a multiple of the associated emission savings long after the project itself has ended.

30. For the sake of this analysis, these "direct post-project" emissions are calculated based on the direct effects that are achieved during project implementation. It is necessary to make assumptions on the impact that the post-project facility (e.g., the revolving fund) will have after the project. For a revolving fund, for example, the rates of reflow and leakage will determine how many investments can be financed after the supervised implementation period. A "turnover factor" (tf) is defined as the number of times the post-project investments will be larger than the direct investments. The formula then is:

$CO_{2\ DPP} = CO_{2\ direct*} * tf$; with
CO2
$CO_{2\ DPP}$ = emissions saved with investments after the project, supported by post-project financial mechanisms
$CO_{2\ direct*}$ = direct emissions savings to the degree that they are supported through the mechanism that causes the post-project impacts
tf = turnover factor, determined for each facility based on assumptions on the fund leakage and financial situation in the project country

31. In the equation above, the turnover factor "tf" is equal to the number of times that the whole fund volume is expected to be invested and reinvested after the project. The first turnover will usually happen within the project's supervised implementation period, and thus count toward the direct emission reduction, not toward emissions reductions taking place through subsequent "turnover" of the funding.

32. The estimates for direct post-project effects are subject to a slightly higher degree of uncertainty than the direct GHG project outputs. In the project, they should be reported separately from the direct project output, as they actually are a form/type of indirect emission reductions, but ones which can be assessed with a higher degree of certainty than the purely indirect emission reductions (see below).

33. Figure 3 illustrates how to calculate direct post-project GHG impacts.

Figure 3: Flowchart for Direct Post-project GHG Emission Reductions

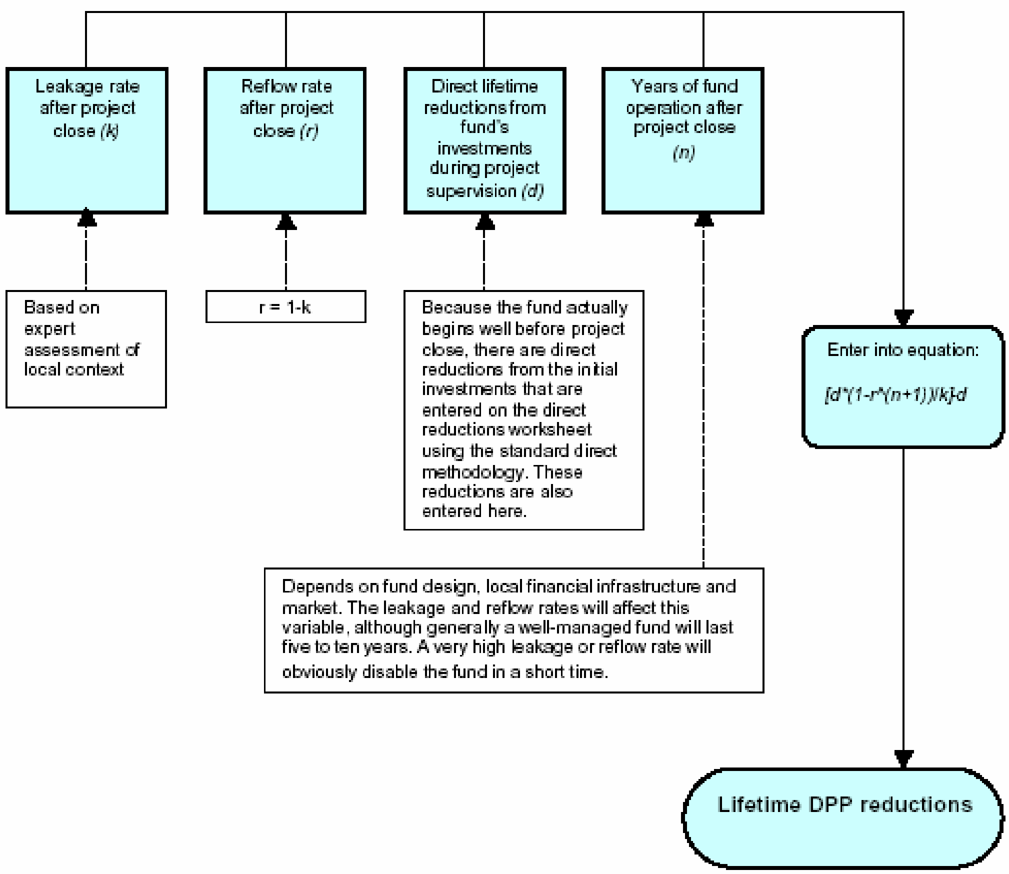
Energy-related projects

Direct Post-Project (DPP) reductions = $CO_{2DPP} = d(t) = [d*(1-r^{\wedge}(n+1))/k]-d$

d = direct lifetime reductions from investments made during project supervision from the financial mechanism only.
t = turnover rate, determined for each mechanism based on assumptions on fund leakage and financial situation in the host country.

In the absence of a good turnover rate estimate, DPP can be estimated with the following equation: $[d*(1-r^{\wedge}(n+1))/k]-d$ where the additional variables are:

n = years of fund operation after project close (typically 5 – 10). This will depend on the leakage rate but 10 years is the default.
k = leakage rate after project close
r = *1 – k* = reflow rate after project close



Calculating Replication and Indirect Impacts

34. Because GEF's approach emphasizes strategic interventions and their long-term impacts, direct GHG emission reduction effects tell only half the story, particularly for energy-efficiency and renewable-energy programs, which focus on removing barriers. Barrier removal activities sponsored by the GEF promote the development of markets for renewable energies and energy efficiency in a country or region, and thus should lead to large GHG abatements in the future. These activities can be found mostly in the areas of technical assistance, capacity building, and the development of investment-enabling environments. Rather than invest large sums of public money, they focus on leveraging private investments beyond the narrow range of project cofinancing.

35. During project preparations, projects must document the estimated market development and long-term impacts of their interventions. Project briefs are therefore expected to contain the data required to complete the estimation. It is difficult to assess the after-implementation impacts of a market facilitation and barrier removal project whose implementation lies years ahead.

36. Because of the big uncertainties related to indirect GHG emission reductions, it is advisable to use ranges to estimate the indirect effects. The limits of the range for the indirect impact can be determined two ways. One way, called the "top-down" methodology, starts with the potential market impacts overall in a country, under given assumptions for costs and benefits of the technology. This will mostly result in an optimistic assessment, and thus an upper limit for the range of potential GEF project impacts. Alternatively, using the "bottom-up" methodology, one can start extrapolating from the project's outputs, assume the project's impact will multiply in the long run, and judge from there what multiple of the GHG emission reductions will ensue in the long run. Using conservative assumptions, this will result in a lower limit of the range of the potential GEF project impact. Both methodologies can be used in a complementary manner and are described in more detail below. To minimize the risk of exaggerated project expectations, one should use conservative estimates for the replication effects in either methodology.

37. The following are some assumptions that have to be made to calculate indirect effects:

- A standard project influence period for the GEF effects has been assumed to be 10 years. This means that a typical project will exert some influence on local market development for about 10 years, i.e., non-baseline investments that happen within 10 years after the project can be counted toward indirect impacts, with the reductions being cumulative over their respective lifetimes. In some cases, the influence period might be shorter.[3]

[3] An example is in energy-efficiency projects with strong baseline shifts, as discussed in an example for the calculations under Energy Efficiency.

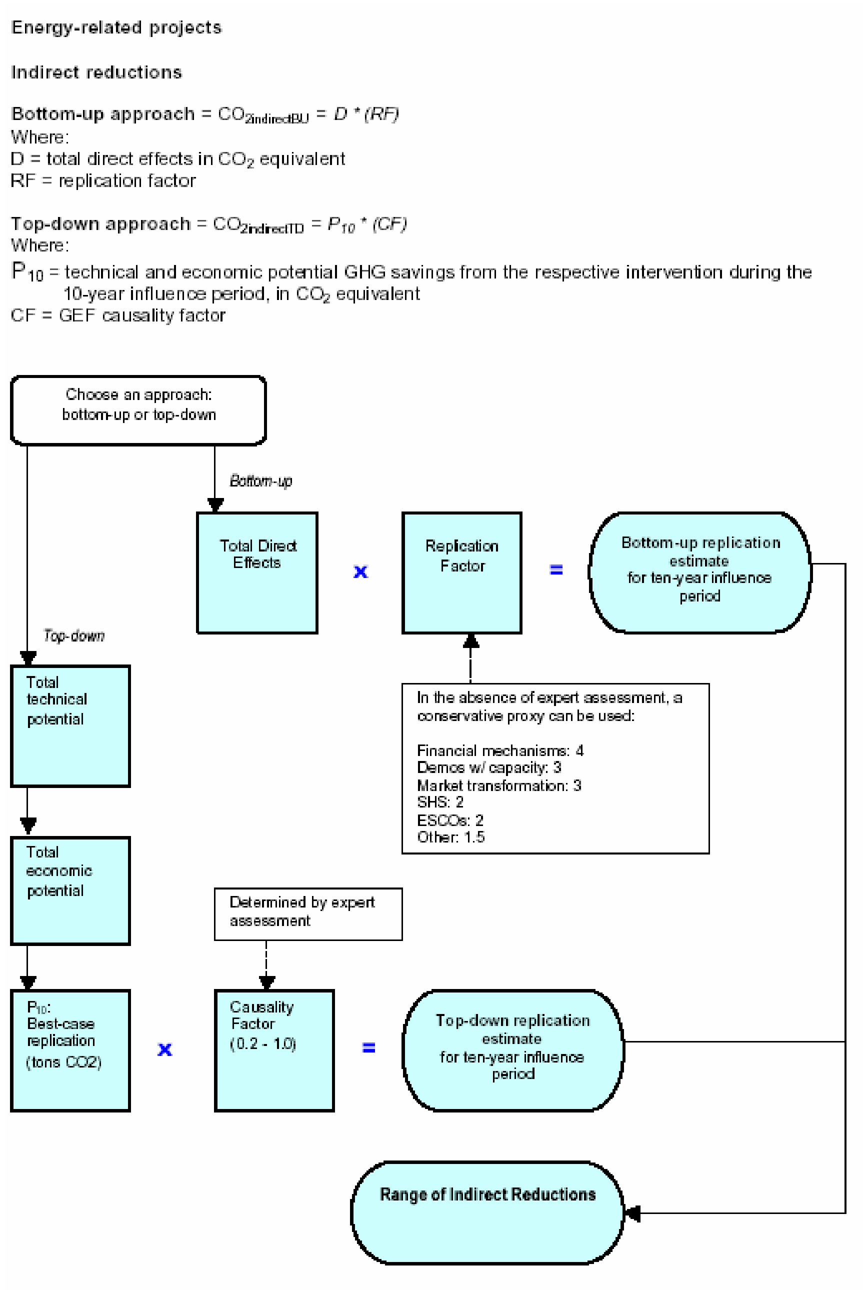
- If a project envisions a second phase or tranche at a later stage, and the GEF contribution to this second phase is not approved by Council, the GHG abatements achieved during the second phase are counted as indirect effects.

- For the sake of a conservative estimate, projects' indirect effects are only accounted for within the same country or region, even if the projects will be replicated in other countries.

- For portfolio-wide aggregation, double counting issues for indirect impacts need to be addressed.

38. Figure 4 illustrates how to calculate the indirect GHG impacts of GEF projects using both approaches. Both approaches are discussed in more detail below.

Figure 4: Flowchart for Direct Post-project GHG Emission Reductions



Calculating Replication and Indirect Impacts—Bottom-up Approach

39. Many GEF projects focus their activities on pilot and demonstration investments, for example, in some pilot areas of a country. The projects often then take measures that facilitate the replication of the investments in other parts of the country. This is a direct expression of the GEF's mission to be innovative and catalytic.

40. The bottom-up approach for calculating indirect GHG reductions starts from the direct effects of the investments under a project, and assumes that a multiple of these effects is going to be achieved by replicating the project's investments. For example, an energy service company (ESCO) supported by a GEF project might make profitable investments leading to energy savings of 200,000 tonnes over the lifetime of the investments. Judging from the local conditions, one could assume that within 10 years after the project ends, five more companies will copy the approach and venture into similar activities. Mathematically, the GHG emission reductions are calculated with the same formula as in the case of direct effects, and then multiplied by the assumed factor of replication:

$CO_{2\ indirect\ BU} = CO_{2\ direct} * RF$; with
$CO_{2\ indirect\ BU}$ = emissions saved with investments after the project, as estimated using the bottom-up approach, in tonnes of $CO_{2\ eq}$
RF = replication factor, i.e., how often will the project's investments be repeated during the 10 years after project implementation
$CO_{2\ direct}$ = estimate for direct and direct post-project emission reductions, in tonnes of $CO_{2\ eq}$

41. In the ESCO example above, the replication factor would be 5, and the indirect savings calculated by the bottom-up methodology would be 1 million tonnes.

42. To date, there is no empirical assessment of the replication factors for the GEF portfolio, partly because the portfolio is not mature enough for systematic observation, partly because no post-project evaluations are taking place. Therefore, for the time being, the replication factors should be explicitly determined in the project proposal for each project. When assessing these replication factors, two major aspects should be taken into account: The first is the expected probability of replication, which is mostly related to the question of whether a particular business model is profitable or politically desirable and for that reason offers some incentives to the local public or private stakeholders for replication. The second is the question of how this likelihood compares to the amount of investment already taking place directly under the project.

43. In the absence of empirical assessments, generalized replication factors can be employed in the assessment, relating to the design and activities of the project, for example:

(a) Rural electrification projects employing solar home systems should typically be designed in such a way that governments and local constituents want to do much more of them. As a compromise between ambitious goals and limited resources, a replication factor of 2 for the 10-year period after the project is the default value proposed by the methodology.

(b) For ESCOs, a default replication factor of 2 is proposed, based on the consideration that while ESCOs can offer profitable business models, they will be restricted in most cases by the availability of capital.

(c) For market transformation programs, it was assumed that they would leverage significant changes in the energy intensity of the marketed goods, and thus a higher replication factor of 3 is appropriate, as the direct emission savings under the projects are typically rather low.

(d) Finally, it was assumed that credit and guarantee facilities would have strong replication effects concurrent with a default replication factor of 4, since they are basically demonstrations of worthwhile business opportunities. However, the replication factor should be in line with the replication of the facility rather than the investments, as the replications within the same facility are already covered by the assessment of the post-project reductions.

44. Developing these replication factors on the basis of experiences collected within GEF projects is a research project for the future. For the time being, each project during preparation/PDF-B should do some research into the local situation and decide on a replication factor based on the knowledge of the local market, keeping in mind that the assessment should be conservative. Some reality checks are that the replication should always be smaller than the overall market potential, and that a comparison with the direct and direct post-project impacts should lend itself to a reasonable explanation.

Calculating Replication and Indirect Impacts—Top-down Approach

45. The underlying assumption of the top-down approach is that removing barriers to a market for cost-effective technologies allows the project to leverage the whole market for the relevant technology. If all barriers to market development are removed, market forces should exploit the full economic potential offered by the respective market. Therefore, the starting point is the whole economic potential for GHG abatement of a given application in the project's country or region.

46. In most GEF climate change interventions, estimates for full economic potential are created in the project development phase. These are expert estimates, already fraught with uncertainty, and assumptions need to be made about the effect of the actual GEF causality. Both of these effects are accounted for in the methodology, but also need to be accounted for in the interpretation of the results. In addition, the economic and technical potential of a given application needs to be assessed with respect to what can be achieved (in the 10 year "post-project influence period").

47. Because market forces or government policies might generate some of these achievements at a later point in time even without a GEF intervention (baseline shifts), this figure is then multiplied by an assumed GEF causality factor, which indicates to what degree the GEF intervention can claim causality for the reduction. For the GEF causality factor, five levels of GEF impact and causality have been assumed:

(a) Level 5 = "The GEF contribution is critical and nothing would have happened in the baseline," GEF causality = 100 percent

(b) Level 4 = "The GEF contribution is dominant, but some of this reduction can be attributed to the baseline," GEF causality = 80 percent

(c) Level 3 = "The GEF contribution is substantial, but modest indirect emission reductions can be attributed to the baseline," GEF causality = 60 percent

(d) Level 2 = "The GEF contribution is modest, and substantial indirect emission reductions can be attributed to the baseline," GEF causality = 40 percent

(e) Level 1 = "The GEF contribution is weak, and most indirect emission reductions can be attributed to the baseline," GEF causality = 20 percent

48. While the GEF causality factor is useful and can deliver consistent results, GEF causality factors should rely on situation-specific justifications and be estimated conservatively. Please note that the GEF causality factor accounts for baseline shifts, that is, for those situations where the nationwide baseline is expected to move toward a less CO_2 –intensive situation even without the GEF intervention. Therefore, when estimating the GEF causality factor, one should also take into account the nature of that baseline. If, in the future, the methodology shifts to a different method of setting the baseline, the GEF causality factor could be simplified.

49. The formula for calculating indirect impacts with the top-down methodology is, accordingly:

$CO_{2\ indirect}$ TD = P10 * CF; with
$CO_{2\ indirect}$ TD = GHG emission savings in tonnes of $CO_{2\ eq}$ as assessed by the top-down methodology
P10 = technical and economic potential GHG savings with the respective application within 10 years after the project
CF = GEF causality factor

Worksheet and Template

50. An Excel worksheet complements this manual. You can use the worksheet as a template to calculate the four figures (direct impact, direct post-project impact, indirect impact using bottom-up methodology, indirect impact using top-down methodology).

III. STEP-BY-STEP GUIDE FOR ENERGY EFFICIENCY PROJECTS

Baselines

51. For energy efficiency projects, the overall CO_2 intensity of the country's economy is important, but in cases such as market transformation projects, the CO_2 intensity trajectory for the specific market is even more important. This choice has to be made early in the development of the project document. Sectorwide energy projects, or projects that are not very specific in their target markets (e.g., ESCO projects in their early stages), as well as projects under Strategic Priority 2 (increased access to local sources of financing) are probably better off focusing on the countrywide or sectorwide CO_2 intensity. Projects that intend to introduce standards and labels for specific sectors, such as appliances or light bulbs, can focus on the specific situation of the local market. In these cases, it is particularly important to understand the baseline (marginal) technology, and the baseline trajectory that the market would take without GEF intervention. Typically, this baseline trajectory already contains some positive market developments for the energy-efficient application that is promoted by the GEF project; thus it cannot be assumed that the energy use and GHG emissions from the application would remain the same in the baseline throughout the implementation of the project (so called "baseline shift").

52. The GEF Alternative Scenario in some cases will simply identify the acceleration of emission reductions that would have happened anyway in the baseline scenario. For example, emission intensities that would be reached in 10 years under a baseline scenario could be reached in four years under a GEF Alternative Scenario. This has to be included in the GHG analysis, as the difference in the emission paths of the two scenarios gives the cumulative emission reduction of the GEF intervention. Keep in mind that to be consistent with past estimates and reduce the number of assumptions necessary, cumulative emission reductions for GEF projects are calculated on the basis of the investment lifetime.

53. It is important that the baseline also accounts for the degree of economic activity in the country—that is, the actual length of the economic lifetimes of the investments. In countries with rapid economic growth, these lifetimes might be very short if one thinks, for example, of industrial equipment. Corrections for rapid reinvestment cycles, or small time lags between the baseline and alternative scenarios, are done through the GEF causality factor (see the section below on indirect emission reductions).

Direct Emission Reduction Effects of GEF Projects

54. In energy efficiency projects, the direct emission reductions can mostly be calculated directly from the energy savings of the project as measured in kWh, by multiplying them by the corresponding emission factor:

$CO_{2\ direct} = E * c$; with
$CO_{2\ direct}$ = direct GHG emission savings of successful project implementation
in tonnes of $CO_{2\ eq}$.

E = cumulative energy saved or substituted, e.g., in kWh, across all technologies that are affected by the intervention, and cumulated over the lifetime of the respective investments

c = CO_2 emission factor of the marginal technology, or of the national power generation portfolio as applicable, in g/kWh.

55. As explained above, the energy savings are to be corrected by the "baseline shift," i.e., that part of the market that would have been tapped anyway, even without a GEF intervention.

56. As a default, the CO_2 emission factor should be the marginal factor. In exceptional cases, or when grid electricity is being saved, the emission factor can be an average emission factor—for example, if grid electricity is being saved, the overall average emission factor of the local power sector, as opposed to the emissions attributable to the next power plant to come on time.

57. The cumulative energy savings are aggregated across all affected markets. For example, if a project introduces standards for household appliances, the savings from refrigerators, washing machines, and dishwashers will all count toward the same figure, labeled "E." The annual savings of each will be multiplied by the expected useful economic lifetime in years. These economic lifetimes might be different for dishwashers and refrigerators. In some investment environments, the economically useful lifetime of capital can be very short, particularly in highly dynamic and fast-growing economies, or in economies where old capital is rapidly replaced. Policy can also affect the lifetime of this investment—for example, through aggressive long-term introduction of standards, or through tax or other fiscal policies. The project proposal should discuss these local factors and integrate them into the assumed lifetimes of the investments.

Direct Post-project Emission Reduction Effects of GEF-financed Interventions

58. In some cases, GEF projects put in place a GEF-supported financing mechanism that will continue supporting direct investments after the project's implementation period. A typical example is a revolving fund for up-front financing of energy investments, which is refinanced from user fees or loan repayments. Another example would be a partial credit risk guarantee facility, which might be fully exposed at the end of the project, but then reduce its exposure and thus keep looking for new opportunities. Depending on the leakage rate and the speed of payback, facilities of this type can multiply the original direct investment and associated emission savings long after the project itself has ended.

59. These "direct post-project" emissions can be calculated with the same formula as the direct effects that are achieved during project implementation. In fact, as the facility that might have a post-project impact is usually set up and operating during the project, the direct emission savings from the first "turnover" of that facility are factored into the direct emission reductions as discussed above. Assumptions are necessary as to how many more "turnovers" the facility will have after the project is completed. For a revolving fund, the rates of reflow and leakage determine how many investments can be financed after the supervised implementation period

(how often the fund can "revolve"). The emission savings from these investments will be estimated as a multiple of the direct GHG outputs of the project. The formula is:

$CO_{2\ DPP} = CO_{2\ direct*}$ * tf; with
$CO_{2\ DPP}$ = emissions saved with investments supported by post-project financial mechanism
$CO_{2\ direct*}$ = direct emission savings to the degree they are supported through the mechanism that causes the post-project impacts
tf = turnover factor, determined for each facility based on assumptions on fund leakage and financial situation in host country.

60. The time period for which these types of impacts are attributed to the project should not be longer than 10 years, even if the facility is expected to be in place longer.

61. Because the payback periods in funds and reduction of exposure of credit guarantees are shorter in energy efficiency projects than renewable energy projects, this aspect of GHG emission reductions is expected to play a larger role in energy efficiency projects. There are few practical experiences that can be used to gauge the typical rates of leakage and default, or the typical rates of turnover in GEF projects. It is important to include an analysis of the underlying characteristics of the financial markets in the project preparation phase, so that the project brief can contain well-based assumptions on turnover rates, typical required sized of partial guarantees, and demand for these instruments.

Calculating Replication and Indirect Impacts for Energy Efficiency Projects—Bottom-up Approach

62. Once the direct emission reductions are calculated, it is sometimes easy to estimate a factor for the probable replication of the project's investments after the project has ended. Mathematically, the GHG emission reductions are calculated with the same formula as that for direct effects, and then multiplied by the assumed factor of replication:

$CO_{2\ indirect\ BU} = CO_{2\ direct*}$ RF; with
$CO_{2\ indirect\ BU}$ = emissions saved with investments after the project, as estimated using the bottom-up approach, in tonnes of $CO_{2\ eq}$
RF = replication factor
$CO_{2\ direct}$ = estimate for direct and direct post-project emission reductions, in tonnes of $CO_{2\ eq}$

63. If possible, the local circumstances should be used to derive the replication factor. Some conservative proxies have been suggested, such as 3 for market transformation and 2 for ESCOs. However, more systematic research into this issue is necessary.

64. Some reality checks can be used to test the final results. For example, the bottom-up indirect calculation should exceed the sum of the direct and direct post-project results.

Calculating Replication and Indirect Impacts for Energy Efficiency Projects—Top-down Approach

65. The top-down calculation starts with an assessment of the total potential for a specific energy-efficient application in the host country. This total amount of potential energy savings should then be corrected downward, if it seems technically unfeasible to tap it within 10 years of the project's completion. In order to correct the 10-year potential by the "baseline shift," i.e., that part of the potential that would have been tapped by the market without a GEF intervention, the GEF causality factor is used. The GEF causality factor describes how much of that savings can really be attributed to the GEF intervention, and how much would have happened in the business-as-usual scenario in the long term. For the GEF causality factor, five levels of GEF impact and causality have been assumed:

(a) Level 5 = "critical and nothing would have happened," GEF causality = 100 percent

(b) Level 4 = "dominating," GEF causality = 80 percent

(c) Level 3 = "substantial but modest," GEF causality = 60 percent

(d) Level 2 = "modest and substantial," GEF causality = 40 percent

(e) Level 1 = "weak," GEF causality = 20 percent

66. A possible reality check is whether the result is larger than the sum of direct plus direct post-project GHG savings, and whether the 10-year potential has to be corrected by the baseline shift.

An Example

67. The project objective is to catalyze investments in energy-efficient public lighting systems. Three project components will contribute to greenhouse gas emissions reductions:

(a) Creating an effective and sustainable advisory service in order to catalyze public lighting investment. This will involve setting up the Investment Facilitation Fund (IFF), which will be a fully operational business unit with the capability to identify and broker public lighting investments.

(b) Financing technical demonstrations with the support of a concession fund. This will involve setting up a project fund to enable the IFF to build an initial portfolio of investments.

(c) Supporting investment in energy-efficient public lighting through information dissemination. The third activity is designed to promote the IFF more widely.

Step 1. Determine the Baseline

68. The majority of the country's public lighting is coming to the end of its useful life and is in need of replacement. The expectation is that in the absence of this project, existing inefficient technology will gradually be replaced by new investments. Only a small share of this investment is going to go into efficient technologies, e.g., sodium lamps. Most of the systems will be replaced with inefficient systems similar to the existing ones. The GEF project will transform the market such that all or most replacements will immediately be made with energy-efficient lighting systems.

69. In the baseline, some programs unrelated to the project would catalyze the gradual replacement of energy-inefficient street lighting with efficient street lighting over time.

70. National programs: established grant financing for public lighting systems in 2002.

71. Investment and savings bank: aims to reduce pollution and greenhouse gas emissions from a specific set of countries. Companies and public authorities are eligible for grant funds of up to euro 1.5 million for a project.

72. It will be assumed that in the "baseline case," uptake of efficient lighting systems due to these programs is 20 percent—i.e., if the GEF project did not occur, 20 percent of the investments would be made into energy-efficient lighting systems anyway. Furthermore, it is expected that this baseline would rise over time (so-called "baseline shift"). For the sake of this example, let's assume that market studies have found out that today, 20 percent of all investments would be energy-efficient investments anyway in the first year; by year five, 40 percent of all investment would be energy efficient; and in year eight, 100 percent of investments would be energy efficient.

73. For the purpose of calculating the CO_2 emission reductions of this project, it is not necessary to calculate the baseline emissions, as the market study already specifies the difference between what would happen if the project did or did not go ahead. Nevertheless, for a reality check it would be useful to calculate the total emissions from street lighting in Slovakia.

Step 2. Determine the GEF Alternative

74. In the GEF Alternative Scenario, municipalities substitute inefficient mercury lamps with efficient sodium lamps. The project intends to increase the uptake of energy-efficient lighting from 20 percent of all investments in the business-as-usual (baseline) case to 100 percent of all investments. Therefore, where lighting systems are upgraded, only emission reductions resulting from 80 percent of the investments, i.e., those that would not have been into energy-efficient lighting systems, can be directly attributable to the GEF project.

75. To reach this alternative scenario, the project consists of three components: demonstrations, advisory services, and awareness-raising. These three components contribute to different categories of CO_2 savings:

(a) Three demonstration lighting subprojects will be undertaken during the three years of project implementation, and will be cofinanced from a GEF-funded project fund. These demonstrations can be counted toward the direct emission reductions of the project.

(b) As the fund is set up as a loan facility, it will be reused toward new public lighting investments after the first round of investments have repaid their loans. These later investments can be counted toward the direct post-project emission reductions.

(c) The impact that the demonstrations, the advisory services, and the awareness-raising activities will have on the national public lighting market will be counted toward the indirect emission reductions of the project.

Step 3. Calculating Direct Emissions Reductions

76. During the project lifetime, the IFF will disburse loans amounting to US$1.5 million. The fund will also catalyze a further US$880,000 from cofinancing sources. In addition, municipalities will be required to contribute 10 percent cofinancing toward the costs of the lighting demonstration projects. Thus, the project is catalyzing a total investment of US$2.635 million during the project lifetime. This investment will result in reduced electricity consumption by the public lighting system.

77. First, the amount of energy saved must be calculated. Project preparation studies have estimated that US$1 of investment in energy efficient public lighting systems will yield on average around 1 kWh per year in energy savings. The total investment of the fund thus corresponds to 2,635 MWh saved per year.

78. As presented above, direct emissions reductions can be calculated by multiplying the energy savings from project activities (measured in kWh or MWh) by the corresponding emissions factor.

$CO_{2\ direct} = E * C$; with

E = cumulative energy saved or substituted
C = CO_2 intensity of the marginal technology or electricity saved

79. Replacing inefficient mercury public lights with more efficient sodium lights results in saved electricity supplied from the local grid. Thus, to obtain the direct CO_2 emissions reduction, the cumulative energy saved (E) and the CO_2 intensity of grid-supplied electricity are multiplied together (see table 3 below).

Table 3. Converting Project's Predicted Energy Savings into $CO_{2\ eq}$

Annual Electricity Savings (MWh/year)	**Public Electricity Emissions Factor** CO2 (t/MWh)	**Annual Emissions Reduction** CO2 (t)
2,635	1.01	2,661.35

80. In the final year of the project, all investments will have been completed. The annual CO_2 emission reductions stemming from these investments were estimated to be 2,661.35 tonnes CO_2 . The assumption is made that all investments have a physical operating life of seven years. The direct emissions reductions stemming from the operation of these investments would equal:

2,661.35 tonnes equivalent of CO_2 /year * 7 years.
= 18,629 tonnes of $CO_{2\ eq}$

81. Roughly 18,600 tonnes of CO_2 are the direct emission reductions achieved through the demonstration investments over their lifetime. It is not necessary to treat the investments from the first year differently from the investments from the third year, as the calculation includes emission savings over the lifetime of the investments, and is not tied to specific calendar years or other dates. The "average effective lifetime" can be assumed to be equal between first-year and third-year installations.

Step 4. Calculating Direct Post-project Emission Reductions

82. As this GEF project is going to put a fund in place that will continue to operate after the close of the project, it is necessary to calculate the CO_2 emission reductions that will stem from new investment in energy-efficient equipment to be financed by the fund after the three year project implementation period has passed. The initial size of the fund is US$1.5 million. By year three of the project, the entire fund will have been utilized in the form of loan financing for demonstration projects. As the loans are paid back, these funds—less some defaults on the loans—will be available for further investments into efficient public lighting. The post-project functioning of the fund is simulated with a number of simplifying assumptions.

Fund Assumptions

The fund will operate for 10 years, including seven years after the close of the project. However, the fund will only produce meaningful emission reductions as long as the technology promoted by the project is fundamentally different from the baseline technology. In the business-as-usual (baseline) case, the technology promoted by the project would have been the industry standard seven years later than with the project. This means that for the purposes of this calculation, seven years should be taken as the maximum time span.

The fund will have a leakage rate of 15 percent net of administration costs (i.e., for every US$1 loaned out by the fund, only US$0.85 will be recovered in loan repayments). For practical reasons, we will simplify this further, to simply assume that every year US$150,000 of loans

will not be repaid.[4]
Every US$1 loaned by the fund after the project closes will catalyze an equal level of reductions in CO_2 emissions as seen during the project.
All capital investments made by the fund will have the same physical lifetime as those made during the project implementation period.

83. The Excel spreadsheet accompanying this manual is programmed to do the calculation automatically. Following the GEF methodology presented in section 3c, the following formula is used to estimate direct post-project emissions reductions:

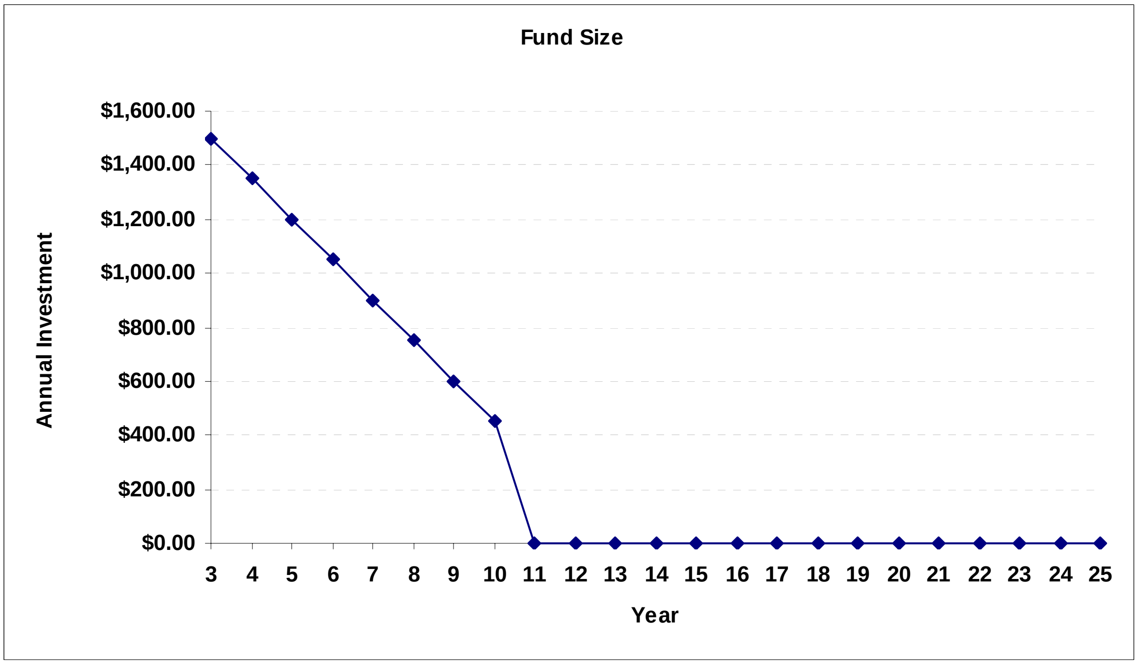
$CO_{2\,DPP} = CO_{2\,direct}$ *tf; with

$CO_{2\,DPP}$ = emission reductions stemming from the post-project operation of the revolving fund
$CO_{2\,direct}$ = direct emission reductions occurring during the project lifetime that were supported by the fund
tf = turnover factor of the fund

84. As we have already calculated direct emission reductions, the task now is to determine the level of turnover, or, put more simply, how much money the fund will invest in the 12 years following the project close. By utilizing the GEF CO_2 spreadsheet, it can be determined that an initial fund of US$1.5 million, operating for 12 years with a 10 percent leakage rate, would result in cumulative investments amounting to US$6.3 million—equal to the area under the graph in figure 5.

[4] Without this simplification, the amount that is not paid back would be smaller each year.

Figure 5. Size of IFF during its Lifespan after Project Implementation Period



Now, to determine t, the following calculation is used:

Turnover factor (tf):
tf = total post-project close fund investment / total fund investments during project

tf = 6.3 / 1.5

tf = 4.2

Therefore, direct post-project emissions reduction can be calculated:

$CO_{2\ DPP} = CO_{2\ direct} * t$
$CO_{2\ DPP} = 18{,}629\ t\ CO_2 * 4.2$
$CO_{2\ DPP} = 78{,}242\ t\ CO_2$

This calculation is not corrected for the baseline shift. In order to come up with a robust and conservative estimate, the figure should now be corrected for the energy-efficient investments that would have happened every year anyway. As the baseline shift in this case is very strong, and the impact of the fund rather large when compared to the total size of the market, it would be appropriate to correct the direct post-project impact drastically downward, for example by halving it.
$CO_{2\ DPP}$ corrected = $78{,}242\ t\ CO_2 : 2 = 39{,}121\ t\ CO_2$

Step 5. Calculating Indirect Emission Reductions

Approach 1. Bottom-up

85. The bottom-up approach aims to calculate how many times the investments made during the project might be replicated, and can be calculated using the following formula:

$CO_{2\ indirect\ BU} = CO_{2\ direct} * RF$; with
$CO_{2\ indirect\ BU}$ = emission reductions following the project close, calculated using the bottom up methodology.
$CO_{2\ direct}$ = estimate for total direct emission reductions
RF = replication factor

86. There is a judgment call to make here whether to include the direct post-project impacts into the multiplication of the indirect calculation. In this case, it was decided to not include the direct post-project impacts. The fund's operation is expected to cover significant parts of the potential investments, and including the fund's savings into the overall indirect savings would lead to double counting. The indirect impact is supposed to represent only those emission savings that are outside of the direct post-project. In order to complete the estimate, a suitable replication factor must be determined. None of the replication factors suggested in figure 4 is quite appropriate for this case, as this is a very specific market. Therefore, in order to arrive at a conservative estimate, the factor of 1.5 for "other project approaches" will be applied.

$CO_{2\ indirect\ BU}$ = 18,629 t CO_2 * 1.5
$CO_{2\ indirect\ BU}$ = 29,944 t CO_2

Approach 2. Top-down

The top-down approach moves away from the project itself, and examines the total economic and technical market potential for CO_2 emission reductions with the type of technology being applied. Once the total market potential for energy savings is determined, it is then corrected downward to determine the top-down estimate for CO_2 emission reductions caused by the GEF project.
$CO_{2\ indirect}$ TD = $CO_{2\ TM} * CF$; with

$CO_{2\ indirect}$ TD = emission reductions following the project close, calculated using the top-down methodology.
CO_2 TM = total market potential for CO_2 emission reductions
CF = causality factor

87. First, the total market potential for CO_2 emission reductions from the public lighting system must be examined. The majority of the country's public lighting system was installed in the 1970s and 1980s. It is now exceeding its expected lifetime, and increasingly, sections are due for replacement. When replacing the public lighting infrastructure, municipalities will have the choice of installing efficiently configured designs (at an estimated cost of US$48 million for the

whole country) or continuing to maintain the current configuration, with some replacement over time, at an estimated cost of US$4.2 million per year.

88. However, as we have already noted, a certain degree of investment would be made even if the project didn't occur. Given the baseline yearly expenditure of around US$4 million, we can assume that under a business-as-usual-scenario, total replacement of the lighting system would occur after around 12 years. However, given the baseline shift, only the investments made during seven of these years can be indirectly linked to the project—after that, the business-as-usual investments would use the same technology, so there are no additional GHG savings due to the project. The investment indirectly attributable to the project is US$28 million (i.e., US$48 million divided by 12 years, then multiplied by 7). In addition, during those years, the baseline is creeping up as described in table 4.

Table 4 Case of Creeping Baseline in Lighting Project Example

Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Share of energy efficient investments in the baseline	20%	20%	20%	30%	30%	40%	60%	80%	100%

89. The average share of energy efficient investments in the baseline over the seven years that the baseline needs to "catch up" to the GEF alternative is 40 percent, i.e., only 60 percent of the total US$28 million investment during years one to seven is energy inefficient. If the project replaces all of this inefficient investment right from the start, US$16.8 million will be invested in energy efficient street lighting. Obviously, this is not what will happen; the displacement of the energy inefficient investment will be more gradual. This will be expressed in this example by an assumed correction of 30 percent, i.e., the project can impact a maximum of US$11.8 million. Given these assumptions, the national annual potential for CO_2 emission reductions can be determined in table 5 below.

Table 5. Total Market Potential for CO_2 emission Reductions in Street Lighting

Cumulative Investment (USD)	**Electricity Saving** (MWh/year)	**Public Electricity Emissions Factor** CO2 (t/MWh)	**Annual Emissions Reductions** CO2 (t/year)
11,800,000	11,800	1.01	11,800

The annual emission reductions are again multiplied by the lifetime of the investment:

$CO_{2\ TM}$ = 11,800 t CO_2 * 7 years
$CO_{2\ TM}$ = 82,600 t CO_2

90. In determining the GEF causality factor (i.e., the percentage of CO_2 emission reductions that can be attributed to the long-term effect of the project through overcoming market barriers), we must again go back to the baseline shift and examine other likely influences on the market. In

the case of this country, there are many planned and ongoing projects that will impact the market for energy efficient public lighting systems.

91. Programs set up and planned in this area include:

(a) ESCOs: The legislative framework exists for ESCO financing, and by 2004 there had been around euro 13.2 million energy efficiency-related investments through ESCOs.

(b) Development funding: The IFC is planning a Commercializing Energy Efficiency Finance (CEEF) program, designed to guarantee the loans of financial intermediaries in energy efficiency, including public lighting.

92. Given these other influences on the market, and the necessity to have a conservative approach to CO_2 assessments, it seems suitable to adopt a Level 2 causality of 40 percent, designated for a GEF project resulting in modest indirect effects over the 10 years following the project. Now the indirect top-down emissions reduction estimate can be calculated as follows:

$CO_{2\ indirect}$ TD = $CO_{2\ TM}$ * CF

$CO_{2\ indirect}$ TD = 82,600 t CO2 * 40%
$CO_{2\ indirect}$ TD = 33,040 t CO2

Step 6: Results Overview and Standardized Text

Measure	Emissions Reduction (t CO_2)
Direct	18,629
Direct Post-project	78,242
Indirect Bottom-up	29,944
Indirect Top-down	33,040

93. In this case, the indirect bottom-up impacts are smaller than the direct post-project impacts. This can be an indication of overly optimistic assumptions for the direct post-project impact, overly pessimistic assumptions for the indirect bottom-up impact, or a large revolving fund compared to the size of the market.

94. The following standardized text can be copied and pasted into the project document after the calculations are completed. The italicized portions should be replaced with the numbers that are estimated for a specific project.

Direct Emission Reductions

95. Part of the outputs of the project will be the following investments: ***Financing technical demonstrations with the support of a concession fund***. These investments will result in direct greenhouse gas emission reductions during the project's implementation phase. As a result of these activities during the project implementation period of: ***Three years, direct greenhouse gas emission reductions totaling 18,629 tonnes of $CO_{2\ eq}$ will be achieved over the useful lifetime of the investments of seven years***. In the non-GEF case, these energy needs would be satisfied by: Marginal coal and gas generation capacity with an emission factor of (f) 1.01 t CO_2 e / MWh.

96. The project also includes activities that would result in direct post-project greenhouse gas emissions. A fund set up by the project is expected to continue to finance investments resulting in GHG emission reductions after the project close. The fund is expected to finance ***$6.3 million*** of new investment, equivalent to a turnover factor of ***4.2***, resulting in direct post-project emission reductions of ***78,242 tonnes $CO_{2\ eq}$***.

Indirect Emissions Reductions

97. Using the GEF bottom-up methodology, indirect emission reductions attributable to the project are ***29,944 tonnes of $CO_{2\ eq}$***. This figure assumes a replication factor of ***1.5***. Using the GEF top-down methodology, indirect emission reductions attributable to the project are ***33,040 tonnes of $CO_{2\ eq}$***. This figure assumes that total technological and economic potential for GHG emission reductions in this area over 10 years is ***82,600 tonnes of $CO_{2\ eq}$***, and a project causality factor of ***40 percent***.

IV. RENEWABLE ENERGY STEP-BY-STEP

Describing the GEF Impact and the Baseline (Business-as-usual) Case

98. GEF renewable energy projects typically lead to the buildup of some renewable energy generation capacity in the country. This generation capacity will provide a certain amount of energy, either in the form of electricity or heat. While generation capacity is measured in kilowatts (kW) or megawatts (MW), energy output is measured in MWh. Both values are standard GEF portfolio monitoring indicators, and have to be provided for all projects, as required by the GEF M&E policy.

99. Without the GEF project, i.e., in the baseline, or business-as-usual case, this buildup of capacity and provision of energy would also have taken place, but with a different technology. This so-called "marginal technology" is the energy generation technology that would be used for the next-least-cost investment. Typically, these are coal, oil, or natural gas power plants, depending on the country's access to these fossil fuels. These would have led to increased GHG

emissions (otherwise the project would not be eligible for GEF support). The baseline description needs to specify this technology and the amount of investment necessary in the baseline case. To assess how much investment would have been necessary in the baseline case, it is important that the comparison is based on useful energy output, and not on the generation capacity provided. The investments in both the GEF project and the baseline should be described in the document.

100. Whether baseline shift is an issue depends on the situation of renewable energy in the country in question. Typically, the GEF project supports a technology that is not currently available or used in the country. Then, typically, the baseline shift does not need to be accounted for, except through the GEF causality factor in the indirect top-down methodology. However, in cases where a technology already shows an upward trend in usage, and the GEF projects will accelerate this trend, the baseline shift needs to be accounted for and described in the baseline scenario. For more specific information on the concept of baseline shift, please refer to the section on energy efficiency.

Calculating Direct Emission Reductions

101. The calculation of the direct emission reductions for renewable energy projects is based on the marginal technology in the project country. Formula (27) applies in a straightforward manner:

$CO_{2\ direct} = E * c = e * l * c$; with
$CO_{2\ direct}$ = direct GHG emission savings of successful project implementation
in tonnes of $CO_{2\ eq}$
E = cumulative energy produced by renewable energy, e.g., in MWh; $E = \Sigma_l e$
c = CO2 intensity of the marginal technology, e.g., in t/MWh
e = annual energy replaced, e.g., in MWh
l = average useful lifetime of equipment in years

102. The baseline CO_2 emission$_s$ are based on the emission factors and conversion efficiencies typical for new fossil fuel generation, and the energy output provided by the GEF-supported investments into renewable energy.

103. In order to be consistent across projects and reduce the number of assumptions necessary, cumulative emission reductions for GEF projects are calculated on the basis of the investment lifetime. It is important that the baseline also accounts for the power production over the full expected lifetime of the renewable energy units. Typical expected lifetimes are given in the box.

Off-grid PV 10 years
BIPV 20 years
Wind 20 years
Small hydro 20 years
Bagasse 10 years

Calculating Direct Post-project Emission Reductions

104. If the projects put a GEF-supported financing mechanism in place that will leverage further investments after the GEF project has ended, like a revolving fund for loans, or a credit guarantee facility, the project might be able to claim direct post-project emission reductions. Depending on the leakage rate and the speed of payback, facilities of this type can multiply the original direct investment and the associated emission savings long after the project itself has ended.

105. These direct post-project emissions can be assessed as multiples of the direct effects that are achieved during project implementation. The direct emission savings from the first "turnover" of that facility are factored into the direct emission reductions, as discussed above. Assumptions are necessary as to how many more "turnovers" the facility will have after the project. For a revolving fund, the rates of reflow and leakage determine how many investments can be financed after the supervised implementation period (how often the fund can "revolve"). The "turnover factor" expresses how many multiples of the original investment can be leveraged through the post-project financing mechanism. The formula is:

$CO_{2\ DPP} = CO_{2\ direct*} * tf$; with
$CO_{2\ DPP}$ = emissions saved with investments supported by post-project financial mechanism
$CO_{2\ direct*}$ = direct emission savings to the degree that they are supported through the post-project financial mechanism impacts.
tf = turnover factor, determined by each facility based on assumptions on fund leakage and financial situation in host country.

The time interval for which these types of impacts are attributed to the project should not be longer than 10 years, even if the facility is expected to be in place for a longer period.

Calculating Indirect Impacts—Bottom-up

106. Once the direct emission reductions are calculated, it should be possible to estimate a factor for the probable replication of the project's investments during the 10 year "influence period" after the project has ended. Mathematically, the GHG emission reductions are calculated with the same formula used in the case of direct effects, and then multiplied by the assumed factor of replication:

$CO_{2\ indirect\ BU} = CO_{2\ direct*}\ RF$; with
$CO_{2\ indirect\ BU}$ = emissions saved with investments after the project, as estimated using the bottom-up approach, in tonnes $CO_{2\ eq}$;
RF = replication factor; and
$CO_{2\ direct}$ = estimate for direct and direct post-project emission reduction, in tonnes $CO_{2\ eq}$

107. It is important to note that there is a risk of double counting the indirect impacts and the direct post-project impacts. The methodology makes this distinction because the direct post-project impacts can be assessed with higher certainty and have a higher probability of occurring

as a consequence of the GEF project than the indirect impacts. In turn, this means that the analysis of the indirect impacts needs to account for the direct post-project impacts, and potentially actively deduct the direct post-project impacts from the indirect impacts. This needs to be decided case by case.

108. If at all possible, the local circumstances should be used to derive the replication factor. More systematic research into this issue is necessary. Some reality checks can be used to test the final results. For example, the bottom-up indirect calculation should exceed the sum of the direct and direct post-project results. On the other hand, it should be smaller than the total market potential of the technology over the influence period of 10 years.

Calculating Replication and Indirect Impacts—Top-down

109. The top-down calculation starts with an assessment of the total potential for the production of energy from the specific renewable energy technology in the host country, as determined by the natural resource situation, technical capacity, and typical investment rates in the country that can be expected under post-project circumstances. This total amount of potential energy production should then be corrected downward, if it seems technically unfeasible to tap it within 10 years of the project's completion. In order to correct the 10-year potential by the "baseline shift," i.e., that part of the potential that would have been tapped by the market without a GEF intervention, the GEF causality factor is used. The GEF causality factor describes how much of the buildup of capacity can really be attributed to the GEF intervention, and how much would have happened in the business-as-usual scenario in the long-term. For the GEF causality factor, five levels of GEF impact and causality have been assumed:

(a) Level 5 = "The GEF contribution is critical and nothing would have happened in the baseline," GEF causality = 100 percent

(b) Level 4 = "The GEF contribution is dominating, but some of this reduction can be attributed to the baseline," GEF causality = 80 percent

(c) Level 3 = "The GEF contribution is substantial, but modest indirect emission reductions can be attributed to the baseline," GEF causality = 60 percent

(d) Level 2 = "The GEF contribution is modest, and substantial indirect emission reductions can be attributed to the baseline," GEF causality = 40 percent

(e) Level 1 = "The GEF contribution is weak, and most indirect emission reductions can be attributed to the baseline," GEF causality = 20 percent

110. While the GEF causality factor is useful and can deliver consistent results, GEF causality factors and the overall potential should rely on situation-specific justifications and be estimated conservatively. Please note that the GEF causality factor accounts for baseline shifts, that is, in those situations where the nationwide baseline is expected to move toward a less CO_2 –intensive situation even without the GEF intervention. Therefore, when estimating the GEF causality factor, one should also take into account the nature of that baseline.

111. The formula for calculating indirect impacts with the top-down methodology is, accordingly:

$CO_{2\ indirect}$ TD = P10 * CF; with
$CO_{2\ indirect}$ TD = GHG emission savings in $CO_{2\ eq}$ as assessed by the top-down methodology;
P10 = technical and economic potential for GHG savings with the respective application within 10 years after the project; and
CF = GEF causality factor.

An Example: Wind Energy Program

Project Duration: 5 years

Project Objective: The project objective is to diversify power generation in the country by assisting with the development of a wind energy industry that could generate employment, as well as export to the wider region.

Project Components:

Component 1: Design financial instruments conducive to the development of wind energy, to be accepted and implemented by the government.

This component aims to design financial polices and instruments that can support the development of the wind energy industry in the country, including:

- Production subsidies to support the project's planned infrastructure investments.
- A power purchase agreement (PPA) between the municipal government and the wind infrastructure provider developed by the project. The PPA will ensure that wind energy receives a premium price compared to thermal generation.
- A guarantee scheme will serve as a purchaser of last resort when 100 percent of the electricity generated by the project's investment is not sold to end-user customers.

Component 2: Assist private developers with pre-feasibility-level project development activities for up to 45 MW wind power generation capacity.

Six private developers will have 50 percent of total cash and in-kind costs covered for pre-feasibility studies for wind power installations up to 45 MW in generating capacity. Based on these studies, a decision will be made on which projects will be developed further. It is anticipated that three to four sites will be taken forward, and will provide the learning experience, and information essential for wind farm replication (licenses, approvals, costs, time spent in studies, etc.).

Component 3: Long-term policy and implementation framework for wind energy.

A long-term policy for wind energy, including an implementation strategy and policy, and financial instruments, will be developed for government approval and incorporation into the national energy policy.

Taken together, components 1 and 2 will be responsible for direct emission reductions, while component 3 will catalyze indirect emission reductions, stemming from the project.

Step 1. Determine the Baseline

Given the existing financial, policy, regulatory, and institutional constraints facing wind energy development in the country, it is highly likely that market development will not occur in the short term without donor-based and long-term financial assistance.

The marginal technology in the country is coal- and gas-fired thermal generation, and to a lesser extent, importing large-scale hydro power. The country will require an additional 1000 MW of generation capacity by 2016, and it is likely that without intervention, this need will be met by coal- and gas-fired generation.

An exact calculation of the baseline is not needed here, as the difference between the GEF alternative scenario and business-as-usual scenario can be directly determined.

Step 2. Determine the GEF Alternative

With the support of the GEF project, critical policy, financial, and institutional barriers will be addressed, allowing the gradual scale-up of wind generation capacity. Wind energy has significant potential in the country, but a gradual approach to achieving a critical mass of 45 MW of wind generating capacity is required.

Over the five-year project, up to 45 MW of wind capacity from private developers will be supported through capacity building and financing that would not have occurred without the project. This, along with the development of new policies and financial instruments, will foster the beginnings of the transformation of the energy market toward one that is more conducive to wind energy. Financial commitments will be put in place up until 2013 for the 45 MW developments. Direct emission reductions will result from these activities.

Through the project’s development of energy policy in the country, wind energy will receive a green power premium, increasing the competitiveness of wind generation vis-à-vis thermal. This will catalyze indirect emissions reductions.

Step 3. Calculating Direct Emissions Reductions

Following the guidance in the GHG emissions manual, direct emission reductions can be calculated by multiplying the displaced demand for thermally produced energy (measured in kWh or MWh) by the corresponding emissions factor of the marginal technology that would supply the on-grid electricity in lieu of the project.

$CO_{2\ direct}$ = E * C ; with

E = cumulative energy saved or substituted
C = CO_2 intensity of the marginal technology or electricity saved

First, the amount of energy generated by investments made during the project must be calculated. In this project, energy generated is reported in the form of MWh (see table 6 below). Installing grid-connected wind power provides a substitute for electricity supplied from other sources to the national grid, currently comprised predominantly of coal- and gas-fired generation. Research conducted as part of the project planning process notes that wind farms in the relevant locations will operate with a capacity factor of 27 percent—that is, over the course of a year, 1 MW of capacity would yield 2,365 MWh (i.e., 1MW * 8,760 hours * 27 percent).

As a result of the project, 45 MW of grid-connected wind capacity will be installed. Thus, the total installed capacity of 45 MW will generate 106,425 MWh per year, or 2,130 gigawatt hours (GWh) over its default lifetime of 20 years.

To obtain the direct CO_2 emission reductions, the cumulative thermal grid-supplied electricity saved due to the installation of wind generation capacity, and the CO_2 intensity of the grid supplied electricity, are multiplied together. Research conducted for project preparation documents have determined the average CO_2 intensity for the national grid-supplied electricity to be 0.89 tonnes of CO_2 per MWh.

This means that given the quantity of wind electricity produced, and the carbon intensity of the electricity supplied on the national grid, the total direct CO_2 emission reductions occurring through the five-year project lifetime can be clearly determined. The simplifying assumption is made that all investments will have an operational lifetime of 20 years. The total direct CO_2 emissions are equal to the annual emission reductions stemming from the installed capacity, multiplied by 20 years.

CO_2 direct = E * C = 2,130,000 MWh * 0.89 tonnes of CO_2 equivalent / MWh =

= 1,890,000 tonnes of CO_2 equivalent

Step 4. Calculating Direct Post-project Emission Reductions

This GEF project has not put in place a financing mechanism, or any sort of component, that will continue to operate after the project closes and catalyze GHG emission reductions. Therefore, no direct post-project emissions reductions will be achieved by the project.

Step 5. Calculating Indirect Emissions Reductions

Approach 1. Bottom-up

The bottom-up approach aims to calculate how many times the investments made during the project might be replicated and can be calculated using the following formula:

$CO_{2\ indirect\ BU} = CO_{2\ direct} * RF$; with
$CO_{2\ indirect\ BU}$ = emission reductions following the project close, calculated using the bottom-up methodology
$CO_{2\ direct}$ = estimate for total direct (including post-project) emission reductions
RF = replication factor

A suitable replication factor must be determined. The default replication factor suggested for a demonstration project with capacity building is 3. The project has a component that focuses on working with policy makers to implement a more sustainable financing scheme. Depending on the success of this, the project's impact could in fact be replicated during the "influence period" of 10 years after the project is completed. In order to be conservative, a replication factor of 1.5 shall be assumed here. This, in the 10 years after completion of the project, 90 MW more wind power will be installed due to the influence that this project exerts on the country's financing capacity for the wind market.

$CO_{2\ indirect\ BU} = CO_{2\ direct} * RF$

= (1,890,000 t CO_2) * 1.5

= 2,835,000 tonnes CO_2

Approach 2a. Top-down information, bottom-up methodology

In this case, we can have two more ways of starting with the overall market potential, and calculating the indirect impact of the project. One uses very specific information on the market size in the country, obtained through the project preparation process. The other (see below) uses more general, publicly available information. The first would be preferred as it has a higher degree of certainty. Once the total market potential for wind energy is determined with either of the two options, it is then corrected downward to determine the top-down estimate for CO_2 emission reductions caused by the GEF project.

$CO_{2\ indirect\ TD} = CO_{2\ TM} * CF$; with
$CO_{2\ indirect\ TD}$ = emission reductions following the project close, calculated using the top-down methodology
$CO_{2\ TM}$ = total market potential for CO_2 emission reductions
CF = causality factor

First, the total market potential for CO_2 emission reductions from installing wind power must be examined. A good indicator of total market potential has been gained by examining the green power premium the project aims to put in place. The project preparation documents note that a maximum of 309 GWh per year can be eligible for the green power premium. As calculated above, the project directly leads to 106 GWh per year, so an additional 203 GWh per year can be achieved by fully exploiting the instrument in the post-project period.

Table 6 Calculation of Top-Down Indirect Emissions

Additional market potential per year (MWh/year)	**Annual Emissions Reductions (t $C0_2$/year)**	**Overall indirect emission reductions over 20-year lifetime of investments (t $C0_2$)**
203,000	180,670	3,613,400

In determining the GEF causality factor (i.e., the percentage of CO_2 emission reductions that can be attributed to the long-term effect of the project through overcoming market barriers) we must examine other likely influences on the market. In the case of this country, there are planned and ongoing projects that will impact the market for energy-efficient public lighting systems. As the development of wind farms in the country is not an easy process, and, under the current market conditions, is not a financially viable route without financial assistance from subsidies or grants, none of the planned project would be expected to materialize without the GEF project.

Given these developments in the wind energy market, it seems suitable to ascribe the project as having a **Level 5** or "dominating" causality factor of **100 percent**, so that no correction is necessary.

<u>Approach 2b. Top-down information, top-down methodology</u>

The pure top-down methodology would not start with a specific market instrument, but rather with the assumption that consequent development could take place that leads to a replication of the project's investments. Therefore, this assessment starts with the total physical potential for using wind power in the country. According to the wind-skeptical national utility, a lowball estimate for wind in the country is 1,000 MW. As this is a very low estimate, given the natural resource situation in the country, using 50 percent of this as the marketable potential in the 10 years after completion of the project is a justifiable assumption.

First, subtract the project impact, i.e., continue on the basis of 500 MW – 45 MW = 455 MW. Then, calculate the projected electricity production over the 20-year expected lifetime of these 455 MW:

$$E = 455\ MW * 8{,}760\ hours * 27\ \% * 20 = 1{,}076\ GWh * 20 = 19{,}277\ GWh$$

Then calculate the GHG emissions avoided through the following equation, assuming the national emission factor remains constant over the respective years:

$$P_{10} = E * C = 19{,}277{,}000\ MWh * 0.89\ t\ CO_2 / MWh = 17{,}156{,}530\ t\ CO_2$$

This seems rather high compared to the other figures, but we are looking at a very long time for the impact (five years project implementation plus 10 years post-project impact) and, in addition, at investments with a long useful lifetime (20 years) and comparatively high power output.

Nevertheless, the GEF will be able to claim only partial responsibility, should such a development actually take place. While the GEF impact will have been substantial, significant other developments will also have had to occur. Therefore, the GEF causality factor is assumed to be 40 percent in this scenario. The final result of the pure top-down assessment is:

$CO_{2\ direct} = P_{10} * CF = 17{,}156{,}530\ t\ CO_2 * 40\ \% = 6{,}863{,}000\ t\ CO_2$

Table 7: Results Overview and Standardized Text

Measure	**Emissions Reduction (ktonnes CO_2)**
Direct	1,890
Direct post-project	0
Indirect bottom-up	2,835
Indirect top-down/ bottom-up mixture	3,613
Indirect top-down pure	6,863

<u>Direct Emissions Reductions</u>

Part of the outputs of the project will be the following investments:

(*a) Design financial instruments conducive to the development of wind energy, to be accepted and implemented by the government. Assist private developers with pre-feasibility-level project development activities for up to 45 MW wind power generation capacity.*

These activities will result in direct greenhouse gas emission reductions during the project's implementation phase.

As a result of these activities during the project implementation period of *(b) five years*, direct greenhouse gas emission reductions totaling *(c) 1,890 ktonnes of CO_2 equivalent* will be achieved over the lifetime of the investments of *(d) 20 years*. In the non-GEF case, these energy needs would be satisfied by *(e) coal- and gas-fired generation comparable to the current national power generation portfolio,* with an emission factor of *(f) 0.89 t CO_2 e / MWh*.

The project does not include activities that would result in direct post-project greenhouse gas emission reductions.

Indirect Emission Reductions

Using the GEF bottom-up methodology, indirect emission reductions attributable to the project are *(j) 2,835 ktonnes of CO_2 equivalent*. This figure assumes a replication factor of *(k) 1.5*.

Using the GEF top-down methodology, indirect emission reductions attributable to the project are *(l) 3,613 ktonnes of CO_2 equivalent*. This figure assumes that the total technological and economic potential for GHG emission reductions in this area over 10 years is *(m) 3,613 ktonnes of CO_2 equivalent*, and a project causality factor of (*n) 100 percent.*

V. NEW CLEAN ENERGY TECHNOLOGIES STEP-BY-STEP

Calculating Baseline CO_2 Emissions

112. For projects that aim to increase the market share of specific low greenhouse gas-emitting technologies, the overall CO_2 intensity of the country's economy is less important than the CO_2 intensity for the specific energy application targeted. The nature of OP7 projects means that it is probably better to focus on sector-specific, market-specific, or application-specific CO_2 intensity, rather than countrywide CO_2 intensity. In these cases, it is particularly important to note the baseline (marginal) technology and the specific CO_2 savings offered by the GEF intervention.

113. The GEF Alternative Scenario will generally lead to the development of emission reductions that would not have occurred, or would have developed at a slower rate, in the baseline scenario. Typically, new technologies are characterized by high costs and high levels of uncertainty, and markets would not be expected to develop these on their own without GEF interventions. For example, it is unlikely that Building Integrated Photovoltaic (BIPV) systems markets would develop in Malaysia without extensive interventions designed to reduce costs and increase local capacity. Thus, emission reductions from this sector would be virtually nil over many years in the baseline scenario; "baseline shift" as in the case of energy efficiency is not an important issue in this area.

114. It is important that the baseline also accounts for the degree of economic activity in the country and in the sector globally—that is, projects must consider if these technologies would become economical in the targeted countries due to cost reductions naturally occurring over time.

Calculating Direct Emission Reductions

115. In low greenhouse gas-emitting technology projects, the direct emission reductions can be determined directly from the amount of energy produced by the project's investments. This energy will substitute energy from more carbon-intensive generating technologies, including local power stations, or more generally, the marginal generating technology that would be used in lieu of the project in off-grid areas. The amount of energy produced by low greenhouse gas-

emitting technology (which corresponds to the amount of energy that will not be produced using the marginal technology), measured in kWh, and is then multiplied by the corresponding emission factor. In this case, the emission factor can be an average emission factor, for example, if grid electricity is being saved, the overall average emission factor of the local power sector. Alternatively for off-grid technologies, the emission factor will be that of the marginal technology that would otherwise be used (for example, small diesel generators). In some cases, e.g., fuel cells running on methane, where the new technology itself has some emissions, the effective emission factor is the difference between the baseline emission factor and the emission factor of the new technology.

$CO_{2\ direct} = E * c$; with

$CO_{2\ direct}$ = direct GHG emission avoided in CO_2 equivalent due to the successful implementation of the project
E = cumulative energy saved or substituted or produced, e.g., in kWh, due to the installation of low greenhouse gas-emitting technologies, calculated over the lifetime of the investments
c = difference between CO_2 intensities of new and marginal technologies, e.g., in g/kWh

116. In determining the cumulative energy saved over the lifetime of the investments, the project proposal should make conservative assumptions about the useful lifetime of new technologies—often they have not been sufficiently tested to assume very long lifetimes.

Calculating Direct Post-project Emission Reductions

117. In some cases, GEF projects put in place a GEF-financed mechanism that will continue supporting direct investments after the project's implementation period. It is unlikely that projects focusing on low greenhouse gas-emitting technologies will include such a mechanism, as financial support offered on its own typically fails to address the totality of barriers facing these markets. If it is the case, please refer to the sections on direct post-project emission reductions of the chapters on energy efficiency and renewable energy, depending on the character of the new technology.

118. Examples of financial mechanisms put in place after the close of a project could be: (a) a revolving fund for up-front financing of energy investments, which is refinanced from user fees or loan repayments, or (b) a partial credit guarantee facility, which might be fully exposed at the end of the project, but then reduce its exposure and thus keep looking for new opportunities. Depending on the leakage rate and the speed of payback, facilities of this type can multiply the original direct investment, and the associated emission savings long after the project has ended.

119. These direct post-project emissions can be calculated with the same formula as the direct effects that are achieved during project implementation. Assumptions are necessary regarding the impact that these interventions will have after the project closes. For a revolving fund, the rates of reflow and leakage determine how many investments can be financed after the supervised implementation period (how often the fund can "revolve"). The GHG emission

savings resulting from switching to low greenhouse gas-emitting technologies can be calculated using the same assumptions as for the direct GHG outputs of the project. The formula is:

$CO_{2\,DPP} = CO_{2\,direct*} * t;$ with

$CO_{2\,DPP}$ = emissions saved with investments supported by post-project financial mechanisms
$CO_{2\,direct*}$ = direct emission savings to the degree that they are supported through the mechanism that causes the post-project impacts
t = turnover factor, determined for each facility based on assumptions on fund leakage and financial situation in host country.

120. There is almost no practical experience of typical rates of leakage and default, or of typical rates of turnover. It is important to include an analysis of the underlying characteristics of the financial markets in the project preparation phase so that the project brief can contain well-based assumptions of turnover rates, the required size of partial guarantees, and the demand for these instruments.

Calculating Replication and Indirect Impacts

121. If it is reasonable to expect that the technology will still have significant incremental capital cost after the project, the autonomous development of a market is rather unlikely. In these cases, assumptions about the indirect CO_2 emission reductions need to be made all the more carefully and conservatively. The local conditions and likely project impacts should be decisive for the assessment whether or not any indirect impacts can be achieved.

122. In principle, the same two methodologies as for OPs 5 and 6—bottom-up and top-down—can be used to estimate a potential range for the impact. However, in some cases (as in the example below), more specific information is given, e.g., about expected policy schemes, and the potential indirect impacts can be directly derived from this information.

123. If not, for the **bottom-up methodology**, a probable replication factor for the project's investments needs to be determined. Mathematically, the GHG emission reductions are calculated with the same formula used to determine direct effects, and then multiplied by the assumed replication factor:

$CO_{2indirectBU} = CO_{2direct} * RF;$ with

$CO_{2\,indirect\,BU}$ = emissions avoided with investments made after the project has closed, estimated using the bottom-up approach, in tonnes CO_2 equivalent
RF = replication factor
$CO_{2\,direct}$ = estimate for direct and direct post-project emission reductions, in tonnes CO_2 equivalent

124. If possible, the local circumstances should be used to derive the replication factor. Nevertheless, it will be hard to justify high replication factors.

125. The **top-down** calculation starts with an assessment of the total potential of a specific new low greenhouse gas-emitting technology in the target country following the 10 years after the project's completion. Typically, new technologies are characterized by high costs, which will decline over time. The implementation of an OP7 project should aim to bring down these costs and increase capacity in the target country's marketplace. When estimating total market potential, it is important to factor in the effects of the successful implementation of the project—that is, after a project has been undertaken, to what extent can the market be expected to expand in the future?

126. Only market expansion that can be expected to occur in the 10 years immediately following the close of the project should be considered. Potential market expansion should be measured in terms of generation capacity installed and total energy generated from the low greenhouse gas-emitting technology. The latter measure can easily be transformed into avoided greenhouse gas emissions by following the same methodology utilized in the calculation of direct emission reductions—that is, to multiply the quantity of zero-emission energy generated by the per-kWh emissions intensity of the local grid or marginal technology.

127. The resulting 10-year potential should be corrected with the GEF causality factor, which describes how much of this generation capacity, generated energy, and avoided emission reductions can really be attributed to the GEF interventions, and how much would have happened in the long-term, business-as-usual scenario. For the **GEF causality factor**, five levels of GEF impact and causality have been assumed:

(a) Level 5 = "critical and nothing would have happened," GEF causality = 100 percent

(b) Level 4 = "dominating," GEF causality = 80 percent

(c) Level 3 = "substantial but modest," GEF causality = 60 percent

(d) Level 2 = "modest and substantial," GEF causality = 40 percent

(e) Level 1 = "weak," GEF causality = 20 percent

128. While the GEF causality factor is useful and can deliver consistent results, GEF causality factors should rely on situation-specific justifications and be estimated conservatively. For OP7 projects, it would be typical to see a level 4 or 5 causality factor. Please note that the GEF causality factor accounts for baseline shifts, that is, for situations where the nationwide baseline is expected to move toward a less CO_2–intensive situation even without the GEF intervention.

129. The formula for calculating indirect impacts with the top-down methodology is, accordingly:

$CO_{2\ indirect\ TD} = P_{10} * CF$, with:

$CO_{2\ indirect\ TD}$ = GHG emissions avoided in CO_2 equivalent as assessed by the top-down methodology
P_{10} = technical and economic potential GHG savings with the respective application
CF = GEF causality factor

An Example: Building-Integrated Photovoltaic Technology Project (BIPV)

*Project Duration***:** 5 years

Project Objective: The project objective is to create a sustainable Building Integrated Photovoltaic (BIPV) market in Malaysia, which will also help stimulate wider BIPV application in other Southeast Asian counties.

Project Components:

Component 1: The "Suria 1000" program

This will include setting up the "Suria 1000" program, which aims to catalyze the installation of 1000 kilowatt peak (KWp) BIPV capacity over the five-year project implementation period. Through this program, a limited quantity of BIPV systems will be offered to the public through a bidding approach.

Component 2: *BIPV demonstration project program.*

Showcase projects in government, commercial, and residential buildings, as well as in public spaces, will be undertaken, resulting in 500KWp of installed BIPV capacity over the five-year project period.

Component 3: *Develop polices and financing mechanisms conducive to BIPV*

The third activity intends to develop a suite of policy, institutional, legal, financial, and fiscal measures through targeted research activities, which will then be presented to the government of Malaysia. These measures are intended to assist in the formulation of a national BIPV target to be included in the 10th Malaysia Plan (2011-2015).

Component 4: *BIPV industry development and R&D enhancement program*

This component aims to strengthen human capacity in BIPV research and development and manufacturing, providing the opportunity to export locally manufactured products to regional markets. The promotion of local BIPV industry is key in driving cost reductions.

Components 1 and 2 will catalyze direct emission reductions, while indirect emission reductions will result from components 3 and 4.

Step 1. Determine the Baseline

Without a GEF project, the technology would not be adopted as a viable form of renewable energy. While some complementing activities in the broader field of PV are planned by the government of Malaysia, a sustainable market and unit-cost reduction for BIPV would not be established without the project. Although Malaysia has 450 KWp grid-connected PV installed today, grid-connected BIPV capacity remains low, and this is unlikely to change without the project. Until 2010, the anticipated requirement for 10 GW of new generation capacity in Malaysia will be met through coal- and natural gas-fired plants; Malaysian grid-supplied electricity is assumed to have a relatively constant CO_2 intensity of 0.62 tonnes of CO_2 per MWh.

Step 2. Determine the GEF Alternative

The GEF Alternative Scenario would see the beginnings of a sustainable BIPV market emerge. The market would be characterized by the development of local technology producers, supported by capacity building programs and favorable policy and financial frameworks for the sale of PV-generated electricity to the Malaysian grid. Public awareness campaigns will foster public demand and private sector involvement in PV services and manufacture.

During the project implementation period, the combination of demonstration projects and the "Suria 1000" program will lead to the installation of 1.5 MWp of BIPV capacity (see table 8 below).

Table 8: Installation Schedule of BIPV

Year	**Annual installed capacity (KWp)**	**Cumulative installed capacity (KWp)**
2006	206	260
2007	300	560
2008	340	900
2009	300	1,200
2010	300	1,500

Step 3. Calculating Direct Emissions Reductions

Following the guidance in the GHG emissions manual, direct emission reductions can be calculated by multiplying the energy savings from project activities (measured in kWh or MWh) by the corresponding emissions factor.

$CO_{2\ direct}$ = E * C ; with

E = cumulative energy saved or substituted
C = CO_2 intensity of the marginal technology or electricity saved

First, the amount of energy saved must be calculated. In this project, energy saved is reported in the form of MWh (see table 8 below). Research conducted as part of the project planning process determined that 1 KWp of installed BIPV capacity in Malaysia will produce an average of 1.2 MWh of electricity annually, without any associated GHG emissions.

In addition to the electricity produced from BIPV, installing these systems results in reduced building air-conditioning requirements. Project preparation documents estimate that for every 1 KWp BIPV capacity installed correctly as a shading device (about 30 percent of capacity), electricity consumption for air-conditioning drops by 5 MWh per year. The energy savings resulting from the reduced energy consumption for air-conditioning is displayed in table 8 below. Furthermore, installing BIPV has the benefit of reducing electricity distribution losses. Project preparation documents estimate that each KWp BIVP capacity installed avoids 0.1 MWh per year of electricity losses. The energy savings resulting from the reduced electricity consumption for air-conditioning is displayed in Table 9 below.

Table 9: Energy Savings from BIPV Installation

Cumulative installed capacity (KWp)	**Annual electricity saved from reduced air-conditioning (MWh)**	**Annual avoided distribution losses (MWh)**	**Annual electricity generated (MWh)**
1500	2,250	150	1,800

Installing grid-connected BIPV saves and substitutes for electricity supplied from the national grid, currently comprised predominantly of coal- and gas-fired generation. Thus, to obtain the direct annual CO_2 emission reductions, the cumulative thermal grid-supplied electricity saved due to the installation of BIPV generation capacity and the CO_2 intensity of the grid-supplied electricity are multiplied together. Research conducted for project preparation documents have determined the average CO_2 intensity for the Malaysian grid-supplied electricity is 0.62 tonnes of CO_2 per MWh.

$CO_{2\ direct}$ per year = total electricity saved or substituted * 0.62

= 1802 MWh /year * 0.62 tonnes of CO_2 / MWh

= 1,117 tonnes CO_2 / year

The assumption is made that all investments, irrespective of when they are made, operate for 10 years. The emission reductions stemming from the continued operation of these investments would equal:

= 1,117 tonnes CO_2 /year * 10years.

= 11,170 tonnes CO_2

Step 4. Calculating Direct Post-project Emissions Reductions

This GEF project has not put in place a financing mechanism that will continue after the close of the project, or any sort of component that will continue to operate after the project close and catalyze GHG emission reductions. Therefore, no direct post-project emission reductions will be achieved.

Step 5. Calculating Indirect Emissions Reductions

11,170 available: without a successful project, the development will remain very slow, while subsequent to the successful completion of the project, a national BIPV scale-up target will be incorporated into the 10th Malaysian Plan. This scale-up target of 20 MWp by 2020 represents the total BIPV market development potential in the country (see table 10 below). This information is sufficient to calculate the indirect emission reductions, and the proponent need not revert to an extrapolation using the top-down and bottom-up methodologies.

Table 10 Installed Capacity of BIPV

Year	**Annual installed capacity (KWp)**	**Cumulative installed capacity (KWp)**
2011	500	2,000
2012	2,000	4,000
2013	2,000	6,000
2014	2,000	8,000
2015	2,000	10,000
2016	2,000	12,000
2017	2,000	14,000
2018	2,000	16,000
2019	2,000	18,000
2020	2,000	20,000

The bottom-up approach aims to calculate how many times the investments made during the project might be replicated. However, the exact replication in case of success is determined by the government's plans, as indicated in table 9. Similarly, the government's targets can also be seen as an indication of potential market size achievable in the long run due to the GEF project.

The project preparation documents indicate that with BIPV's incorporation into the 10th Malaysia Plan, the market would undergo rapid growth, reaching 20 MWp by 2020 (see table 11 below). This growth in BIPV capacity can be directly translated into emission reductions using the same methodology applied to calculate direct emission reductions.

Table 11: Emission Reductions from BIPV Capacity

Year	**Cumulative installed capacity (KWp)**	**Annual BIVP substituted/saved electricity (MWh)**	**Annual avoided GHG emissions (t CO_2)**
2011	2,000	5,600	3,472
2012	4,000	11,200	6,944
2013	6,000	16,800	10,416
2014	8,000	22,400	13,888
2015	10,000	28,000	17,360
2016	12,000	33,600	20,832
2017	14,000	39,200	24,304
2018	16,000	44,800	27,776
2019	18,000	50,400	31,248
2020	20,000	56,000	34,720

By 2020, 20,000 KWp of BIVP capacity will be put in place, catalyzing annual emission reductions amounting to 34,720 tonnes CO_2. Again, we will assume a physical lifetime of 10 years, resulting in total indirect emissions reductions of:

CO_2 Indirect = 34,720 t CO_2 * 10 years

= 347,200 t CO_2

Table 12 Results Overview and Standardized Text for BIPV Example

Measure	**Emissions Reduction (t CO_2)**
Direct	**11,170**
Direct post-project	**0**
Indirect	**347,200**

Direct Emission Reductions

Part of the outputs of the project will be the following investments:

(a) The Suria 1000 program (aims to catalyze the installation of 1,000 KWp BIPV) and a BIPV demonstration project program.

These activities will result in direct greenhouse gas emission reductions during the projects' implementation phase. As a result of these activities during the project implementation period of *(b) five years*, direct greenhouse gas emission reductions totaling (c*) 11,170 tonnes of* CO_2 *equivalent* will be achieved over the lifetime of the investments of *(d) 10 years*. In the non-GEF case, these energy needs would be satisfied by *(e) coal- and natural-gas fired plants*; with an emission factor of *(f) 0.62 t* CO_2 */ MWh.*

The project does not include activities that would result in direct post-project greenhouse gas emission reductions.

Indirect Emission Reductions

This project did not follow the standard bottom-up and top-down methodologies. Therefore no standardized text can be included.

Using the data provided by project preparation documents, policy put in place by the successful completion of the project will lead to indirect emission reductions totaling 347,200 tonnes of CO_2 *equivalent*.

VI. APPENDIX

Standardized Text for Inclusion in Project Preparation Documents

Instructions: Use the text below for the project documentation. Replace the letters with data suggested in corresponding boxes etc. This data will have been obtained from following the methodology in the Manual for Calculating GHG Benefits of GEF projects and can be calculated using the accompanying spreadsheet. For full examples, refer to the examples presented for each OP.

Direct Emission Reductions

(1) Part of the outputs of the project will be the following investments: (a) these activities will result in direct greenhouse gas emission reductions during the project's implementation phase.

(a) Enter project activities

(2) As a result of these activities during the project implementation period of (b) years, direct greenhouse gas emission reductions totaling (c) tonnes of CO_2 equivalent will be achieved over the lifetime of the investments of (d) years. In the non-GEF case, these energy needs would be satisfied by (e) with an emission factor of (f).

(b) Enter duration of project implementation

(c) Enter the reduction in the tonnes of direct CO_2 equivalent emissions

(d) Enter the assumed useful lifetime of investments

(e) Enter marginal technology

(f) Enter emissions factor of marginal technology or national grid

<u>Direct Post-project Emission Reductions</u>

Instructions: Chose 1 or 2. If 1 is applicable, move to post-project emission reductions; if 2 is applicable, continue below.

(1) The project does not include activities that would result in direct post-project greenhouse gas emission reductions.

(2) The project does include activities that would result in direct post-project greenhouse gas emission reductions.

Instructions: The project will have set up a financing structure or some other activity that will function after the project has closed and continue to reduce GHG emissions.

(3) A fund set up by the project is expected to continue to finance investments resulting in GHG emission reductions after the project close. The fund is expected to finance $ (g) of new investment, equivalent to a turnover factor of (h), resulting in direct post-project emission reductions of (i) tonnes CO_2 equivalent.

(g) Enter the quantity of financing expected to be made available during the fund's post-project lifetime.

(h) Enter the fund's assumed post-project replication factor

(i) Enter the emission reductions expected to arise from the post-project functioning of the fund.

<u>Indirect Emission Reductions</u>

(1) Using the GEF bottom-up methodology, indirect emission reductions attributable to the project are (j) tonnes of CO_2 equivalent. This figure assumes a replication factor of (k).

(j) Enter indirect GHG emission reductions calculated using the GEF bottom-up methodology

(k) Enter the assumed replication factor

2) Using the GEF top-down methodology, indirect emission reductions attributable to the project are (l) tonnes of CO_2 equivalent. This figure assumes that total technological and economic potential for GHG emission reductions in this area over 10 years is (m) tonnes of CO_2 equivalent, with a project causality factor of (n) %.

(l) Enter indirect GHG emission reductions calculated using the GEF top-down methodology.

(m) Enter assumption for total possible GHG emission reductions possible in this area over the 10 years after the close of the project.

(n) Enter assumed causality factor

Mitigating Climate Change with Energy-related TC projects

Guidelines for Calculating GHG Emission Impact

DRAFT

gtz Climate Protection Program

On behalf of
Federal Ministry
for Economic Cooperation
and Development

Imprint

Published by
Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH
Dag-Hammarskjöld-Weg 1-5
P.O. Box 5180
65726 Eschborn / Germany
info@gtz.de
www.gtz.de

On behalf of the
Federal Ministry for Economic Cooperation and Development

Responsible:
Anja Wucke, GTZ Climate Protection Programme

Contact:
Anja.Wucke@gtz.de
www.gtz.de/climate

Authors:
Projekt-Consult GmbH (2003 edition)
Prof. Dr.-Ing Christoph Menke (revised edition 2008)

Edited by:
Peter Cummins

Layout:
Roger Krichbaum, GTZ

Executive Summary

Background

The Technical Assistance (TA) projects of GTZ are aimed at sustainable development in broader perspective. Climate protection is one of the important themes in international cooperation. Contributing to the reduction of emissions in host countries is accomplished in TA projects, in general, through policy advice, training and consultancy. These aim to improve the framework conditions for energy investments in renewable energies and/or energy efficiency which are the main tasks. Investments – if at all – are more likely to be small, e. g. pilot scale or demonstration investments.

GTZ has already established a quantification procedure for its CO_2e balance at the headquarters in Eschborn and Berlin, as a part of its environmental report. This approach so far does not include project activities in the field or emissions of the GTZ country offices. It is GTZ´s environmental management policy to extend this approach to country offices and projects in the field. At that time, this would be still on voluntary bases and these guidelines shall become the basis for calculation of GHG impact of TA projects in terms of CO_2e.

Objective

The objective of these guidelines is twofold. Firstly to develop an approach under Part A of these guidelines to quantify the emissions due to a project's own activities in the individual projects. Under Part B, many projects promote energy efficiency and introduce the use of renewable energy systems thereby reducing the levels of GHG emission. Such projects may have a direct involvement and can be called: ***a direct contribution of the project to GHG emission savings***. Furthermore, there are projects wherein policy advice would stimulate the impact at ground level by favouring the development of energy related projects, increased flow of investment in the promotion of energy projects, or through enforcement of regulations in labelling and standards. If the framework conditions are improved and/or pilot projects are successful, then a wider dissemination and replication of the demonstrated technologies will occur, resulting in a further, climate change mitigation potential, compared to the direct activities of the project itself. These impacts can be called: ***an additional indirect contribution of the project to GHG emission savings***.

To calculate emissions caused under Part A, emission factors are needed for a specific activity and are sourced from various references. However the approach followed is unique under Part A. If detailed information - related to the personnel transportation (such as project owned vehicles, commuting to work and non-road transport) of project staff, consultants and interns (all people that are on the "pay role" of the project) – of electricity consumption at the site is available, then it is suggested to use the worksheet "Part A detailed". In circumstances where the detailed information is not available, it is suggested to use "Part A short" where suggestions are given for the quantity in each mode, which can be used in the absence of own data.

These guidelines are evaluated and tested to investigate and quantify for GHG, the impact of the TA projects with examples from a field test in Mexico, Indonesia, the Caribbean, Thailand and China, as well as examining examples from Jordan, the Solomon Islands and Bolivia. The procedure for calculating the emissions mitigated (i. e. Part B) is different in each project and, only for renewable energy projects, can standard approaches be followed. For energy efficiency project activities, individual approaches have to be defined as shown in these guidelines for selected cases. This approach would have the advantage of the Framework for Contracts and Cooperation (AURA), as all the projects in the inception stage must establish quantifiable and measurable indicators. Many energy related projects already have energy quantities or CO_2e related indicators.

These indicators are monitored and evaluated once every year during the project duration. While doing so, the only task is to translate these results from the quantifiable indicators into GHG emissions which is possible if energy units are mentioned directly in the indicator i.e. amount of fuel saved or replaced. There is no extra task necessary, for

the project GHG impact reporting is the baseline and the savings have to be established under the annual reporting for the German Ministry of Development and Economic Co-operation, BMZ. In the absence of indicators, a direct approach would be an alternative option to translate the impact or results of the project that mentions quantity of energy saved or expressed results in quantity of emissions mitigated. An alternative could be for some kind of TA projects, the Programme of Activities under CDM, developed under UNFCCC wherein climate change mitigation could be calculated using sets of procedures and methodologies. This is an international-accepted standard approach and could be used in the future for evaluating GHG impact of GTZ TA projects, which would be promoted through policy.

Summary

In summary, the GHG emission savings of a project consist of a direct and an indirect contribution. The total amount of GHG emission savings is calculated based on an utilisation period of ***10 years***, for the implemented energy systems are in accordance with one of the options under the UNFCCC approach.

However GTZ would like to estimate the GHG impact of its TA projects on a voluntary bases. Thus this uniform reporting would not balance Part A and Part B estimates; instead it would be reported individually, as mentioned below in the following example:

Example: Mini Hydro Power for Sustainable Economic Development Programme in Indonesia, GTZ Project number: 2001.2037.8

- Part A: The project caused around 300 t CO_2 during its three years of implementation.
- Part B: The project directly and indirectly contributed to CO_2 savings of 90,000 t CO_2, (of which 30,000 t CO_2 are directly contributed), when a utilisation time for the realized hydro power plants is assumed to be 10 years.

Table ES1 A summary on the projects tested under the guidelines evaluation

Project	***Part A*** (t CO_2 / year)	***Part B*** (t CO_2 / utilisation period)
Mini Hydro Power for Sustainable Economic Development, Indonesia	99	89,988
Wind Park in Jordan (TERNA Project)	-	410,850
Photovoltaic (PV) systems in Mexico up to 30 kW	136	9,807
Use of micro hydroelectric power in the Solomon Islands – diesel grid	-	2,248
Electricity generation from biogas and biomass systems in POMs in Thailand under E3Agro project	56	4,409,960
Caribbean Renewable Energy Development Program (CREDP/GTZ)	151	477,848
Solar water heating systems replacing LPG fired heaters in Mexico	136	578,129
Decentralized energy supply project / household energy (solar home systems) in Bolivia	-	13,750
Energy Efficiency of Existing Buildings (EEEB) – China	-	74,385,903
Power Plant Optimisation in China – Environmental Protection in the Energy Industry (EPEI)	221	24,717,049
Energy & Eco-Efficiency in Agro-Industry (E3Agro) project in Thailand	56	2,994,720

Contents

Abbreviations

AURA	Framework for Contracts and Cooperation with BMZ
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development)
CDM	Clean Development Mechanism
CDM PoA	Clean Development Mechanism Programme of Activities
CER	Certified Emission Reductions
CERUPT	Certified Emission Reduction Unit Procurement Tender
CFL	Compact Fluorescent Lamp
CO2	Carbon Dioxide
DNA	Designated National Authority
EE	Energy Efficiency
EF	Emission Factor
EnDev	Energising Development, Project implemented by GTZ on behalf of the Government of the Netherlands
GEMIS	Global Emission Model of integrated systems
GHG	Greenhouse Gas
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Technical Cooperation)
JGSEE	The Joint Graduate School of Energy and Environment
LPG	Liquefied Petroleum Gas
NCV	Net Calorific Value
PDD	Project Design Document
PV	Photovoltaic
PVP	Photovoltaic Pumps
RE	Renewable Energy
SENER	Secretaría de Energía energia, México (Energy Secretariat)
SHS	Solar Home Systems
SiMIMex	Sistema de Monitoreo orientado hacia Impactos para las actividades de la GTZ en México (Impact-based monitoring system for activities of GTZ in Mexico)
t	tonnes
TA	Technical Assistance
T&D (losses)	Transmission & Distribution
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	US Environmental Protection Agency
VER	Verified Emission Reductions
WBCSD	World Business Council for Sustainable Development

Introduction and Aims

Background

The Technical Co-operation (TC) programmes and projects of the German Development Co-operation are aimed at sustainable development in a broader perspective. Climate protection is one important issue in international cooperation. In general, contributing to the reduction of emissions in host countries is accomplished in energy programmes and projects through various forms of consultancy and investment programmes that aim at improving energy efficiency, or that introduce renewable energy systems. In TA projects, in general, policy advice, training and consultancy to improve the framework conditions for energy investments in renewable energies and/or energy efficiency are the main tasks. Investments – if at all – are more likely to be small, for example, pilot scale or demonstration investments.

GTZ has already established a quantification procedure for its CO_2e balance at the headquarters in Eschborn and Berlin, as a part of its environmental report. Between 2004 and 2008 this was in the range of 11 000 - 14 000 t CO_2e. This quantification includes emissions due to commuting to and from work, business travel as well as electricity and fuel consumption for the buildings. This approach so far does not include project activities in the field or emissions of the GTZ country offices.

Objective

The objective of these guidelines is twofold:

1. Develop an approach under Part A of these guidelines to quantify the emissions due to the project's own activities in the individual projects. Flexibility is provided in estimating the emissions wherein two approaches are suggested, based on the information available related to a project (i.e. "Part A detailed" and "Part A short"). In "Part A short", suggestions are given for the quantity in each mode, which can be used in the absence of its own data.
2. On the other hand, programmes and projects, especially in the energy sector, have a positive effect in connection with Greenhouse Gas (GHG) emissions (i.e. these projects promote energy efficiency and introduce the use of renewable energy systems thereby reducing the levels of GHG emission). Part B of these guidelines develops an approach to address the emissions mitigated through project implementation. It is important to note that, in most projects, the GHG emissions estimated under Part B are much larger than those under Part A.

The GHG benefit can be classified in two different ways: The GHG saving due to these activities can be called: a ***direct contribution of the project to GHG emission savings***, when it is a direct benefit within the results chain.

In addition, if the framework conditions are improved and/or pilot projects are successful, then a wider dissemination and replication of the demonstrated technologies ocur, which then have a much wider climate-change mitigation potential, compared to the direct activities of the project itself. These impacts can be called: ***an additional indirect contribution of the project to GHG emission savings***, especially if a relation between project activity and impact can be established according to the "AURA impact monitoring" concept. (This is a concept of the German TA focussing on monitoring of impacts rather than on results). In this case it is most likely an indirect benefit within the impact chain.

The aim of these guidelines is to investigate and quantify the GHG impact of the TA projects with examples from field tests in Mexico, Indonesia, the Caribbean, Thailand and China as well as examples from Jordan, the Solomon Islands and Bolivia. The procedures for calculating the emissions mitigated is different in each project and, only for renewable energy projects, can standard approaches be followed. For all other project activities, individual approaches have to be defined as shown in these guidelines for selected cases. Thus the aim of these guidelines is to estimate the GHG impact of TA projects.

Indicators selection

Since recently, the climate change mitigation potential of TA programmes and projects has been quantified in many energy-related projects on the level of targets and indicators, either on the level of the overall project/programme goal or on the level of the individual programme components. The approach of the Framework for Contracts and Cooperation (AURA) with quantifiable and measurable indicators has established a much better starting point to quantify the climate change impact, compared with the situation a few years ago. In all these cases the only task for the project manger is to translate these results from the quantifiable indicators into GHG emissions, which is possible if energy units are mentioned directly in the indicator (i.e. amount of fuel saved or replaced). There is no extra task necessary for the climate change impact reporting, for regardless, the baseline and the savings have to be established under the annual reporting for the German Ministry of Development and Economic Cooperation, BMZ .

Summary

In summary, the investigations here will differentiate between the ***emissions caused*** by project's activities in Part A of the guideline and the direct and indirect contributions to ***emissions saved*** due to the project activities in Part B. This guideline suggests a uniform method for the Part A, which tries to use the approach of the headquarters, to have uniform emission factors wherever possible. For Part B as well a uniform reporting format is suggested without forcing a uniform approach for estimating the climate change impact.

A first attempt to do this was made by GTZ in the year 2003. In 2007, a field test of that method was requested.which, following discussions with the respective project managers, resulted in this update and a revision of the method to make it more pragmatic and able to cope with the framework conditions of energy related projects of GTZ. (All discussions with the project managers involved in this procedure have been documented in separate memos,which are included in the attachment folder to this guideline, for further reference).

Manuals and approaches by other organisations

In preparation for the update, a detailed review of all existing methodologies for identifying climate change impacts of institutions/ processes was done in a literature review which is in the Attachment folder No. 1 of these guidelines, for further information. The result of this review was that, up to date, no other approach can be suggested to fulfil the tasks requested by GTZ for their energy-related projects. Therefore the proposed procedures remain valid. Two recent - and the most interesting approaches - are from GEF and from UNFCCC which are described here in brief.

GEF Manual

GEF Manual for GHG benefit

In mid-April 2008, GEF approved a "Manual for Calculating the GHG Benefits of GEF Projects: Energy Efficiency and Renewable Energy Projects". For more information, please refer to attachment 11 for the manual and 12 for the spreadsheet.

The GEF methodology concerns the CO_2 emissions mitigated through its GEF projects. The categories of the projects would include demonstration projects and direct investments, to financing mechanisms that leverage local private-sector financing. Some of the projects are capacity-building and technical assistance, to the development and implementation of government policies supporting climate-friendly investments in energy and other sectors. As GTZ programmes, many GEF project activities do not have a direct GHG impact but implementation of these projects would have a significant influence on the projects in future.

Therefore, the methodology followed under GEF would adequately assess the CO_2 emission reduction of these projects, categorizing the impacts into three different sets. The approach followed in each category is different and thus the accuracy level would also vary.

a) Direct contribution: The CO_2 emission reduction achieved by investments that are directly part of the results of the project. The quantification of CO_2 emissions saved, is calculated similarly to CDM projects. The life-time of the project (rather utilization period) varies from seven to 20 years (project specific).for example: off-grid photovoltaic 10 years, building integrated photovoltaic 20 years, wind 20 years, small hydro 20 years and bagasse 10 years. The accuracy level of the emissions reduction calculation is very high. These projects are tracked through monitoring and evaluation systems.

Comment: This direct contribution is similar to the concept in our GTZ programmes and projects except the utilization periods differ, as we suggest uniform 10 years, whereas energy efficiency projects related to buildings is 20 years.

b) Direct post-project contribution: GEF projects frequently put in place (financial) mechanis such as partial credit guarantee facilities, risk mitigation facilities, or revolving funds that will still be operational after the project ends. The emission reductions, through mechanisms that are supported by GEF, will still be active after a given project's supervised duration. Although it is difficult to identify the utilization period, a turnover factor is introduced (determined for each facility based on assumptions on fund leakage and the financial situation in the host country). The quantification of the emissions reductions is similar to CDM projects, based on assumptions of functioning post-project mechanisms. But the emissions-reduction accuracy is not as high as a direct contribution.

Comment: This category can be useful for the GTZ in case financial mechanisms are installed in GTZ programs.

c) Indirect contribution: Because GEF projects emphasize capacity-building, innovation, and catalytic action for replication, their largest impacts typically lie in the long-term GHG such as market facilitation and development, achieved after a GEF project's completion The emissions reduction would be quantified through either bottom-up or top-down approaches. Based on the approach selected, a replication factor would be introduced. Therefore the results would often be less accurate.

Comment: This category is quite vague and has a lot of assumptions included to make it as accurate as possible. It is questionable if such an input is justified in the light of the inaccuracy any indirect contribution will have. Therefore, it is suggested not to use this GEF approach for the indirect contribution, but to leave it to the judgement of the individual project manager, to describe and judge the indirect contribution of the GTZ program.

d) In any case the methodology doesn't recommend totalling these figures, while in our GTZ proposal, we suggest to combine the sum of indirect and direct contributions and make them visible which will be in direct proportion to the amount displayed.

UNFCC

Programmatic CDM by UNFCCC

It is rather important to first discuss the approach followed under CDM for projects to register and receive credits in the form of Certified Emissions Reduction (CERs). In the categories defined and the scale of operation, a project shall identify a methodology to estimate the CO_2 emissions saved (emission reductions). If the project scope doesn't match the existing methodology, then one could propose a new methodology. In either case, the methodology will include how the parameters used in the emission calculation are monitored. Most importantly, CDM is evaluated on a project-by-project basis and, therefore, it is very important that a project fulfils the additional criteria defined in the methodology or methodology related tools. As mentioned earlier, the aim of these guidelines is different and furthermore it will not be tested for GTZ projects.

Another recent interesting approach is the CDM Programme of Activities (PoA) which quantifies the benefit for GHG emission reduction projects added into a programme during a period e.g. renewable energy and energy-efficiency projects promoted through policy advice. Most German TA projects are executed in cooperation with governmental organisations and related to policy advice. Hence the CDM programme of activities (PoA) could be a future tool that offers a consistent approach to quantify the climate-change impact of, for example, renewable energy policy interventions and the subsequent resulting additional projects. This approach can serve as an example to establish the GHG impact of TA projects, as well as the procedures and guidelines already established, to register the project activities under a CDM PoA, as a single CDM project activity developed, using approved baseline and monitoring methodologies[1]. Possible CDM PoA concepts for a few cases are detailed under attachments 2a, 2b & 2c. But it is too early to suggest, that the CDM PoA approach is a uniform tool for most energy-related projects. An example of a CDM PoA pilot project supported by the German government is the: ***CFL programme in India***. One probable project that could fall in this category is the distribution of energy-saving light bulbs in India. The target is to replace 80% of incandescent light bulbs – approximately 320 million light bulbs currently used in Indian households.

Clarification about the usage of GHG figures in the context of GTZ programmes/ projects

To avoid any misunderstandings, GTZ does not plan to balance the emissions caused by and the emissions saved in a project, nor is it planned to claim that the emissions saved can be credited to GTZ. The purpose of these guidelines is to estimate the impact of both parts and to present a guideline that helps to establish these figures in a transparent manner, without requiring too much input of resources for the respective project managers. The first purpose of these figures is to help GTZ to report back to BMZ, the GHG impact of energy-related TA projects.

Note*: All the mentioned annexes in the manual are part of this document, whereas attachments are not. The folder with all attachments is available via E-mail and could be received from anja.wucke@gtz.de.*

1 For information on the related documents, refer to http://cdm.unfccc.int/Reference/PDDs_Forms/PoA/index.html

Emission Calculations

Determining CO_2 emissions in the project[2].

What are we causing?

To answer this question, there are already a whole row of internationally-recognised calculating methods available, such as the GHG protocol, ISO 14064 etc. A detailed overview is presented in attachment 1. Experience shows that the activities with major sources of emissions, are the transport needed on site and the considerable amount of international travel necessary for the work undertaken by the project actors. The estimates indicate that this would be around 75 to 90 % of the total emissions caused by a project.

As mentioned above, Part A could be done in two ways and the selection is left to the project manager, as it depends on the circumstances. If detailed information related to the personnel transportation (such as project-owned vehicles, commuting to work and non-road transport) of project staff, consultants and interns (all people that are on the "pay-roll" of the project), and the electricity consumption at the site is available, then it is suggested to use the worksheet "Part A detailed". In circumstances where the detailed information is not available, it is suggested to use "Part A short" where suggestions are given for the quantity in each mode which can be used in the absence of actual data. However, both worksheets use Emission Factors (EF) from various sources including GTZ headquarters - or the source GTZ headquarters is using wherever possible. All these EFs are excluding the up-stream emissions. However if it is intended to calculate the up-stream emissions, then the emission factors would be roughly an additional 20% to the current EF. The data source of the up-stream EF could be derived from the Global Emission Model of integrated systems (GEMIS). Further information on the EF and their sources can be seen in attachment 3.

The calculations for the most important emissions in a project under Part A are given in Table 1. The specific CO_2[3] factors used are selected on the basis of generally-known or especially ascertained EF for the employed technologies and transport medium used. The information related to some other activities which might fall under Part A are included in Annex 2.

Table 2 contains example values that can be used for a project where detailed data are not available. The result of the calculation is the total amount of GHG emissions in t CO_2 over one year, caused by the project

More examples are reported in the field reports for the visited energy projects which are in the attachments 4 - 8. Most TA projects have caused between 50 and 200 t CO_2 emissions per year of operation. A similar reporting could be done for all GTZ country offices, if GTZ plans to estimate the total amount of emissions caused. GTZ´s environmental management system is supposed to be extended to country offices and projects in the field in future. Until that time, this is still on a voluntary bases.

This part of the guidelines can become the basis for calculation of the GHG impact from TA projects in terms of CO_2e. It can be used to establish the "Carbon Footprint" of the GTZ.

---

2 Project here is used synonymously with programme, programme component or individual measure.

3 In most cases this refers to CO_2, and if other gases come into question, then these have to be converted in accordance with their equivalent CO_2 "Global Warming Potential" factor; for methane this is 21. For the sake of simplicity however, we are referring here only to CO_2 values.

Table 1 Summary of emission factors (EF) for transport-related activities under Part A[3]

Transport medium	***Emission factor (without upstream emissions)***		***Remarks***
Car – petrol	2.36	kg CO_2 / liter	TREMOD (2006)[5]
Car – diesel	2.64	kg CO_2 / liter	TREMOD (2006)
Car – petrol	0.162	kg CO_2 / km (per vehicle)	TREMOD (2006)
Car – diesel	0.137	kg CO_2 / km (per vehicle)	TREMOD (2006)
Motorcycle	0.093	kg CO_2 / km (per vehicle)	EPA 2001 Guide
Airplane – long haul (10000 km), business class	0.478	kg CO_2 / person km	http://www.atmosfair.de
Airplane – long haul (10000 km), economy class	0.307	kg CO_2 / person km	http://www.atmosfair.de
Airplane – medium haul (2000 km), economy class	0.237	kg CO_2 / person km	http://www.atmosfair.de
Airplane – short haul (500 km), economy class	0.197	kg CO_2 / person km	http://www.atmosfair.de
Train – electric	0.066	kg CO_2 / person km	TREMOD (2006)
Train – diesel	0.172	kg CO_2 / person km	WRI 2002
Public transport mix (local train, bus & metro)	0.074	kg CO_2 / person km	TREMOD (2006)
Bus (diesel, long distance)	0.049	kg CO_2 / person km	WRI 2002

3 For information on the related documents, refer to http://cdm.unfccc.int/Reference/PDDs_Forms/PoA/index.html
4 German Federal Environment Agency (Umweltbundesamt), "Data and calculation model: Energy consumption and emission of pollutants of motorized traffic in Germany (TREMOD)", version 4.17, 2006

Table 2 CO_2 emission due to the project – Calculation Example 1 (Mini Hydro Power for Sustainable Economic Development, Indonesia)

*Quick assessment of part A related emissions caused by the Technical Assistance project**		Unit	*Mode of use / range / size*					*Emission factor*				*Amount of CO_2 released*	*Percentage contribution*
1.1	***Transport (vehicle) related emissions***		***Vehicles***	***Low (1-10k)***	***Medium (10-25k)***	***High (25-50k)***	x	***kg CO_2/Unit***	x	***Years***	=	***kg CO_2***	
1.1.1	Petrol car(s) owned by project office	km/year	1		17,500			0,162		1		2,835	19%
1.1.2	Diesel car(s) owned by project site	km/year	1			37,500		0,137		1		5,138	
1.1.3	Rented diesel cars - run at site	km/year	1			37,500		0,137		1		5,138	
1.1.4	Rented petrol cars	km/year	1			37,500		0,162		1		6,075	
1.1.5	Motorcycles	km/year						0,093		1		-	
1.2	***Non-road transport personnel - air travel***		***Flights/year***	***Short (2000)***	***Medium (6000)***	***Long (10000)***	x	***kg CO_2/Unit***	x	***Years***	=	***kg CO_2***	
1.2.1	Airplane – long haul (10000 km), business class (distance for oneway flight)	P-km/yr						0,478		1		-	67%
1.2.2	Airplane – long haul (10000 km), economy class (distance for oneway flight)	P-km/yr	20			10000		0,307		1		61,400	
1.2.3	Airplane – medium haul (2000 km), economy class (distance for oneway flight)	P-km/yr						0,237		1		-	
1.2.4	Airplane – short haul (500 km), economy class (distance for oneway flight)	P-km/yr	50	500				0,197		1		4,925	
1.3	***Employees commuting to work***		***Cars/persons***	***Low (1-10k)***	***Medium (10-25k)***	***High (25-50k)***	x	***kg CO_2/Unit***	x	***Years***	=	***kg CO_2***	
1.3.1	Own petrol car	km/year	1	5000				0,162		1		810	2%
1.3.2	Own diesel car	km/year						0,137		1		-	
1.3.3	Public transport (local tram, bus & metro)	P-km/year	2	5000				0,074		1		740	
1.3.4	Bus (diesel, long distance)	P-km/year						0,049		1		-	
1.3.5	Motorcycle	km/year						0,093		1		-	
1.4	***Electricity consumption of project office***		***** per unit***	***1-30 m²***	***30-50 m²***	***50-100 m²***	x	***kg CO_2/kWh***	x	***Years***	=	***kg CO_2***	
1.4.1	With aircondition - Office 01	kWh/m²/yr	250	15				0.8540		1		3,203	12%
1.4.2	With aircondition - Office 02	kWh/m²/yr	250		40			0.8540		1		8,540	
1.4.3	Without aircondition - Office 01	kWh/m²/yr	50							1		-	
1.4.4	Without aircondition - Office 02	kWh/m²/yr	50							1		-	
	Total sum during year in t CO_2											***99***	

* For project staff, consultants and interns, but not for head quarter staff visiting the project

** Assumed values

Emission Calculations

Part A

Determining CO_2 emissions saved through the project[5].

What do we mitigate?

Part B estimates the emission savings due to the implementation of project activities. Given the wide nature of energy-related projects, the procedure for emissions calculation under Part B is left to the choice of project except using the country-specific emission factor. The emission savings, as a rule, can be determined with the help of a baseline which means comparing the situation between an actual project and in the hypothetical absence of a project.

The amount of emissions saved can be calculated by the usual methods, but the effect that the project has is often difficult to define: What has actually been influenced by the TA project in its effective sphere of operation? This could well be done through quantifiable and measurable indicators that have been set in project designs, according to the Framework for Contracts and Cooperation (AURA) approach. In addition, some energy-related projects do follow other methods like the approach developed for energy projects implemented on behalf of the Government of the Netherlands (Energising Development, EnDev) which have stringent indicator systems to quantify their savings and impact. All these indicators are set in the project inception stage itself. The projects are required to do a baseline study and monitor their impact and the achievements of these indicators regularly. In all these cases, the only additional task, due to this guideline, is to translate the calculated energy savings into GHG emission savings and report them in a uniform way.

AURA indicators

Therefore to summarise the difference in the approach followed in this guideline with the others such as CDM is at the planning stage of the project AURA which would propose certain indicators. Every year, during the project phase (or as required), these indictors verified with the baseline and impacts are quantified / monitored. This will result in a real achievement of the project which might create such impacts at different stages during the implementation phase. It is assumed that an impact would last for 10 years from its implementation. However in the case of a CDM project under UNFCCC, the emissions saving due to the project are estimated according to methodology and are considered for 10 years. However, each year these emission reductions would be verified and certified (there could be a variation in the emissions saved due to project each year).

The GHG emission savings sometimes result from direct interventions of the project, like a pilot or demonstration project or direct support to the implementation of energy systems. In these cases, the GHG emission savings are a direct benefit (outcome) of the project interventions, according to the GTZ project results chain and are a direct benefit before the attribution gap. In these cases, the GHG emission savings would be stated as a ***direct contribution from the project to GHG emission savings due to project interventions***.

In many cases, where the project works more on a policy-advisory level and assists in the implementation of regulations, training and capacity measures, the GHG emission savings are mostly not declared as a direct benefit but as an indirect benefit and therefore beyond the "attribution gap" as per GTZ´s impact chain approach (for more detailed information on AURA, (refer to attachment 9). In these cases the GHG emission savings of project interventions are called an ***indirect contribution to GHG emission savings due to project interventions***.

In summary, the GHG emission savings of a project consists of a direct and an indirect contribution. The total amount of GHG emission savings is calculated, based on an utilisation period of 10 years for the implemented energy systems in accordance with the UNFCCC approach. Undoubtedly, most energy systems have a longer technical lifetime,

5 Project here is used synonymously with programme, programme component or individual measure.

but in a majority of the cases, the demand and supply situation in a project environment is changing within that time-frame and assumed conditions do not apply for much longer. Only in cases of energy-efficiency measures in buildings, is a longer period of ***20 years*** assumed. This is a conservative assumption to avoid over-estimation of GHG emission savings.

In the following section, examples for part B GHG emission savings are presented. Detailed discussions of the field-tested examples are presented in the attachments 4-8. In the case of renewable energy projects, the guidelines give some examples. Likewise, in the case of energy-efficiency projects, examples are given for energy-efficiency measures in buildings, power plant improvement measures and energy-efficiency measures in agro-industry. But no general approach can – or, should be – suggested, as they all conform to a different pattern.

In general, the approved baseline methodologies of the CDM Executive Board, under the Kyoto Protocol, are a good guidance on how to quantify GHG emission savings. See an overview about an actual list for approved methodologies in the Annex 3.

To summarise the approach under Part B

Step ① Identify the indicators or a baseline (through baseline study conducted under the project). The calculation of GHG emission savings, due to a project intervention, can be categorised based on the type of project and the baseline it replaces (depends on end use of output).

Step ② Analyse the performance parameters of indicators or monitor the project impact / achievements of the project compared to baseline in a year.

Step ③ Translate this data into GHG emissions saved due to project implementation using methodology(ies) mentioned under UNFCCC (http://www.unfccc.int or http://cdm.unfccc.int/methodologies/index.html) or 2006 IPCC Guidelines for National Greenhouse Gas Inventories or any other suitable approach developed under the project.

- While doing this, if the emission factor of a country is required (for example, exported electricity to national grid by the project(s)), then visit UNFCCC website for recently submitted documents under CDM or JI (http://www.unfccc.int or http://cdm.unfccc.int/Projects/projsearch.html).
- If sufficient data is available, then calculate using the "Tool to calculate the emission factor for an electricity system" (http://cdm.unfccc.int/methodologies/Tools/EB35_repan12_Tool_grid_emission.pdf)
- If fossil fuel is saved due to the project, then calculate the emissions using 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
- Also follow some of the examples listed under Table 3.

Table 3 An overview of the examples analysed under Part B

A	***Grid/mini-grid connected use of renewable energy systems***	
A.1	Mini-Hydro Power for Sustainable Economic Development, Indonesia	Type: Grid connected mini hydro power Baseline: Mini grid emission factor Monitoring system: Number of persons connected as per Energising Development (EnDev) and estimated electricity generated
A.2	Wind Park in Jordan (TERNA Project)	Type: Grid connected wind energy Baseline: Grid emission factor sourced from CERUPT[6] Monitoring system: Metered electricity generated
A.3	Photovoltaic (PV) systems in Mexico up to 30 kW	Type: Grid connected PV systems Baseline: Grid emission factor sourced from latest submitted Project Design Document under CDM, November 2007 Monitoring system: Estimated electricity generated (as per SiMIMex[7] and AURA)
A.4	Use of micro hydroelectric power in the Solomon Islands – diesel grid	Type: Grid connected micro hydro power Baseline: Island grid – diesel-based power system Monitoring system: Metered electricity generated
A.5	Electricity generation from biogas and biomass systems in Palm Oil Mills in Thailand	Type: Grid connected biogas and biomass power generation systems Baseline: Grid emission factor sourced from latest submitted PDD under CDM Monitoring system: As per procedures established under CDM, Benchmarking and AURA
A.6	Caribbean Renewable Energy Development Program (CREDP/GTZ)	Type: Grid connected hydro and wind energy systems Baseline: Island grid – diesel based power system Monitoring system: Metered electricity generated
B	***Use of renewable energy in the household energy sector***	
B.1	Solar water heating systems replacing LPG fired heaters in Mexico	Type: Renewable energy household application Baseline: Replacement of LPG used Monitoring system: Newly installed collector area (as per SiMIMex and AURA) and estimated hot water production
B.2	Decentralized energy supply project/household energy (solar home systems) in Bolivia	Type: Renewable energy household application Baseline: As per suggested approach under CERUPT[8] Monitoring system: Number of systems installed and their watt peak (Wp) and estimated electricity generated
C	***Energy Efficiency projects***	
C.1	Energy Efficiency of Existing Buildings (EEEB) – China	Type: Energy Efficiency in buildings Baseline: Coal used for space heating Monitoring system: Measurement of energy saved and estimation of coal saved (as per AURA)
C.2	Power Plant Optimisation in China – Environmental Protection and Energy Management (EEIP)	Type: Energy efficiency in power plants Baseline: Measurement of coal consumption before improvement Monitoring system: Evaluation of test reports for each optimization measure in each power plant
C.3	Energy & Eco-Efficiency in Agro-Industry (E3Agro) – Thailand	Type: Energy Efficiency in Agro-Industry Baseline: Benchmarking – adding value to waste, avoided methane emissions, grid electricity and fossil fuel replaced Monitoring system: Benchmarking and AURA

The background calculations related to Part B of the above projects are included as examples in the worksheets of the Excel spreadsheet in Annex 1.

6 Certified Emission Reduction Unit Procurement Tender
7 Sistema de Monitoreo orientado hacia Impactos para las actividades de la GTZ en México (Impact-based monitoring system for activities of GTZ in Mexico)
8 J.W. Martens, S.N.M. van Rooijen, M.T. van Wees, F. N. Nieuwenhout, V. Bovée, H.J. Wijnants, M. Lazarus, D. Violette, S.L. Kaufman, A.P.H. Dankers (2001): Standardised Baselines and Streamlined Monitoring Procedures for Selected Smallscale Clean Development Mechanism Project Activities, Volume 2c: Baselines studies for small-scale project categories - A guide for project developers (Version 1.0). Ministry of Housing, Spatial Planning and the Environment of the Netherlands, p. 33.

Case A

Grid / mini grid connected use of renewable energy systems

Case A covers the following types: wind energy, micro-hydroelectric power plant, photovoltaic solar-energy, use of biomass etc. which replace conventionally-generated electricity.

Example 1

Mini-Hydro Power (MHP) for Sustainable Economic Development, Indonesia

The Project support focuses on capacity-building for local manufacturing of mini-hydro equipment ,a sustainable Mini Hydro Power Project (MHPP) planning and development, operation, management issues and income-generating end-use of energy. Barriers with regard to the regulatory framework and the access to financing are also addressed, in order to create a self-sustaining market for rural energy services. As a result, rural areas in Java, Nusa Tenggara Barat, Nusa Tenggara Timur, Sulawesi and Sumatra will be adequately supplied with energy generated from mini-hydropower.

As MHPP is part of the Dutch funded Energizing Development program, the project developed a customized method of monitoring, compatible with the requirements of the Dutch Directorate General for International Co-operation. It is suggested to use this baseline and monitoring procedure, to calculate the emission savings due to the project, without the need for collecting additional site data.

Overall objective: Electric power supply from mini-hydro power is improved in the priority regions of German-Indonesian development cooperation, as well as in additionally – selected rural areas on Sulawesi, Java and Sumatra.

Indicators (partly): Social infrastructure facilities (schools, health stations, community centers serving a total of up to 14,000 people), are provided with electricity from mini-hydro power schemes. Furthermore, some 167,000 people are supplied with household energy (apart from energy for cooking) generated from mini-hydro power.

In the case of MHPP, the following approach – discussed with the respective GTZ principle advisor and the project manager – was chosen:

The monitoring system, already established, will be used for measuring the climate-change mitigation. This system counts the number of persons supplied with sustainable household energy (except cooking), the number of social infrastructure facilities connected and the additional productive uses of energy, as a result of the project activities. This is compared with the figures before the start of the project, which serve as the baseline. The established monitoring system monitors directly the number and the individual size of installed mini-hydro power plants in a given year.

From these figures, the average size (26.5 kW) and the total number of newly-installed mini hydro power plants in an individual year (20 in 2006) can be derived without any additional effort: 26.5 kW x 20.

For the baseline, the average operating time of a diesel generator in a village, which would be replaced by the mini hydro power plant, is assumed for the calculation of the generated electricity amount.[9] This is used for the calculation of the “saved CO_2”. In this case, it has an average operating time of four hours/day for 365 days/year.

The mini hydro power plants are operating more hours per day, but the saved CO_2 emissions are based on the baseline electricity consumption before the project starts, when it is assumed that the diesel generator would be running only four hours per day.

Comment: *It is worth rethinking that approach in future, when villages develop and they will use more electricity for a longer period during the day, as the local economy develops.*

9 Excluding stand alone renewable energy schemes. In most villages in Indonesia electricity supply from small diesel gensets represents the only alternative to grid supplied power and is therefore taken as the baseline reference.

The average CO_2 emission of a diesel generator of the size commonly installed and operated in rural villages is 1.3 kg CO_2/kWh.

The following Table 4 gives the details on emission factor for mini-grid systems.

Table 4 Emission factors for diesel generator systems (in kg CO_2e/kWh*) for three different levels of load factors**

Cases in kg CO_2e/kWh	***Mini-grid with 24 hour service***	***i) Mini-grid with temporary service (4-6 hr/day) ii) Productive applications iii) Water pumps***	***Mini-grid with storage***
Load factors (%)	25%	50%	100%
<15 kW	2.4	1.4	1.2
>=15 <35 kW	1.9	1.3	1.1
>=35 <135 kW	1.3	1.0	1.0
>=135<200 kW	0.9	0.8	0.8
> 200 kW***	0.8	0.8	0.8

* A conversion factor of 3.2 kg CO_2per kg of diesel has been used (following revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories)

** Figures are derived from fuel curves in the online manual of RETScreen International's PV (photovoltaic) 2000 model, downloadable from http://retscreen.net/

*** Default values

Source: Reproduced from approved small-scale methodology AMS-I.D under CDM

This result in CO_2 saving as direct benefit (outcome) of the project activity means that the activities of the MHPP project can be called "direct contribution to CO_2 saving".

Direct contribution to CO_2 saving/yr = 26.5 kW x 20 nos. x 4 h/d x 365 d/yr x 1.3 kg CO_2/kWh = 1006 tCO_2/yr.

In addition to this direct contribution during the project implementation, indirect benefit is also attributed to the project. Through the existence of the MHPP project and the services provided by itself and its partners, an additional 20 mini-hydro power projects were developed for the respective project year (for the example – 2006). In these mini-hydro power projects, MHPP is not directly involved, but their partners and, through the information and know-how provided via the various media (internet, manuals, training courses, videos, technical literature, etc), the project contributes to the realization of these additional power plants. Although the project is not actively involved in their implementation, without the existence of the MHPP project, these other projects would not materialize. In general these Mini-Hydro power plants are of higher capacity and replace diesel generators, which run on average 6 h/d.

This result in CO_2 saving as "additional indirect contribution" can be calculated as: Additional indirect contribution to CO_2 saving/yr = 35 kW x 20 nos. x 6 h/d x 365 d/yr x 1.3 kg CO_2/kWh = 1993 tCO_2/a.

Table 5 Calculation of GHG emission savings through Mini Hydro Power (MHP) as line of action 1 (direct contribution)

	Basic unit	***Year***							***Total (Σ)***
Type of project activity		2002	2003	2004	2005	2006	2007	2008	
Installed capacity	kW	-	-	-	-	530	-	-	530
Equivalent full load operating hours	h	-	-	-	-	4	-	-	1,460
	OR								
Energy generated by the project activity	MWh/yr	-	-	-	-	773.80	-	-	774
Auxillary energy consumption within the plant	MWh/yr	-	-	-	-	-	-	-	-
Total replaced electricity of the national grid/yr	MWh	-	-	-	-	774	-	-	774
Project assumed utilisation period 10 years	yr	10	10	10	10	10	10	10	
Total replaced electricity of the national grid/10 yr	MWh	-	-	-	-	7,738	-	-	7,738
Baseline Emission Factor (conservative)	t CO_2/MWh	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
Scenario 1: GHG Emission saved during one year	kg CO_2	-	-	-	-	1,005,940	-	-	***1,005,940***
Scenario 2: Direct contribution to CO_2 emission saved through assumed utilisation period of 10 years	t CO_2	-	-	-	-	10,059	-	-	***10,059***

Table 6 Calculation of GHG emission savings through Mini Hydro Power (MHP) as line of action 2 (indirect contribution)

	Basic unit	***Year***							***Total (Σ)***
Type of project activity		2002	2003	2004	2005	2006	2007	2008	
Installed capacity	kW	-	-	-	-	700	-	-	700
Equivalent full load operating hours	h	-	-	-	-	6	-	-	2,190
	OR								
Energy generated by the project activity	MWh/yr	-	-	-	-	1,533.00	-	-	1,533
Auxillary energy consumption within the plant	MWh/yr	-	-	-	-	-	-	-	-
Total replaced electricity of the national grid/yr	MWh	-	-	-	-	1,533	-	-	1,533
Project assumed utilisation period 10 years	yr	10	10	10	10	10	10	10	
Total replaced electricity of the national grid/10 yr	MWh	-	-	-	-	15,330	-	-	15,330
Baseline Emission Factor (conservative)	t CO_2/MWh	1.3	1.3	1.3	1.3	1.3	1.3	1.3	
Scenario 1: GHG Emission saved during one year	kg CO_2	-	-	-	-	1,992,900	-	-	***1,992,900***
Scenario 2: Indirect contribution to CO_2 emission saved through assumed utilisation period of 10 years	t CO_2	-	-	-	-	19,929	-	-	***19,929***

Therefore the GHG emission savings of this project can be reported in the uniform format as:

Table 7 Direct and indirect contribution to CO_2 emissions saved

Indonesia: Mini-Hydro Power for Sustainable Economic Development, (MHPP)	***Savings in t CO_2*** (based on 10 years of utilisation)			
	2006	2007*	2008*	Total
Direct contribution to CO_2 savings through MHP plants built	10,059	10,000*	10,000*	30,059*
Indirect contribution to CO_2 savings through MHP plants built	19,929	20,000*	20,000*	59,929*
Total contribution to CO_2 savings due to project	29,988	30,000*	30,000*	***89,988****

* Values for 2007 and 2008 are just assumed to show the principle

Hence the above information could be reported as:

- Part B: The project directly and indirectly contributed to CO_2 savings of 89 988 t CO_2, (of which direct contribution is 30 059 t CO_2) when the utilization period of the system is assumed to be for 10 years.

Example 2

Wind Park in Jordan

At the end of 1999, Jordanian Ministry of Energy and Mineral Resources (MEMR) applied to GTZ for assistance in conducting wind measurements and preparing feasibility studies for two locations in Aqaba and Shawbak. GTZ supported MEMR and National Energy Research Center (NERC) for an evaluation of the feasibility study that revealed good conditions for setting up wind farms at both locations. Analyses at the Aqaba location showed a mean wind velocity of 6.8 m/s at a height of 40 m, but these measurements were associated with uncertaintie, since long-cycle changes to the wind climate have been ascertained in these areas. Early in 2002 the Jordanian Ministry of Energy requested international tenders for the construction and operation of wind farms at the investigated locations.

The Wind Park, consisting of 37 wind turbines, with each turbine generating around 600 to 700 kW, will feed around 55,000 MWh/a into the country's high-voltage grid and thereby displace the energy being generated by conventional power plants (diesel engines, oil-fired steam boilers with gas turbines, or gas-fired gas turbines).

Here the country specific emission factor without T&D losses is used (because the electricity generated is fed directly into the high-voltage national grid) and is sourced from CERUPT[10] guidelines, as there is no other data source – for example from a proposed CDM project. Since 2001, as these guidelines have not been updated, it is not encouraged to use them if there is an alternative. The economic utilisation period of the plant is taken to be 10 years. On this basis, the GHG emission savings amount to 410 850 t CO_2.

10 J.W. Martens, S.N.M. van Rooijen, M.T. van Wees, F. N.Nieuwenhout, V. Bovée, H.J. Wijnants, M. Lazarus, D. Violette, S.L. Kaufman, A.P.H. Dankers (2001): Standardised Baselines and Streamlined Monitoring Procedures for Selected Smallscale Clean Development Mechanism Project Activities, Volume 2c: Baselines studies for small-scale project categories - A guide for project developers (Version 1.0). Ministry of Housing, Spatial Planning and the Environment of the Netherlands, p. 33.

Table 8 Calculation of GHG emission savings through the Wind Park in Shawab, Jordan compared to baseline replacement of electricity from the national grid

	Basic unit	***Year***	***Total (∑)***
		2002	
Size	MW	25	
Energy generated per year through wind park	kWh/a	55,000,000	
Baseline:			
National grid CO_2 emission factor in 2000 without T&D losses (as per CERUPT)	kg CO_2/kWh	0.747	
Replaced electricity of the national grid	kWh/a	55,000,000	
GHG Emission of baseline	kg CO_2/a	41,085,000	
Assumed utilisation period of the project	years	10	
Total CO_2 emmision saved through assumed utilisation period of 10 years	***kg CO_2***	***410,850,000***	
	t CO_2	***40,850***	
Direct contribution to CO_2 emission saved through assumed utilisation period of 10 years	***t CO_2***		***410,850***

Therefore the above information could be reported as:

- Part B: The project directly contributed to CO_2 saving of 410 850 tCO_2, when a utilisation period for the Wind Park is assumed to be 10 years.

Example 3

Grid connected Photovoltaic systems in Mexico (up to 30 kW)

GTZ focuses its work in Mexico on the priority area of environmental management and sustainable use of natural resources which also cover the promotion of renewable energies [Partner Secretary of Energy - SENER, Mexico)].

Solar PV systems is one of the lines of action under the promotion of renewable energy, whereby the program contributed to a regulation which enables grid connected PV systems (up to 30kW) to benefit from a net-metering mechanism. That was not legally possible before. The contribution (in this case an ***indirect*** contribution to GHG emission savings) can be quantified simply by the additional installed area of PV and its annual electricity production which is replacing conventional power from the national grid. The country-specific emission factor was sourced from the latest submitted Project Design Document under CDM, as of August 2007[11]. The specific yield of a PV system was calculated with around 1400 kWh/kWp/a by using a simulation software (PV SOL rel. 3.3). As this PV program is about to start, the assumed data for 2007 and 2008 were used in this display, to show it as an example (they are not real data).

11 Tultitlan – EcoMethane Landfill Gas to Energy Project (2007): Available at http://cdm.unfccc.int/UserManagement/FileStorage/6FJ00TTNGS7EWZTXR2ZCGNPB3EWAQR (accessed in August 2007). In A document submitted under UNFCCC for CDM credits, p. 57.

Table 9 Calculation of GHG emission savings through grid connected PV systems in Mexico compared to baseline replacement of electricity from national grid

	Basic unit	Year 1993	2004	2005	2006	2007	2008	2009	Total (∑)
Assumption: due to project in future grid connected PV systems can be connected	kW/a	-	-	-	-	500	1,000	-	
Assumption: Electricity production of PV systems in Mexico	kWh/kW p/a	1,400							
Energy generated by the project activity	MWh/a	-	-	-	-	700	1,400	-	2,100
Auxillary energy consumption within the plant	MWh/yr	-	-	-	-	-	-	-	-
Total replaced electricity of the national grid/yr	MWh	-	-	-	-	700	1,400	-	2,100
Assumed utilisation period for solar systems of 10 years	yr	10	10	10	10	10	10	10	
Total replaced electricity of the national grid/10 yr	MWh	-	-	-	-	7,738	-	-	21,000
Baseline Emission Factor (conservative)	t CO_2/MWh	0.467	0.467	0.467	0.467	0.467	0.467	0.467	
GHG Emission saved during one year	t CO_2	-	-	-	-	327	654	-	***981***
Additional indirect contribution to CO_2 emission saved through assumed utilisation period of 10 years	t CO_2	-	-	-	-	3,269	6,538	-	***9,807***

Therefore the above information could be reported as:

- Part B: The project indirectly contributed to CO2 savings of 9,807 t CO_2, when a utilization period for the PV systems is assumed to be 10 years.

Example 4

Use of micro-hydroelectric power in the Solomon Islands – diesel grid

This micro-hydroelectric power plant replaces the electricity generated by diesel generators in an island grid. Within the framework of this TA project, the micro-hydroelectric power plant (150 kW) was planned, built and put into operation. The electricity generated by the hydro-electric plant displaced the electricity in a mini-scale diesel grid, showing a specific CO_2 factor of 0.8 kg CO_2/kWh_{el} (refer to the Table 4 for details on emission factor for mini grid systems).

The economic utilisation period of the plant is taken to be 10 years. On this basis the GHG emission savings amount to practically 2,248 t CO_2 during the effective utilisation period of the plant.

Table 10 Calculation of GHG emission savings through the micro-hydropower plant in Solomon Islands, compared to baseline replacement of Island-based mini-scale diesel grid

	Basic unit	***Year***	***Total (∑)***
		2002	
Size	kW	150	
Energy generated per year	kWh/a	280,972	
Baseline: Selected Case - Mini diesel grid > 200 kW	kg CO_2/kWh	0.8	
Replaced diesel generator electricity	kWh/a	280,972	
GHG Emission of baseline per year	kg CO_2/a	224,778	
OR			
Replaced diesel for generator	litre/a	0	
with specific CO_2 value for diesel	kg CO_2/litre	2.64	
GHG Emission of baseline per year	kg CO_2/a	0	
Assumed utilisation period of the project	years	10	
Total CO_2 emmision saved through assumed utilisation period of 10 years	***kg CO_2***	***2,247,776***	
	t CO_2	***2,248***	
Direct contribution to CO_2 emission saved through assumed utilisation period of 10 years	***t CO_2***		***2,248***

Therefore the above information could be reported as:

- Part B: The project directly contributed to CO_2 savings of 2,248 t CO_2 when a utilisation period for the micro hydro plant is assumed to be 10 years.

Example 5

Electricity generation from biogas and biomass systems in Palm Oil Mills in Thailand

The aim of the Thai-German E3Agro Project is,

a) to strengthen the competitiveness of the Thai agro-industry through the implementation of cost-effective production process technologies and professional management techniques

b) to promote the efficient use of energy and improve the utilization of biomass for energy production.

The project integrates the overall management of quality, environment, energy and information into a combined system of international best-practice manufacturing. The first sector targeted under the programme is Palm Oil Mills (POMs). The data below indicates the electricity production from biogas and biomass power systems in POMs. Further energy efficiency and process improvement measures in the three sectors and related data is presented under example C.3.

Generated electricity from biogas and biomass is exported to the grid: Over 90% of the CO_2 mitigation of E3Agro so far has been achieved in the palm oil industry as a direct contribution, mainly through nine projects, which were independent from GTZ support, developed as CDM projects. Most of them are currently already approved – or under request for approval – by the Thai DNA. The GTZ is directly involved in one Palm Oil project, where GTZ wants to buy the CER's for its own purpose. These nine CDM Projects would add up to 440,996 t CO_2e annually calculated according to the methodologies used for these CDM projects. This number includes avoided methane emissions due to the implementation of biogas plants and electricity/thermal energy generation using biogas and biomass. Two projects among these are biomass plants that generate electricity.

At the beginning of the project in 2004, no POM was selling electricity to the grid. There was one pilot biogas plant at that time and it released methane unutilised. It is assumed that, due to the implementation of these nine projects under the programme, a tenfold increase of CO_2 emissions was evident and that saving will result as an indirect contribution due to the replication of the concept in other POMs in the future. However, as this indirect contribution cannot be quantified, it is not considered in the final display of the results.

Table 11 Emissions saved due to biogas and biomass projects developed as CDM projects in Thailand

	Basic unit	***Year***	***Total (∑)***
Part B.1: Palm oil mill energy savings		***2006***	
a) Generated electricity from biogas and biomass is exported to the grid			
Natural Palm Oil Company Limited – 1 MW Electricity Generation and Biogas Plant Project	t CO_2e/yr	14.480	
Chumporn Applied Biogas Technology for Advanced Waste Water Management	t CO_2e/yr	30.028	
Organic Waste Composting at Vichitbhan Plantation, Chumporn Province	t CO_2e/yr	265.000	
Wastewater treatment with biogas system in palm oil mill at Sikao, Trang	t CO_2e/yr	16.446	
Wastewater treatment with biogas system in palm oil mill at Saikhueng, Surat Thani	t CO_2e/yr	18.570	
Wastewater treatment with biogas system in palm oil mill at Sinpun, Surat Thani	t CO_2e/yr	17.083	
Wastewater treatment with biogas system in palm oil mill at Bangsawan, Surat Thani	t CO_2e/yr	14.068	
Wastewater treatment with biogas system in palm oil mill at Kanjanadij, Surat Thani	t CO_2e/yr	17.083	
Univanich lamthap POME biogas project in Krabi	t CO_2e/yr	48.238	
Total emissions saved	t CO_2e/yr	440.996	
Direct contribution to CO_2e emission saved through assumed utilisation period of 10 years	t CO_2		***4.409.960***

Therefore the above information could be reported as:

- Part B: The project directly contributed to CO_2 savings of 4,409,960 t CO_2 when the utilisation period for the biogas and biomass plants is assumed to be 10 years.

Example 6

Caribbean Renewable Energy Development Program (CREDP/GTZ), America NA

The Caribbean region is currently heavily dependent on fossil fuels, with petroleum products accounting for an estimated 93% of commercial energy consumption. Despite the substantial wind, solar, hydropower and biomass resources, renewable energy provides less than 2% of the region's commercial energy. In 1998, 14 Caribbean countries and two British dependencies agreed to work together, to prepare a regional project to remove barriers for the use of renewable energy and thereby foster its development and commercialization.

The Caribbean Renewable Energy Development Programme (CREDP) was launched with the major objective of demonstrating and strengthening the ability of Caribbean countries to mobilise investors within the energy sector, to shift from conventional energy investment towards renewable energy investment. The CREDP concentrates on those renewable energy technologies (RET) that have the widest possibility of duplication and strong potential for reducing GHG emissions.

The GTZ project (CREDP/GTZ) is a financially and organisationally separate project that is closely co-ordinated with the CREDP/UNDP project of the overall programme which is headquartered at the Caribbean Community (CARICOM) Secretariat in Guyana. The aim of the CREDP/GTZ is to support decision- makers in selected Caribbean countries in creating favourable framework conditions for RE-investments and initiate the realisation of RE-investment projects.

CREDP/GTZ provides Technical Assistance to Caribbean Countries through international and regional renewable energy experts and through capacity building measures in renewable energies, for staff members of energy ministries and electric utilities. While the CREDP/UNDP project involves all CARICOM member countries, the CREDP/GTZ concentrates on selected countries that can be taken as models for the situation in the Caribbean and present prospects of successful implementation and transfer of the experience gained to other countries. The selected countries for the current project phase are: Jamaica, Dominica, St. Lucia, St. Vincent and the Grenadines and Grenada.

The CREDP/GTZ has its project office in St. Lucia, hosted by the CARICOM's Caribbean Environmental Health Institute (CEHI). The first phase of the German Project was completed in April 2008 and is currently in the second phase which would last until 2012.

The results achieved have been:

a) The project analyzed - and in part commented on - the Energy Sector Policy and Strategy in three countries (Jamaica, Dominica and Grenada) and drafted Energy Policy documents for St. Lucia, St. Vincent and the Grenadines - presently under review of the respective governments. The project is also assisting the government of Dominica in setting up the National Regulatory Commission and in elaborating the rules and regulations for the enacted new Electricity Supply Act.

b) Fourteen Renewable Energy project proposals have been identified and studied at pre- and feasibility-level so far. Among these, five technically, economically and financially viable projects (all hydropower) in Jamaica, St. Vincent and Dominica through it proposals submitted to the potential investors. Three wind energy projects are being prepared in St. Lucia, St. Vincent and the Grenadines and Barbados. Further wind energy projects are under review in St. Kitts and Nevis and Dominica.

c) The series of Technical Seminars on Renewable Energies, which were jointly organized by CARILEC, CREDP/GTZ and CREDP/UNDP, and other PR measures like the regular involvement of the project in the annual "Energy Week" in St. Lucia have lead to an increased awareness and raised interest of utilities and private investors in renewable energy projects.

The results that could be considered under the analysis of saved CO_2 emissions are renewable energy projects approved due to the intervention of the project i.e. point b). In all these countries, currently the electricity is supplied using large scale (> 200 kW) diesel based power systems. Therefore from the Table 4, emission factor could be considered as 0.8 t CO_2e/MWh and the results are summarised in Table 12.

Table 12 Emissions saved due to renewable energy projects developed in Caribbean

	Basic unit	*Value*	*Remarks*
Wind Park Sugar Mill Saint Lucia	MWh/yr	24,400	On a conservative basis - 12.6 MW at 22% capacity factor
Wind Park Ribishi Point St. Vincent	MWh/yr	12,400	On a conservative basis - 6 MW at 23% capacity factor
Micro Hydro Power Great Low Land River Jamaica	MWh/yr	16,650	2MW capacity – new
Micro Hydro Power South River, SVG	MWh/yr	2,180	Additional generation after rehabilitation and expansion of the plant
Micro Hydro Power Richmond, SVG	MWh/yr	2,360	Additional generation after rehabilitation and expansion of the plant
Micro Hydro Power John Compten Dam, St. Lucia	MWh/yr	543	190kW capacity – new
Micro Hydro Power New Town, Dominica	MWh/yr	1,198	145kW capacity – new
Total electricity saved	***MWh/yr***	***59,731***	

Therefore the above information could be reported as:

- Part B: The project directly contributed to CO_2 savings of 477 848 tCO_2 when the utilisation period for the renewable energy power systems is assumed to be 10 years.

Case B

Use of renewable energy in the household energy sector

Example 1

Solar water heating systems replacing LPG-fired heaters in Mexico

As mentioned above, under Example A.3, in the promotion of renewable energy, the Mexico program also has one other line of action which is the promotion of solar water-heating systems. For this part of the solar thermal systems, the project in Mexico contributed substantially to a new national program for the promotion of solar water-heaters. The project has chosen the indicator "Additional installed square meter solar collectors per year", in comparison with the base-line year and the 'business as usual' installations continuing without project intervention. This kind of indicator makes a quantification of the CO_2 emission savings possible. Already for the year 2005 and 2006, an additional collector area of around 60,000 square meters was estimated, based on the installed monitoring system of the project. The base for this systematic monitoring system is explained in the SiMIMex Handbook, which gives a conclusive approach for monitoring. This handbook is in the attachment 10.

The baseline was established by monitoring the annual installation of the square meter collector area since 1993 up to 2004. This led to a normal increase of installation of around 40 240 m^2/a. The annual savings of a collector system in Mexico for this purpose, were calculated using a simulation tool (T-Sol 4.3) and resulted in around 821 kWh/m^2/a and an LPG-fired boiler with an annual boiler efficiency of 85%.

The project manager in Mexico has chosen to have the contribution of the GTZ classified as an indirect contribution to the national solar water-heating programme (the figures for 2007 and 2008 are only for display purpose).

Table 13 Calculation of GHG emission savings through solar water-heating systems in Mexico compared to baseline where LPG is used

	Basic unit	***Year***							***Total (Σ)***
		1993	2004	2005	2006	2007	2008	2009	
Baseline: Total installed collector area in the past	m^2	200,000	642,644						
Annual normal increase	m^2/a		40,240						
New installation due to intervention	m^2/yr			100,278	96,764				
Additional installation due to intervention	m^2/a			60,038	56,524	70,000	80,000	-	266,561
Assumed useful thermal heat provided by solar system installed	$kWh/m^2/a$	821							
Replaced fossil fuel: Assumption LPG replaced									
LPG with NCV (as per PICC 1996 guidelines)	MJ/kg	47.31							
Assumed efficiency of water heater	%	0.85							
Amount of LPG replaced	kg/a			4,413,972	4,155,622	5,146,406	5,881,606	-	19,597,606
Specific CO_2 emission for LPG	kg CO_2 /kg LPG			2.95	2.95	2.95	2.95	2.95	
Assumed utilisation period for solar systems of 10 years	yr			10	10	10	10	10	
CO_2 emission saved during one year	t CO_2			13,021	12,259	15,182	17,351	-	***57,813***
Indirect contribution to CO_2 emission saved through assumed utilisation period of 10 years	t CO_2			130,212	122,591	151,819	173,507	-	***578,129***

Therefore the above information could be reported as:

- Part B: The project indirectly contributed to CO_2 savings of 9,807 t CO_2, when a utilization period for the PV systems is assumed to be 10 years.

Example 2

Solar home systems in Bolivia

The emission reduction levels achieved by TA projects in the decentralized electricity supply sector through the introduction of renewable energy systems can be calculated, but the establishment of a baseline can be quite cumbersome and requires a lot of field-data research.

With "Household Electricity Systems" the project-specific GHG emission savings can be estimated roughly by using empirical equations (suggested under CERUPT) for selected renewable-energy systems, based on the given characteristic figure for the systems used, e.g. Watt peak (Wp) for PV systems:

Table 14: Empirical equations for renewable energy systems (if no baseline is available) in kg CO_2 / year[12].

Baseline for daily energy consumption of a household of 50 - 500 Wh/d	
Standardised emission reduction factor (baseline emissions minus project emissions)	
General small renewable household electrification	75 kg/y + 0.8* (daily energy consumption in Wh/d) in kg CO_2/y/Wh/d
Solar home systems	75 kg/y + 4 * (Power in Wp) in kg CO_2/y/Wp
Pico hydropower	75 kg/y + 2 * (Installed capacity in W) in kg CO_2/y/W
Wind battery chargers	75 kg/y + 350 * D * D kgCO_2/y/m^2, with D = Rotor diameter in m

The result of the calculation shows the amount of CO_2 emissions the project has saved per year by the installation of PV or Pico Hydro power etc.

The following procedure gives an example of a project to promote the use of solar home systems (SHS) in Bolivia, with the number of 5,000 PVs, each of 50 Wp Module capacity installed to operate for 10 years. This produces an installed performance rate totalling 25 kW. By using the simplified empirical equations from CERUPT, savings of 13,750 t CO_2 over an SHS economic-utilisation period of 10 years resulted.

Table 15 Calculation of GHG emission savings through SHS in Bolivia, when no baseline is available

	Basic unit	***Year***	***Total (∑)***
		2002	
Assumed daily energy consumption of household	Wh/d	250	
Number of systems installed / households during project	Systems	5,000	
Assumed utilisation period of SHS in the project	years	10	
General small renewable household electrification	kg CO_2/year	75 + 0.8*	
GHG Emission of baseline per year	kg CO_2/a	1,375,000	
Total CO_2 emmision saved through assumed utilisation period of 10 years	***kg CO_2***	***13,750,000***	
	t CO_2	***13,750***	
Direct contribution to CO_2 emission saved through assumed utilisation period of 10 years	***t CO_2***		***13,750***

12 J.W. Martens, S.N.M. van Rooijen, M.T. van Wees, F. N.Nieuwenhout, V. Bovée, H.J. Wijnants, M. Lazarus, D. Violette, S.L. Kaufman, A.P.H. Dankers (2001): Standardised Baselines and Streamlined Monitoring Procedures for Selected Smallscale Clean Development Mechanism Project Activities, Volume 2c: Baselines studies for small-scale project categories - A guide for project developers (Version 1.0). Ministry of Housing, Spatial Planning and the Environment of the Netherlands, p. 33.

Therefore the above information could be reported as:

- Part B: The project directly contributed to CO_2 savings of 13 750 t CO_2 when a utilisation period for the stand-alone SHS systems is assumed to be 10 years.

Case C

Energy Efficiency projects

The kind of projects in this case would save electricity, heat and fuel, for example, in the industry, transport and building sectors.

Example 1

Energy Efficiency of Existing Buildings (EEEB) – China

Among the gross building area of 40 billion m2 in China, the civil buildings in urban areas are around 16 billion m^2 - including 6.5 billion m2 heated area - but only less than 10% of them meet the 50% energy-saving standard constituted in 1996. The energy demand of the buildings comes to around 30% of the total energy demand in China, while the existing residential buildings in northern China waste a lot of heating energy. Nevertheless, the indoor temperatures in the flats are still too cold during the winter period. Disease risks for the inhabitants come along with low air-quality in the cities and high green-house gas emissions.

The mission of the EEEB Project is to introduce advanced energy efficiency solutions and ideas from Germany, through demonstration projects, to develop and adapt integrated retrofitting concepts, technologies and financing modes suitable for the energy efficiency in existing buildings in Northern China, to strengthen personnel and institutional capacity.

During the first year of the project (2006), the activities were mainly concentrated on the integrated retrofitting of the buildings and the modernisation of the heating systems of three residential buildings in compound Hebei No.1 of Tangshan, with around 6000 m^2 heated area. The integrated retrofitting includes thermal insulation of the building envelope, exchange of old windows against new double-glassed windows, modernisation of heating systems with heat cost allocators and thermal-state valves and modernisation of the kitchen and water closets etc.

The direct-energy saving, achieved through retrofitting of the building is 39 kWh/m^2/yr without temperature correction. With the temperature correction, the energy saving would be 78 kWh/m^2/yr. This is the amount for heat energy requirement in the improved buildings. In addition, the noise from the street traffic and dust penetration into the living rooms has been dramatically reduced and the average indoor temperatures in the flats rose from 15 to 22 degrees during the heating period, while still more than 50% of heating energy was saved.

Based on the positive experiences from the EEEB project, Tangshan BEE (Building Energy Efficiency) Office has worked out a suggestion to the municipal government for wide scale retrofitting pf the city government buildings. This would include roughly 60 million m^2 of heated area in the town which would mean the renovation of around 100,000 apartments in 30,000 building blocks. According to the respective project managers, recent discussions with the ministry of construction indicate that this number could be up to 2.5 billion m2 which is about one third of the total heating area of residential buildings in northern China. Nevertheless, a conservative number of 60 million m^2 has been considered in the calculations (below) for the indirect contribution. Once this has been implemented, it would mean a tremendous GHG emission savings, which would then be an indirect contribution to GHG emission savings, as the EEEB project is only indirectly involved in this. But without the pilot activity in demonstration projects, it would most likely not have been started yet. The calculation of direct and indirect GHG emission savings is as follows:

Table 16 Calculation of direct GHG emission savings through three building blocks under the project Energy Efficiency measures in Existing Buildings in China

	Basic unit	Year	Total (Σ)
Direct emissions saved		***2006***	
Overall direct reduction of heat energy requirement per m² *	kWh/m²/yr	39	
With temperature correction	kWh/m²/yr	39	
Total improved living area in these three building blocks	m²	6,135	
Net Calorific Value of Standard coal – SKE**	MJ/kg	29.31	
Heat losses in the heat distribution network		30%	
Efficiency of heating system		60%	
Heating energy derived from coal	kWh/kg	3.42	
Total heat energy saved	kWh/yr	478,530	
Savings in terms of primary energy coal	kg/yr	139,953	
Effective CO_2 emission factor (kg/TJ)***	kg CO_2/TJ	94,600	
Oxidation factor		98%	
CO_2 emissions saved	kg of CO_2/yr	380,259	
Assumed utilisation period of the project	years	20	
Direct contribution to CO_2 emission saved through assumed utilisation period of 20 years	***t CO2***		***7.605***

Table 17 Calculation of indirect GHG emission savings under the project Energy Efficiency measures in Existing Buildings in China

	Basic unit	Year	Total (Σ)
Indirect emissions saved		***2007-2010***	
Overall direct reduction of heat energy requirement per m² *	kWh/m²/yr	39	
With temperature correction	kWh/m²/yr	39	
Additional indirect contribution due to program activities during 2007-2010	m²	60,000,000	
Net Calorific Value of standard coal – SKE**	MJ/kg	29.31	
Heat losses in the heat distribution network		30%	
Efficiency of heating system		60%	
Heating energy derived from coal	kWh/kg	3.42	
Total heat energy saved	kWh/yr	4,680,000,000	
Savings in terms of primary energy coal	kg/yr	1,368,733,110	
Effective CO_2 emission factor (kg/TJ)***	kg CO_2/TJ	94,600	
Oxidation factor		98%	
CO_2 emissions saved	kg of CO_2/yr	3,718,914,902	
Assumed utilisation period of the project	years	20	
Indirect contribution to CO_2 emission saved through assumed utilisation period of 20 years	***t CO2***		***74.378,298***

* gross area
** Standard coal (SKE) data received from project
*** IPCC 2006 guidelines default emission factor for other bituminous

Therefore the following figures can be reported for the EEEB programme in China,

- Part B: The project directly and indirectly contributed to CO_2 savings of 74,385,903 t CO_2, (of which the direct contribution is 7,605 t CO_2) when a utilisation period of the system is assumed for 20 years.

Example 2

Environmental Protection in the Energy Industry (EPEI) in China

China has large coal resources and is the largest coal producer in the world. The energy supply of the country relies on coal. Around 80% of the electricity is produced in coal-fired power plants. Due to tremendous economic growth rates the power sector is also developing extremely fast. Over past years, the installed capacity increased by approximately 50-70 GW per year. By the end of the year 2005, the installed capacity, based on coal, had reached 384 GW.

On average, the specific coal consumption in Chinese coal-fired power plants lies around 15% above the specific coal consumption of power plants in Germany. The CO_2 emissions from power plants amount to approximately 13 million tonnes per year. Acid rain has become a serious problem and affects more than one third of China's area. The specific water consumption in Chinese power plants is roughly 50% higher than the water consumption in German power plants. Due to spontaneous coal-seam fires, China loses roughly 20 million tonnes of coal per year, with negative effects on the living conditions in the region and on the global climate due to greenhouse gas emissions.

Against that background, the overall objective of the programme is to improve the environmental-friendly use of the resources coal and water in the examined power plants and the protection of the coal resource in their natural deposits.

The program consists of five components:

- Policy advice in the field of environmental protection for coal- and power plant sector
- Cleaner Production in coal-fired power plants
- Process optimization in coal-fired power plants
- Water management in coal-fired power plants
- Extinguishing of coal-seam fires

The indicator for the overall objective is: Preservation of app. one million tonnes of the natural resource coal in the province of Xinjiang, which equals the yearly coal consumption of a 300 MW power plant or the reduction of three million CO2-equivalent.

The GTZ programme has done an inventory of the programme impact in the 100 coal-power plants on which it has so far advised directly or through its partner. The inventory looked into the reduction of local emissions, availability and performance-improvement of the power plants, as well as reduction of coal consumption, based on GTZ advisory service from 2001 till date. This inventory is the result of test reports for each power plant and the detailed-impact monitoring undertaken. The preliminary results of this review are as follows:

a) CO_2 emissions reduction through optimization measures in Chinese power plants

During this project, GTZ worked with 11 advisory institutes at provincial level. Up to now, three institutes evaluated the measures (optimization measures and measures suggested by partner institutes) adapted by the power plants in three provinces. The basis for calculation is real data on coal and operating conditions. It is assumed that the average operating time is 5,000 hours per year which is a conservative assumption in the case of China. So far, there are about 100 monitoring reports produced in this process of evaluation. It could be concluded that, up ito now, a total CO_2 emission reduction of 700 000 t CO_2/yr has been achieved under the project.

Other institutes are also conducting an evaluation of the power plants in other provinces. But the data are not available until finalization of this guideline (June 2008). However, in the northern region, there is the potential for significant improvement. It is assumed that, if similar measures are adapted in 200 power plants, an indirect contribution to the emissions saved would be 1,500,000 t CO_2/yr.

b) Extinguishing coal-seam fires

After four years of continued effort under the project, approximately 1,000,000 tonnes of very high quality coal were saved. Thus, it could be estimated that over a period of four years, about 3,000,000 t CO_2 emissions could be avoided (the calculations are performed as per the methodology suggested under CDM) and Table 18 indicates the details.

Table 18 Calculation of indirect GHG emission savings under the project Environmental Protection in the Energy Industry (EPEI) in China

	Basic unit	***Year***	***Total (∑)***
		2006	
Direct emissions saved CO_2 emissions saved due to implementation of optimisation measures in three provinces (as pilot scale)	t CO_2/yr	700,000	
Indirect emissions saved CO_2 emissions saved due to implementation of optimisation measures in 200 power plants in the northern region	t CO_2/yr	1,500,000	
Direct and indirect contribution to CO_2 emission saved through assumed utilisation period of 10 years	***t CO_2***		***22,000,000***

	Basic unit	***Value***	***Total (∑)***
Amount of coal saved due to the project implementation through reduced coal-seam fires	tonnes	100,000	
Net calorific value of standard coal – SKE*	GJ/tonne	29.31	
Effective CO_2 emission factor (kg/TJ)**	t CO_2/TJ	94.60	
Oxidation factor		98%	
CO_2 emissions saved from coal savings during period of four years	t CO_2	***2,717,049***	
Indirect contribution to CO_2 emission saved through reduced coal-seam fires (can be assumed only for the project duration period of four years)	***t CO_2***		***2,717,049***
Total direct and indirect contribution to CO_2 emission saved through the project	***t CO_2***		***24,717,049***

* Standard coal (SKE) data received from Project
** IPCC 2006 guidelines default emission factor for other bituminous coal

Therefore the following figures can be reported for the EEIP program in China,

- Part B: The project directly and indirectly contributed to CO_2 savings of 24,717,049 t CO_2, (of which the direct contribution is 7,000,000 t CO_2) when the energy-efficiency improvements in the power plants are assumed to be valid for a 10–year-period (assumed 10 years only for power plant optimisation measures). The total direct and indirect contribution will also include the amount of coal saved through reduced coal-seam fires of 2,717,049 t CO_2, indirectly contributed through reduced coal-seam fires during the last four years of the programme.

Example 3

Energy & Eco-Efficiency in Agro-Industry in Thailand

The aim and objectives of the E3Agro programme are explained under the example A.5. Besides producing electricity from biogas, other energy-efficiency measures and process improvements were adapted in Palm Oil Mills sector are as follows:

a) Due to the energy-efficiency measures adapted under the project, the specific electricity consumption is reduced by an average of 9% i.e. 1.7 kWh/t fresh fruit bunch. Thus an equal amount of electricity drawn from the grid is saved. Assuming an utilization period of 10 years, the emissions saved are as follows:

Table 19 Calculation of GHG emission savings due to reduced specific electricity consumption in POMs by 9% in Thailand

	Basic unit	***Year***	***Total (∑)***
Reduced electricity consumption		***2006***	
Number of industries involved in the benchmarking programme		18	
Yearly processing of Fresh Fruit Bunch (FFB)	t FFB/yr	200,000 - 300,000	
On a conservative approach consider	t FFB/yr	200,000	
The specific electricity consumption is reduced by an average of 9% i.e.	kWh/t FFB	1.7	
Electricity saved	kWh/yr	340,000	
The country specific emission factor	t CO_2/MWh	0.5125	
Total emissions saved	***t CO_2/yr***	***174***	
Direct contribution to CO_2 e emission saved through assumed utilisation period of 10 years	***t CO_2***		***1,743***

b) Due to the energy efficiency measures adapted under the project, the specific steam consumption is reduced by an average of 11% i.e. 0.065 t steam/t FFB. Furthermore, an equal amount of fossil-fuel used for thermal energy is saved. Assuming an utilization period of 10 years, the emissions saved are as follows:

Table 20 Calculation of GHG emission savings due to reduced steam consumption in POMs by 11% in Thailand

	Basic unit	***Year***	***Total (∑)***
Reduced steam consumption		***2006***	
Yearly processing of Fresh Fruit Bunch (FFB) – conservative approach	t FFB/yr	200,000	
The specific steam consumption is reduced by an average of 11% i.e.	t steam/t FFB	0.06	
Steam saved	t steam/yr	12,000	
Fuel used for steam production is assumed to be Residual Fuel Oil (RFO) in the baseline scenario	t RFO/t steam	0.065	
Net Calorific Value of RFO	TJ/kt	40.4	
Fuel specific emission factor of RFO	t CO_2/TJ	77.4	
Oxidation factor		0.99	
Total emissions saved	***t CO_2/yr***	***2,415***	
Direct contribution to CO_2 e emission saved through assumed utilisation period of 10 years	***t CO_2***		***24,146***

c) Due to the energy efficiency measures, the palm oil production losses are reduced by 11% i.e. 2.2 kg/t FFB. Assuming that the end use of the palm oil produced is to replace diesel fuel, then the emissions saved are as follows:

Table 21: Calculation of GHG emission savings due to reduced palm oil loses in POMs by 11% in Thailand

	Basic unit	*Year*	*Total (∑)*
Reduced palm oil losses		***2006***	
Yearly processing of Fresh Fruit Bunch (FFB) – conservative approach	t FFB/yr	200,000	
The oil losses are reduced by 11% i.e.	kg/t FFB	2.2	
Total palm oil saved	t/yr	440	
Assuming NCV of palm oil as	TJ/kt	14.25	
Oxidation factor		0.99	
The end use of the palm oil produced is to replace diesel fuel, then specific emission factor of diesel	t CO_2/TJ	74.1	
Total emissions saved	***t CO_2/yr***	***460***	
Direct contribution to CO_2 e emission saved through assumed utilisation period of 10 years	***t CO_2***		***4,599***

Another targeted sector under the programme is the starch-processing industries. The value added, through improvement measures that could be represented in terms of climate change, from the evaluation of six starch-processing industries that are participating in the benchmarking programme are,

a) With process improvement measures, the yield of biogas is improved by 8% in six factories. Then the emissions saved are as follows:

Table 22 Calculation of GHG emission savings due to improved biogas yield by 8% in biogas plants of starch-processing industries in Thailand

	Basic unit	*Year*	*Total (∑)*
Improved biogas yield		***2006***	
Total biogas yield is improved by 8% (overall six factories)	m^3/yr	1,860,000	
Methane content is 60%	m^3 CH_4/yr	1,116,000	
Density of methane	kg/m^3 at 0° C	0.716	
@ 30° C	kg/m^3 at 30° C	0.645	
Quantity of methane that was avoided	kg CH_4/yr	719,942	
GWP_{CH4}	t CO_2/tCH_4	21	
Total emissions avoided	***t CO_2 e/yr***	***15,119***	
Direct contribution to CO_2 e emission saved through assumed utilisation period of 10 years	***t CO_2e***		***151,188***

b) With energy efficiency measures, the specific electricity consumption is reduced by an average of 5%. Then the emissions saved are as follows:

Table 23 Calculation of GHG emission savings due to reduced electricity consumption by 5% in starch processing industries in Thailand

	Basic unit	***Year***	***Total (Σ)***
b) Reduced electricity consumption		***2006***	
No. of starch industries involved in the benchmarking programme		6	
Starch processed	t/day	200	
No. of days operated in a year	days/yr	200	
Electricity consumption in an industry	kWh/t of starch	212	
Specific electricity consumption is reduced by an average of 5% i.e.	MWh/yr	2544	
Contry specific emission factor	t CO_2 /MWh	0.5125	
Total emissions saved	***t CO_2 /yr***	***1,304***	
Direct contribution to CO_2 e emission saved through assumed utilisation period of 10 years	***t CO_2***		***13,038***

The third sector targeted under the programme is shrimp farming. With the energy-efficiency measures, the specific electricity consumption is reduced by an average of 38% from the pilot-scale project. Although this is not that significant under pilot-scale, if similar measures are replicated across the country, then the indirect emissions saved would be significant ,(i.e. 280,000 t CO_2 /yr), according to the project manager.

Therefore the GHG-emission savings of this project can be reported in the uniform format as:

Table 24 Direct and indirect contribution to CO_2 emissions saved

Thailand: Energy & Eco-Efficiency in Agro-Industry (E3Agro)	***t CO_2 per year*** 2005-06	2006-07	2007-08	...	2014-15	Total t CO_2 due to project and saved due to project
	2005-06	***2006-07***	***2007-08***	***...***	***2014-15***	
Part B.1: Direct emissions saved due to Renewable Energy and energy efficiency measure in palm oil mill	3,049	3,049*	3,049*	...	3,049*	30,490*
Part B.2: Starch processing industries	16,423	16,423*	16,423*	...	16,423*	164,230*
Part B.3: Indirect emissions saved due to the replication of similar measure in shrimp farms cross country[13]			280,000*	...	280,000*	2,800,000*
Part B: Contribution to CO_2 savings due to project in t CO_2	***19,472***	***19,472****	***299,472****	***...***	***299,472****	***2,994,720****

* Values for 2006-07 till 2014-15 are just assumed to show the principle. However Part A emissions are until 2007-08

Hence the above information could be reported as:

- Part B: The project directly and indirectly contributed to CO_2 savings of 2,994,720 t CO_2, (of which the direct contribution is 194 720 t CO_2) when a utilisation period of the system is assumed to be for 10 years.

13 (Part B.3 – from 2007-08 until 2016-17)

Reporting

The final question is how to report the results of these calculations:

The suggestion is that the guidelines and reporting of results under Part A (What are we causing?) will become part of GTZ existing guidelines for environmental management and reporting in country offices abroad and shall be reported on a yearly basis.

For Part B (What do we mitigate?) it could become part of a three or four year project progress report if not part of the annually report to BMZ.

However this will depend upon internal discussions of GTZ in the near future.

Nevertheless, based on the approach and methods used, it is suggest to introduce a uniform reporting for the Climate Change related impact of Energy related TA projects:

Example

Mini Hydro Power for Sustainable Economic Development Programme in Indonesia, GTZ Project number: 2001.2037.8

Part A: The project caused around 300 t CO_2 during its three years of implementation.

Part B: The project directly and indirectly contributed to CO_2 savings of 90,000 t CO_2, (of which 30,000 t CO_2 are directly contributed), when a utilisation time for the realized hydro power plants is assumed to be 10 years.

Annexure

Annex I	**General Evaluation spreadsheet for Climate Change Impact of Technical Assistance Projects** • Introduction • Part A detailed • Part A short • Part B – Summary • Examples: Indonesia, Mexico, China, Jordan, Solomon Islands, Bolivia, Thailand, Caribbean
Annex II	**Emission Factors Considered in the analysis of Part A**
Annex III	**List of approved methodologies listed under UNFCCC**

Evaluating Relevant Climate Change Impact **in** **Energy related Projects of GTZ**

Introduction: This excel based spreadsheet is specifically designed to evaluate the relevant Climate Change Impact in Energy related Projects of German Technical Cooperation (GTZ). The questionnaire has primarily 3 worksheets excluding Introduction and Summary and example sheets wherein the names are self explanatory. The data that needs to be collected is broadly devided into two parts. **Part A** would evaluate the emissions due to project office operation. **Part B** would indicate the emission saved through the implementation of project activity.

Part A could be audited in two ways and the selection is left to the project as it depends on the circumstances. If the detailed information related to the personnel transportation (such as project owned vehicles, commuting to work and non-road transport) of project staff, consultants and interns (all people that are on the "pay role" of the project), electricity consumption at the site is available, then use the worksheet "Part A detailed". In circumstances where the detailed information is not available, it is suggested to use "Part A short". In "Part A short" suggestions are given for the quantity in each mode, which can be used in the absence of own data. However both worksheets use Emission Factors from various sources including GTZ head quarter wherever possible.

Part B estimates the emission savings due to the implementation of project activity. Given the wide nature of energy related projects, the emissions calculation under Part B is left to the choice of project except using the country specific emission factor. In case of renewable energy projects the manual gives some examples as guidance. In the case of energy efficiency projects savings must be calculated based on the individual circumstances.

A Quick Guide

Data Sheets	
Part A Data:Transport/Electricity/Fuel related data of GTZ project site/office	
Part A detailed	
Part A short	
Part B Data: Project impact data (Contribution from project)	
Part B	Examples are given on how to calculate emissions saved through projects of different nature - "**Ex Part B - Indonesia**" Analyses the climate change impact through Micro Hydro Power project in Indonesia, "**Ex Part B - Mexico**" Analyses the climate change impact mitigated through Solar thermal and Solar PV projects in Mexico, "**Ex Part B - China(1)**" & **"Ex Part B - China(2)"** Analyses the climate change impact mitigated through improvement in Energy Efficiency of Existing Buildings and Environmental Protection in the Energy Industry (EPEI) projects in China, "**Ex Part B - Jordon**" Analyses the climate change impact mitigated through Windpark project in Jordon, "**Ex Part B - Solomon Islands**" Analyses the climate change impact mitigated through Mini Hydro Power Plant project in Solomon Islands, **"Ex Part B - Bolivia"** Analyses the climate change impact mitigated through SHS project in Bolivia, **"Ex Part B - Thailand"** Energy Efficiency in the Agro-Industry, **"Ex Part B - Caribbean"** Analyses the renewable energy projects development in Caribbean

Summary: Summary of Project Assessment with regard to Climate Change contribution

Detailed Emissions Calculation for Part A

For project staff, consultants and interns, but not for head quater staff visiting the project

Transport Related Emissions

		Unit/year		Quantity/year		Emission factor		Number of years		Amount of carbon dioxide released
		❶		❷		❸		❹		❺
1,1	**Transport related emissions of the project**				X	kg CO_2/Unit	X		=	kgCO_2
1.1.1	**Petrol** car(s) owned by company	liters/year				2,36		1		-
1.1.2	**Diesel** car(s) owned by company	liters/year				2,64		1		-
1.1.3	Project or rented **diesel** cars	km/year				0,162		1		-
1.1.4	Project or rented **petrol** cars	km/year				0,137		1		-
1.1.5	Motor-bycles	km/year				0,093		1		-
1,2	**Vehicle for transport of goods**									
1.2.1	Total kilometers of small transport lorry (<3.5 tonne)	t-km/year				1,1		1		-
1,3	**Non-road transport of persons - Aeroplane/Train**									
1.3.1	Airplane - Long haul [Business class] (10 000 km) (Distance for oneway)	P-km/yr				0,478		1		-
1.3.2	Airplane - Long haul [Economy class] (10 000 km) (Distance for oneway)	P-km/yr				0,307		1		-
1.3.3	Airplane - Medium haul [Economy class] (2 000 km) (Distance for oneway)	P-km/yr				0,237		1		-
1.3.4	Airplane - Short haul [Economy class] (500 km) (Distance for oneway)	P-km/yr				0,197		1		-
1.3.5	Train - Electric (distance for one way)	P-km/yr				0,066		1		-
1.3.6	Train - Diesel (distance for one way)					0,172				
1,4	**Non-road transport of goods**									
1.4.1	Air Freight long haul	t-km/year				0,57		1		-
1.4.2	Train freight	t-km/year				0,04		1		-
1,5	**Employees commuting to work**									
1.5.1	Own **Petrol** car	km/year				0,162		1		-
1.5.2	Own **Diesel** car	km/year				0,137		1		-
1.5.3	Public Transport - Local tram, Bus & Metro	P-km/year				0,074		1		-
1.5.4	Bus Diesel - long distance	P-km/year				0,049		1		-
1.5.5	Motorcycle	km/year				0,093		1		-
	Total sum during year in t CO_2:									**0**

Electricity Consumption at Site

	Unit/year		Quantity/year		Emission factor		Number of years		Amount of carbon dioxide released
	❶		❷		❸		❹		❺
Country				X	kg CO_2/Unit	X		=	kgCO_2
Indonesia	kWh/year				0,85		1		-
China	kWh/year				0,85		1		-
India	kWh/year				0,86		1		-
Mexico	kWh/year				0,47		1		-
Caribbean	kWh/year				0,80		1		-
Germany	kWh/year						1		-
Total sum during year in t CO_2:									**0**

Instructions to *Transport Related Emissions*

a) Enter the respective Unit/year data for a year in the Column 2 - only in the applicable cells and are highlighted "*Yellow*"

b) If required - should insert the rows and copy the values accordingly

c) if the "Number of years" is other than 1 in Column 4, then change the number and indicate the reason as "*Comment*".

NOTE:
It is anticipated that there would be changes on yearly basis and may vary from year to year. In such a case take an average over the years (i.e. 4 or 5) and place the number in the cell.

Annexure 01: Country Specific Emission Factors

Country	WAE ❶		CM ❷		Offgrid ❸
	Emission factors				
	kg CO_2/kWh				
Indonesia					0,8000
Java-Bali grid			0,8540		
China					
North China Power Grid			1,0303		
North East China Power Grid			1,0518		
East China Power Grid			0,9047		
Middle China Power Grid			0,9746		
North West China Power Grid			0,8498		
South China Power Grid			0,8434		
Power Grid in Hainan Province			0,8363		
India					
North	0,720		0,7550		
East	1,050		1,0350		
South	0,790		0,8600		
West	0,920		0,8950		
North East	0,460		0,4550		
India	0,840		0,8600		
Mexico			0,4670		
Caribbean					0,8000

Instructions to ***Annexure 01***

For Column 1, 2 and 3:

Please follow the procedure as indicated in the revised guidelines. Use the applicable and conservative factor.

Note:

The Emission factors could also be sourced from latest submitted PDD's under CDM executive board of UNFCCC.

Quick Assessment of part A related Emissions caused by the TA Project

For project staff, consultants and interns, but not for head quater staff visiting project

No.	Item	Unit/year	Number of Cars	User Mode in km/year				Emission factor		Number of years		Amount of CO_2 released	Description	Suggestion for average distance driven in km / year		
		❶	❷	❸				❹		❺		❻	❼	❽		
1,1	**Transport (Vehicle) related emissions of the project**			Low (1-10k)	Medium (10k-25k)	High (25-50)	X	kg CO_2/Unit	X		=	$kgCO_2$		Low	Medium	High
1.1.1	**Petrol** car(s) owned by project office	km/year						0,162		1,00		-		5000	17500	37500
1.1.2	**Diesel** car(s) owned by project site	km/year						0,137		1,00		-				
1.1.3	Rented **diesel** cars - run at site	km/year						0,137		1,00		-				
1.1.4	Rented **petrol** cars	km/year						0,162		1,00		-				
1.1.5	Motor-bycles	km/year						0,093		1,00		-				

No.	Item	Unit/year	Number of flights/year	Flight haul/year (distance for one way)				Emission factor		Number of years		Amount of CO_2 released	Description	Suggestion for average distance (km) of flight		
1,2	**Non-road transport personnel - Air travel**			Short (2000)	Medium (6000)	Long (10000)	X	kg CO_2/Unit	X		=	$kgCO_2$		Short	Medium	Long
1.2.1	Airplane - Long haul [Business class] (10 000 km) (Distance for oneway)	P-km/yr						0,478		1		-	Between Continents	500	2000	10000
1.2.2	Airplane - Long haul [Economy class] (10 000 km) (Distance for oneway)	P-km/yr						0,307		1		-	Between Continents			
1.2.3	Airplane - Medium haul [Economy class] (2 000 km) (Distance for oneway)	P-km/yr						0,237		1		-	Within Continent			
1.2.4	Airplane - Short haul [Economy class] (500 km) (Distance for oneway)	P-km/yr						0,197		1		-	Within a Country			

No.	Item	Unit/year	Number of Cars/persons	Low (1-10k)	Medium (10k-25k)	High (25-50)	X	kg CO_2/Unit	X		=	$kgCO_2$		Low	Medium	High
1,3	**Employees commuting to work**															
1.3.1	Own **Petrol** car	km/year						0,162		1		-		5000	17500	37500
1.3.2	Own **Diesel** car	km/year						0,137		1		-				
1.3.3	Public Transport - Local tram, Bus & Metro	P-km/year						0,074		1		-				
1.3.4	Bus Diesel - long distance	P-km/year						0,049		1		-				
1.3.5	Motorcycle	km/year						0,093		1		-				

No.	Item	Unit/year	Assumed units/yr	size of office (m^2)				Emission factor		Number of years		Amount of CO_2 released	Description	Suggestion for size of office (m2)		
1,4	**Electricity consumption of project office**			Small (1-30)	Medium (30-50)	Big (50-100)	X	kg CO_2/kWh	X		=	$kgCO_2$		Small	Medium	Big
1.4.1	With Aircondition - Office 01	kWh/m²/yr	250							1		-		15	40	75
1.4.2	With Aircondition - Office 02	kWh/m²/yr	250							1		-				
1.4.3	Without Aircondition - Office 01	kWh/m²/yr	50							1		-		**Suggestion for electricity consumption in kWh/m²/a**		
1.4.4	Without Aircondition - Office 02	kWh/m²/yr	50							1		-		Office with AC		300

Total sum during year in t CO_2: -

Instructions to this sheet

a) If required - should insert the rows and copy the values accordingly

b) Enter the data in the Column 2 - only in the applicable cells and are highlighted "*Yellow*". The same case with Column 3, but observe the respective applicable number from Column 8 and insert in Column 3.

c) if the "Number of years" is other than 5 in Column 4, then change the number and indicate the reason as "*Comment*".

NOTE:
It is anticipated that there would be changes on yearly basis and may vary from year to year. In such a case take an average over the years (i.e. 4 or 5) and place the number in the cell.

Emissions Saved due to Project Activity

Instructions to this sheet

a) The format and data manipulation is left to the choice of the project as it varies depends on the project nature

Summary: Climate Change contribution of project

GTZ project number: XXXX.XXXX.X

"XXX"

		Year						Total tonnes of CO_2 due to/saved due to intervention
Part A: CO_2 emissions caused by the project	**t CO_2/yr**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	
Detailed Emissions Calculation	-	-	-	-	-	-	-	**-**
or								
Quick Assessment of related GHG Emissions caused by the TA Project	-	-	-	-	-	-	-	**-**
Total	**-**							

Part B: Contribution to CO_2 savings due to project in t CO_2	**t CO_2**	-	-	-	-	-	-	**-**

Line of action XX: XXXX

GHG Emission saved during one year - t CO_2/yr								
GHG Emission saved through assumed utilisation period of 10 a - t CO_2/10 yr								
Total	**0**							

Emissions Saved due to Project Activity - Indonesia

Line of action 1: Direct benefit (Direct contribution)

	Basic unit	Year							Total (Σ)	Description
	❶	❷							❸	❹
Type of project activity		2002	2003	2004	2005	2006	2007	2008		
Installed Capacity	kW					530			530	
Equivalent full load operating hours	h					4			1.460	
	(OR)								-	
Energy generated by the project activity	MWh/yr	-	-	-	-	773,80	-	-	774	Metered output from the project; Sum all individual projects (similar baselines) togather
Auxillary energy consumption within the plant	MWh/yr	-	-	-	-	-	-	-	-	Sum all individual projects (baselines implied) togather
Total replaced electricity of the national grid/yr	MWh	-	-	-	-	774	-	-	774	Sum all individual projects togather
Project assumed utilisation period 10 years	yr	10	10	10	10	10	10	10		
Total replaced electricity of the national grid/10 yr	MWh	-	-	-	-	7.738	-	-	7.738	
Baseline Emission Factor (conservative)	tCO_2/MWh	1,3	1,3	1,3	1,3	1,3	1,3	1,3		Refer worksheet "01.04 CS EF"
Scenario 1: GHG Emission saved during one year	kg CO_2	-	-	-	-	1.005.940	-	-	**1.005.940**	**Result under Scenario 1**
Scenario 2: Direct contribution to CO_2 emission saved through assumed utilisation period of 10 years	tCO_2	-	-	-	-	10.059	-	-	**10.059**	**Result under Scenario 2**

Line of action 2: Indirect benefit (Indirect contribution)

	Basic unit	Year							Total (Σ)	
	❶	❷							❸	
Type of project activity		2002	2003	2004	2005	2006	2007	2008		
Installed Capacity	kW					700	0		700	
Equivalent full load operating hours	h					6	0		2.190	
	(OR)								-	
Energy generated by the project activity	MWh/yr	-	-	-	-	1.533,00	-	-	1.533	Metered output from the project; Sum all individual projects (similar baselines) togather
Auxillary energy consumption within the plant	MWh/yr	-	-	-	-	-	-	-	-	Sum all individual projects (baselines implied) togather
Total replaced electricity of the national grid/yr	MWh	-	-	-	-	1.533	-	-	1.533	Sum all individual projects togather
Project assumed utilisation period 10 years	yr	10	10	10	10	10	10	10		
Total replaced electricity of the national grid/10 yr	MWh	-	-	-	-	15.330	-	-	15.330	
Baseline Emission Factor (conservative)	tCO_2/MWh	1,3	1,3	1,3	1,3	1,3	1,3	1,3		Refer worksheet "01.04 CS EF"
Scenario 1: GHG Emission saved during one year	kg CO_2	-	-	-	-	1.992.900	-	-	**1.992.900**	**Result under Scenario 1**
Scenario 2: Indirect contribution to CO_2 emission saved through assumed utilisation period of 10 years	tCO_2	-	-	-	-	19.929	-	-	**19.929**	**Result under Scenario 2**

Instructions to this sheet

a) The format and data manipulation is left to the choice of the project as it varies depends on the project nature

Emissions Saved due to Project Activity - Mexico

Line of action 3: Solar water heater

	Basic unit	Year							Total (Σ)	Description
	❶	❷							❸	❹
		1993	2004	2005	2006	2007	2008	2009		
Baseline: Total installed collector area in the past	m^2	200.000	642.644							Example for a base line for solar thermal market development activities
Annual normal increase	m^2/a		40.240							
New installation due to intervention in m²/yr	m^2/yr			100.278	96.764					
Additional installaion due to intervention	m^2/a			60.038	56.524	70.000	80.000	-	266.561	
Assumed useful thermal heat provided by solar system installed	$kWh/m^2/a$	821								
Relaced fossil fuel: Assumption LPG replaced										
LPG with NCV [as per IPCC 1996 guidelines]	MJ/kg	47,31								
Assumed efficency of water heater	%	0,85								
Amount of LPG replaced	kg/a			4.413.972	4.155.622	5.146.406	5.881.606	-	19.597.606	
specific CO_2 emission for LPG	kg CO_2/ kg LPG			2,95	2,95	2,95	2,95	2,95		
Assumed utilisation period for solar systems of 10 years	yr			10	10	10	10	10		
CO_2 emission saved during one year	tCO_2			13.021	12.259	15.182	17.351	-	**57.813**	
Indirect contribution to CO_2 emission saved through assumed utilisation period of 10 years	tCO_2			130.212	122.591	151.819	173.507	-	**578.129**	

Emissions Saved due to Project Activity - Mexico

Line of action 2: Connection of PV systems up to 30 kW

	Basic unit	Year							Total (Σ)	
	❶	❷							❸	
		1993	2004	2005	2006	2007	2008	2009		
Assumption: due to project in future grid connected PV systems can be connected	kW/a					500	1.000			
Assumption: Electricty production of PV sytems in Mexico	kWh/kWp/a	1.400								
Energy generated by the project activity	MWh/a	-	-	-	-	700	1.400	-	2.100	Metered output from the project; Sum all individual projects (similar baselines) together
Auxillary energy consumption within the plant	MWh/yr	-	-	-	-	-	-	-	-	Sum all individual projects (baselines implied) togather
Total replaced electricity of the national grid/yr	MWh	-	-	-	-	700	1.400	-	2.100	Sum all individual projects togather
Assumed utilisation period for solar systems of 10 years	yr	10	10	10	10	10	10	10		
Total replaced electricity of the national grid/10 yr	MWh	-	-	-	-	7.000	14.000	-	21.000	
Baseline Emission Factor (conservative)	tCO_2/MWh	0,467	0,467	0,467	0,467	0,467	0,467	0,467		Refer worksheet part A detailed
CO_2 emission saved during one year	tCO_2	-	-	-	-	327	654	-	**981**	
Additional indirect contribution to CO_2 emission saved through assumed utilisation period of 10 years	tCO_2	-	-	-	-	3.269	6.538	-	**9.807**	

Instructions to this sheet

a) The format and data manipulation is left to the choice of the project as it varies depends on the project nature

Emissions Saved due to Project Activity

Programme No 1 - Environmental Protection in the Energy Industry (EPEI)

	Basic unit	Year	Total (Σ)
	❶	❷	❸
		2006	
Direct CO_2 emissions saved due to implementation of optimisation measures in three provinces (as pilot scale)	t CO_2/yr	***700.000***	
Indirect CO_2 emissions saved due to implementation of optimisation measures in 200 power plants in the northern region	t CO_2/yr	***1.500.000***	
Direct and indirect contribution to CO_2 emission saved through assumed utilisation period of 10 years	**t CO_2**		**22.000.000**
	Basic unit	**Value**	**Total (Σ)**
	❶	❷	❸
Amount of coal saved due to the project implementation through reduced coal-seam fires	tonnes	1.000.000	
Net Calorific Value of Standard coal - SKE*	GJ/tonne	29,31	
Effective CO_2 emission factor (kg/TJ)**	t CO_2/TJ	94,60	
Oxidation factor		98%	
CO_2 emissions saved from coal savings during	t CO_2	***2.717.049***	
Indirect contribution to CO_2 emission saved through reduced coal-seam fires (can be assumed only for the project duration period of four years)	**t CO_2**		**2.717.049**

Total direct and indirect contribution to CO_2 emission saved through the project	**t CO_2**		**24.717.049**

* Standard coal (SKE) data received from Project
**IPCC 2006 guidelines default emission factor for other bituminous coal

Instructions to this sheet

a) The format and data manipulation is left to the choice of the project as it varies depends on the project nature

Emissions Saved due to Project Activity - China

Programme No 2 - Energy Efficiency of Existing Buildings (EEEB)

	Basic unit	Year	Total (Σ)
	❶	❷	❸
Direct emissions saved		**2006**	
Overall direct reduction of heat energy requirement per m² (gross area)	kWh /m²/yr	39	
With temperature correction	kWh /m²/yr	39	
Total improved living area in these three building blocks	m²	6.135	
Net Calorific Value of Standard coal - SKE*	MJ/kg	29,31	
Heat losses in the heat distribution network		30%	
Efficiency of heating system		60%	
Heating energy derived from coal	kWh/kg	3,42	
Total heat energy saved	kWh/yr	478.530	
Savings in terms of primary energy coal	kg/yr	139.953	
Effective CO_2 emission factor (kg/TJ)**	kg CO_2/TJ	94.600	
Oxidation factor		98%	
CO_2 emissions saved	kg of CO_2/yr	**380.259**	
Assuming the assumed utilisation period of the project	years	20	
Direct contribution to CO_2 emission saved through assumed utilisation period of 20 years	**t CO_2**		**7.605**

* Standard coal (SKE) data received from Project

**IPCC 2006 guidelines default emission factor for other bituminous coal

	Basic unit	Year	Total (Σ)
	❶	❷	❸
Indirect emissions saved		**2007-2010**	
Overall direct reduction of heat energy requirement per m² (gross area)	kWh /m²/yr	39	
With temperature correction	kWh /m²/yr	39	
Additional indirect contribution due to program activities during 2007-2010	m²	60.000.000	
Net Calorific Value of Standard coal - SKE*	MJ/kg	29,31	
Heat losses in the heat distribution network		30%	
Efficiency of heating system		60%	
Heating energy derived from coal	kWh/kg	3,42	
Total heat energy saved	kWh/yr	4.680.000.000	
Savings in terms of primary energy	kg/yr	1.368.733.110	
Effective CO_2 emission factor (kg/TJ)**	kg CO_2/TJ	94.600	
Oxidation factor		98%	
CO_2 emissions saved	kg of CO_2/yr	**3.718.914.902**	
Assuming the assumed utilisation period of the project	years	20	
Indirect contribution to CO_2 emission saved through assumed utilisation period of 20 years	**t CO_2**		**74.378.298**

* Standard coal (SKE) data received from Project

**IPCC 2006 guidelines default emission factor for other bituminous coal

Instructions to this sheet

a) The format and data manipulation is left to the choice of the project as it varies depends on the project nature

Emissions Saved due to Project Activity - Jordan

Windpark in Jordan

Calculation of GHG savings through project during its utilisation period compared to baseline
Replacement of electricity from national grid through a windpark in Shawab, Jordan

	Basic unit	Year	Total (Σ)
	❶	❷	❸
		2002	
Size:	MW	25	
Energy generated per year through wind park	kWh/a	55.000.000	
Baseline:			
National grid CO_2 emission factor in 2000 without T&D losses (as per CERUPT)	kg CO_2/kWh	0,747	
Replaced electricity of the national grid in kWh/a	kWh/a	55.000.000	
GHG Emission of baseline per year	kg CO_2 /a	41.085.000	
Assumed utilisation period of the project in years	years	10	
Total CO_2 emmision saved through assumed utilisation period of 10 years	**kg CO_2**	**410.850.000**	
	t CO_2	**410.850**	
Direct contribution to CO_2 emission saved through assumed utilisation period of 10 years	**t CO_2**		**410.850**

Instructions to this sheet

a) The format and data manipulation is left to the choice of the project as it varies depends on the project nature

Emissions Saved due to Project Activity - Solomon Islands

Mini Hydro Power Plant

Calculation of GHG savings through project during project utilisation period compared to baseline replacement of electricity from mini diesel grid through Mini Hydro Power Plant in Solomon Islands

	Basic unit ❶	Year ❷	Total (Σ) ❸
		2002	
Size:	kW	150	
Energy generated per year	kWh/a	280.972	
Baseline: Selected Case - Mini diesel grid > 200 kW	kg CO_2/kWh	0,8	
Replaced diesel generator electricity in kWh/a	kWh/a	280.972	
GHG Emission of baseline per year	kg CO_2 /a	224.778	
OR			
Replaced diesel for generator in litres/year	litre/a	0	
with specific CO_2 value for diesel	kg CO_2/litre	2,64	
GHG Emission of baseline per year	kg CO_2 /a	0	
Assumed utilisation period of the project in years	years	10	
Total CO_2 emmision saved through assumed utilisation period of 10 years	**kg CO_2**	**2.247.776**	
	t CO_2	**2.248**	
Direct contribution to CO_2 emission saved through assumed utilisation period of 10 years	**t CO_2**		**2.248**

Instructions to this sheet

a) The format and data manipulation is left to the choice of the project as it varies depends on the project nature

Emissions Saved due to Project Activity - Bolivia

Calculation of GHG savings through project during project lifetime based on PV Technology
Stand alone household applications

Baseline for daily energy consumption between 50-500 Wh/d
Standardised emission reduction factor (baseline emissions minus project emissions)

5000 SHS Systems of 50 Wp each, utilisation period is 10 years.

	Basic unit	Year	Total (Σ)
	❶	❷	❸
		2002	
Assumed daily energy consumption of household:	Wh/d	250	
Number of systems installed/hosueholds during project:	Systems	5.000	
Assumed utilisation period of SHS in the project	years	10	
Method according CERUPT Vol. 2.c: (kg CO_2/ year)			
General small renewable household electrification	kg CO_2/ year	75kg/y + 0.8*(daily energy cons. in Wh/d) kg/y/Wh/d	
GHG Emission of baseline per year	kg CO_2 /a	1.375.000	
Total CO_2 emmision saved through assumed utilisation period of 10 years	**kg CO_2**	**13.750.000**	
	t CO_2	**13.750**	
Direct contribution to CO_2 emission saved through assumed utilisation period of 10 years	**t CO_2**		**13.750**

Instructions to this sheet

a) The format and data manipulation is left to the choice of the project as it varies depends on the project nature

Emissions Saved due to Project Activity

	Basic unit	Year	Total (Σ)
	❶	❷	❸
Part B.1: Palm Oil Mill energy savings		**2006**	
a) Generated electricity from biogas and biomass is exported to the grid			
Natural Palm Oil Company Limited – 1 MW Electricity Generation and Biogas Plant Project	t CO_2e/yr	14.480	
Chumporn Applied Biogas Technology for Advanced Waste Water Management, Thailand	t CO_2e/yr	30.028	
Organic Waste Composting at Vichitbhan Plantation, Chumporn Province, Thailand	t CO_2e/yr	265.000	
Wastewater Treatment with biogas System in palm oil mill at Sikao, Trang, Thailand	t CO_2e/yr	16.446	
Wastewater Treatment with biogas System in palm oil mill at Saikhueng, Surat Thani, Thailand	t CO_2e/yr	18.570	
Wastewater Treatment with biogas System in palm oil mill at Sinpun, Surat Thani, Thailand	t CO_2e/yr	17.083	
Wastewater Treatment with biogas System in palm oil mill at Bangsawan, Surat Thani, Thailand	t CO_2e/yr	14.068	
Wastewater Treatment with biogas System in palm oil mill at Kanjanadij, Surat Thani, Thailand	t CO_2e/yr	17.083	
Univanich lamthap POME biogas project in Krabi, thailand	t CO_2e/yr	48.238	
Total emissions saved	***t CO_2e/yr***	***440.996***	
Direct contribution to CO_2e emission saved through assumed utilisation period of 10 years	***t CO_2***		***4.409.960***

	Basic unit	Year	Total (Σ)
	❶	❷	❸
b) Reduced electricity consumption		**2006**	
No of industries involved in the Benchmarking programme		18	
Yearly processing of Fresh Fruit Bunch (FFB)	t FFB/yr	200000 - 300000	
On a conservative approach consider	t FFB/yr	200000	
The specific electricity consumption is reduced by an average of 9% i.e.	kWh/t FFB	1,7	
Electricity saved	kWh/yr	340000	
The country specific emission factor	t CO_2/MWh	0,5125	
Total emissions saved	***t CO_2/yr***	***174***	
Direct contribution to CO_2e emission saved through assumed utilisation period of 10 years	t CO_2		**1.743**

	Basic unit	Year	Total (Σ)
	❶	❷	❸
c) Reduced steam consumption		**2006**	
Yearly processing of Fresh Fruit Bunch (FFB) on a conservative approach	t FFB/yr	200000	
The specific steam consumption is reduced by an average of 11% i.e.	t steam/t FFB	0,06	
Steam saved	t steam/yr	12000	
Fuel used for steam production is assumed to be Residual Fuel Oil (RFO) in the baseline scenario	t of RFO/t steam	0,065	
NCV of RFO	TJ/kt	40,4	
Fuel specific emission factor of RFO	t CO_2/TJ	77,4	
Oxidation factor		0,99	
Total emissions saved	***t CO_2/yr***	***2.415***	
Direct contribution to CO_2e emission saved through assumed utilisation period of 10 years	t CO_2		**24.146**

	Basic unit	Year	Total (Σ)
	❶	❷	❸
d) Reduced palm oil losses		**2006**	
Yearly processing of Fresh Fruit Bunch (FFB) on a conservative approach	t FFB/yr	200000	
The oil losses are reduced by 11% i.e.	kg/t FFB	2,2	
Total palm oil saved	t/yr	440	
Assuming NCV of Plam oil as	TJ/kt	14,25	
Oxidation factor		0,99	
The end use of the palm oil produced is to replace diesel fuel, then specific emission factor of diesel	t CO_2/TJ	74,1	
Total emissions saved	***t CO_2/yr***	***460***	
Direct contribution to CO_2e emission saved through assumed utilisation period of 10 years	t CO_2		**4.599**

Part B.2: Starch processing industries

	Basic unit	Year	Total (Σ)
	❶	❷	❸
a) Improved biogas yield		**2006**	
Total biogas - yield is improved by 8% (overall 6 factories)	m^3/yr	1.860.000	
Methane content is 60%	m^3 CH_4/yr	1.116.000	
Density of methane	kg/m^3 at 0°C	0,716	
@ 30º C	kg/m^3 at 30°C	0,645	
Quantity of methane that was avoided	kg CH_4/yr	719.942	
GWP_{CH4}	tCO_2/tCH_4	21	
Total emissions avoided	***t CO_2 e/yr***	***15.119***	
Direct contribution to CO_2e emission saved through assumed utilisation period of 10 years	t CO_2		**151.188**

	Basic unit	Year	Total (Σ)
	❶	❷	❸
b) Reduced electricity consumption		**2006**	
No of starch industries involved in the Benchmarking programme		6	
Starch processed	t/day	200	
No of days operated in a year	days/yr	200	
Electricity consumption in a industry	kWh/t of starch	212	
The specific electricity consumption is reduced by an average of 5% i.e.	MWh/yr	2544	
The country specific emission factor	t CO_2/MWh	0,5125	
Total emissions saved	***t CO_2 /yr***	***1.304***	
Direct contribution to CO_2e emission saved through assumed utilisation period of 10 years	t CO_2		**13.038**

Part B.3: Energy efficiency measures in Shrimp Farms

	Basic unit ❶	Year ❷	Total (Σ) ❸
a) Reduced electricity consumption		**2007**	
No of industries involved in the Benchmarking programme			
Yearly production of Shrimp	t		
The specific electricity consumption is reduced by an average of 38% i.e.	kWh/t		
Electricity saved	kWh/yr	0	
The country specific emission factor	t CO_2/MWh	0,5125	
Total emissions saved	***t CO_2/yr***	**-**	
Direct contribution to CO_2e emission saved through assumed utilisation period of 10 years	t CO_2		**-**
Indirect contribution to CO_2e emissions saved	t CO_2/yr	**280.000**	
Indirect contribution to CO_2e emissions saved through assumed utilisation period of 10 years	***t CO_2***		**2.800.000**

Direct contribution to CO_2 emission saved through assumed utilisation period of 10 years	**t CO_2**		**4.604.673**
Indirect contribution to CO_2 emission saved through assumed utilisation period of 10 years	**t CO_3**		**2.800.000**

Instructions to this sheet

a) The format and data manipulation is left to the choice of the project as it varies depends on the project nature

Emissions Saved due to Project Activity - Caribbean

Calculation of GHG savings through different renewable energy projects during project utilisation period compared to baseline

	Basic unit	Value	Remarks
	❶	❷	❸
Wind park Sugar Mill Saint Lucia	MWh/yr	24.400	On a conservative basis - 12.6 MW at 22% capacity factor
Wind park Ribishi Point St. Vincent	MWh/yr	12.400	On a conservative basis - 6 MW at 23% capacity factor
Micro Hydro Power Great Low Land River Jamaica	MWh/yr	16.650	2MW capacity - New
Micro Hydro Power South River, SVG	MWh/yr	2.180	Additional generation after rehabilitation and expansion of the plant
Micro Hydro Power Richmond, SVG	MWh/yr	2.360	Additional generation after rehabilitation and expansion of the plant
Micro Hydro Power John Compten Dam, St. Lucia	MWh/yr	543	190kW capacity - New
Micro Hydro Power New Town, Dominica	MWh/yr	1.198	145kW capacity - New
Total electricity saved/yr	MWh/yr	59.731	
Emission factor for diesel based power systems of capacity > 200kW	t CO_2/MWh	0,8	As per UNFCCC AMS-1D
Total CO_2 emmision saved/yr	**t CO_2/yr**	**47.785**	
Direct contribution to CO_2 emission saved through assumed utilisation period of 10 years	**t CO_2**	**477.848**	

Instructions to this sheet

a) The format and data manipulation is left to the choice of the project as it varies depends on the project nature

Emission Factors Considered in the analysis of Part A

Transport medium	Current evaluation	
	Without upstream emissions	Reference / Remarks
	kg CO_2/liter	
Car - Petrol	2,36	TREMOD (2006)*
Car - Diesel	2,64	TREMOD (2006)

	kg CO_2 / km (total vehicle)	
Car - petrol	0,162	TREMOD (2006)
Car - diesel	0,137	TREMOD (2006)
Motor bike	0,093	EPA 2001 Guide
Bus diesel (cap. 20 Persons)	0,886	GEMIS 4.1

	kg CO_2 / Person * km	
Aeroplane - Long haul [Business class] (10000 km)	0,478	http://www.atmosfair.de
Aeroplane - Long haul (10000 km) Economy	0,307	http://www.atmosfair.de
Aeroplane - Medium haul (2000 km) Economy	0,237	http://www.atmosfair.de
Aeroplane - Short haul (500 km) Economy	0,197	http://www.atmosfair.de
Train - Electric	0,066	TREMOD (2006)
Train - Diesel	0,172	WRI 2002
Public Transport Mix (Local train, Bus & Metro)	0,074	TREMOD (2006)
Bus diesel -long distance	0,049	WRI 2002

Goods transport	kg CO_2 / tonne * km	
Small lorry (<3.5 t)	1,1	GEMIS 4.1
Big lorry (> 3.5 t)	0,25	GEMIS 4.1
Ship inland	0,03	GEMIS 4.1
Ship overseas	0,01	GEMIS 4.1
Small aeroplane	12	GEMIS 4.1
Air Freight Long haul	0,57	INFRAS, 1995, DETR, 1999
Train freight (Diesel)	0,04	GEMIS 4.1

Those highlighted are frequently used

*German Federal Environment Agency (Umweltbundesamt), "Data and calculation model: Energy consumption and emission of pollutants of motorized traffic in Germany (TREMOD)", version 4.17, 2006

Comparision of Emission Factors																		
	Data selected for 2003 methodology			**Current evaluation**			**WRI 2002**	**INFRAS**	**VfU**	**TREMOD (2006)**	**GTZ headquarters - VfU**	**Source**			GEMIS 4.1	GEMIS 4.1	VfU Bilanzierungsrichtlinie	
	with upstream emissions	**with upstream emissions**	**Source**	**without upstream emissions**	**with upstream emissions**	**Source**						CO2 Emissions for fuels (default values)		UNEP GHG Indicator	(only direct emissions)	with upstream emissions	(with upstream emissions)	
kg CO2/kWh	**kg CO2/liter**	**kg CO2/kWh**		**kg CO2/liter**	**kg CO2/kWh**		**kg CO2/liter**					kg CO2 / litre	kg CO2/kWh	kg CO2/kg	kg CO2/kWh	kg CO2/kWh	kg CO2/kWh	
Car - Petrol	**3,05**		Calculated from default values for litre and kWh and supplement for KEA	**2,36**		Calculated from default values for litre and kWh and supplement for KEA	2,34			2,36				#BEZUG!				
Car - Diesel	**3,50**		Calculated from default values for litre and kWh and supplement for KEA	**2,64**		Calculated from default values for litre and kWh and supplement for KEA	2,68			2,64								
												Source						
												UNEP GHG	GHG				VfU Bilanzierungsrichtlinie	
Person transport		**with upstream**			**with upstream**							Indicator	Protocol	GEMIS 4.1		GEMIS 4.1		IWR Rechner
in kg CO2 / km (total car)		**emissions**			**emissions**							only direct emissions	only direct emissions	(only direct emissions)		with upstream emissions	(with upstream emissions)	only direct emissions)
Car - petrol		**0,35**	GEMIS 4.1	0,162	**0,35**	GEMIS 4.1	0,27	**0,185**		0,150	0,32	0,185	0,2	0,27		0,351	0,32	0,232
Car - diesel		**0,25**	GEMIS 4.1	0,137	**0,25**	GEMIS 4.1	0,14	**0,156**		0,150		0,156	0,12	0,196		0,265	0,2779	
Motor bike		**0,15**	GEMIS 4.1	0,093	**0,15**	GEMIS 4.1							0,093	0,117		0,149		
Bus diesel (cap. 20 Persons)		**1,30**	GEMIS 4.1	0,886									1,034	0,886		1,32		
in kg CO2 / Person * km																		
airplane short distance 10000		**0,432**	VfU Bilanzierungsrichtlinie	0,307	**0,432**	Aeroplane - Long haul (10000 km)	0,180	**0,18**	0,326		0,432	0,18	0,18	0,253		0,29	0,432	0,29
airplane medium distance 2000				0,237	**0,304**	Aeroplane - Medium haul (2000 km)	0,126				0,30365							
airplane long distance 500		**0,1753**	VfU Bilanzierungsrichtlinie	0,197	**0,1753**	Aeroplane - Short haul (500 km)	0,110	**0,11**	0,1164		0,1753	0,11	0,11	0,168		0,193	0,1753	0,15
Train, electric		**0,045**	VfU Bilanzierungsrichtlinie	0,066				**0,034**	0,055	0,066	0,045	0,034	0,06				0,045	0,1
Diesel train				0,1719			0,172											
							0,344											
Public Transport Mix (Local train, Bus & Metro)				0,074	**0,118**	An average number sourced from GHG protocol of WBCSD&WRI for bus (diesel)- long distance & urban transit			0,199	0,074	0,147		1,034	0,886		1,32		
Bus diesel -long distance				0,05			0,05											
							0,19											
Goods transport																		
in kg CO2 / tonne * km																		UBA Texte 26/97
Small lorry		**1,10**	GEMIS 4.1	1,10	**1,10**	GEMIS 4.1								0,937		1,08		IFEU 1996
Big lorry		**0,25**	GEMIS 4.1	0,25	**0,25**	GEMIS 4.1								0,147		0,25		0,111
Ship inland		**0,03**	GEMIS 4.1	0,03	**0,03**	GEMIS 4.1						0,035	0,014	0,028		0,032		
Ship overseas		**0,01**	GEMIS 4.1	0,01	**0,01**	GEMIS 4.1						0,01	0,007	0,0074		0,0092		
Small aeroplane		**12,0**	GEMIS 4.1	12,00	**12,0**	GEMIS 4.1								10,15		11,9		
Air Freight Long haul		**0,70**	UNEP data plus 25% excess due to GEMIS data to be insecure! (Conservative estimate)	0,57	**0,70**	INFRAS, 1995, DETR, 1999						0,57	0,57	1,68		1,93		
Train		**0,04**	GEMIS 4.1	0,04	**0,04**	GEMIS 4.1						0,047	0,03	0,03		0,036		

p://www.wri.org/publication/working-9-5-climate-change-office-guide#

Emissions factors for air travel

Definition of short haul: less than	452	km
Definition of medium haul: less than	1600	km
Definition of long haul: more than	1600	km

Method of Travel	kg CO_2 per passenger km	kg CO_2 per passenger mile	1 km equals	0,6214 miles
Short haul (approx.)	0,18	0,29		
Medium haul (approx.)	0,126	0,20		
Long haul	0,11	0,18		

Source: Air travel definitions and factors are from the GHG Protocol Mobile Combustion Tool. The emissions factors for short and long haul flights are originally from UK DEFRA. The emissions factor for medium haul flights was derived, using an assumed d

Liquid Fuel	kg of CO_2/gallon	Kg of CO_2/litre
Jet kerosene	9,6	2,5
Aviation Gasoline	8,3	2,2

Source: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2000,* Appendix B, Table B1.

Note: Jet kerosene is used by jet engines only. Aviation gasoline is used in piston powered airplanes. Jet kerosene is more common.

Emissions factors for rail travel

Type of Train	kg CO_2 per passenger km	kg CO_2 per passenger mile
UK Rail[1]	0,06	0,10
US Diesel Train[2]	0,17	0,28
US Electric Train[3]	0,34	0,55
US Coal Train[4]	0,22	0,37
US Transit Rail[5]	0,34	0,55

1. Source: Railtrack http://www.railtrack.co.uk/our_business/environment/benefits_of_rail/index.cfm gives annual passenger-miles and tonnes of CO2.

2. Source: Bureau of Transportation Statistics, 2000 (table 4.20/energy intensity for Amtrak 1997)

3. Multiplies diesel locomotive numbers times two, assuming generation fuel mix is slightly less carbon intensive than diesel, but generation and transmission are about 40% efficient. This will vary considerably depending upon the carbon intensity.

4. Multiplies diesel emissions per unit by 26.3/20.2, the ratio of CO2 emissions per gigajoule, coal to diesel.

5. To obtain this number, the following were multiplied:
3105Btu/psgr-mile(TEDB) * 1.055kJ/Btu (conversion) * 1kwh/3600 kJ (conversion) * 1.34 lbsCO2/kwh (EIA) * 0.4536 kgCO2/lbsCO2 (conversion)
Sources:
TEDB = Transportation Energy Data Book, Edition 22

Emissions factors for bus travel

Type of Bus	kg CO2 per passenger km	kg CO_2 per passenger mile
Diesel, long distance	0,05	0,08
Diesel, urban	0,19	0,30
CNG, urban	0,14	0,23

Source for diesel: Bureau of Transportation, National Transportation Statistics for 2000.
Source for CNG: Multiplies diesel (urban) emissions per unit by 56/73.9, the ratio of CO2 emissions per terrajoule, natural gas to diesel. Emission factors are based

Emissions factors for car travel

Liquid Fuel	kg of CO_2/gallon	Kg of CO_2/litre
Gas/petrol	8,9	2,3
Diesel	10,2	2,7

Source: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2000,* Appendix B, Table B1.

Size of Car	Units	Kg CO_2 per unit
Small petrol (max. 1.4 litre engine)	miles	0,28
	km	0,17
Medium petrol (1.4 – 2.1 litre engine)	miles	0,36
	km	0,22
Large petrol (above 2.1 litres)	miles	0,44
	km	0,27

Source: Environmental Reporting – Guidelines for Company Reporting on GHG Emissions, UK DEFRA.
http://www.defra.gov.uk/environment/envrp/gas/10.htm

Size of Car	Units	Kg CO2 per unit
Small diesel (2.0 litre engine or under)	miles	0,19
	km	0,12
Large diesel (Over 2.0 litre engine)	miles	0,23
	km	0,14

Source: Environmental Reporting – Guidelines for Company Reporting on GHG Emissions, UK DEFRA.
http://www.defra.gov.uk/environment/envrp/gas/10.htm

Fuel efficiency values

Size of car	miles per gallon (mpg)
New small gas/petrol/electric hybrid	56
Small gas/petrol, highway	32
Small gas/petrol, city	26
Medium gas/petrol, highway	30
Medium gas/petrol, city	22
Large gas/petrol, highway	25
Large gas/petrol, city	18
Liquid Petroleum Gas (LPG)	21
Diesel	24

Source: miles per gallon for typical vehicles based on averages from US EPA 2001 Guide.
http://www.epa.gov/autoemissions.

Transport	CO_2 Emission Factor	
	tCO_2/kilometre	tCO_2/mile
Average Petrol Car[1]	0,000185	0,000299
Average Diesel Car	0,000156	0,000251
HGV	0,000782	0,00126

[1] Based on INFRAS data, refer to Appendix 8.5

Source: INFRAS, 1999

Transport Mode	Basis	Emission factor for carbon dioxide (tCO_2/ P.km)
Air- short haul[1]	Person.kilometre	0,00018
Air- long haul[2]	Person.kilometre	0,00011
Train[3]	Person.kilometre	0,000034

[1] Average distance of 500 km.

[2] Average distance of 6495 km.

[3] Average length of train 9.8 wagons with occupancy of 31%.

Source: INFRAS, 1995;DETR, 1999

Transport Mode	Basis	Emission factor for carbon dioxide (tCO_2/ T.km)
Air Freight Short haul[1]	Tonne.kilometre	0,000158
Air Freight Long haul[2]	Tonne.kilometre	0,00057
Train Freight[3]	Tonne.kilometre	0,000047
Inland shipping[4]	Tonne.kilometre	0,000035
Marine shipping[5]	Tonne.kilometre	0,00001

[1] Average distance of 457 km

[2] Average distance of 6342 km

[3] Average length of 27 wagons with 49% capacity.

[4] Average tonnage capacity of ~2500 tonnes.

[5]Average tonnage capacity of 51500 tonnes

Source: INFRAS, 1995, DETR, 1999

	Indicators	7) Direct and indirect greenhouse gas emissions								Details	Source
		Internal GHG Emissions			Down/Upstream GHG Emissions			Total			
		Conversion factor	Unit	Source of Emission	Conversion factor	Unit	Source of emission	Conversion factor	Unit		
1) Direct Energy	**1a) Electricity consumed in premises in kWh**										
	electricity from hydroelectric run-of-river power stations	-	kg/kWh	no direct emissions	0,003	kg/kWh	production of electricity	0,003	kg/kWh	Average for Europe	ecoinvent 2000 (PSI 2000)
	electricty from hydroelectic reservoir power stations	-	kg/kWh	no direct emissions	0,004	kg/kWh	production of electricity	0,004	kg/kWh	Average for Europe	ecoinvent 2000 (PSI 2000)
	electricity from wind power stations	-	kg/kWh	no direct emissions	0,011	kg/kWh	production of electricity	0,011	kg/kWh	Average for Europe	ecoinvent 2000 (PSI 2002)
	electricity from biomass power stations	-	kg/kWh	no direct emissions	0,040	kg/kWh	production of electricity	0,040	kg/kWh	Based on wook 6,4 MWth, allocation by exergy	ecoinvent 2000 (PSI 2001)
	electricity from photovoltaic power stations	-	kg/kWh	no direct emissions	0,074	kg/kWh	production of electricity	0,074	kg/kWh	Production mix of photovoltaic electricity in Switzerland	ecoinvent 2000 (PSI 2000)
	electricity from combined cycle power plant	-	kg/kWh	no direct emissions	0,411	kg/kWh	production of electricity	0,411	kg/kWh	Average for Europe BAT (2000)	ecoinvent 2000 (PSI 2002)
	electricity generated by gas-fired power stations	-	kg/kWh	no direct emissions	0,621	kg/kWh	production of electricity	0,621	kg/kWh	Average for Europe	ecoinvent 2000 (PSI 2000)
	electricity generated by oil-fired power stations	-	kg/kWh	no direct emissions	0,875	kg/kWh	production of electricity	0,875	kg/kWh	Average for Europe	ecoinvent 2000 (PSI 2000)
	electricity generated by black coal fired power stations	-	kg/kWh	no direct emissions	1,031	kg/kWh	production of electricity	1,031	kg/kWh	Average for Europe	ecoinvent 2000 (PSI 2000)
	electricity generated by brown coal fired power stations	-	kg/kWh	no direct emissions	1,224	kg/kWh	production of electricity	1,224	kg/kWh	Braun-coal average mix (UCPTE) for europe in year 2000	ecoinvent 2000 (PSI 2000)
	electricity generated by nuclear power stations	-	kg/kWh	no direct emissions	0,008	kg/kWh	production of electricity	0,008	kg/kWh	Average mix (UCPTE) for Europe	ecoinvent 2000 (PSI 1999)
	electricity from average market mix:										
	see spreadsheet F1	-	kg/kWh	no direct emissions	0,033	kg/kWh	production of electricity	0,033	kg/kWh	see spreadsheet F1	
	1b) Fossil fuels consumed in premises in kWh										
	natural gas	0,20200	kg/kWh	emissions from burning gas	0,043	kg/kWh	production of gas	0,245	kg/kWh	Erdgas, in Heizkessel atm. LowNOx nicht-mod. <100kW	Faist (2003)
	heating oil	0,26700	kg/kWh	emissions from burning oil	0,046	kg/kWh	production of oil	0,313	kg/kWh	Extra light oil, 100kW burner, not modulated	Jungbluth (2003)
	fuels for emergency power units (petrol, diesel)	0,26700	kg/kWh	emissions from burning oil	0,046	kg/kWh	production of oil	0,313	kg/kWh	Extra light oil, 100kW burner, not modulated	Jungbluth (2003)
	coal	0,34200	kg/kWh	emissions from burning coal brike	0,415	kg/kWh	production of coal briketts	0,757	kg/kWh	Browncoal-Brikett, in Einzelofen 5-15kW. House heating. The module describes	Röder (2003)
	no heating	-	kg/kWh		-	kg/kWh		-	kg/kWh		
	1c) Other energy consumed in premises in kWh										
	renewable heating energy (solar power, bioorganic, etc.)	0,00240	kg/kWh	emissions from burning wood	0,009	kg/kWh	infrastructure	0,011	kg/kWh	This module describes the combustion of natural wood chips. Included are the i	Bauer (2003)
	district heating	-	kg/kWh	no direct emissions	0,161	kg/kWh	production of heat/energy	0,161	kg/kWh	District heating Zurich	E2
	no heating	-	kg/kWh		-	kg/kWh		-	kg/kWh		
2) Business travel	2a) rail travel	-	kg/km	no direct emissions	0,055	kg/km	production of electricity, train, infrastucture, ma	0,055	kg/km	Average train for Switzerland	Infras (1995)
	2b) road travel	0,13150	kg/km	emissions from burning gasoline	0,068	kg/km	production of car, infrastucture, maintenance, c	0,199	kg/km	Gasoline, Catalyzer, 8.9 Liter/km	Infras (1995)
	2c) short-haul air travel	0,16500	kg/km	emissions from burning kerosin	0,161	kg/km	production of aircraft, infrastucture, maintenanc	0,326	kg/km	Short distance (Europe)	Ecoinvent 2000 Update 1.3 2006
	2d) long-haul air travel	0,10400	kg/km	emissions from burning kerosin	0,012	kg/km	production of aircraft, infrastucture, maintenanc	0,116	kg/km	Long distance (intercontinental)	Ecoinvent 2000 Update 1.3 2006
3) Paper	3a) post-consumer recycled	-	kg/t	no direct emissions	394,000	kg/t	production of recycling paper	394	kg/t	Recycling with Deinking (t94)	EMPA (1996)
	3b) new fibres ECF + TCF	-	kg/t	no direct emissions	787,000	kg/t	production of paper	787	kg/t	Kraftpapier unbleached	EMPA (1996)
	3c) new fibres chlorine bleached	-	kg/t	no direct emissions	1.594,000	kg/t	production of paper	1.594	kg/t	Kraftpapier chlorine bleached	EMPA (1996)
4) Water	4a) rain water	-	kg/m3	no direct emissions	0,283	kg/m3	Waste water treatment	0,283	kg/m3	Treatment of waste water, not polluted, in waste water treatmentfacility, size 3	Doka Gabor (2003)
	4b) natural water	-	kg/m3	no direct emissions	0,283	kg/m3	Waste water treatment	0,283	kg/m3	Treatment of waste water, not polluted, in waste water treatmentfacility, size 3	Doka Gabor (2003)
	4c) drinking water	-	kg/m3	no direct emissions	0,375	kg/m3	Waste water treatment, Production of drinking	0,375	kg/m3	Waste water treatement in switzerland and drinking water plant	Doka Gabor (2003) / Althaus (2003)
5) Waste	5a) valuable materials separated and recycled	-	kg/t	no direct emissions	-	kg/t	no emissions from recycling	-	kg/t		-
	5b) waste incinerated	-	kg/t	no direct emissions	557,000	kg/t	emissions from the incineration, emissions fror	557	kg/t	Incineration of average 'household' waste	GHG-protocol
	5c) waste disposed of in landfills	-	kg/t	no direct emissions	0,546	kg/t	emissions from the landfill	1	kg/t	Landfill of average 'household' waste	E2
	5d) special waste treatment	-	kg/t	no direct emissions	1.824,000	kg/t	emissions from the treatment	1.824	kg/t	Special Waste Treatment CH	Doka Gabor (2003)

CO_2-Emissionen Verkehr ab 2004

			CO_2/pkm oder kg CO_2/L	2004 Pkm/Jahr	2004 Tonnen CO_2	2004 Verbrauch (L/Jahr) Dienst-fahrzeuge	2004 Tonnen CO_2	2005 Pkm/Jahr	2005 Tonnen CO_2
1. Berufsverkehr									
	PKW/KRAD	Benzin, Diesel Mittelwert	0,150	*6.483.364*	*969,26*			10.425.000	1.558,54
	ÖPNV	S-, U-, Straßenbahn, Bus	0,074	*2.354.439*	*174,23*			2.275.000	168,35
	Summe			*8.837.804*	*1.143,49*			12.700.000	1.726,89
2. Wochenendheimfahrer									
	PKW	Benzin, Diesel Mittelwert	0,150	*1.635.372*	*244,49*			1.122.561	167,82
	Bahn fern		0,066	*3.185.906*	*210,27*			2.245.122	148,18
	ÖPNV	S-, U-, Straßenbahn, Bus	0,074	*303.928*	*22,49*			0	0,00
	Summe			*5.125.205*	*477,25*			3.367.683	316,00
Summe Berufsverkehr + Wochenendheimfahrer					*1.620,74*			16.067.683	2.042,89
3. Dienstreisen-Bahn									
			0,066	1.681.043	110,95			2.053.812	135,55
4. Dienstreisen-Flug									
	DEUTSCHLAND		nach atmosfair Emissionsrechner 2005	1.466.360				1.427.065	
	EUROPA			6.334.074				5.639.854	
	INTERNATIONAL			40.328.166				40.882.405	
	Summe			48.128.600	7.558,73			47.949.325	7404,65
5. Dienstreisen-PKW									
	mit Dienstfahrzeugen der GTZ	Benzin	0,162	38.191	6,19			39.682	6,43
		Diesel	0,137	57.009	7,81			52.873	7,24
	Gesamtverbrauch in **Litern [L]**	Benzin	2,360			4.591	10,83		
		Diesel	2,640			4.615	12,18		
	Dienstreisen MIV-privat	n.e.		0	0,00	0	0,00	0	0,00
	Summe			95.200	14,00	9.206	23,02	92.555	13,67
Gesamt				63.867.852	9.313,44			66.163.375	9.604,60
MA gewichtet (ohne Externe)				1128				1122	
CO_2-Emissionen / MA (t CO_2/MA)				8,26				8,56	

		2006			
h (L/Jahr) Dienst-	Tonnen CO_2	Pkm/Jahr	Tonnen CO_2	(L/Jahr) Dienst-fahrzeuge	Tonnen CO_2
		8.559.467	1.279,64		
		1.897.806	140,44		
		10.457.273	1.420,08		
		1.199.680	179,35		
		2.399.359	158,36		
		0	0,00		
		3.599.039	337,71		
		14.056.312	1.757,79		
		2.259.505	149,13		
		1.512.112			
		6.915.510			
		46.906.307			
		55.333.929	10.397,73		
		67.084	10,87		
		36.280	0,00		
4.387	10,35			7.088	16,73
4.227	11,16			2.842	7,50
0	0,00	0	0,00	0	0,00
8.614	21,51	103.364	10,87	9.930	24,23
		71.753.110	12.328,88		
		1199,5			
		10,28			

CO_2-Emissionen Verkehr 1999-2003

		CO_2-Emissionsfaktoren	2003		2004		2005		2006	
		VfU (1996) kg CO_2/pkm	Pkm/Jahr	Tonnen CO_2 VfU	Pkm/Jahr	Tonnen CO_2 VfU	Pkm/Jahr	Tonnen CO_2 VfU	Pkm/Jahr	Tonnen CO_2 VfU
1. Berufsverkehr										
	PKW/KRAD	0,32	6.644.299	2.126,18	6.483.364	2.074,68	10.425.000	3.336,00	8.559.467	2.739,03
	ÖPNV	0,147	2.412.883	354,69	2.354.439	346,10	2.275.000	334,43	1.897.806	278,98
	Summe		9.057.182	2.480,87	8.837.803	2.420,78	12.700.000	3.670,43	10.457.273	3.018,01
2. Wochenendheimfahrer										
	PKW	0,32	1.675.966	536,31	1.635.372	523,32	1.122.561	359,22	1.199.680	383,90
	Bahn	0,045	3.264.989	146,92	3.185.906	143,37	2.245.122	101,03	2.399.359	107,97
	PKW/BAHN	0,147	311.472	45,79	303.928	44,68	0	0,00	0	0,00
	Summe		5.252.427	729,02	5.125.206	711,36	3.367.683	460,25	3.599.039	491,87
3. Dienstreisen-Bahn										
		0,045	1.563.613	70,36	1.681.043	75,65	2.053.812	92,42	3.599.039	161,96
4. Dienstreisen-Flug										
	DEUTSCHLAND	0,432	1.651.526	713,46	1.466.360	633,47	1.427.065	616,49	1.512.112	653,23
	EUROPA	0,3037	7.310.258	2.219,76	6.334.074	1.923,34	5.639.854	1.712,54	6.915.510	2.099,89
	INTERNATIONAL	0,1753	47.554.462	8.336,30	40.328.166	7.069,53	40.882.405	7.166,69	46.906.307	8.222,68
	Summe		56.516.246	11.269,52	48.128.600	9.626,34	47.949.324	9.495,72	55.333.929	10.975,80
5. Dienstreisen-PKW										
	mit Dienstfahrzeugen der GTZ	0,32	90.722	29,03	95.200	30,46	92.555	29,62	103.364	33,08
	Dienstreisen MIV-privat	0,32	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.	n.e.
	Summe		90.722	29,03	90.722	30,46	92.555	29,62	92.555	33,08
Gesamt			72.480.190	14.578,80	63.863.374	12.864,59	66.163.374	13.748,43	73.081.835	14.680,71
MA gewichtet (ohne Externe)			1156		1128		1122		1199,5	
CO_2-Emissionen / MA			12,6114182		11,40477727		12,25350579		12,2390259	

Kennzahlen Dienstreisen	1999
Inlanddienstreise (km)	1.810.231
Inlanddienstreise (km) / MA	1.616
Anteil Bahn (km) - Inland	59,16
Anteil Flug (km) - Inland	33,55
Anteil PKW (km) - Inland	7,30
Auslanddienstreisen (km)	53.485.031
Auslanddienstreisen (km) / MA	47.754
CO2-Emissionen Dienstreisen	10.337,95

Emission Factors derived from https://www.atmosfair.de for Indonesia

km	Travel summary	EF (kg CO_2/km)	Type of Aeroplane	EF (kg CO_2/km)
11171	Jakartha - Franfurt (Business)	0,478	Boeing 747-400	0,504
	Jakartha - Franfurt (Economy)	0,307	Boeing 747-400	0,324
5047	Jakartha - Delhi (Business)	0,432	Boeing 747-400	0,416
	Jakartha - Delhi (Economy)	0,277	Boeing 747-400	0,267
2366	Jakartha - Bangkok (Business)	0,423	Boeing 747-400	0,368
	Jakartha - Bangkok (Economy)	0,270	Boeing 747-400	0,237
934	Jakartha - Singapur (Business)	0,407	Standard aircraft	
	Jakartha - Singapur (Economy)	0,268	Standard aircraft	
1033	Jakartha - Bali (Business)	0,445	Boeing 717-200	0,397
	Jakartha - Bali (Economy)	0,290	Boeing 717-200	0,261

Emission Factors derived from https://www.atmosfair.de for Mexico

km	Travel summary	EF (kg CO_2/km)	Type of Aeroplane
9614	Mexico city - Franfurt (Business)	0,474	Standard aircraft
	Mexico city - Franfurt (Economy)	0,305	Standard aircraft
2106	Mexico city - Miami (Business)	0,370	Standard aircraft
	Mexico city - Miami (Economy)	0,237	Standard aircraft
355	Mexico city - Miami (Business)	0,310	Standard aircraft
	Mexico city - Miami (Economy)	0,197	Standard aircraft

Baseline studies for small project categories (source: CERUPT)

Baseline case 2: Mini-grid emission factors for diesel generator systems (in kg CO_{2e}/kWh*) for three different levels of load factors**

Cases:	Mini-grid with 24 hour service	i) Mini-grid with temporary service (4-6 hr/day) ii) Productive applications iii) Water pumps	Mini-grid with storage
Load factors [%]	25%	50%	100%
<15 kW	2,4	1,4	1,2
>=15 <35 kW	1,9	1,3	1,1
>=35 <135 kW	1,3	1	1
>=135<200 kW	0,9	0,8	0,8
> 200 kW***	0,8	0,8	0,8

*) A conversion factor of 3.2 kg CO_2 per kg of diesel has been used (following revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories)
**) Figures are derived from fuel curves in the online manual of RETScreen International's PV 2000 model, downloadable from http://retscreen.net/
***) default values
Source: Reproduced from approved small-scale methodology AMS-I.D under CDM

Stand-alone household applications (off grid)			
Baseline for daily energy consumption between 50-500 Wh/d			
Standardised emission reduction factor (baseline emissions minus project emissions)			
	kg CO_2/ year		
General small renewable household electrification	75 kg/y + 0,8* (daily energy consumtion in Wh/d) kg/y/Wh/d		
Solar home systems	75 kg/y + 4 * (Power in Wp) kg/y/Wp		
Pico hydropower	75 kg/y + 2 * (Installed capacity in W) kg/y/W		
Wind battery chargers	75 kg/y + 350 * D * D kg/y/m², with D = Rotor diameter in m		

Type of Aeroplane
Standard aircraft
Standard aircraft
Standard aircraft
Standard aircraft
Standard aircraft
Standard aircraft
Standard aircraft
Standard aircraft

List of methodologies listed under UNFCCC[1]

Source: http://cdmpipeline.org/publications/CDMpipeline.xls (Data as on 2nd March 2008).

Table 1. Approved baseline and monitoring methodologies

Methodology number	Sectors covered	Number of projects
	Zero emission renewables:	
ACM2 (ver 7)	Grid-connected electricity generation for renewable sources (no biomass)	831
AM26 (ver 2)	Zero-emissions grid-connected electricity generation from renewable sources in Chile or in countries with merit order based dispatch grid	4
AM5	Small grid-connected zero-emission renewable electricity generation	6
AM19 (ver 2)	Ren. Energy project replacing the electricity of one single fossil plant (excl. biomass)	0
	Biomass: (not applicable for non-renewable biomass, EB21)	
AM4 (ver 2)	Grid-connected biomass power generation that avoids uncontrolled burning of biomass	2
AM7	Switch from coal/lignite to seasonal agro-biomass power	0
AM15	Bagasse-based cogeneration connected to an electricity grid	29
ACM3 (ver 7)	Emission reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture	15
ACM6 (ver 6)	Grid-connected electricity from biomass residues (includes AM4 & AM15)	170
AM27 (ver 2.1)	Substitution of CO_2 from fossil or mineral origin by CO_2 from renewable resources in production of inorganic compounds	1
AM36 (ver 2)	Fuel switch from fossil fuels to biomass residues in boilers for heat generation	8
AM42	Grid-connected electricity generation using biomass from newly developed dedicated plantations	0
	Biofuels:	
AM47 (ver 2)	Production of biodiesel based on waste oils and/or waste fats from biogenic origin for use as fuel	0
	Waste:	
ACM1 (ver 8)	Landfill gas project activities	132
ACM14	Avoided methane emissions from wastewater treatment	1
AM2 (ver 3)	Landfill gas capture & flaring with public concession contract (ex-post baseline correction)	1
AM3 (ver 4)	Simplified financial analysis for landfill gas capture projects (no CERs from electricity) (ex-ante correction)	5
AM10	Landfill gas electricity (CERs from electricity)	2
AM11 (ver 3)	Landfill gas recovery with electricity generation (no CERs from electricity)	7
AM12	Biodigester power from municipal waste (only India)	1
AM13 (ver 4)	Biogas power from open anaerobic lagoon waste water treatment systems	9
AM22 (ver 4)	Avoided wastewater and on-site energy use emissions in the industrial sector	21
AM25 (ver 10)	Avoided emissions from organic waste through alternative waste treatment processes	20
AM39 (ver 2)	Methane emissions reduction from organic waste water and bioorganic solid waste using co-composting	23

[1] This list will be updated regularly and requested to follow www.cd4cdm.org and the link suggested above.

Methodology number	Sectors covered	Number of projects
AM53	Biogenic methane injection to a natural gas distribution grid	0
AM57 (ver 2)	Avoided emissions from biomass wastes through use as feed stock in pulp and paper production	0
	Animal waste:	
AM6	GHG emission reduction from manure management systems (on hold)	14
ACM10 (ver 3)	GHG emission reductions from manure management systems	12
AM16 (ver 3)	Change of animal waste management systems	40
	Fossil fuel switch:	
AM8	Fuel switch from coal/oil to natural gas	14
ACM9 (ver 3)	Industrial fuel switching from coal or petroleum fuels to natural gas	10
AM29	Grid connected electricity generation plants using natural gas	36
AM50	Feed switch in integrated Ammonia-urea manufacturing industry	1
ACM3 (ver 5)	Emission reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture	1
ACM11 (ver 2)	Fuel switching from coal and/or petroleum fuels to natural gas in existing power plants for electricity generation	2
	Fugitive emission from fuels:	
AM9 (ver 2.1)	Recovery and utilization of gas from oil wells that would otherwise be flared or vented	17
AM37 (ver 1.1)	Flare reduction and gas utilization at oil and gas processing facilities	6
ACM8 (ver 4)	Coal bed methane and coal mine methane capture and use for power (electrical or motive) and heat/or destruction by flaring	45
AM64	Methodology for mine methane capture and destruction in underground, hard rock, precious and base metal mines	0
AM23 (ver 2)	Leak reduction from natural gas pipeline compressor or gate stations	0
AM43 (ver 2)	Leak reduction from a natural gas distribution grid by replacing old cast iron pipes with polyethylene pipes	0
AM41	Mitigation of Methane Emissions in the Wood Carbonization Activity for Charcoal Production	1
	Energy distribution:	
AM45 (ver 1.1)	Grid connection of isolated electricity systems	3
AM58	Introduction of a new primary district heating system	0
	HFCs, PFCs & SF6:	
AM1 (ver 5.1)	Incineration of HFC23 waste streams from HCFC22 production	19
AM30 (ver 2)	PFC emission reduction from anode effect mitigation at primary aluminium smelting facilities	2
AM35	SF6 Emission Reductions in Electrical Grids	0
AM59	Reduction in GHGs emission from primary aluminium smelters	0
AM65	Replacement of SF_6 with alternate cover gas in the magnesium industry	0
	Cement:	0
ACM5 (ver 3)	Increasing the blend in cement production	37
AM33 (ver 2)	Use of non-carbonated calcium sources in the raw mix for cement processing	6
AM40 (ver 1.1)	Use of alternative raw materials that contain carbonates in clinker manufacturing in cement kilns	1
ACM15		0
	CO_2 capture:	
AM63	Recovered of CO_2 from tail gas in industrial facilities to substitute the use of fossil fuels for production of CO_2	0
	N2O:	
AM21 (ver 2)	Decomposition of N_2O from existing adipic acid production plants	4

Methodology number	Sectors covered	Number of projects
AM28 (ver 4.1)	Catalytic N_2O destruction in the tail gas of nitric acid or caprolactam production plants	16
AM34 (ver2)	Catalytic reduction of N_2O inside the ammonia burner of nitric acid plants	42
AM51 (ver 2)	Secondary catalytic N_2O destruction in nitric acid plants	0
	Energy efficiency, Supply side	
ACM7 (ver 2)	Conversion from single cycle to combined cycle power generation	8
AM14 (ver 4)	Natural gas-based package cogenereation	40
AM48	New cogeneration facilities supplying electricity and/or steam to multiple customers and displacing grid/off-grid steam and electricity generation with more carbon-intensive fuels	0
AM52	Increased electricity generation from existing hydropower stations through Decision Support System optimization	1
AM61	Rehabilitation and/or energy efficiency improvement in existing power plants	0
AM62	Energy efficiency improvementr of a power plant through retrofitting turbines	0
ACM13	new grid connected fossil fuel fired power plants using a less GHG intensive technology	2
	Energy efficiency, own generation (of electricity)	
ACM4	Waste gas and/or heat for power generation	219
ACM12	GHG reductions for waste gas or waste heat or waste pressure based energy system	44
AM24	Waste gas recovery and utilization for power generation at cement plant	11
AM32	Waste gas or waste heat based cogeneration system	2
AM49	Gas based energy generation in an industrial facility	0
AM55	Recovery and utilization of waste gas in refinery facilities	1
	Energy efficiency, Industry:	
AM17 (ver 2)	Steam system efficiency improvement by replacing steam traps and returning condensate	0
AM18 (ver 1.1)	Baseline methodology for steam optimization systems	15
AM38	Improved electrical energy efficiency of an existing submerged electric arc furnace used for the production of SiMn	1
AM44	Energy efficiency improvement projects: boiler rehabilitation or replacement in industrial and district heating sectors	0
AM54	Energy efficiency improvement of a boiler by introducing oil/water emulsion technology	0
AM56	Efficiency improvement by boiler replacement or rehabilitation and optional fuel switch in fossil fuel-fired steam boiler systems	0
AM60	Power saving through replacement by efficient chillers	0
	Energy efficiency, Households:	
AM46 (ver 2)	Distribution of efficient light bulbs to households	0
	Energy efficiency, Service:	
AM20	Water pumping efficiency improvement	0
	Transport:	
AM31	Baseline Methodology for Bus Rapid Transit Project	3
	Afforestation & Reforestation:	
AR-AM1 (ver 2)	Reforestation of degraded land	6
AR-AM2	Restoration of degraded lands through afforestation/reforestation	1
AR-AM3 (ver 2)	Afforestation and reforestation of degraded land through tree planting, assisted natural regeneration and control of animal grazing	1
AR-AM4 (ver 2)	Reforestation or afforestation of land currently under agricultural use	1

Methodology number	Sectors covered	Number of projects
AR-AM5	Afforestation and reforestation project activities implemented for industrial and/or commercial uses	1
AR-AM6	Afforestation/Reforestation with Trees Supported by Shrubs on Degraded Land	0
AR-AM7	Afforestation and Reforestation of Land Currently Under Agricultural or Pastoral Use	0
AR-AM8	Afforestation or reforestation on degraded land for sustainable wood production	0
AR-AM9 (ver 2)	Afforestation or reforestation on degraded land allowing for silvopastoral activities	0
AR-AM10	Afforestation and reforestation project activities implemented on unmanaged grassland in reserve/protected areas	0
	Total	**1974**

This colour means withdrawn

Table 2. Small-scale CDM projects

Project types	Small-scale CDM project activity categories	Number	Methodology number
Type I: Renewable energy projects <15 MW	A. Electricity generation by the user	22	AMS-I.A.
	B. Mechanical energy for the user	4	AMS-I.B.
	C. Thermal energy for the user	162	AMS-I.C.
	D. Renewable electricity generation for a grid	857	AMS-I.D.
	E. Switch from Non-Renewable Biomass for Thermal Applications by the User	0	AMS-I.E.
Type II: Energy efficiency improvement projects <60 GWh savings	A. Supply side energy efficiency improvements - transmission and distribution	1	AMS-II.A.
	B. Supply side energy efficiency improvements - generation	16	AMS-II.B.
	C. Demand-side energy efficiency programmes for specific technologies	15	AMS-II.C.
	D. Energy efficiency and fuel switching measures for industrial facilities	98	AMS-II.D.
	E. Energy efficiency and fuel switching measures for buildings	15	AMS-II.E.
	F. Energy efficiency and fuel switching measures for agricultural facilities and activities	3	AMS-II.F.
	G. Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass	0	AMS-II.G.
Type III: EB27: <60 ktCO$_2$ reduction	A. Agriculture (no methodologies available)	0	AMS-III.A.
	B. Switching fossil fuels	46	AMS-III.B.
	C. Emission reductions by low-greenhouse emission vehicles	4	AMS-III.C.
	D. Methane recovery	209	AMS-III.D.
	E. Avoidance of methane production from biomass decay through controlled combustion	55	AMS-III.E.
	F. Avoidance of methane production from biomass decay through composting	41	AMS-III.F.
	G. Landfill methane recovery	16	AMS-III.G.
	H. Methane recovery in wastewater treatment	58	AMS-III.H.
	I. Avoidance of methane production in wastewater treatment through replacement of anaerobic lagoons by aerobic systems	6	AMS-III.I.

Project types	Small-scale CDM project activity categories	Number	Methodology number
	J. Avoidance of fossil fuel combustion for carbon dioxide production to be used as raw material for industrial processes	0	AMS-III.J.
	K. Avoidance of methane release from charcoal production by shifting from pit method to mechanized charcoaling process	1	AMS-III.K.
	L. Avoidance of methane production from biomass decay through controlled pyrolysis	0	AMS-III.L.
	M. Reduction in consumption of electricity by recovering soda from paper manufacturing process	2	AMS-III.M.
	N. Avoidance of HFC emissions in rigid Poly Urethane Foam (PUF) manufacturing	0	AMS-III.N.
	O. Hydrogen production using methane extracted from biogas	0	AMS-III.O.
	P. Recovery and utilization of waste gas in refinery facilities	1	AMS-III.P.
	Q. Waste gas based energy systems	11	AMS-III.Q.
	R. Methane recovery in agricultural activities at household/small farm level	1	AMS-III.R.
	S. Introduction of low-emission vehicles to commercial vehicle fleets	0	AMS-III.S.
	T. Plant oil production and use for transport applications	0	AMS-III.T.
	Total	**1644**	

Table 3. Afforestation and reforestation category

Project types	Small-scale Afforestation/reforestation CDM project activity categories	Number
AR-AMS1 (ver 4) **<8 ktCO_2 absoption**	Afforestation and reforestation project activities under the clean development mechanism implemented on grasslands or croplands	5

DRAFT

Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ) GmbH

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn/Deutschland
T +49 61 96 79-0
F +49 61 96 79-11 15
E info@gtz.de
I www.gtz.de