Accounting for Greenhouse Gas Emissions in Energy-Related Projects

Applying an Emission Calculating Tool to Technical Assistance

gtz Climate Protection Program

On behalf of
Federal Ministry
for Economic Cooperation
and Development

Imprint

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Executive Summary

Background

The Technical Assistance (TA) projects of GTZ aim to promote sustainable development in a wide range of areas. Climate protection is one of the important themes in international cooperation. The reduction of emissions in host countries is accomplished in TA projects, in general, through policy advice, training and consultancies. These aim to improve the framework conditions for investments in renewable energies and / or energy efficiency. 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 reporting. The approach so far does not include project activities in the field or emissions from the GTZ country offices. It is GTZ´s environmental management policy to apply this approach to country offices and projects in the field. Use of the quantification tool would be on a voluntary basis and these guidelines will serve as the basis for calculation of GHG impacts of TA projects in terms of CO_2e.

Approach

The objective of these guidelines is twofold. First, to develop an approach under Part A to quantify the emissions generated by a project's own activities. Under Part B, many projects promote energy efficiency and introduce the use of renewable energy systems , thereby reducing the levels of GHG emissions. Such projects may be classified as making: ***a direct contribution 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, increasing the flow of investment in the promotion of energy projects, or through enforcing the 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 the emissions caused under Part A, emission factors are needed for specific activities and are sourced from various references. However, the approach followed is unique under Part A. If detailed information related to the 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), as well as 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 data.

These guidelines have been evaluated and tested to investigate and quantify GHGs and to monitor the impact of the TA projects through field tests in Mexico, Indonesia, the Caribbean, Thailand and China. Projects in Jordan, the Solomon Islands and Bolivia were also examined. The procedure for calculating the mitigated emissions (i. e. Part B) is different in each project and only in the case of 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 takes 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 defined energy quantities or CO_2e-related indicators.

The indicators are monitored and evaluated once a year throughout the project's duration. The main task is to translate the results from the quantifiable indicators into GHG emissions, which is possible if energy units are provided by the indicator, i. e. amount of fuel saved or replaced. No additional task is necessary since the project's GHG impact reporting serves as the baseline, and the savings must be provided under the annual reporting for the German Ministry of Development and Economic Cooperation, BMZ. In the absence of indicators, a direct approach would be an alternative option to translate the project's impacts or results into quantity of energy saved or quantity of emissions mitigated. An alternative could be for certain TA projects to use sets of procedures and methodologies developed under the UNFCCC for the Programme of Activities under CDM, wherein climate change mitigation can also be calculated. This is an internationally accepted, standard approach and could be used in the future for evaluating the GHG impacts of GTZ TA projects.

Summary

In summary, the GHG emission savings of a project consist of direct and indirect contributions. The total amount of GHG emission savings is calculated based on an utilisation period of ***10 years*** for the implemented energy systems that 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 basis, and a uniform reporting does not distinguish Part A and Part B estimates. Part A and Part B emissions should 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 of 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 Cooperation aim to promote sustainable development in a wide range of areas. 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 consultancies to improve the framework conditions for investments in renewable energies and/or energy efficiency are the main tasks. Investments – if at all – are 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 reporting. Between 2004 and 2008 emissions were 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. The approach so far does not include project activities in the field or emissions generated by the GTZ country offices.

Approach

The objective of these guidelines is twofold:

1. Develop an approach under Part A to quantify the emissions generated by the project's own activities. Flexibility is permitted 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 to help quantify each emission-producing mode, which may be used in the absence of project data.
2. On the other hand, programmes and projects, especially in the energy sector, can have a positive effect in reducing 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.

The GHG benefit may be classified in two different ways: When project activities result in GHG savings, then activities are considered to be: ***a direct contribution of the project to GHG emission savings***.

If the framework conditions are improved and/or pilot projects are successful, which results in a wider dissemination and replication of the demonstrated technologies and subsequently a much wider climate-change mitigation potential than would be achieved by the direct activities of the project itself, then the impacts can be called: ***an additional indirect contribution of the project to GHG emission savings***. In order to estimate indirect emissions, a relationship between project activity and impact should ideally be established according to the "AURA impact monitoring" concept. (This is a concept of the German TA which focusses 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 TA projects. Examples from field tests in Mexico, Indonesia, the Caribbean, Thailand and China, as well as examples from Jordan, the Solomon Islands and Bolivia are provided. The procedures for calculating the mitigated emissions varies by project, and only renewable energy projects use a standard approach. For all other project activities, individual approaches must 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.

Quantifiable & measurable

Until recently, the climate change mitigation potential of TA programmes and projects has been quantified in many energy-related projects based on targets and indicators, either at the level of the overall project/programme goal or at the level of the individual programme components. The approach of the Framework for Contracts and Cooperation (AURA), with its quantifiable and measurable indicators, establishes a much better starting point to quantify climate change impacts, when compared with the situation a few years ago. The only task for the project manager is to translate the results from the quantifiable indicators into GHG emissions, which is possible if energy units are provided within the indicator (i.e. amount of fuel saved or replaced). No additional tasks are necessary for climate change impact reporting since the baseline and savings have to be established under the annual reporting for the German Ministry of Development and Economic Cooperation, BMZ.

Summary

In summary, the investigations presented herein 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 Part A, which seeks to use the approach of the headquarters and apply uniform emission factors wherever possible. For Part B, a uniform reporting format is suggested with a flexible approach for estimating the climate change impact.

A first attempt to apply the method was made by GTZ in the year 2003. In 2007, a field test of the method was requested, which resulted in a revision of the method in order to make it more user-friendly and compatible with the framework conditions of GTZ energy-related projects.

Alternate approaches

Manuals and approaches by other organisations

In preparation for the method update, a detailed literature review of all existing methodologies for identifying climate change impacts of institutions / processes was carried out. The result of this review was that no better approach can be suggested to fulfil the tasks requested by GTZ for their energy-related projects. Therefore, the proposed procedures remain valid. Two noteworthy approaches are provided by GEF and UNFCCC and 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, as well as financing mechanisms that leverage local private-sector financing. Some of the projects range from capacity-building and technical assistance, to the development and implementation of government policies supporting climate-friendly investments in energy and other sectors. Similar to GTZ programmes, many GEF project activities do not have a direct GHG impact but implementation of these projects would have a significant influence on future projects.

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 applied in GTZ programmes and projects except the utilization periods differ, as GTZ suggests uniform 10 years, whereas energy efficiency projects related to buildings use a 20 year time frame.

b) Direct post-project contribution: GEF projects frequently put in place (financial) mechanisms such as partial credit guarantee facilities, risk mitigation facilities, or revolving funds that will still be operational after the project ends. The emissions, through mechanisms that are supported by GEF, will still be mitigated 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 impacts 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 light of the inaccuracy any indirect contribution will have. Therefore, it is suggested not to use this GEF approach for the indirect emissions calculation, but rather to leave it to the judgment of the individual project manager to describe and judge the indirect contribution of the GTZ program.

UNFCCC

Programmatic CDM by UNFCCC

It is important to first discuss the approach followed under CDM to register projects and receive credits in the form of Certified Emissions Reductions (CERs). In the defined categories and within 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 must explain 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 fulfil the additional criteria defined in the methodology or methodology-related tools.

CDM Programme of Activities

Another recent and interesting approach is the CDM Programme of Activities (PoA), which quantifies the benefit for GHG emission reduction activities, which are added into a programme during a set 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 include elements of policy advice. Hence, the PoA could be used in the future to quantify the climate-change impact of, for example, renewable energy policy interventions and the subsequent additional projects. This approach may serve as an example of how to establish the GHG impact of TA projects, using approved baseline and monitoring methodologies[1]. Possible CDM PoA concepts for a few

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

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 under this category is the distribution of energy-saving light bulbs in India. The target is to replace 80% of incandescent light bulbs, which represents approximately 320 million light bulbs currently used in Indian households.

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

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 Parts A and B, and to present a guideline that helps to establish these figures in a transparent manner, without demanding too much input of resources from the respective project managers. The primary purpose of these figures is to help GTZ report back to BMZ the GHG impact of energy-related TA projects.

Emission Calculations

Determining CO_2 emissions in the project[2].

What are we causing?

To answer this question, there are already a whole series 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.

Emissions from operations

As mentioned above, Part A could be calculated in two ways and the selection is left to the project manager, as it depends on the circumstances. If detailed information related to 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 emissions related to 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 a calculation of the up-stream emissions is desired, then the emission factors would be roughly 20% higher than the current EFs. The data source of the up-stream EF can be derived from the Global Emission Model of integrated systems (GEMIS).

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 EFs 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 sample values that can be used for a project where detailed data are unavailable. The resulting calculation is the total amount of GHG emissions in t CO_2 over one year caused by the project

Most TA projects have caused between 50 and 200 t CO_2 emissions per year. A similar reporting could be done for all GTZ country offices if GTZ plans to estimate the total amount of emissions generated. GTZ´s environmental management system is supposed to be extended to country offices and projects in the field in future. Until that time, application of the quantification method is still used on a voluntary basis.

This part of the guidelines forms the basis for calculation of the GHG impact from TA projects in terms of CO_2e. It can be used to determine 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 emissions 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	
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	19%
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		-	
1.2.2	Airplane – long haul (10000 km), economy class (distance for oneway flight)	P-km/yr	20			10000		0,307		1		61,400	67%
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	
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	2%
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 m^2***	***30-50 m^2***	***50-100 m^2***	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	
1.4.2	With aircondition - Office 02	kWh/m²/yr	250		40			0.8540		1		8,540	12%
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

Determining CO_2 emissions saved through the project[5].

What do we mitigate?

Emissions from implementation

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 up to the project however, still uses 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 between the approach followed in this guideline and the others, such as CDM, is that during the planning stage of the project, certain indicators would be proposed using AURA. Every year, during project implementation (or as required), these indictors are verified against the baseline and impacts are quantified / monitored. It is assumed that an impact would last for 10 years from the time of its implementation. However, in the case of a CDM project under UNFCCC, the emissions savings due to the project vary by 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 the project each year).

Indirect and direct GHG savings

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 project interventions. 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 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. In these cases the GHG emission savings of project interventions are called an ***indirect contribution to GHG emission savings due to project interventions***.

Utilisations period

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, 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 the lifetime of the emissions-reducing technology. 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.

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

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

In general, the approved baseline methodologies of the CDM Executive Board, under the Kyoto Protocol, provide a good guidance on how to quantify GHG emission savings.

To summarise the approach under Part B

Steps to follow

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***							***Total (∑)***
		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: 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/m², 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_2e 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_2e 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 (Σ)*
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 (Σ)*
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
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

(Annexes I and II are available as Excel spreadsheets)

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

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