No.

Project Study on Quantification of Greenhouse Gases (GHGs) Emission Reduction

Final Report

May 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.
SUURI – KEIKAKU Co., LTD.

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Preface

The international community is becoming more conscious of the fact that climate change poses a major threat to the human race and is a global problem that must be tackled urgently by the developed and developing countries working together in unity. Under the present United Nations Framework Convention on Climate Change (UNFCCC) there is no obligation imposed on the developing countries to reduce Green House Gases (GHGs), but under the principle of 'common but differentiated responsibility' the promotion of mitigation strategies in the developing countries, which account for roughly half of all GHG emissions, is becoming ever more important.

This being the situation, in order to promote efforts to contribute both to sustainable development in the developing countries and the reduction/curbing of GHG emissions, in 2007 the Japan International Cooperation Agency (JICA) implemented an investigative study entitled 'JICA's Assistance for Mitigation to Climate Change — The Co-Benefits Approach to Climate Change'. This study reviewed existing JICA projects, principally intended to provide the benefits of development, from the perspective of climate change mitigation strategies, and analyzed those fields of cooperation that contribute to the climate change mitigation strategies, and clarified qualitatively the expected effectiveness of such climate change mitigation strategies.

Meanwhile the Bali Action Plan that was agreed on at the 13th Conference of Parties (COP 13) of the UNFCCC held in December 2007 clearly states the need for 'nationally appropriate climate change mitigation actions by developing country Parties in the context of sustainable development, supported by and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner'. Further, at the Davos World Economic Forum held in January 2008, the then Prime Minister of Japan Mr. Yasuo Fukuda set out the 'Cool Earth Partnership', which is a financial mechanism for the purpose of supporting developing countries in their climate change strategies, and announced aid of approximately $10 billion over the period of the next five years via ODA. For these reasons, it is expected that JICA will not only be required to actively provide climate change mitigation strategy support to developing countries, but will also be required to elucidate the effectiveness of such support in a more objective and quantitative manner.

In view of the above and on the basis of the results of 'JICA's Assistance for Mitigation to Climate Change — The Co-Benefits Approach to Climate Change' mentioned above, from September 2008 the Global Environment Department initiated the 'Project Study on Quantification of Greenhouse Gases (GHGs) Emission Reduction,' targeting in particular technical cooperation (technical cooperation projects and development studies). This Report contains the results of that study.

It is our sincere hope that this Report will be widely read and will be of some help in the planning and implementation of matters relating to the climate change mitigation strategies of the developing countries.

The implementation of the Project Study and preparation of the Report was commissioned to a joint enterprise (representative: Oriental Consultants Co. Ltd) involved in the project study on quantification of greenhouse gases (GHGs) emission reduction, and the study proceeded with the participation and cooperation of very many personnel both from JICA and elsewhere. We would like to express our deepest appreciation to all those who were instrumental in the successful completion of the Study.

May 2009

Kikuo Nakagawa,
Director General, Global Environment Department
Japan International Cooperation Agency

May 2009

Mr. Kikuo Nakagawa
Director General, Global Environment Department
Japan International Cooperation Agency

Letter of Transmittal

Dear Mr. NAKAGAWA:

We are pleased to submit to you the Final Report on the Project Study on Quantification of Greenhouse Gases (GHGs) Emission Reduction. This report is a compilation of the results of the project study carried out between September 2008 and May 2009, and was prepared in accordance with the contract concluded between the Japan International Cooperation Agency (JICA), Oriental Consultants Co. Ltd., and Suuri-Keikaku Co. Ltd.

The Final Report on the Project Study is composed of Main Report and Annex (only in Japanese). The Main Report describes the background leading to the decision to consider quantification of the reduction effect of greenhouse gases (GHGs) in JICA technical cooperation; the approach to quantification; quantification guidebooks for each field; and recommendations. In addition, the Annex contains the results of the review of JICA technical cooperation projects and development studies, as well as the results of a review of existing quantification methodology, field study reports, etc. We hope that the results of this report will be widely referred to and made use of in JICA's global warming mitigation measures, to calculate the reduction effectiveness of greenhouse gases (GHGs).

In submitting this report we would like to express our heartfelt thanks for the support and cooperation we received from JICA Headquarters and related departments, who were extremely supportive, and also from the JICA overseas offices and their counterpart organisations in Laos, Jordan and Turkey, the countries in which the field studies were carried out.

Very truly yours,

Masahiko Fujimoto
Team Leader, Project Study Team on Quantification of Greenhouse Gases (GHGs) Emission Reduction
Oriental Consultants Co. Ltd.

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List of Abbreviations

A/R	Afforestation / reforestation
ACM	Approved Consolidated Methodology
ADB	Asian Development Bank
AFD	Agence Française de Développement
AM	Approved Methodology
AMS	Approved Small-scales Methodology
AR4	Fourth Assessment Report (of IPCC)
AURA	Development-policy framework for contracts and cooperation agreed on between the German Federal Ministry for Economic Cooperation and Development (BMZ) and the GTZ
BCS	Battery Charge System
BM	Build margin
BOD	Biochemical Oxygen Demand
CDM	Clean development mechanism(s)
CDM/JI	Clean Development Mechanism/Joint Implementation
CER	Certified emission reduction
CNG	Compressed Natural Gas
COP	Conference of the Parties
D/D	Detailed design
Defra	Department for Environment, Food and Rural Affairs (UK)
DOC	Dissolved Organic Carbon
EGTT	Expert Group on Technology Transfer
EU-ETS	the European Union Greenhouse Gas Emission Trading Scheme
FOD	First Order Decay
F/S	Feasibility study
GHGs	Greenhouse gases
GIS	Geographic Information System
GPG	Good Practice Guidance
GRT	Gross Tonnage
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit
HFC	Hydro fluoro compounds
IGCC	Integrated Coal Gasification Combined Cycle
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
ITS	Intelligence Transport System
JBIC	The Japan Bank for International Cooperation
JICA	The Japan International Cooperation Agency
J-VER	Japan Verified Emission Reduction
J-VETS	Japan’s Voluntary Emission Trading Scheme
L/A	Loan Agreement
LCA	Life cycle assessment
LNG	Liquefied natural Gas
LRT	Light Rail Transit
LULUCF	Land Use, Land-use Change and Forestry

MCF	Methane Correction Factor
METI	Ministry of Economic, Trading and Industry
MOE	Ministry of Environment
MRV	Measurable, reportable, verifiable
N_2O	Nitrous oxide
NGO	Non-governmental Organizations
NO_2	Nitrogen Dioxide
ODA	Official development assistance
PDCA	Plan, Do, Check, Action
PDD	Project design document
PFC	Perfluoro compounds
PM_{10}	Particulate Matter
PV	photovoltaic
RDF	Refuse Derived Fuel
SAF	Special assistance facility
SF_6	Sulfur hexafluoride
SHS	Solar Home System
SO_2	Sulfur Dioxide
TARAM	Tool for Afforestation and Reforestation Approved Methodologies
TC	Technical cooperation
TOE	Ton oil equivalent
UK	the United Kingdom of Great Britain and Northern Ireland
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USC	Ultra-Super-Critical Thermal Power Plant
VER	Voluntary Emission Reductions
3R	Reduce, reuse and recycle

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CHAPTER 1 Background

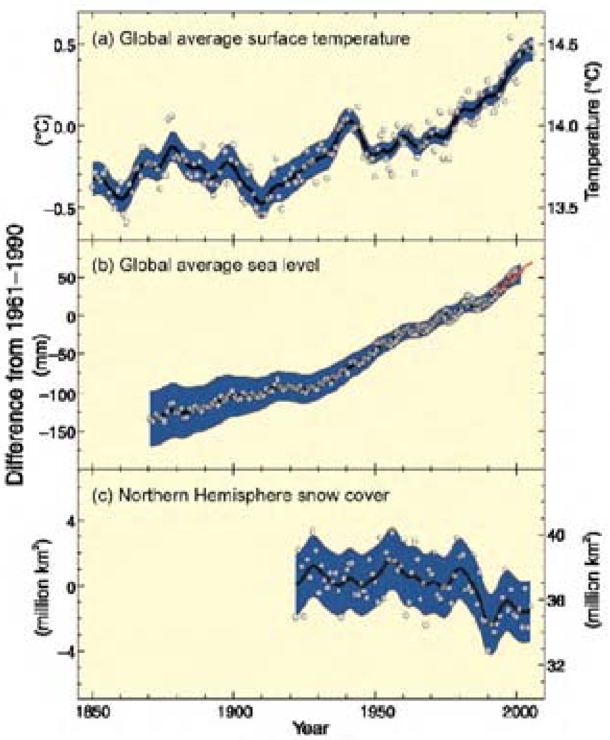
1.1 Necessity to Establish Quantification Methods for GHG Emissions Reduction Estimation

(1) Climate Change and its Effects

The Intergovernmental Panel on Climate Change (IPCC) assertively stated that the changes in climate system are taking place, stating in its Fourth Assessment Report (AR4) that “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.”

According to the Report, eleven of the recent 12 years from 1995 to 2006 were recorded as the warmest years in terms of global surface temperature since records began in 1850. AR4 also concludes this change is consistent with the trend of sea level rise.

Moreover, change in snow cover is also consistent with the global warming trend, and it is reported that mountain glaciers and snow cover have been decreasing on average in northern and southern hemispheres.



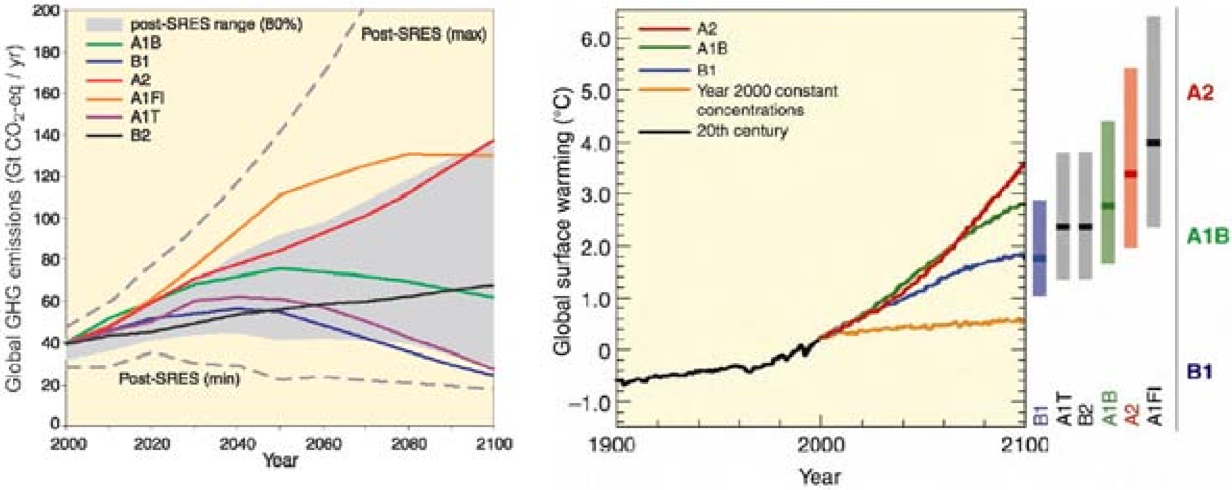
Source: IPCC Fourth Assessment Report (AR4) 2007

Figure1.1.1 Changes in Temperature, Sea Level and Northern Hemisphere Snow Cover

Effects of climate change are widely noticed throughout the world and a wide range of impacts are observed. AR4 also reports the change in precipitation patterns in many parts of the planet: the precipitation trend from 1900 to 2005 shows the amount of precipitation increased in high latitude areas such as the eastern parts of North and South America, as well as northern Europe, while the amount decreased in tropical and subtropical regions such as the Sahel, the Mediterranean, and southern Asia. The total area affected by drought has increased globally since the 1970s, the Report added.

Furthermore, IPCC conclusively identifies the anthropogenic GHG emission increase as a cause of global warming, as expressed in AR4, "Most of the observed increase in globally-averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentration."

IPCC makes a projection of the earth's surface temperature of a rapidly growing society that emphasizes the use of fossil fuels; an increase of about 4 degrees Celsius (raging from 2.4 to 6.4 degrees Celsius) from the year 2000 level is expected by the end of the 21st century. This scenario is projected to produce continuous warm temperatures and heat waves as well as increasing chances of intense precipitation. It is pointed out that this condition will be sustained even if the GHG concentration in the atmosphere is stabilized, as it is expected the warming effect and sea level rise will continue for several centuries.



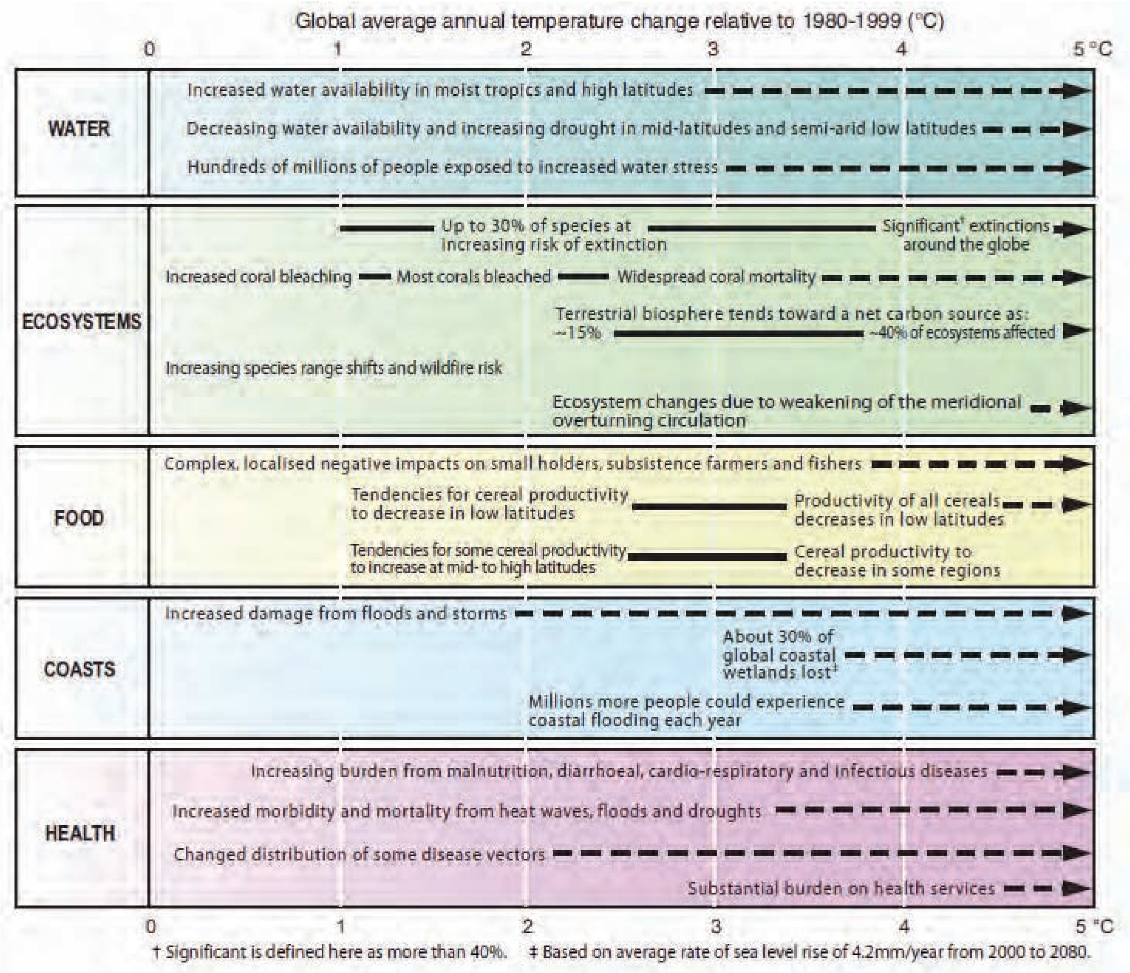
A1FI: A very rapid economic growth society scenario (fossil intensive)
A1T: A very rapid economic growth society scenario (non-fossil energy resources)
A1B: A very rapid economic growth society scenario (all sources balanced)
A2: Heterogeneous society scenario (regionally oriented economic development and politics)
B1: Sustainable development society scenario
B2: Locally sustainable society scenario

Source: IPCC Fourth Assessment Report (AR4) 2007

Figure 1.1.2 Scenarios for GHG Emissions from 2000 to 2100
in the absence of Additional Climate Policies

(2) Climate Change Impacts on Developing Countries

In order for developing countries to respond to climate change and its effects, development and improvement of socioeconomic infrastructures is critical. Developing countries, however, have not taken sufficient measures to cope with climate change and they are regularly suffering a variety of impacts from climate change, notably flood and drought. Main causes for this is that those countries do not have sufficient infrastructures such as general socioeconomic infrastructures, technology, information, financial sources, and management capacity.



NOTE*: *Impacts will vary by extent of adaptation, rate of temperature change and socio-economic pathway.

Source: IPCC Fourth Assessment Report (AR4) 2007

Figure1.1.3 Examples of Impacts associated with Global Average Temperature Change

It is easily predicted that such developing countries will suffer even larger impacts when the changes in climate become more intense in the future. Particularly, people living in an area vulnerable to natural disasters or those who depend on natural resources for their life are impacted by climate change to a greater extent.

If a large number of people are relocated due to the significant change in their living environment caused by such climate change impacts as flood, drought, or sea level rise, it could generate uncertainties in society, which can undermine the human security.

Thus, it is required to assist developing countries. It is effective to make the best use of the financial resources, technologies, and knowledge and experience of developed countries regarding climate change. It is also important to assist developing countries from two climate change control approaches; a mitigation approach to reduce greenhouse gas emissions, and an adaptation approach to enhance adjustment to climate change and its effects.

(3) International Trend in GHG Emission Quantification and Application of Quantification to JICA Projects

The Bali Road Map was agreed to at COP 13, which was held in Bali, Indonesia in December 2007, where measurable, reportable, and verifiable (MRV'able) emission mitigation measures will be examined not only by developed countries but also by developing countries.

It is also indicated that the MRV system should be applied to mitigation measures in developing countries that are "supported by and enabled by technology, financing and capacity-building," and therefore, cooperation activity from developed countries to developing countries is now required to implement the MRV'able measures[1].

The Japan International Cooperation Agency (JICA) recognizes climate change mitigation in development cooperation as a vital issue and conducted a study in 2008 titled "JICA's Assistance for Mitigation to Climate Change — The Co-Benefits Approach to Climate Change." In this study JICA analyzes the existing JICA technical cooperation projects that are aimed for the benefit of the development of developing countries from the aspects of GHG mitigation and analyzes the possibility of the GHG mitigation contribution of each project.

The study qualitatively identifies the mitigation impacts of each project, which are divided into 7 major sectors (Natural Resources and Energy, Forestry and Natural Resource Conservation, Environmental Management, Transportation, Urban Development, Water Resources and Disaster Management, and Agriculture and Rural Development).

[1] "Nationally appropriate mitigation actions by developing country Parties in the context of sustainable development, supported by and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner"

In order to further enhance effective cooperation to developing countries through mitigation projects and to satisfy the international requirement to apply the MRV system to international cooperation activity, it is essential to objectively evaluate the mitigation impacts for JICA projects that can be at present estimated solely qualitatively. [2]

In light of such situation, this Project Study examines the possibility to quantitatively and logically evaluate the mitigation activities taken in the JICA technical cooperation projects from the 7 major sectors mentioned above.

The result of the Project Study is compiled as the "GHG Quantification Guidebook."

[2] The scope of activities to be implemented in an MRV (measurable, reportable, verifiable) manner is broad, and not only mitigation actions related to climate change, but also the technology, financing, and capacity-building supporting them are subject to the scope of activities. Even in the scope of an MRV manner related to mitigation actions, there are wide-ranging views that the developing country can evaluate the reduction activity by methods defined by themselves, and also that the energy intensity achieved as a result of the mitigation actions should be MRV. Further, MRV performance indicators in connection with capacity-building are currently being studied, and candidates include the number of organizations established or supported by the technology transfer, the number of participants in the cooperation program, the number of participants at seminars held, number of successful capacity development activities, etc.
In this project research, within the broad concept of MRV, we focus on the concept that the amount of GHG emissions reduction caused by JICA mitigation actions should be MRV. JICA technical cooperation projects include some fields such as training or dissemination activities, etc., for which quantification of GHG reduction is not easy. However, even if GHG quantification is not possible, that does not mean that the activity does not conform to a mitigation measure from the viewpoint of MRV. For example, (1) the number of organizations established or supported by technology transfer, (2) the number of participants in a cooperation program, (3) the number of participants in seminars held, and (4) the number of successful capacity development activities, etc., in connection with mitigation or adaptation to climate change can be adopted as indices for measurement of MRV.

1.2 Sectors covered in the GHG Quantification Guidebook

The following 6 sectors are covered in the Guidebook;

- Natural Resources and Energy
- Forestry and Natural Conservation
- Environmental Management
- Transportation
- Water Resources Management
- Rural Development

The Urban Development sector is not covered in this Study. Although the project activity in the Urban Development sector contains mitigation measures, it is considered that actual activities that contribute to GHG emissions reduction from this sector will be included in the Natural Resources and Energy sector or the Environmental Management, or Transportation sector.

Also, the Guidebook contains some case studies, which are selected from JICA's technical cooperation projects and development studies.

1.3 Preconditions

(1) Emission Reduction/ Control Measures to be quantified

This Guidebook will cover emission reduction and emission control impacts that are directly and indirectly attributable to project activities undertaken in a project site after the project initialization.

Although some point out the importance of life cycle assessment (LCA) in estimating GHG emissions, which takes into account emissions from procurement, production, consumption, and disposal of raw materials or raw products, this Guidebook does not undertake quantification of emissions from such processes. This is due to various constraints caused by the considerably large volume of data required for quantification, which needs to be obtained through additional study, and also by the unestablished LCA evaluation methodology.

Examples of such emission sources for JICA projects may include emissions from aviation for a preparatory study or emissions from vehicles used at the project area. Likewise, for an activity that involves construction of a pilot plant, for example of a photovoltaic power generation unit or more energy-efficient kitchen stove, it is considered to estimate GHG emissions from production and disposal of such pilot plant facilities; however, such elements will be excluded from the consideration in this Guidebook for the same reasons mentioned above.

(2) Prepare GHG Emissions Reduction Data for both "***With***" and "***Without***" Project Activity Cases

GHG emissions reduction is calculated by subtracting the amount of GHG emissions when the project activity is carried out ("***With***" case) from the amount of GHG emissions when the project activity is not carried out ("***Without***" case).

The amount of GHG emissions is calculated by multiplying the amount of GHG emission activity and the GHG emission factor; and the GHG emission data for these two parameters needs to be obtained both for the "***With***" and "***Without***" project activity cases. It is also critical to calculate emissions for the same time period for both for the ***With*** and ***Without*** cases.

As an example of energy efficiency improvement project of a factory, ["energy consumption" × "GHG emission per unit fuel"] of "***With***" and "***Without***" cases at the time of project completion (or when the energy conservation facility is introduced) are calculated and the difference between the two cases constitutes a GHG emissions reduction.

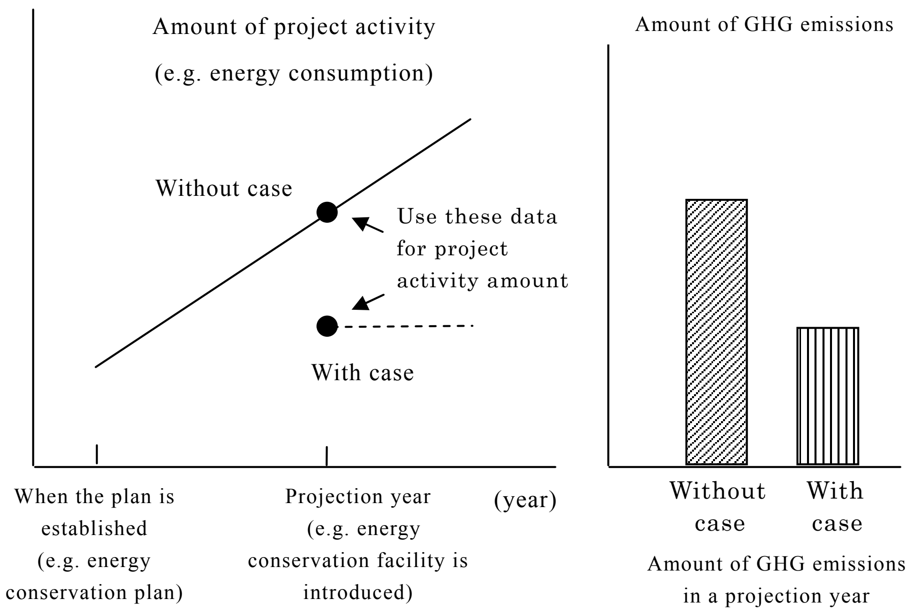


Figure 1.3.1 Example of GHG Emissions Estimation

(3) Use Data calculated/ estimated at the Time of Project Planning

This Guidebook is prepared with emphasis on identification of the method to calculate GHG emissions reduction in a simple manner." In line with this principle, the Guidebook assumes that the study result, such as a baseline study, is directly used as an input to calculate GHG emissions reduction, which can avoid additional study to obtain the further data necessary for emission reduction calculation. Also default values are applied for some of the specific parameters such as the CO_2 emission factor of fuel.

Similarly, data and information obtained during the operation and study stage of the project will be principally used for calculations for the data that affects the amount of GHG emission activity, such as the country's economic condition and policies/ regulations that need to be taken into account in calculation.

1.4 How to Use the Guidebook

This Guidebook is presented as a tool to determine whether an activity within each sector can be qualitatively assessed for its GHG emission reduction impacts, and it also acts as an effective tool that allows users to search for the activity's quantification methods and required data for that quantification.

Users can follow the following steps to use the Guidebook.

Step 1:

Users refer to the table titled "Components of GHG emission reduction activities" presented in the each section and check the GHG emission reduction activities titled "GHG reduction components" contained in major project examples of each sector.

In the schematic titled "Quantification possibility of each component", users can check, by GHG emission reduction activity, whether the project activity will lead to GHG emissions reduction, and how and why it will/ will not lead to reduction.

Users then check the "**Quantification Sheet**" of the corresponding activity to check the detailed quantification methods. Some project activities are presented with their case studies, in which actual project information and data are used as inputs to the **Quantification Sheet**.

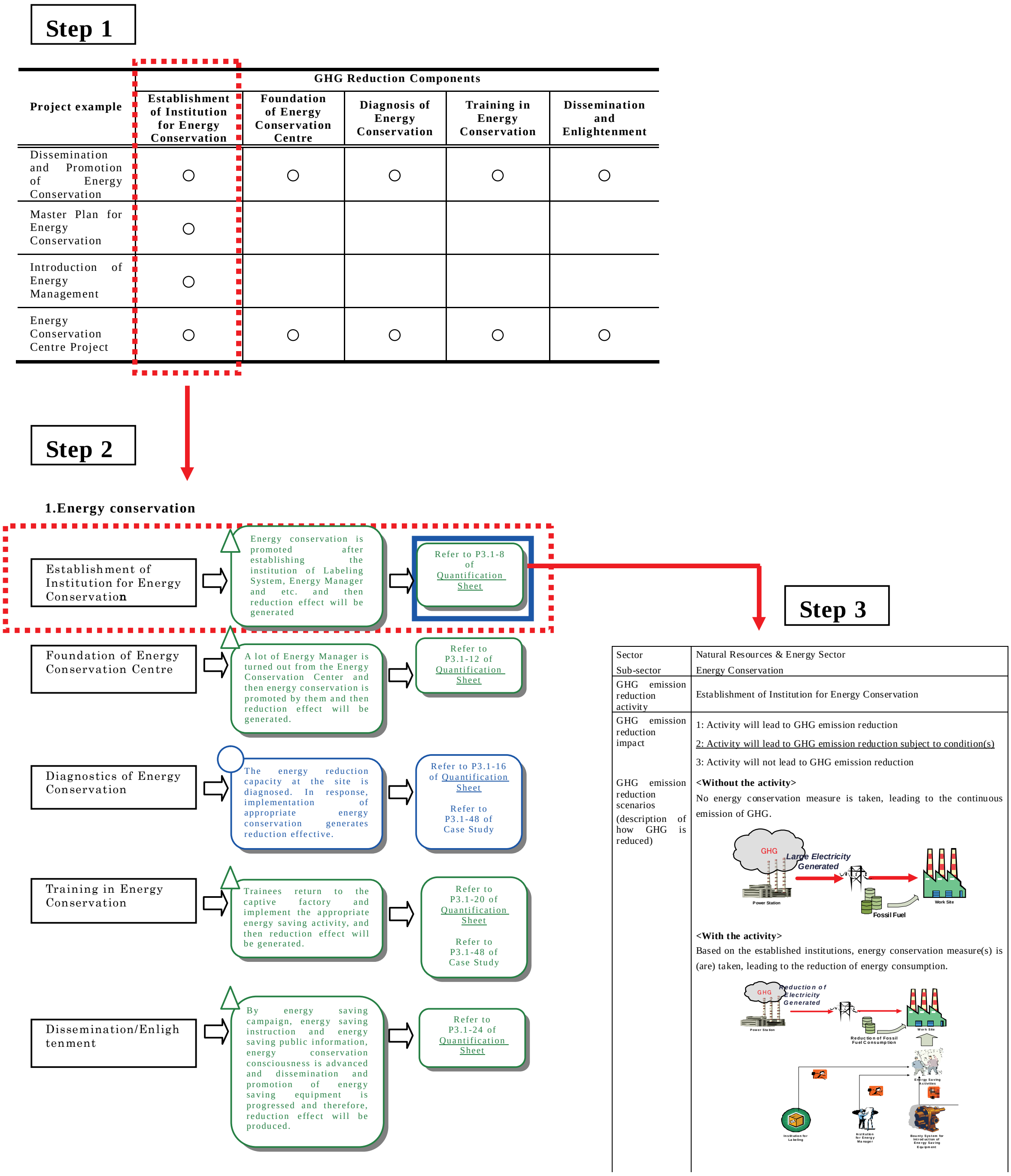
Step 2:

Users refer to the **Quantification Sheet** where users can check the GHG emission reduction scenarios, detailed quantification methods and required data for calculations, as well as preconditions and special notes related to the quantification.

Users can also refer to case studies for some of the projects, in which actual project information and data are applied in the **Quantification Sheet**.

Step 3:

Users carry out quantification by applying the quantification methods presented in the corresponding **Quantification Sheet**.



CHAPTER 2 Concept of GHG Emissions Reduction Quantification

2.1 Quantification of GHG Emissions Reduction

"Quantification of GHG emission reduction impacts" represents quantitative estimation of the amount of a certain GHG emission source*[1] that is reduced by a certain GHG emission reduction activity (for example, an activity that involves the introduction of an energy conservation facility into a factory: defined in this Guidebook as "With project" or "With scenario"), compared to the case where the said activity is not undertaken (for the above example, the said energy conservation facility is not introduced into the said factory: defined in this Guidebook as "Without project" or "Without scenario").

Quantification of GHG emissions reduction is generally undertaken in the following processes:

(1) Identify a GHG emission sources that are reduced by a GHG emission reduction activity
(2) Identify the details of a GHG emission reduction activity (With scenario)
(3) Identify the "Without scenario": situation where the GHG emission reduction activity is not undertaken *[2]
(4) Calculate the amount of GHG emissions from GHG emission sources for the "With scenario"
(5) Calculate the amount of GHG emissions from GHG emission sources for the "Without scenario"
(6) Deduct the amount of GHG emissions for the "With scenario" from that for the "Without scenario." If the value is positive, it can be concluded that the activity has a GHG emissions reduction impact, the yielded value representing the amount of GHG emissions reduction.

The above processes can be converted into the following equation:

Amount of GHG emissions reduction = GHG emissions for Without scenario − GHG emissions for With scenario

Relationship between GHG emission amount from the Without scenario, that from the With scenario, and GHG emissions reduction amount can be illustrated for three different scenarios as shown in the figures below.

*[1] In the case of a GHG removal activity, the term "source of removal" is used instead of "source of emission." "Amount of GHG removal" instead of "amount of GHG reduction" and "GHG removal impacts" instead of "GHG emission reduction impacts" are used likewise.
*[2] "Without scenario" is called a "baseline scenario" in CDM. Identification of a baseline is one of the most important processes of CDM project activity.

Case 1: GHG emissions for the Without scenario increase over time and a GHG emission reduction measure is taken to rectify that situation. Many cases in developing countries can be applied to this case.

Case 2: GHG emissions for the Without scenario remain constant and a GHG emission reduction measure is taken to reduce that amount.

Case 3: GHG emissions for the Without scenario decrease but a GHG reduction measure is taken to reduce emissions further. This case can be applied to the situation in ambitious developed countries.

As described above, quantification of GHG emission reduction impacts needs to be undertaken in accordance with a certain process and also taking into account GHG emission sources and characteristics of a GHG emission reduction activity.

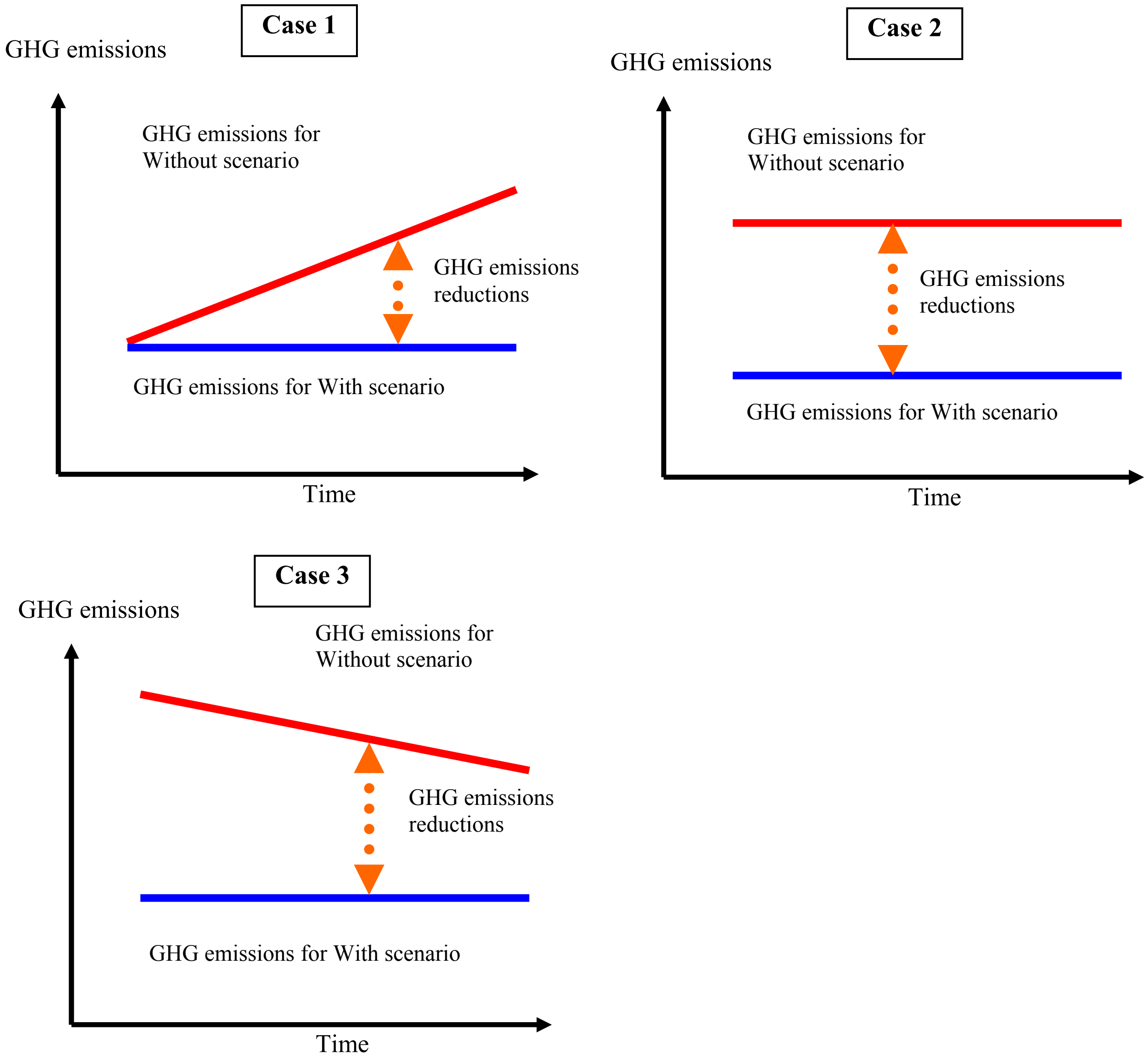


Figure 2.1.1 Typical GHG Emissions Reduction Cases

2.2 Works Implemented by JICA in the Past

Just after this project study started, the former JICA (Japan International Cooperation Agency) which was in charge of technical cooperation and a part of a grant aid, and the former JBIC (Japan Bank for International Cooperation) which was in charge of the loan were integrated. Both of the organizations independently implemented their works on GHG quantification.

(1) Works Implemented by the former JICA

Even though the former JICA has not systematically implemented the quantification of GHG emissions reduction in its technical cooperation projects and development studies, GHG emissions reduction were quantified voluntarily for the project, "The Acid Deposition Control Strategy in the Kingdom of Thailand".

Where after the Kyoto Protocol came into effect in February 2005, and JICA had implemented some ODA studies on the measures against Climate Change as CDM projects, one of the Kyoto Mechanisms, which was activated gradually.

Especially, it is considered that the CDM should have relation with and cooperation from JICA because the CDM aims to assist the developing countries in achieving sustainable development as well as for developed countries to obtain CER (Certified Emission Reduction) by jointly implementing projects. Therefore, JICA published the report titled "JICA's Assistance and the Clean Development Mechanism (CDM) – How JICA can confront the CDM?" in July 2006, and investigated the potentials and directions on how JICA can participate in and contribute to the CDM as a technical cooperation implementing organization of Japanese ODA. As a result, JICA as the facilitator of the CDM, and practical approaches were summarized in two points as follows.

1. Capacity development of stakeholders in developing countries to establish/ improve necessary conditions and systems
2. Introduction of a new point of view of regarding CDM to conventional projects by JICA

The measures against Climate Change were divided into two major categories of mitigation measures which will reduce GHG emission and stabilize ambient GHG concentration, and the adaptation measures which will change social and economic systems to adapt to climate change and the associated increase of temperature and sea level.

Even if various efforts for mitigation are quickly undertaken, it is expected by some that immediate stabilization of climate will be very difficult and impact upon the globe to a certain extent will be inevitable. Especially, adaptation measures for the poor in developing countries who are vulnerable to climate change, is important. From this viewpoint, the potentials and directions on adaptation measures in various sectors were summarized in the report, "JICA's Assistance for Adaptation to Climate Change".

On the other hand, CDM projects were expanded recently, but it becomes clear that there is a limitation on promoting of sustainable development in developing countries only by CDM projects. Then, the co-benefit approach, which aims to contribute to sustainable development in developing countries together with mitigation measures to reduce climate change, is revealed to the public. JICA published the report, "JICA's Assistance for Mitigation to Climate Change – The Co-Benefits Approach to Climate Change", in June 2008. In the report, JICA analyzed examples of approaches from development to mitigation measures to climate change and investigated the potentials in various sectors such as natural resource and energy, forestry and natural resource conservation, environmental management, , transportation, urban development, water resource and disaster management, agriculture and rural development. As a result, consideration of the necessity of climate benefit quantification, in other words, GHG emissions reduction quantification was described and this project study was included in the series of the ODA studies.

(2) Works Implemented by the former JBIC

The former JBIC was in charge of loans, and also implemented software components as a part of infrastructure development and study called SAF (Special Assistance Facility), but the major tasks of JBIC were infrastructures development. Recently, the ratio of loans related to the environment has increased.

The former JBIC established an evaluation mechanism for loan projects using PDCA cycles (Plan > Do > Check > Action). Preliminary evaluation is implemented during the appraisal phase, and a follow-up evaluation is implemented two years after project completion. GHG emissions reduction was evaluated in some examples of preliminary and follow-up evaluations. The examples of the preliminary evaluation are the project, "Xinjiang Uygur Autonomous Region Yining City Comprehensive Environmental Renovation Project (II)" with L/A in year 2007, and the example of the follow-up evaluation is the project, "Promotion of Electricity Energy Efficiency Project" with completion of loan disbursement in year 2002.

Two reports on GHG emissions reduction quantification in electricity and transportation (urban railway) were made in August 2008.

"Guideline Study on Project Formation of Climate Change Measures in Electricity Energy"

"Study on CO_2 Reduction Effect accompanied with Urban Railway Development"

a. Electricity Sector

Regarding GHG emissions reduction quantification methods in the electricity sector, a simplified version of CDM approved methodologies such as ACM0002 were applied, particularity taking into account the JBIC loan projects. As a result, the methods in the report have come into the same line as the ones in this project study, and the methods in the report can be also used.

The major differences from the CDM methodologies are as follows.

- Build margin in the CDM methodologies is not considered.
- The grid in the whole country is targeted.
- High priced electricity sources are preferentially replaced.

b. Transportation Sector

GHG emissions reduction quantification in the transportation sector, especially in urban railways is implemented by subtracting the emission "with" construction of railway from the one "without" the construction.

The quantification included calculations such as construction and maintenance works etc. from the life cycle assessment (LCA) viewpoint, but major GHG reduction was attributed to fuel consumption reduction with substitution of railway transport for road travel. Substituted vehicle kilometres from road use to railway use were expected to be estimated in the feasibility study at the appraisal phases in certain levels, and the quantification methods were described according to the estimation levels.

The quantification methods proposed in the report are similar to the ones in this project study.

2.3 International Works on GHG Emissions Reduction Quantification

(1) Methods of GHG Emissions Reduction Quantification under UNFCCC

a. IPCC guidelines

The IPCC guidelines were published in 1995, 1996, and 2006, the Good Practice Guidance (GPG and GPG-LULUCF) were published in 2000, 2003 and the Revised 1996 IPCC Guideline for National Greenhouse Gas Inventories is mainly used at present because it was decided that the revised 1996 guideline should be used during the first commitment period of the Kyoto Protocol. In this meaning, the revised 1996 guideline was the first international GHG emissions quantification method.

It was decided that the 1996 revised IPCC guideline should be used during the first commitment period of the Kyoto Protocol, and the guideline consists of three volumes as follows;

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories

Volume 1 Reporting Instructions
Volume 2 Workbook
Volume 3 Reference Manual

The details of GHG emissions quantification are described in the volume 3, as six sectors such as "1 energy, 2 industrial processes, 3 Solvent and other product use, 4 Agriculture, 5 Land-use change and forestry, and 6 Waste" are included.

Simple method (Tier 1) and detailed methods (Tier 2 and Tier 3) are prepared for GHG emissions quantifications in each category, and default values can be basically used for GHG emissions calculation in Tier 1 cases. Local data in the target country are used in Tier 2 cases, and models and GIS are used for Tier 3 calculations.

This guideline by IPCC originally aims to estimate GHG emissions at the national level, but project-based emissions can be calculated using the following methods.

The CDM methodologies sometimes use the default values of the IPCC guideline for the quantification of GHG emissions, and the IPCC guideline covers all sectors because the aim of the guideline is to estimate national GHG emissions.

b. CDM methodologies

The Kyoto Protocol was adopted in 1997, but we had to wait until 16th February 2005 for the Kyoto Protocol to come into effect. However, CDM projects were admitted after year 2000 and the methodology, “Incineration of HFC23 Waste Streams” (ACM0001) was approved as the first approved methodology at the 10th CDM Executive Board meeting on 29th July 2003.

After that, more than 100 CDM methodologies were approved, including 56 large-scale, 14 consolidated, and 40 small-scale methodologies). The CDM methodologies target project-based GHG emissions reduction as differences between baseline scenario and project scenario, which is completely in line with objective of this project study.

The CDM methodologies tend to be considered complicated and the process takes much time for approval of the projects, much of the discussions during the approval processes related to the demonstration of additionality while almost all of quantification methods of GHG emissions reduction are logical.

The applicability of approved CDM methodologies to JICA project activities were examined in comparison between the categories of CDM methodologies and those of JICA projects.

The CDM methodologies of the activities such as renewable energy, energy conservation, recovery and usage of waste gas/heat, and fuel switch correspond to the activities in the JICA projects of the natural resources and energy category, and the number of the methodologies is more than 70.

The CDM methodologies that correspond to the JICA projects for environmental management are mostly categorized as methane emission avoidance and methane recovery and usage, and the methodologies are considered to be used in waste management projects and a part of water environment projects. Adding to this, the methodologies of energy conservation, fuel switch and biomass usage are also considered as applicable.

The JICA project categories of agriculture and rural development and urban development coincide with natural resources and energy, the methodologies of renewable energy and energy conservation may be applicable.

On the other hand, very few methodologies are applicable for JICA project activities in the transportation sector and there are no applicable methodologies to JICA project activities in the water resource and disaster management sector or the forestry and natural resource conservation sector.

Table 2.3.1 Categories of CDM and JICA Project Activities

Categories of CDM Project Activities
Methane recovery and usage
Methane emission avoidance
Waste gas and heat recovery and usage
Fuel switch
Fuel change
Raw material change
Renewable energy
Energy conservation
Biomass usage
HFC emission reduction
N_2O emission redcution
PFC emission reduction
SF6 emission reduction
Bio-fuel
Transportation

Categories of JICA Project Acitivities
Forestry and natural resource conservation
Environmental management
Natural resources and energy
Transportation
Urban development
Water resources and disaster management
Agriculture and rural development

(2) Various Methods of GHG Emissions Reduction Quantification

a. GEF

The manual on GHG emissions reduction made by GEF in April 2008 was referred to by the guideline of GTZ mentioned later, and the World Bank follows the manual for projects except CDM projects. The proposed methodology on direct/ indirect emissions reduction for JICA projects in the next section, takes the concept of this manual of GEF as reference.

The GEF project divided the GHG reductions into the following three categories.

Direct GHG emissions reduction: the GHG reduction induced by investment during the project implementation period.

Direct post-project emissions reduction: the GHG reduction induced after the project period by the finance mechanism established in the project. For example, a revolving fund was established during the project, and GHG emissions reduction was implemented with the re-investment of the recovered fund. The quantification method used for these direct GHG emissions reduction uses similar methodology to CDM methodology.

Indirect GHG emissions reduction: estimated with a bottom-up approach or top-down approach. The replication of the investment achieved during the project assumes after the project for the bottom-up approach. In the top-down approach, the maximum potential of GHG emissions reduction due to the technology of the project was estimated, and then subsequently, the actual GHG emissions reduction during the 10 years following the completion of the project were monitored and recorded taking into consideration the extent of the impact of the GEF project.

GEF has the concept of incremental cost, and GEF grants cover the additional cost difference associated with transforming a project with national benefits into one with global environmental benefits. Simplified guidelines for calculating incremental costs are being developed.

b. GTZ

GTZ has been formulating the draft Guideline for Calculating GHG Emissions: "Mitigating Climate Change with Energy-related TC Projects – Guidelines for Calculating GHGs Emission Impact (draft)".

In this draft guideline, the GHG emissions related to the project implementation are estimated in Part A, and the GHG emissions reductions targeted in this project study estimated in Part B are divided into direct reduction and indirect reduction (policy recommendation etc.).

GTZ does not intend to insist the GHG emissions reduction estimated as GTZ's credit, but the purpose is to estimate both of the impacts in Part A and Part B, and provide the guideline with which these values can be quantified in a transparent manner without excessive load to each project manager.

In the approach in Part B, indicators and baselines are identified based on the study under the project, and the identified indicators are translated using the CDM methodologies, the 2006 IPCC guidelines, or any suitable approach developed under the project. Furthermore, the emission factors are obtained from the PDD documents of recent CDM/JI projects, calculations using the "Tool to calculate the emission factors for electricity system," or 2006 IPCC guidelines. The project duration period is uniformly set at 10 years with some exceptions.

In the GTZ draft guideline, depending on indicators set based on the implementation policy of GTZ project called AURA, the GHG reduction quantification involves solely conversion from the indicators into GHG reduction amount. For example, a certain amount of quantitative indicators such as one million tonnes of coal consumption reduction is mentioned as a target of the project. Furthermore, achievement of the target will be monitored and verified during and after the project.

In the other case study in the GTZ guideline, baseline of annual increase in PV (photovoltaic) area sizes is set before a PV dissemination project, and GHGs reduction amount is calculated by subtracting baseline PV area sizes from the actual PV area size increase.

c. World Bank

Around 1994, the World Bank and the other institutions issued some documents on GHG emission quantification, and quantification of GHG emissions reduction was implemented. And the World Bank published the Greenhouse Gas Assessment Handbook in 1998 and tried to estimate the GHG emissions at the preliminary stages of projects.

The methods in the handbook followed the methods and data in 1995 IPCC Guidelines for National Greenhouse Gas Inventories. The IPCC guideline was made in order to estimate national level GHG emissions from the beginning, and the methods and data were applied to each project.

The World Bank applies CDM methodologies for the project activities to obtain CERs, and uses the GEF manual for other projects.

Adding to the above, the World Bank is involved in 8 A/R-CDM methodologies and 19 methodologies in other sectors, and 4 methodologies from each A/R and other sectors were registered by 1st March 2009. The World Bank focused on CDM project development applying the CDM methodologies. Besides A/R CDM, the number of methodologies related to energy conservation of supply-side, distributions comes to 10.

d. Other Agencies

- USAID provides GHG emissions reduction quantification methods on its website in simplified and detailed versions for energy and forest sectors. A calculator on its website allows users to input, for example, data on fuel reduction amount or size of forest cover into the simple calculators, emission factors by regions and activities are automatically calculated and the GHG reductions are also presented. The detailed methods use GHG protocol and TARAM manual.

- The Asian Development Bank estimates GHG reductions only for the projects that have the possibility to be a CDM project activity.

- GHG protocol analyzed the methodologies for GHG emissions reduction quantification not depending on certain system. Because GHG protocol is not related to a certain system, evaluation level seems to differ from the other methods or protocols.

- Gold Standards which is said to be the most reliable within the VERs (Voluntary Emission Reductions), approved original methodologies, but just two methodologies have been approved to date, one for bio-digesters and one for cooking stoves.

- ISO14064 establishes a framework for GHG emissions reduction quantification, but does not propose practical calculation methodologies.

- Defra (Department for Environment, Food and Rural Affairs) of UK decided methodologies for GHG emissions reduction quantification for the UK emission trading system. The methodologies are used in the UK, and utilize domestic electricity emission factors. Guidelines for monitoring and reporting for EU–ETS were prepared.

- UNEP also made a guideline for GHG emissions quantification in 2000, and proposed methodologies for energy, transportation and industrial processes and some default emission factors.

- In Japan, some methodologies for GHG emissions reduction quantification are proposed for JVETS (Japan's Voluntary Emission Trading Scheme) and JVER (Japan Verified Emission reduction) used for carbon offset by the MOE (Ministry of Environment), and domestic CDM implemented by the METI (Ministry of Economic, Trading and Industry).

- Various domestic and international organizations and groups provide carbon calculators related to "Carbon Offset," including Defra of UK, Carbon Footprint Ltd., Carbon Fund (NGO), airline companies, and automobile manufacturers etc.

- AFD Carbon Footprint was developed for preliminary evaluation of GHG emissions. It consists of two tools, "GHG emissions analysis tool for development project" and "Vulnerability analysis tool for future by climate change impact".

(3) Why are CDM Methodologies and IPCC Guidelines applied?

As stated in (2) above, many organizations are making efforts towards quantifying GHG emissions and the amount of their reductions, but the scope, assumed conditions, calculation methods, etc., differ.

Of these methods, the most widespread method adopted internationally for quantifying reductions in GHG on a project basis is the CDM methodology. The number of registered CDM projects using the CDM methodology exceeds 1,500, indicating the large number of actual registered projects, in other words the large number of case studies. Moreover, the CDM methodology has a high level of reliability from the viewpoint of transparency and accountability as a result of being debated on a public forum as part of the process of being registered with the CDM Executive Board. For the JICA project classifications, it is possible to quantify GHG emissions by applying a part of the CDM methodology or the IPCC guidelines for "transportation" for which the corresponding CDM methodology is limited, and, for "water resources and disaster management" and "forestry and natural resource conservation" for which it is considered that there is no direct corresponding CDM methodology.

On the other hand, the CDM methodology was developed and approved for the purpose of verification of CDM projects, so there are the problems of uneven distribution of fields, as the methodology has not been developed for fields where there is no need for CDM projects, and a lot of time and money is required to obtain approval of a CDM methodology.

The most widely used method for calculating GHG emissions at the national level, rather than on the project level is the IPCC guidelines. The purpose of the IPCC guidelines is the calculation of

GHG emissions for individual countries, so the IPCC guidelines themselves do not include a process of assuming a baseline scenario, but in order to calculate the GHG emissions for a country as a whole, the calculation method encompasses almost all fields. Also, to deal with the capability of obtaining data and the status of applicable activities, selection options are provided ranging from the simplest Tier 1 to the complex Tier 3.

The difficulty of verification of additionality for CDM projects creates the impression that the methodology itself is difficult, but simple methods are used for quantifying GHG reductions. It is considered that the uneven distribution of fields can be resolved to a certain extent by combining the use of the IPCC guidelines.

This project study quantified the GHG emissions in accordance with the CDM methodology and the IPCC guidelines taking into account that many GHG quantification methods in the world are based on the CDM methodology, and the IPCC guidelines.

Table 2.3.2 Comparison of GHG Emissions Reduction Quantification Method

	GHG Quantification Method	Description
1	IPCC Guideline	GHG quantification method for emissions of national-level, and covers whole sectors
2	CDM Methodology	Project-based quantification method of GHG emissions reduction, many projects approved using the approved methodology, highly reliable
3	GEF Manual	Similar quantification methods of GHG emissions reduction with CDM methodologies are adopted.
4	GTZ Guideline	CDM methodologies and IPCC guidelines are mainly adopted.
5	World Bank	CDM methodologies for CDM projects and follow GEF manual for the other projects
6	USAID	Simple calculators and detailed versions adopt GHG protocol and TARAM manual.
7	Asian Development Bank	CDM methodologies are adopted for CDM projects.
8	GHG Protocol	Methodologies for GHG emissions reduction quantification not related to certain system
9	Gold Standard	Original methodologies for GHG emissions reduction quantification
10	ISO 14064	Definition of framework for methodologies for GHG emissions reduction quantification

2.4 Quantification Concept for Technical Cooperation

(1) Background to Quantification

As stated previously, various aid agencies are undertaking GHG quantification, but most aid agencies do not have GHG quantification methods for technical cooperation, and only GEF has issued a manual for energy conservation and renewable energy, which was done in April 2008. GTZ is currently preparing draft guidelines (energy conservation, renewable energy) based on the GEF manual.

At the present time each aid agency is in the process of preparing manuals and guidelines for quantifying GHG reductions, but they are still in the initial stage, starting from the "energy conservation, renewable energy" sector, in which quantification is simplest.

(2) Concepts of Quantification

a. Direct / Indirect Reductions

Aid agencies including JICA are investigating the question: "what is the scope that should be counted as reduction effects due to the implementation of a project? ". In most cases, the "direct reduction effects" due to activities within a project during the project period in the project area are counted (project purpose level of a technical cooperation project). The reduction effects due to activities outside the project area after completion of the project are also counted as "indirect reduction effects" (overall goal level of the technical cooperation project). The project reduction effects include both the direct effects and the indirect effect.

For example, in the GEF manual, if a pilot project or demonstration project was carried out during the project period, the GHG emissions reduction by operation of a demonstration plant would be considered to be "Direct GHG Reduction", and other reduction due to the independent effort by the developing countries using the outcomes of projects would be "Indirect GHG Reduction".

JICA's technical cooperation have the objectives of capacity development or technology transfer to developing countries, so the direct reduction effects are limited to pilot projects for afforestation and other non-revenue water countermeasures that are carried out during the project period. On the other hand, the proportion of indirect reduction effects due to independent efforts by the developing country after completion of the project by using the transferred technology is large. Therefore it is necessary to count these effects of indirect reductions as one of the impacts of "reduction due to the implementation of the technical cooperation".

For example, in technical cooperation project for a non-revenue water control project, if a non-revenue water control pilot project is implemented in a pilot site of project area during the project period, the GHG reduction is calculated by multiplying "non-revenue water reduction amount due to the pilot project" by "quantity of electricity used per unit of water supplied" by

"GHG emission factor for electricity". It will be counted as the "direct effect". After completion of the project (or during implementation of the project), if the quantity of non-revenue water is reduced in areas outside the pilot site by using the non-revenue water control technology transferred in the project, the GHG reduction due to the reduction of non-revenue water would be taken to be an "indirect effect".

At the present time, the details of quantification of indirect reduction effects is being studied, and the only integrated calculation method that has been proposed is the GEF manual, but even that is only provisional, and GTZ is preparing a provisional version based on the GEF manual.

The method of estimating indirect reduction in the GEF manual is based on the direct reduction. Using the existing calculation methods in the CDM methodology, the "direct reduction" is calculated by multiplying the amount of energy reduction by the GHG emission factor, and the "indirect reduction" is calculated by multiplying the "direct effect" (for example, the amount of GHG reduction in the pilot project), by a certain enlarging factor (for example, the dissemination ratio).

In this Guidebook, the direct effect and the indirect effect for each project scheme type (technical cooperation project, development study) were studied, with reference to the GEF manual, etc. The results of this study are as follows.

In the following, one way of thinking about the method of calculating the direct effect and the indirect effect is given, but it is not proposed as an integrated method of calculation for JICA as a whole. It should be noted that appropriate further detailed studies are necessary based on the concept of this Guidebook.

b. Development Study

In the development study, GHG emissions reductions achieved by pilot projects, demonstration projects, or the construction and operation of demonstration plants during development study are calculated as the "reduction achieved by the JICA technical cooperation(direct reduction)". In addition, the amount of reduction expected due to the achievement of the target values of the activities proposed in a master plan is taken to be an "expected reduction".

Of the expected reduction, the amount of reduction due to activities (for example, construction of semi-aerobic landfill site, etc.) realized through financial assistance such as grant aid, ODA loan, etc., or Japanese technical cooperation is taken to be a "direct effect", and the amount of reduction due to the developing country's independent efforts or other donors is taken to be an "indirect reduction".

For example, consider the case that a comprehensive waste management plan is produced in a development study.

When the master plan is formulated, the expected reduction is calculated assuming that the target values of the activities that will contribute to GHG reductions, such as improvement of collection, promotion of 3R activities, improvement of final disposal sites, etc., are all achieved.

In the implementation stage of the master plan, if a feasibility study (F/S), detailed design (D/D), etc., are implemented, and if finally, for example, a semi-aerobic landfill site is constructed and operated through Japanese Government funding or Japanese technical cooperation, and if its effects are quantitatively monitored, the GHG reduction due to this final disposal facility is calculated as "reduction due to the implementation of the project (direct reduction)".

Also, if activities are implemented that are the same as proposed in the development study (for example, construction of final disposal site, introduction of more effective waste collection system, introduction of recycling or composting, etc.) through other donors or the developing country's independent efforts, and if their effects are quantitatively monitored, the GHG reduction due to these activities is calculated to be "reduction due to the implementation of the project (indirect reduction)".

Table 2.4.1 GHG Emissions Reductions in Development Study

Preliminary Study	Development Study (in process of master plan formulation)	Development Study (after pilot project completion)	Implementation of Master Plan	Remarks
	Expected Reduction			Amount of reduction expected due to the achievement of target values of activities proposed in a master plan
		Reduction achieved by the JICA technical cooperation (Direct reduction)	Reduction due to the implementation of the project (Direct reduction)	Implemented in JICA project or by Japanese governmental fund or technical cooperation
			Reduction due to the implementation of the project (Indirect reduction)	By other donors, local government fund or independent efforts

Note: monitoring activity needs to be executed in order to calculate direct and indirect GHG emissions reductions.

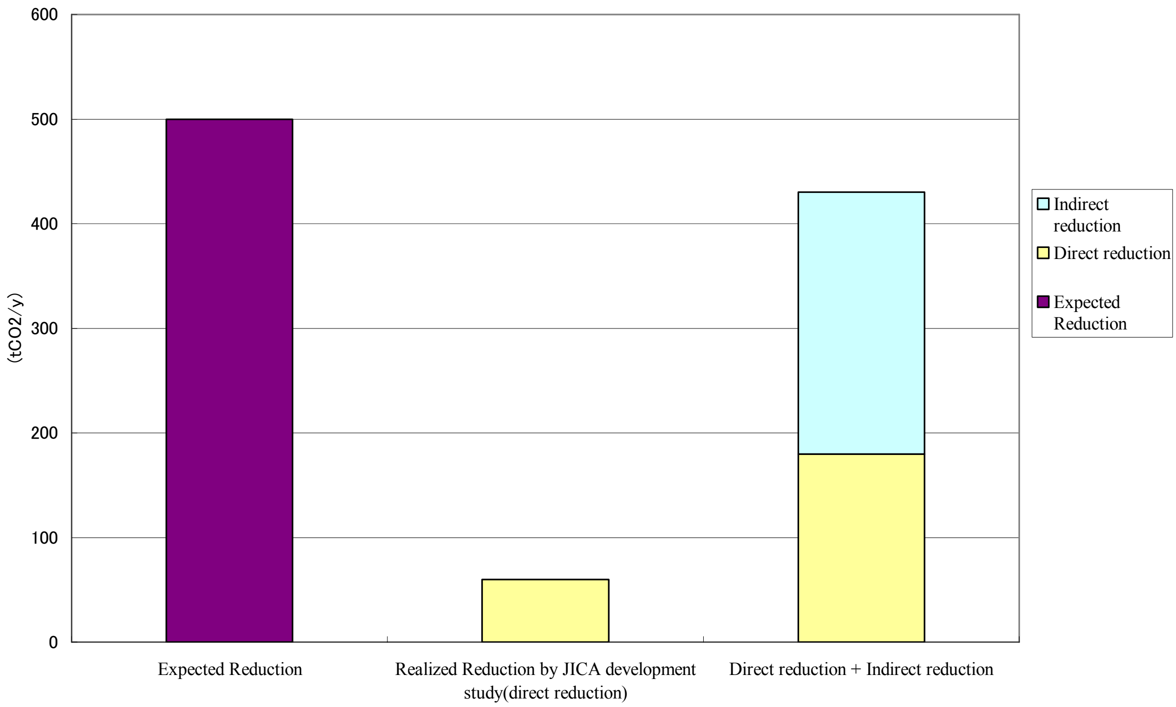


Figure 2.4.1 GHG Emissions Reductions in Development Study

c. Technical Cooperation Projects

In the case of a technical cooperation projects, the aspect of "sustainability" is important, in which activities are independently enhanced using the transferred technology by the developing country after completion of the project. Therefore, when the project is started, in addition to the "expected reduction" expected through implementation of the project activities, the potential for reductions in that country, area, or sector that the project sets the stage for is classified as "potential reduction".

For example, consider the case of a project to strengthen energy conservation training capacity in the energy conservation centre.

If a target value (for example, such as achievement of 10 % energy conservation, etc.) is set for the improvement in energy conservation in country, area or sector covered by the project, the "potential reduction" is calculated based on the target values.

The expected reduction is calculated as the amount of energy saving in the case that all the trainees that receive energy conservation training up to the time of project completion return to the factory or company that they belong to, and carry out the energy conservation activities that they learned during training. For the purpose of the calculation, indices established as the project purpose are used (for example, the implementation of energy conservation training for 100 people by the time of project completion). The amount of energy saving is multiplied by the amount of reduction in GHG per unit of energy to calculate the "expected reduction". The expected amount calculated here is the expected amount assuming the indices are achieved, so it is necessary to revise the expected reduction when the project is completed, based on the actual number of people trained.

In the case where, in addition to training during the project period, actual energy conservation activities are implemented aiming at further strengthening of training capacity at a factory or company as a pilot project, the amount of GHG reductions due to the amount of energy saved as a result of these activities is counted as “reduction achieved by the JICA technical cooperation (direct reduction)”.

In the same way as for a development study, of the expected reduction, the amount of reduction due to activities achieved through Japanese Government funds or technical cooperation (for example, such as the introduction of energy conservation equipment by grant aid) is taken to be “reduction due to the implementation of the project (direct reduction)”. Also, the amount of reduction due to other donors or the developing country’s independent efforts is taken to be “reduction due to the implementation of the project (indirect reduction)”.

Table 2.4.2 GHG Emissions Reductions in Technical Cooperation Project

Preliminary Evaluation	T.C. Project Preparatory Study (in process of project purpose establishment)	T.C. Project Impelementation	A Few Years after T.C. Project Completion	Remarks
Potential Reduction	→→→	→→→	→→→	Potential for reductions in that country, area, or sector that the project sets the stage for
	Expected Reduction	Reduction achieved by the JICA technical cooperation (Direct reduction)	Reduction due to the implementation of the project (Direct reduction)	Implemented in JICA project or by Japanese governmental fund or technical cooperation
			Reduction due to the implementation of the project (Indirect reduction)	By other donors, local government fund or independent efforts

Note: monitoring activity needs to be executed in order to calculate direct and indirect GHG emissions reductions.
T.C.: Technical Cooperation

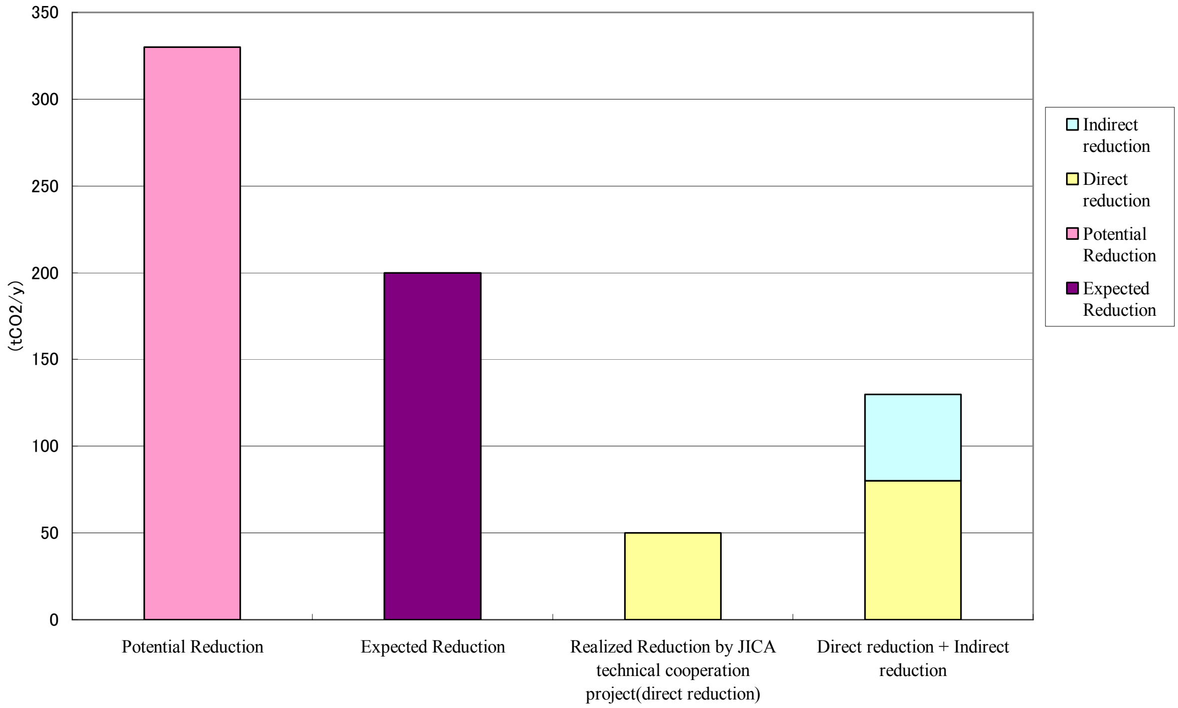


Figure 2.4.2 GHG Emissions Reductions in Technical Cooperation Project

Chapter 3 GHG Quantification Guidebook by Sector

3.1 Natural Resources and Energy Sector

3.1.1 Preconditions for the sector

As JICA projects in the sector of Natural Resources and Energy consist primarily of development studies, projects that can contribute directly to the reduction of GHG emissions are rather limited except for pilot projects. However, the number of projects in energy conservation and renewable energy sectors have recently increased. Therefore, the following three sub-sectors are discussed and analyzed in this Guidebook;

1) Energy conservation
2) Renewable energy
3) Improvement of energy efficiency

1) Energy conservation

In the energy conservation sub-sector, the GHG emissions reduction activities can not be easily defined. Therefore, energy conservation activities in this Guidebook are defined as those that involve the implementation of energy-saving activities. In the Guidebook, the amount of reduction of energy and/or electricity by energy-saving at the activity site is quantified.

2) Renewable energy

It is assumed that GHG emissions from project activity (*PE*) is zero for all renewable energy projects including photovoltaic, geothermal, hydro, wind power generation, etc. Also, in estimating a grid CO_2 emission factor, it is assumed that the planned power plants are not affected[1] by the construction of a new renewable energy electricity generation facility, or in other words, build margin (BM) is not taken into account in the estimation. This is the precondition set out by the former JBIC in the study on the estimation of GHG emission reduction effects[2]. Likewise, CH_4 and N_2O emissions from geothermal power generation activity are excluded from the quantification, as these emissions are supposed to be low and ignorable.

3) Improvement of energy efficiency

In the sub-sector of energy efficiency improvement, the retrofit and improvement of a generator and a boiler are included. In order to collect data for GHG emissions reduction calculation, GHG emissions from emission sources of project activities

[1] “Affected” means that the construction of the planned coal power plant is canceled by the construction of a new renewable energy power plant, for example.

[2] “Guideline Study on Project Formation of Climate Change Measures in Electricity Energy” Final Report, JBIC, August in 2008

should be monitored before and after implementation of energy efficiency improvement measures.

3.1.2 Summary of quantification methods

1) Energy conservation

Amount of GHG emission reduction (*ER*) is calculated by subtracting the GHG emission from the energy-saving project activity (*PE*) from the GHG emission from energy (including electricity) production in absence of an energy-saving activity (*BE*), as calculated in the following equation;

$$ER = BE - PE$$

2) Renewable energy

As GHG emissions from project activities that involves renewable energy (either the project facility is grid-connected or not) is zero or negligible ($PE = 0$), then $ER = BE$ which means that GHG emission reduction is equal to the GHG emission generated from the electricity that is substituted for by the renewable energy.

3) Improvement of energy efficiency

GHG emission reduction is achieved by retrofitting or improving efficiency of energy generators such as an electricity generator and a boiler. This activity will lower the values of fuel consumption *FC* (and electricity consumption *EL*) and CO_2 emission factor *EF* of equipment. GHG emissions before and after the project activities are as follows;

$$BE = FC_{BL} \text{ (or } EL_{BL}) \times EF_{BL} \text{ or,}$$

$$PE = FC_{PJ} \text{ (or } EL_{PJ}) \times EF_{PJ}$$

Where,

GHG emission reduction *ER* is

$$ER = BE - PE$$

Emission reduction is achieved under the following conditions:

FC_{BL} (or EL_{BL}) $\geq FC_{PJ}$ (or EL_{PJ}): fuel/ electricity consumption from the baseline (without project) is greater than that from the project activities, or

$EF_{BL} \geq EF_{PJ}$: emission factor of the baseline is greater than that of the project activities.

4) Common terms

- GHG emissions from electricity consumption: Electricity consumption *EL* × CO_2 emission factor of the electricity *EF*
- GHG emissions from fuel consumption: Fuel consumption *FC* × CO_2 emission factor of the fuel *EF*

Refer to ***Annex 1*** and ***Annex 2*** for the details of the above CO_2 emission factors.

3.1.3 GHG emission reduction activities of JICA projects

Project examples listed in Table 3.1.1(1) to Table 3.1.1(3) consist of the projects that were recognized to be effective for mitigation of climate change in the research called “JICA’s Assistance for Mitigation to Climate Change - The Co-Benefits Approach to Climate Change”. And they also include the projects that JICA specified as the mitigation projects from JICA projects of year 2008.

Therefore, these project examples do not contain all of JICA projects. In other words, there are other JICA projects with other GHG reduction components shown in Table 3.1.1(1) to Table 3.1.1(3).

Table 3.1.1(1) Components of GHG Emission Reduction Activities (energy conservation)

Project example	**GHG Reduction Components**				
	Establishment of Institution for Energy Conservation	**Foundation of Energy Conservation Centre**	**Diagnosis of Energy Conservation**	**Training in Energy Conservation**	**Dissemination and Enlightenment**
Dissemination and Promotion of Energy Conservation	○	○	○	○	○
Master Plan for Energy Conservation	○				
Introduction of Energy Management	○				
Energy Conservation Centre Project	○	○	○	○	○

Table 3.1.1(2) Components of GHG Emission Reduction Activities (renewable energy)

Project example	**GHG Reduction Components**	
	Photovoltaic Generation, Geothermal Generation, Mini Hydropower Generation, Wind Generation – Grid-connected	**Photovoltaic Generation, Geothermal Generation, Mini Hydropower Generation, Wind Generation – No Grid-connected**
Master Plan for Renewable Energy	○	○
Regional Electrification Plan	○	○

Table 3.1.1(3) Components of GHG Emission Reduction Activities (improvement of energy efficiency)

Project example	**GHG Reduction Components**			
	Renovation/ Improvement of Generators	**Improvement of Plant Heat Efficiency**	**Power Loss Reduction of Transmission/ Distribution Electric Networks**	**Introduction of Large Scale Coal-fired Generation**
Generator Renovation Plan	○	○		
Generating Station Renovation Plan	○			
Transmission and Distribution Electric Networks Power Loss Reduction Plan			○	
Introduction of Large Scale Coal-fired Generation				○

3.1.4 Summary of GHG emission reduction scenarios and quantification methods by activity

GHG emission reduction activities in the Natural Resources and Energy Sector are categorized into the following three types of activities;

1) Energy conservation, 2) Renewable energy, and 3) Improvement of energy efficiency

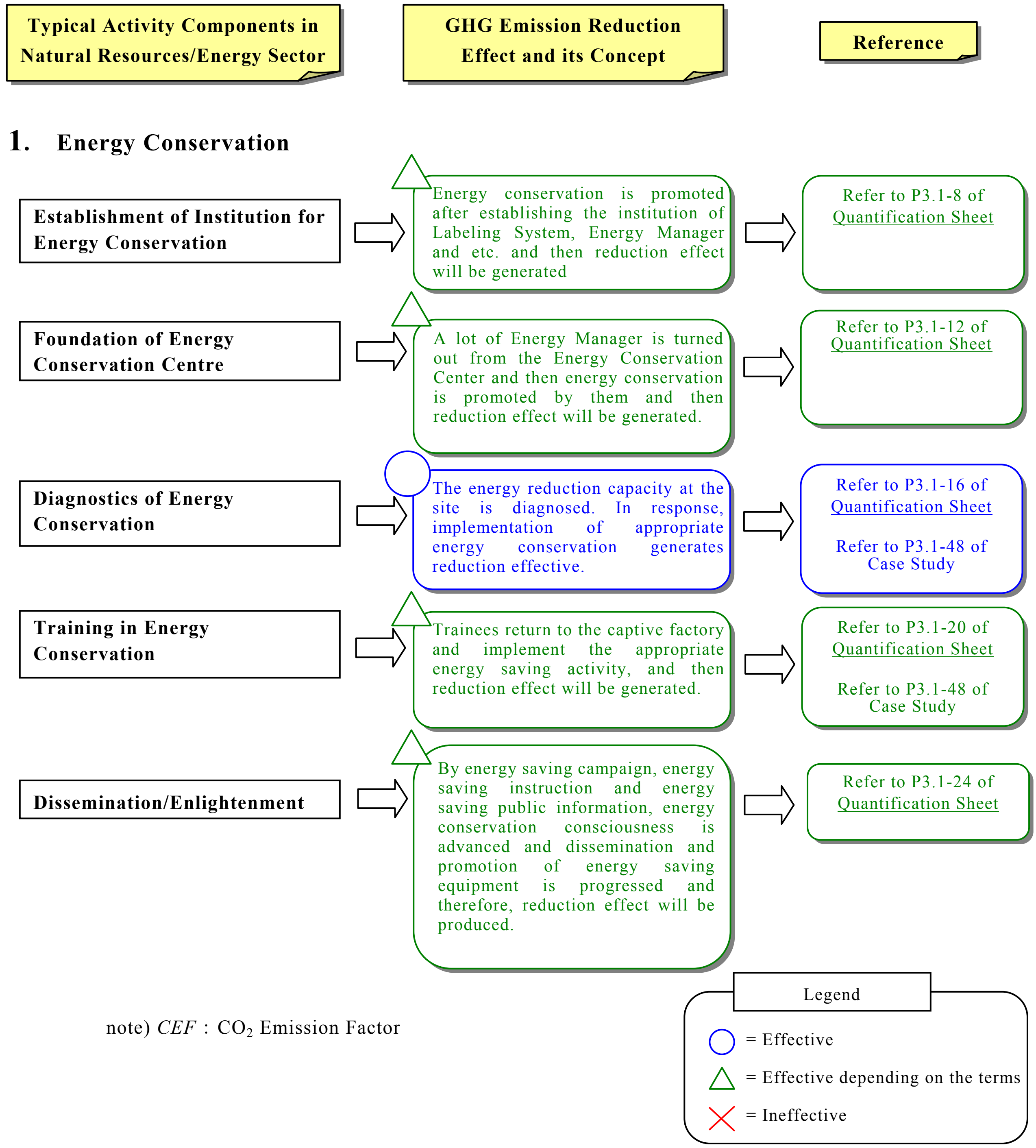


Figure 3.1.1 Quantification possibility of each component (energy conservation)

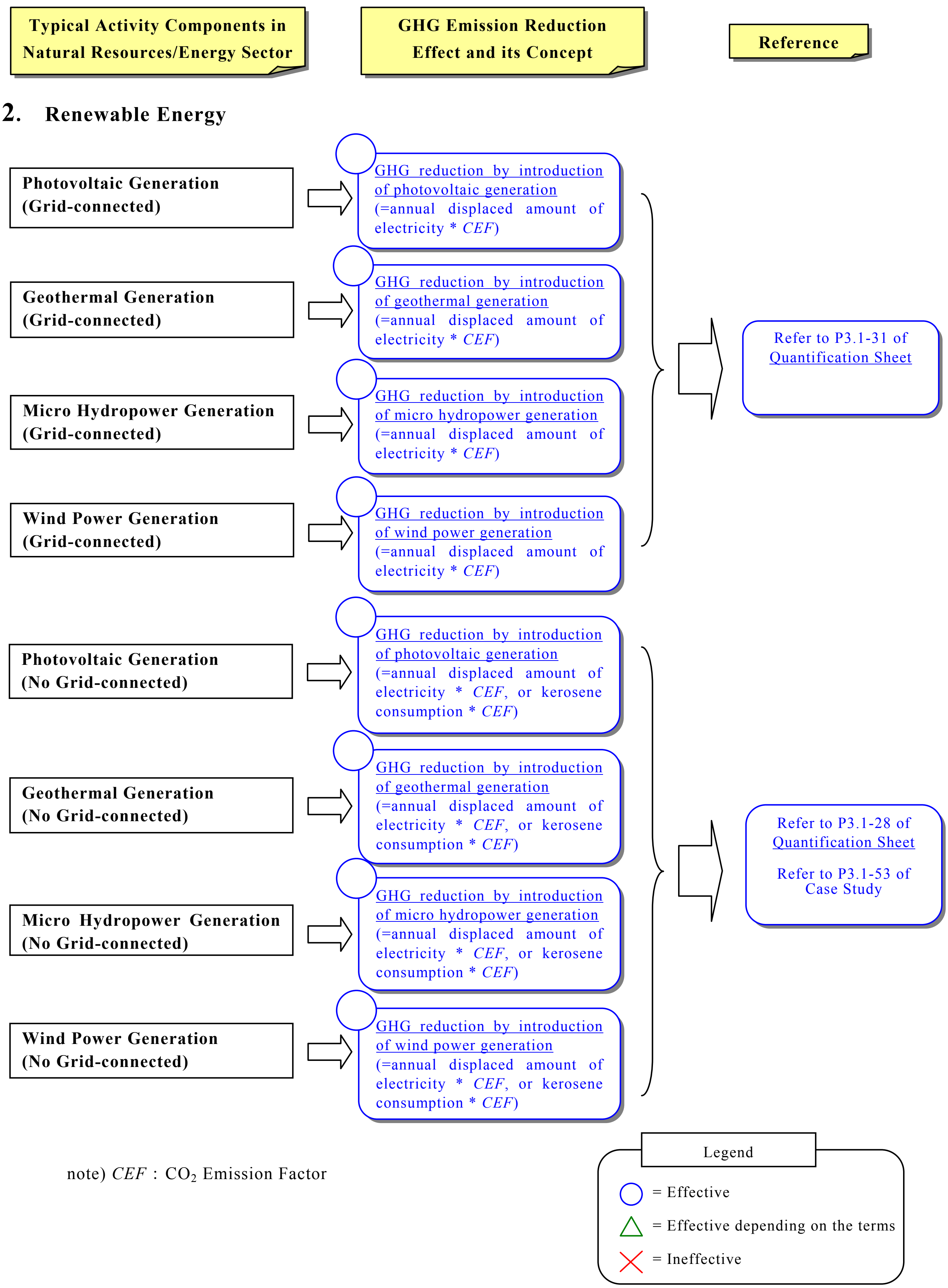


Figure 3.1.2 Quantification possibility of each component (renewable energy)

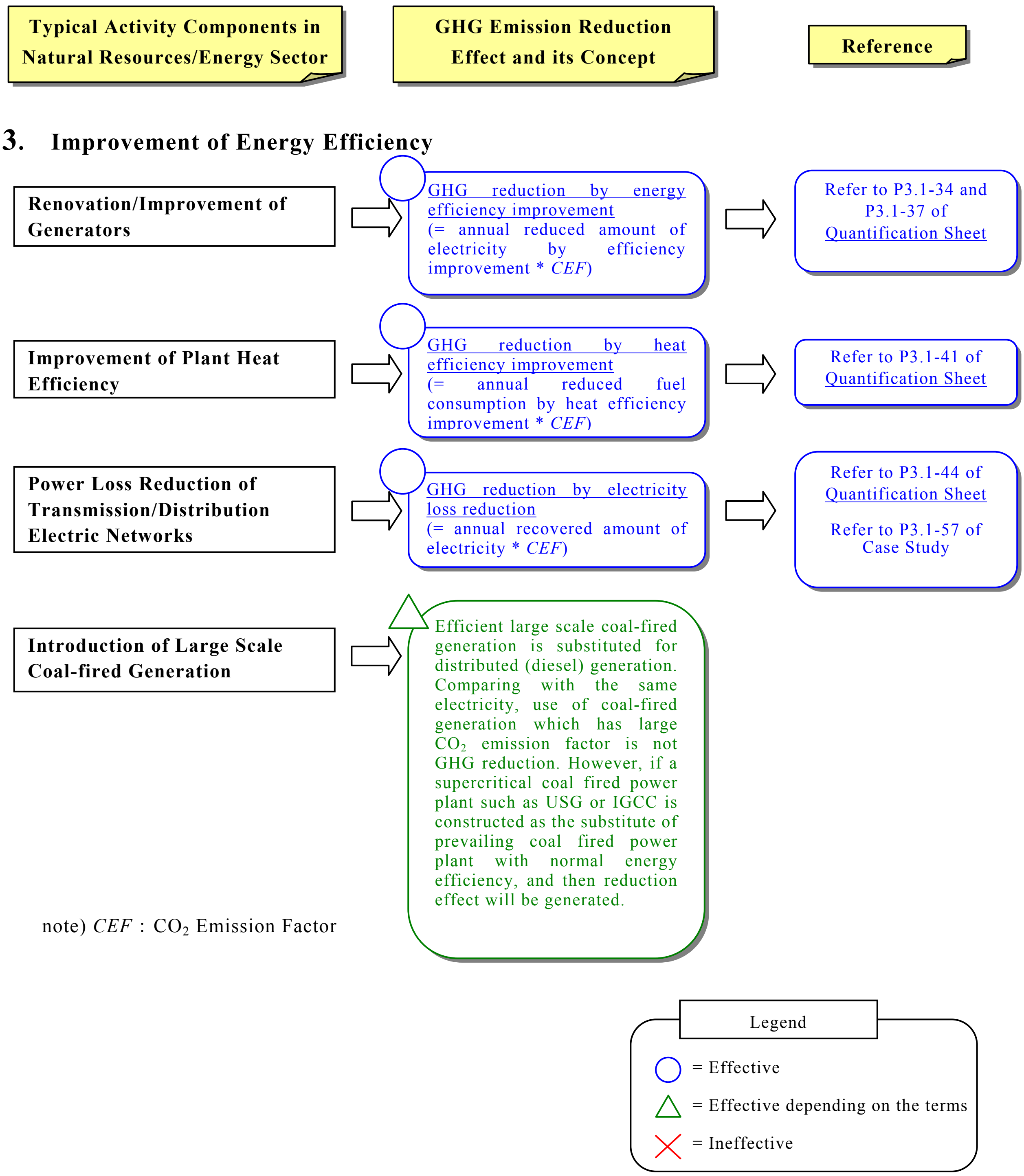
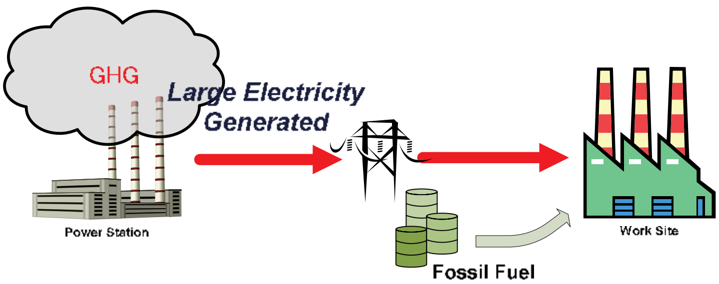
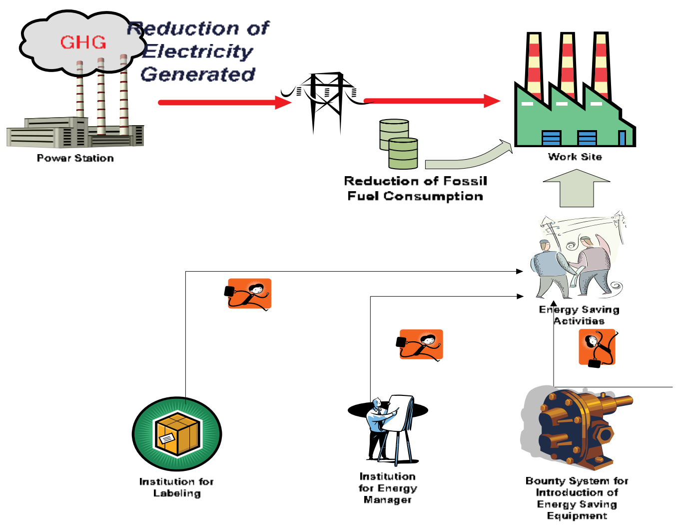
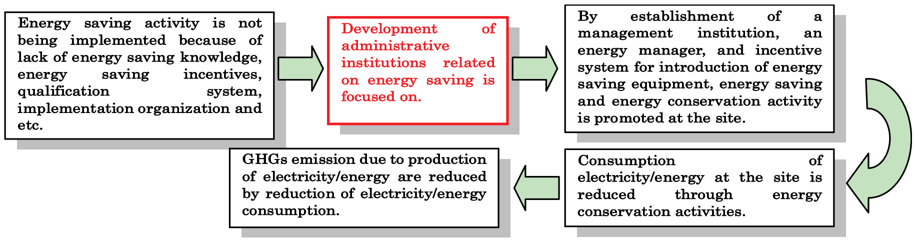


Figure 3.1.3 Quantification possibility of each component (improvement of energy efficiency)

Quantification Sheet

Activity: Establishment of Institution for Energy Conservation

Sector	Natural Resources & Energy Sector
Sub-sector	Energy Conservation
GHG emission reduction activity	Establishment of Institution for Energy Conservation
GHG emission reduction impact	1: Activity will lead to GHG emission reduction 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** No energy conservation measure is taken, leading to the continuous emission of GHG.  **<With the activity>** Based on the established institutions, energy conservation measure(s) is (are) taken, leading to the reduction of energy consumption. 

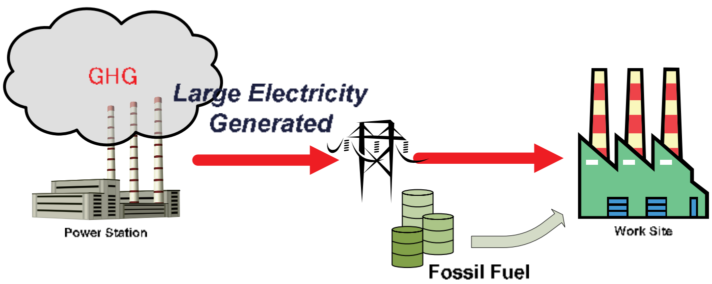
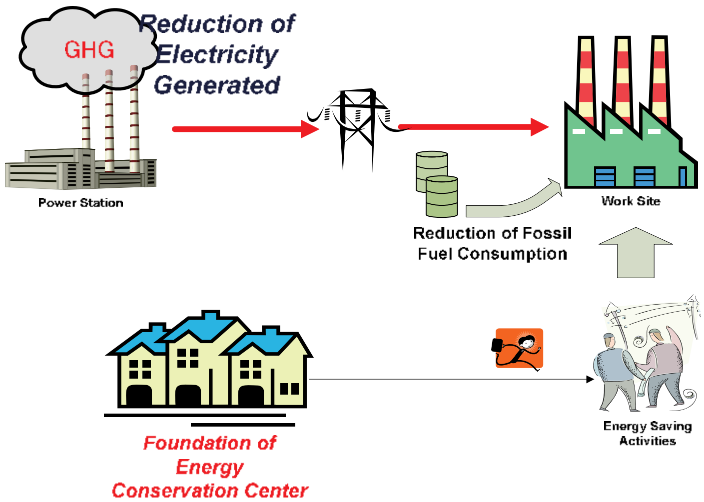
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	**[Calculation method]** ***ER*** is calculated as ***PE_{with} With the activity*** as reduced by energy saving activity deducted from ***$BE_{without}$*** of energy production with no energy saving activity, i.e. ***Without the activity***. (case of fossil fuel) Difference obtained is the GHG reduction ***ER***. **[Equations]** Quantification is based on the CDM small-scale approved methodologies; **II.A., II.B., II.D.** of **TYPE II – ENERGY EFFICIENCY IMPROVEMENT PROJECTS.** **<u>Without the activity</u>** Calculating GHG emission (***$BE_{without}$***) due to energy production at the site in case of no establishment of institution related to energy conservation Case of Fossil Fuel $\boldsymbol{BE_{without}}=EC_{BL,FC}$ (kJ or TOE/yr) × EF_{FF} ($kgCO_2$/kJ) *f*(1) $EC_{BL,FC}$: annual energy consumption before establishment of institution for energy conservation (kJ or TOE/yr) EF_{FF}: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) or Case of Electricity $\boldsymbol{BE_{without}}=EC_{BL,EL}$ (kWh/yr) × EF_{EL} ($kgCO_2$/kWh) *f*(2) $EC_{BL,EL}$: annual electricity consumption before establishment of institution for energy conservation (kWh/yr) EF_{EL}: CO_2 emission factor of electricity ($kgCO_2$/kWh) **<u>With the activity</u>** Calculating GHG emission (***PE_{with}***) due to energy produced at the site after establishment of institution for energy conservation

	Case of Fossil Fuel $\boldsymbol{PE_{with}}=EC_{PJ,FC}$ (kJ or TOE/yr) × EF_{FF} ($kgCO_2$/kJ) *f*(3) $EC_{PJ,FC}$: annual energy consumption after establishment of institution for energy conservation (kJ or TOE/yr) EF_{FF}: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) or Case of Electricity $\boldsymbol{PE_{with}}=EC_{PJ,EL}$ (kWh/yr) × EF_{EL} ($kgCO_2$/kWh) *f*(4) $EC_{PJ,EL}$: annual electricity consumption after establishment of institution for energy conservation (kWh/yr) EF_{EL}: CO_2 emission factor of electricity ($kgCO_2$/kWh) **<u>GHG emission reductions</u>** Therefore, GHG emission reduction ***ER*** by establishment of institution; $\boldsymbol{ER} = \boldsymbol{BE_{without}} - \boldsymbol{PE_{with}}$ $= f(1) - f(3)$ ($kgCO_2$/yr) or $= f(2) - f(4)$ ($kgCO_2$/yr)
Required data and data source	$\boldsymbol{EC_{BL,FC}}$, $\boldsymbol{EC_{PJ,FC}}$: annual energy consumption before and after establishment of institution for energy conservation (kJ or TOE/yr) $\boldsymbol{EC_{BL,EL}}$, $\boldsymbol{EC_{PJ,EL}}$: annual electricity consumption before and after establishment of institution for energy conservation (kWh/yr) Obtain through interviews with operational management body at the site or if that is difficult at each work site, use the annual target value for energy conservation in the industrial sector $\boldsymbol{EF_{FF}}$: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) Refer to ***Annex 2*** $\boldsymbol{EF_{EL}}$: CO_2 emission factor of electricity ($kgCO_2$/kWh) Refer to ***Annex 1***
Preconditions	Energy saving activity will definitely be implemented after establishment of institution for energy conservation. Energy saving activity is carried on in the future.
Special notes	As the factory production amount in developing countries generally increases year by year, there is some possibility of the total energy consumption increasing even if the energy saving measure is implemented. Therefore, it is essential to compare the basic unit such as

	energy (electricity) per production amount or number of products before and after implementing the energy saving measures, which are greatly affected by increase and decrease of these parameters. These additional data such as energy (electricity) per production amount and number of products should be obtained and the basic unit calculated using these data should be appended to the report. It is hard to specify the effectiveness of institutional GHG reduction. As individual factors such as establishment of an institution for energy management and/or subsidized introduction of energy saving equipment are significantly affected, GHG reduction effectiveness by institutional establishment should be shown as comprehensive values integrated with other countermeasures.

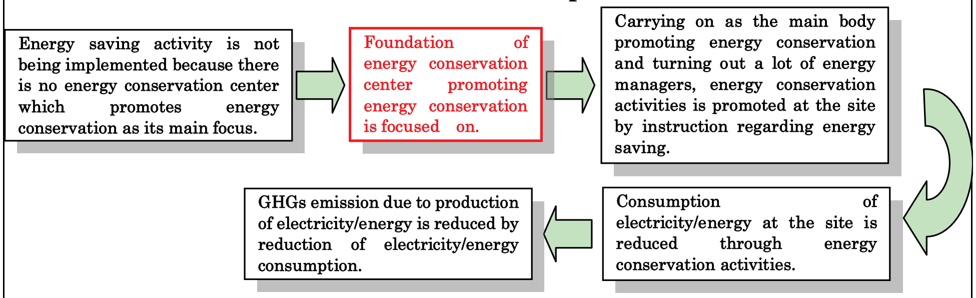
Quantification Sheet

Activity: Foundation of Energy Conservation Centre

Sector	Natural Resources & Energy Sector
Sub-sector	Energy Conservation
GHG emission reduction activity	Foundation of Energy Conservation Centre
GHG emission reduction impact	1: Activity will lead to GHG emission reduction 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** No energy conservation measure is taken, leading to the continuous emission of GHG.  **<With the activity>** Based on the foundation of energy conservation, energy conservation measure(s) is (are) taken, leading to the reduction of energy consumption. 

<table>
<tr><td></td><td>

[Schematics of GHG emission reduction process]



</td></tr>
<tr><td>Calculation of GHG emission reduction</td><td>

[Calculation method]

ER is calculated as $\boldsymbol{PE_{with}}$ ***With the activity*** as reduced by the energy saving activity deducted from $\boldsymbol{BE_{without}}$ of energy production with no energy saving activity, i.e. ***Without the activity***. (case of fossil fuel)

Difference obtained is the GHG reduction ***ER*** by foundation of energy conservation centre.

[Equations]

Quantification is based on the CDM small-scale approved methodologies; **II.A., II.B., II.D.** of **TYPE II – ENERGY EFFICIENCY IMPROVEMENT PROJECTS.**

<u>Without the activity</u>

Calculating GHG emission ($\boldsymbol{BE_{without}}$) due to energy production at the site in case of no foundation of energy conservation centre

Case of Fossil Fuel

$\boldsymbol{BE_{without}} = EC_{BL,FC}$ (kJ or TOE/yr) × EF_{FF} ($kgCO_2$/kJ) *f*(1)

$EC_{BL,FC}$: annual energy consumption before foundation of energy conservation centre (kJ or TOE/yr)

EF_{FF}: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ)

or

Case of Electricity

$\boldsymbol{BE_{without}} = EC_{BL,EL}$ (kWh/yr) × EF_{EL} ($kgCO_2$/kWh) *f*(2)

$EC_{BL,EL}$: annual electricity consumption before foundation of energy conservation centre (kWh/yr)

EF_{EL}: CO_2 emission factor of electricity ($kgCO_2$/kWh)

<u>With the activity</u>

Calculating GHG emission ($\boldsymbol{PE_{with}}$) due to energy produced at the site after foundation of energy conservation centre

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	Case of Fossil Fuel $PE_{with}=EC_{PJ,FC}$ (kJ or TOE/yr) × EF_{FF} ($kgCO_2$/kJ) *f*(3) $EC_{PJ,FC}$: annual energy consumption after foundation of energy conservation centre (kJ or TOE/yr) EF_{FF}: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) or Case of Electricity $PE_{with}=EC_{PJ,EL}$ (kWh/yr) × EF_{EL} ($kgCO_2$/kWh) *f*(4) $EC_{PJ,EL}$: annual electricity consumption after foundation of energy conservation centre (kWh/yr) EF_{EL}: CO_2 emission factor of electricity ($kgCO_2$/kWh) **GHG emission reductions** Therefore, GHG emission ***ER*** as reduced by foundation of energy conservation centre; $ER = BE_{without} - PE_{with}$ $= f(1) - f(3)$ ($kgCO_2$/yr) or $= f(2) - f(4)$ ($kgCO_2$/yr)
Required data and data source	$EC_{BL,FC}$, $EC_{PJ,FC}$: annual energy consumption before and after foundation of energy conservation centre(kJ or TOE/yr) $EC_{BL,EL}$, $EC_{PJ,EL}$: annual electricity consumption before and after foundation of energy conservation centre (kWh/yr) Obtain through interviews with operational management body at the site or if this is difficult at each work site, use the annual target value for energy conservation in the industrial sector EF_{FF}: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) Refer to ***Annex 2*** EF_{EL}: CO_2 emission factor of electricity ($kgCO_2$/kWh) Refer to ***Annex 1***
Preconditions	Energy saving activity will definitely be implemented after foundation of energy conservation centre. Energy saving activity is carried on in the future.
Special notes	As the factory production amount in developing countries generally increases year by year, there is some possibility of the total energy consumption increasing even if the energy saving measure is implemented. Therefore, it is essential to compare the basic unit such as energy (electricity) per production amount or number of products before

	and after implementing the energy saving measures, which are greatly affected by increase and decrease of these parameters. These additional data such as energy (electricity) per production amount and number of products should be obtained and the basic unit calculated using these data should be appended to the report. It is hard to specify the effectiveness of GHG reduction caused by Foundation of an Energy Conservation Centre. As individual factors such as not only Foundation of Energy Conservation Centre but also introduction of an energy manager and energy saving diagnosis are significantly-affected, GHG reduction effectiveness by Foundation of an Energy Conservation Centre should be shown as comprehensive values integrated with other countermeasures.

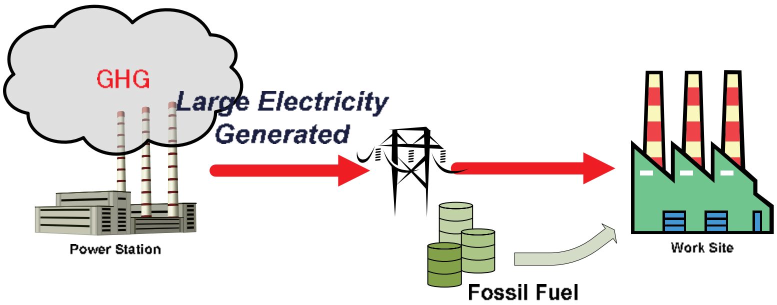
Quantification Sheet

Activity: Diagnosis of Energy Conservation

<table>
<tr><td>Sector</td><td>Natural Resources & Energy Sector</td></tr>
<tr><td>Sub-sector</td><td>Energy Conservation</td></tr>
<tr><td>GHG emission reduction activity</td><td>Diagnosis of Energy Conservation</td></tr>
<tr><td>GHG emission reduction impact</td><td><u>1: Activity will lead to GHG emission reduction</u>
2: Activity will lead to GHG emission reduction subject to condition(s)
3: Activity will not lead to GHG emission reduction</td></tr>
<tr><td>GHG emission reduction scenarios
(description of how GHG is reduced)</td><td>

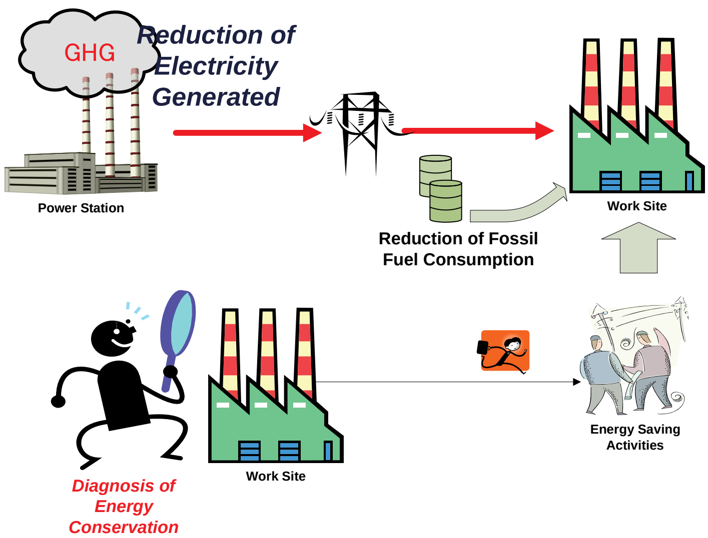
<Without the activity>

No energy conservation measure is taken, leading to the continuous emission of GHG.



<With the activity>

Based on the diagnosis of energy conservation, energy conservation measure(s) is (are) taken, leading to the reduction of energy consumption.



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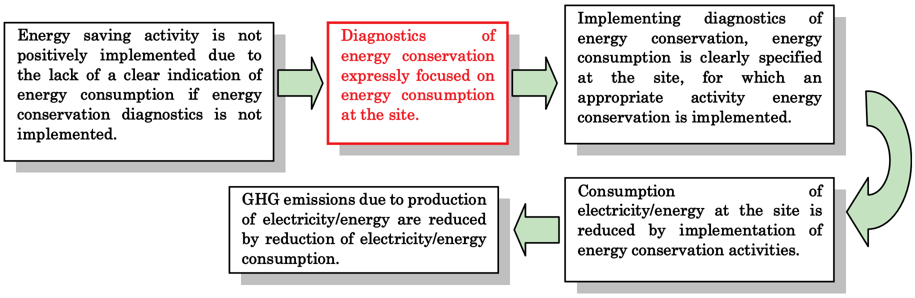
</table>

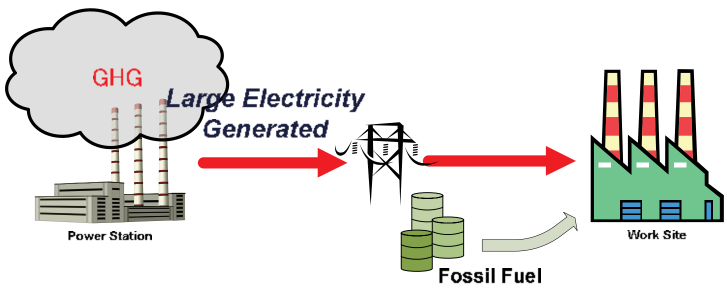
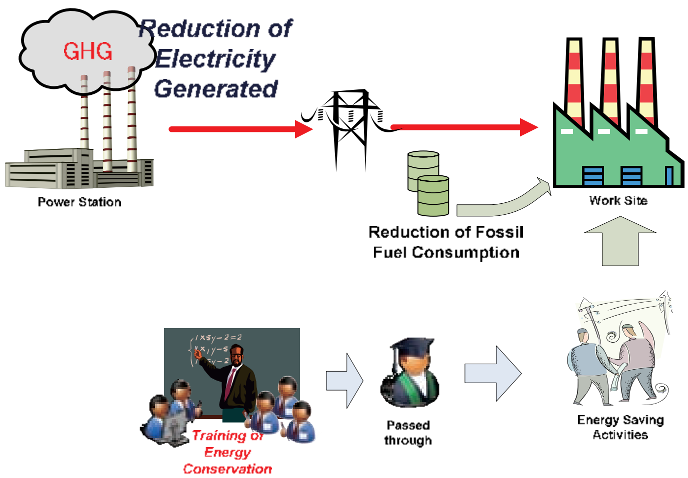
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	**[Calculation method]** ***ER*** is calculated as $\boldsymbol{PE_{with}}$ ***With the activity*** as reduced by energy saving activity subtracted from the $\boldsymbol{BE_{without}}$ due to energy production with no energy saving activity, ***Without the activity***. (case of fossil fuel) Difference obtained is the GHG reduction ***ER*** by diagnosis of energy conservation. **[Equations]** Quantification is based on the CDM small-scale approved methodologies; **II.A., II.B., II.D.** of **TYPE II – ENERGY EFFICIENCY IMPROVEMENT PROJECTS.** **<u>Without the activity</u>** Calculating GHG emission ($\boldsymbol{BE_{without}}$) due to energy production at the site in case of no diagnosis of energy conservation Case of Fossil Fuel $\boldsymbol{BE_{without}}=EC_{BL,FC}$ (kJ or TOE/yr) × EF_{FF} ($kgCO_2$/kJ) *f*(1) $EC_{BL,FC}$: annual energy consumption before diagnosis of energy conservation (kJ or TOE/yr) EF_{FF}: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) or Case of Electricity $\boldsymbol{BE_{without}}=EC_{BL,EL}$ (kWh/yr) × EF_{EL} ($kgCO_2$/kWh) *f*(2) $EC_{BL,EL}$: annual electricity consumption before diagnosis of energy conservation (kWh/yr) EF_{EL}: CO_2 emission factor of electricity ($kgCO_2$/kWh) **<u>With the activity</u>** Calculating GHG emission ($\boldsymbol{PE_{with}}$) due to energy produced at the site after diagnosis of energy conservation

	Case of Fossil Fuel $\boldsymbol{PE_{with}}=EC_{PJ,FC}$ (kJ or TOE/yr) × EF_{FF} ($kgCO_2$/kJ) *f*(3) $EC_{PJ,FC}$: annual energy consumption after diagnosis of energy conservation (kJ or TOE/yr) EF_{FF}: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) or Case of Electricity $\boldsymbol{PE_{with}}=EC_{PJ,EL}$ (kWh/yr) × EF_{EL} ($kgCO_2$/kWh) *f*(4) $EC_{PJ,EL}$: annual electricity consumption after diagnosis of energy conservation (kWh/yr) EF_{EL}: CO_2 emission factor of electricity ($kgCO_2$/kWh) **GHG emission reductions** Therefore, GHG emission reductions ***ER*** by diagnosis of energy conservation; $\boldsymbol{ER} = \boldsymbol{BE_{without}} - \boldsymbol{PE_{with}}$ = *f*(1) – *f*(3) ($kgCO_2$/yr) or = *f*(2) – *f*(4) ($kgCO_2$/yr)
Required data and data source	$\boldsymbol{EC_{BL,FC}}$, $\boldsymbol{EC_{PJ,FC}}$: annual energy consumption before and after diagnosis of energy conservation (kJ or TOE/yr) $\boldsymbol{EC_{BL,EL}}$, $\boldsymbol{EC_{PJ,EL}}$: annual electricity consumption before and after diagnosis of energy conservation (kWh/yr) Obtain through interviews with operational management body at the site or if this is difficult at each work site, use the annual target value for energy conservation in the industrial sector $\boldsymbol{EF_{FF}}$: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) Refer to ***Annex 2*** $\boldsymbol{EF_{EL}}$: CO_2 emission factor of electricity ($kgCO_2$/kWh) Refer to ***Annex 1***
Preconditions	Energy saving activity will definitely be implemented after diagnosis of energy conservation. Energy saving activity is carried on in the future.
Special notes	As the factory production amount in developing countries generally increases year by year, there is some possibility of the total energy consumption increasing even if the energy saving measure is implemented. Therefore, it is essential to compare the basic unit such as energy (electricity) per production amount or number of products before and after implementing the energy saving measures, which are greatly

	affected by increase and decrease of these parameters. These additional data such as energy (electricity) per production amount and number of products should be obtained and the basic unit calculated using these data should be appended to the report. It is generally hard to specify the effectiveness of GHG reduction caused by diagnosis of energy conservation except in the case that the energy saving equipment is installed based on the result of energy diagnosis and its energy saving effect is obviously specified.

Quantification Sheet

Activity: Training in Energy Conservation

Sector	Natural Resources & Energy Sector
Sub-sector	Energy Conservation
GHG emission reduction activity	Training in Energy Conservation
GHG emission reduction impact	1: Activity will lead to GHG emission reduction <u>2: Activity will lead to GHG emission reduction subject to condition(s)</u> 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** No training in energy conservation is taken, leading to the continuous emission of GHG, associated with a lack of consciousness and knowledge of energy conservation.  **<With the activity>** Based on the training in energy conservation, energy conservation measure(s) is (are) taken, leading to the reduction of energy consumption. 

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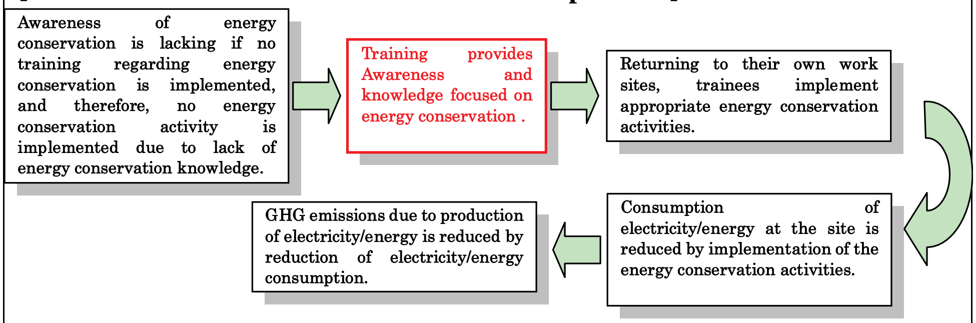
[Schematics of GHG emission reduction process]



</td>
</tr>
<tr>
<td>Calculation of GHG emission reduction</td>
<td>

[Calculation method]

ER is calculated as ***PE*** $\boldsymbol{PE_{with}}$ ***With the activity*** as reduced by energy saving activity subtracted from $\boldsymbol{BE_{without}}$ of energy production with no energy saving activity, i.e. ***Without the activity***. (case of fossil fuel)

Difference obtained is the reduction in GHG ***ER*** by training in energy conservation.

[Equations]

Quantification is based on the CDM small-scale approved methodologies; **II.A., II.B., II.D.** of **TYPE II – ENERGY EFFICIENCY IMPROVEMENT PROJECTS.**

<u>Without the activity</u>

Calculating GHG emission ($\boldsymbol{BE_{without}}$) due to energy production at the site in case of no training in energy conservation

Case of Fossil Fuel

$\boldsymbol{BE_{without}} = EC_{BL,FC}$ (kJ or TOE/yr) × EF_{FF} ($kgCO_2$/kJ) *f*(1)

$EC_{BL,FC}$: annual energy consumption before training in energy conservation (kJ or TOE/yr)

EF_{FF}: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ)

or

Case of Electricity

$\boldsymbol{BE_{without}} = EC_{BL,EL}$ (kWh/yr) × EF_{EL} ($kgCO_2$/kWh) *f*(2)

$EC_{BL,EL}$: annual electricity consumption before training in energy conservation (kWh/yr)

EF_{EL}: CO_2 emission factor of electricity ($kgCO_2$/kWh)

<u>With the activity</u>

Calculating GHG emission ($\boldsymbol{PE_{with}}$) due to energy produced at the site after training in energy conservation

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</tr>
</table>

	Case of Fossil Fuel $\boldsymbol{PE_{with}} = EC_{PJ,FC}$ (kJ or TOE/yr) × EF_{FF} ($kgCO_2$/kJ) *f*(3) $EC_{PJ,FC}$: annual energy consumption after training in energy conservation (kJ or TOE/yr) EF_{FF}: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) or Case of Electricity $\boldsymbol{PE_{with}} = EC_{PJ,EL}$ (kWh/yr) × EF_{EL} ($kgCO_2$/kWh) *f*(4) $EC_{PJ,EL}$: annual electricity consumption after training in energy conservation (kWh/yr) EF_{EL}: CO_2 emission factor of electricity ($kgCO_2$/kWh) **GHG emission reductions** Therefore, GHG emission reductions ***ER*** due to training in energy conservation; $\boldsymbol{ER} = \boldsymbol{BE_{without}} - \boldsymbol{PE_{with}}$ $= f(1) - f(3)$ ($kgCO_2$/yr) or $= f(2) - f(4)$ ($kgCO_2$/yr)
Required data and data source	$\boldsymbol{EC_{BL,FC}}$, $\boldsymbol{EC_{PJ,FC}}$: annual energy consumption before and after training of energy conservation (kJ or TOE/yr) $\boldsymbol{EC_{BL,EL}}$, $\boldsymbol{EC_{PJ,EL}}$: annual electricity consumption before and after training of energy conservation (kWh/yr) Obtain through interviews with operational management body at the site or if that is difficult at each work site, use the annual target value for energy conservation in the industrial sector $\boldsymbol{EF_{FF}}$: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) Refer to ***Annex 2*** $\boldsymbol{EF_{EL}}$: CO_2 emission factor of electricity ($kgCO_2$/kWh) Refer to ***Annex 1***
Preconditions	Energy saving activity will definitely be implemented after training in energy conservation. Energy saving activity is carried on in the future.
Special notes	As the factory production amount in developing countries generally increases year by year, there is some possibility of the total energy consumption increasing even if the energy saving measure is implemented. Therefore, it is essential to compare the basic unit such as energy (electricity) per production amount or number of products before and after implementing the energy saving measures, which are greatly

	affected by increase and decrease of these parameters. These additional data such as energy (electricity) per production amount and number of products should be obtained and the basic unit calculated using these data should be appended to the report. It is hard to specify the effectiveness of GHG reduction by training in energy conservation. As individual factors such as not only enlightenment in energy conservation awareness and knowledge related to training in energy conservation but also introduction of an energy manager and energy saving diagnosis are significantly affected, GHG reduction effectiveness due to training of energy conservation should be shown as comprehensive values integrated with other countermeasures.

Quantification Sheet

Activity: Dissemination and Enlightenment

<table>
<tr><td>Sector</td><td>Natural Resources & Energy Sector</td></tr>
<tr><td>Sub-sector</td><td>Energy Conservation</td></tr>
<tr><td>GHG emission reduction activity</td><td>Dissemination and Enlightenment</td></tr>
<tr><td>GHG emission reduction impact</td><td>1: Activity will lead to GHG emission reduction

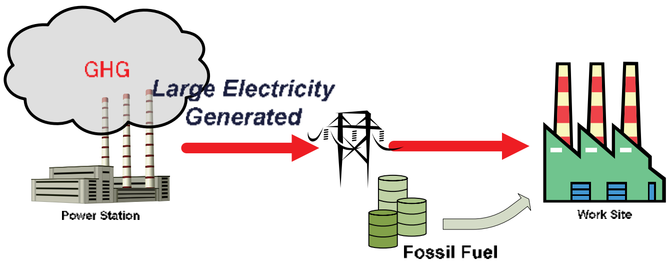
<u>2: Activity will lead to GHG emission reduction subject to condition(s)</u>

3: Activity will not lead to GHG emission reduction</td></tr>
<tr><td>GHG emission reduction scenarios

(description of how GHG is reduced)</td><td>

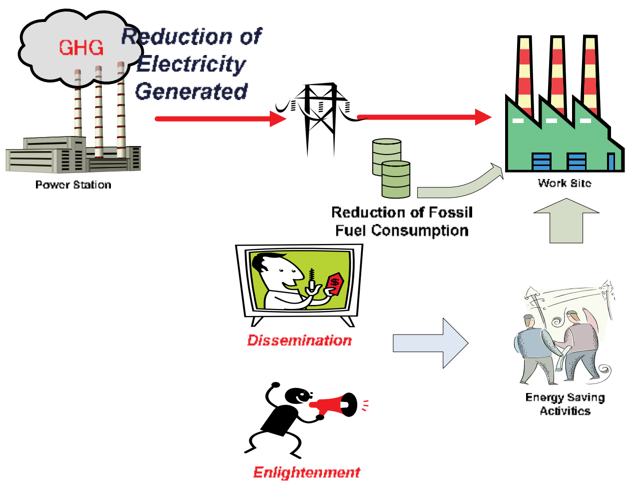
<Without the activity>

No dissemination/enlightenment occurs, leading to the continuous emission of GHG, associated with a lack of consciousness and lack of diffusion of energy conservation.



<With the activity>

Based on the dissemination and enlightenment, energy conservation measure(s) is (are) taken, leading to the reduction of energy consumption.



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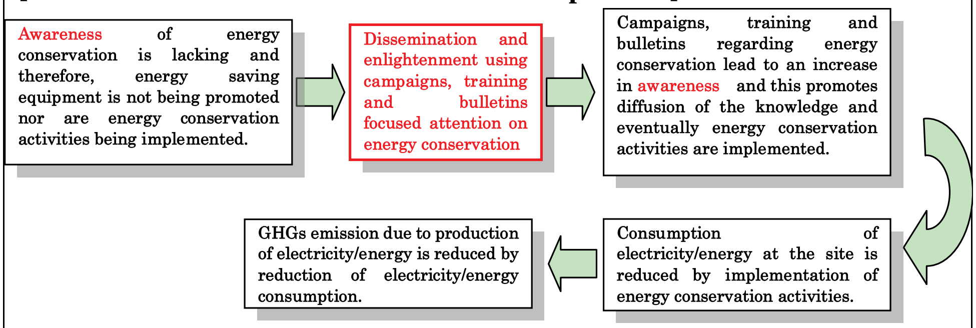
</table>

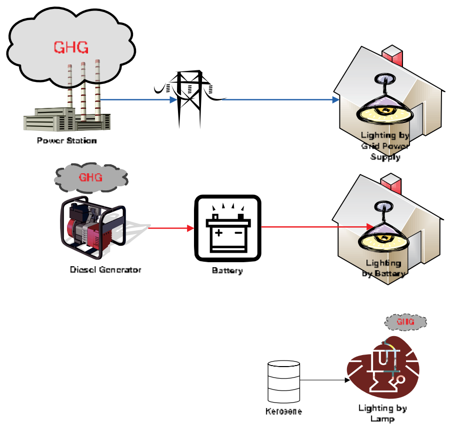
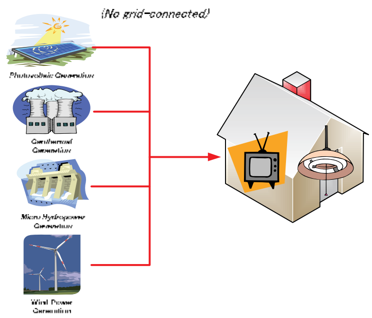
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	**[Calculation method]** ***ER*** is calculated as $\boldsymbol{PE_{with}}$ ***With the activity*** as reduced by energy saving activity subtracted from $\boldsymbol{BE_{without}}$ of energy production with no energy saving activity, i.e. ***Without the activity***. (case of fossil fuel) Difference obtained is the reduction in GHG ***ER*** due to dissemination and enlightenment. **[Equations]** Quantification is based on the CDM small-scale approved methodologies; **II.A., II.B., II.D.** of **TYPE II – ENERGY EFFICIENCY IMPROVEMENT PROJECTS.** **Without the activity** Calculating GHG emission ($\boldsymbol{BE_{without}}$) due to energy production at the site in case of no dissemination/enlightenment Case of Fossil Fuel $\boldsymbol{BE_{without}}=EC_{BL,FC}$ (kJ or TOE/yr) × EF_{FF} ($kgCO_2$/kJ) *f*(1) $EC_{BL,FC}$: annual energy consumption before dissemination/enlightenment (kJ or TOE/yr) EF_{FF}: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) or Case of Electricity $\boldsymbol{BE_{without}}=EC_{BL,EL}$ (kWh/yr) × EF_{EL} ($kgCO_2$/kWh) *f*(2) $EC_{BL,EL}$: annual electricity consumption before dissemination/enlightenment (kWh/yr) EF_{EL}: CO_2 emission factor of electricity ($kgCO_2$/kWh) **With the activity** Calculating GHG emission ($\boldsymbol{PE_{with}}$) due to energy produced at the site after dissemination/enlightenment

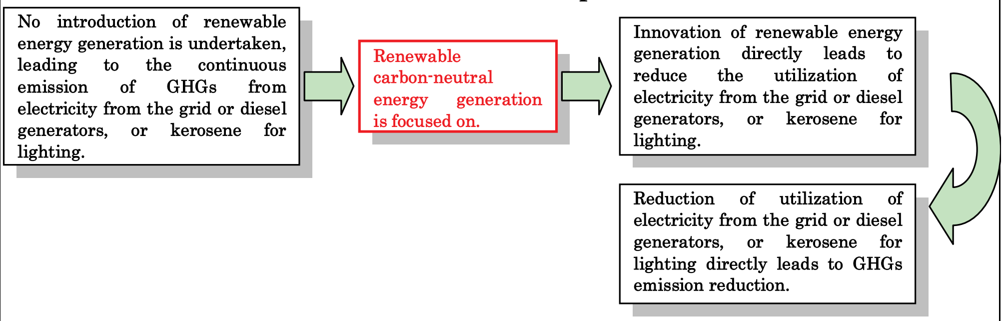
	Case of Fossil Fuel $\boldsymbol{PE_{with}}=EC_{PJ,FC}$ (kJ or TOE/yr) × EF_{FF} ($kgCO_2$/kJ) *f*(3) $EC_{PJ,FC}$: annual energy consumption after dissemination/enlightenment (kJ or TOE/yr) EF_{FF}: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) or Case of Electricity $\boldsymbol{PE_{with}}=EC_{PJ,EL}$ (kWh/yr) × EF_{EL} ($kgCO_2$/kWh) *f*(4) $EC_{PJ,EL}$: annual electricity consumption after dissemination/enlightenment (kWh/yr) EF_{EL}: CO_2 emission factor of electricity ($kgCO_2$/kWh) **GHG emission reductions** Therefore, GHG emission reductions ***ER*** due to dissemination / enlightenment; $\boldsymbol{ER} = \boldsymbol{BE_{without}} - \boldsymbol{PE_{with}}$ $= f(1) - f(3)$ ($kgCO_2$/yr) or $= f(2) - f(4)$ ($kgCO_2$/yr)
Required data and data source	$\boldsymbol{EC_{BL,FC}}$, $\boldsymbol{EC_{PJ,FC}}$: annual energy consumption before and after dissemination/enlightenment (kJ or TOE/yr) $\boldsymbol{EC_{BL,EL}}$, $\boldsymbol{EC_{PJ,EL}}$: annual electricity consumption before and after dissemination/enlightenment (kWh/yr) Obtain through interviews with operational management body at the site or if that is difficult at each work site, use the annual target value for energy conservation in the industrial sector $\boldsymbol{EF_{FF}}$: CO_2 emission factor of fossil fuel ($kgCO_2$/kJ) Refer to ***Annex 2*** $\boldsymbol{EF_{EL}}$: CO_2 emission factor of electricity ($kgCO_2$/kWh) Refer to ***Annex 1***
Preconditions	Energy saving activity will definitely be implemented after dissemination and enlightenment. Energy saving activity is carried on in the future.
Special notes	As the factory production amount in developing countries generally increases year by year, there is some possibility of the total energy consumption increasing even if the energy saving measure is implemented. Therefore, it is essential to compare the basic unit such as energy (electricity) per production amount or number of products before

	and after implementing the energy saving measures, which are greatly affected by increase and decrease of these parameters. These additional data such as energy (electricity) per production amount and number of products should be obtained and the basic unit calculated using these data should be appended to the report. It is hard to specify the effectiveness of GHG reduction by dissemination and enlightenment. As individual factors such as enlightenment regarding energy conservation awareness and knowledge related to dissemination and enlightenment and more importantly, introduction of energy saving equipment are significantly-affected, GHG reduction effectiveness by dissemination and enlightenment should be shown as comprehensive values integrated with other countermeasures.

Quantification Sheet

Activity: Photovoltaic Generation, Geothermal Generation, Micro Hydropower Generation, Wind Power Generation (no grid-connected)

Sector	Natural Resources & Energy Sector
Sub-sector	Renewable Energy
GHG emission reduction activity	Photovoltaic Generation, Geothermal Generation, Micro Hydropower Generation, Wind Power Generation (no grid-connected)
GHG emission reduction impact	<u>1: Activity will lead to GHG emission reduction</u> 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** No introduction of renewable energy generation is taken, leading to the continuous emission of GHG from electricity from the grid or diesel, or kerosene for lighting.  **<With the activity>** Innovation of renewable energy generation directly leads to a reduction in the utilization of electricity from the grid or diesel, or kerosene for lighting, and this leads to GHG emission reduction. 

	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	**[Applicable Condition]** Project activities for installation and/or improvement/conversion of off grid micro hydropower generation, wind power generation, geothermal generation, photovoltaic generation, wave power generation and tidal power generation are applicable. **[Equations]** Quantification is based on the CDM small-scale approved methodologies; **I.A.** of **TYPE I – RENEWABLE ENERGY PROJECTS.** **<u>Without the activity</u>** Case of using electricity from the grid $\boldsymbol{BE_{grid,y}} = EG_y \cdot EF_{grid,y}$ $BE_{grid,y}$: Baseline emission of grid electricity in *y* year (tCO_2/y) EG_y: Electricity supplied by project activity (MWh) $EF_{grid,y}$: CO_2 emission factor of grid electricity in *y* year (tCO_2/MWh) Case of using electricity produced by diesel generation $\boldsymbol{BE_{diesel,y}} = EG_y \cdot EF_{diesel,y}$ $BE_{diesel,y}$: Baseline emission of grid electricity in *y* year (tCO_2/y) EG_y: Electricity supplied by project activity (MWh) $EF_{diesel,y}$: CO_2 emission factor of diesel in *y* year (tCO_2/MWh) Case of using kerosene for lighting $\boldsymbol{BE_{kerosene,y}} = EG_y \cdot EF_{kerosene,y}$ $BE_{kerosene,y}$: Baseline emission due to lighting in *y* year (tCO_2/y) EG_y: Kerosene consumption by project activity (TJ/y) $EF_{kerosene,y}$: CO_2 emission factor of kerosene in *y* year (tCO_2/TJ) **<u>With the activity</u>** $\boldsymbol{PE_y} = 0$

PE_y: Project emission in y year

GHG emission reductions

$$ER_y = BE_y - PE_y$$

Required data and data source

EG_y: Electricity supplied by project activity (MWh)

Utilize the results of pilot project

Obtain through interviews with operational management body of electricity at the site

Or implement monitoring

$EF_{grid,y}$: CO_2 emission factor of grid in y year (tCO_2/MWh)

Refer to ***Annex 1***

$EF_{diesel,y}$: CO_2 emission factor of diesel in y year (tCO_2/MWh)

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

Cases:	Mini-grid with 24 hour service	i) Mini-grid with temporary service (4-6 hr/day) ii) Productive applications iii) Water pumps	Mini-grid with storage
Load factors [%]	25%	50%	100%
<15 kW	2.4	1.4	1.2
>=15 <35 kW	1.9	1.3	1.1
>=35 <135 kW	1.3	1.0	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_2 per kg of diesel has been used (following revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories)
**) Figures are derived from fuel curves in the online manual of RETScreen International's PV 2000 model, downloadable from http://retscreen.net/
***) Default values

Reference: CDM SSC Methodologies: TYPE I – RENEWABLE ENERGY PROJECTS, I.D.

$EF_{kerosene,y}$: CO_2 emission factor of kerosene in y year (tCO_2/TJ)

Refer to ***Annex 2***

Preconditions

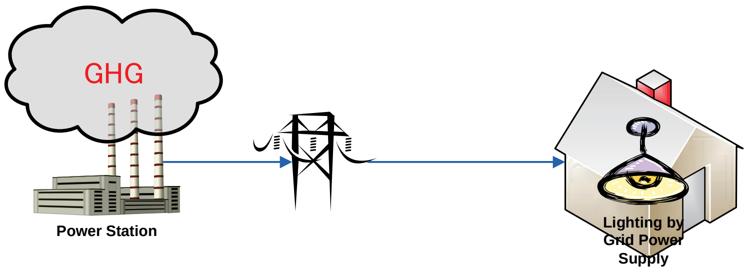
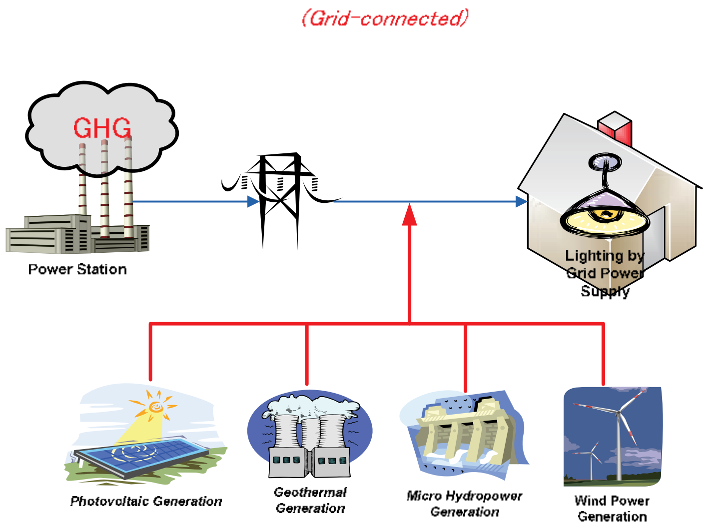
GHG emissions by manufacturing and construction when renewable energy generation is introduced are not considered.

Special notes

CO_2 emission factor of fuel used in the power plant in the grid, or diesel or kerosene for lighting should be referred to the value for the region/state or the IPCC default value.

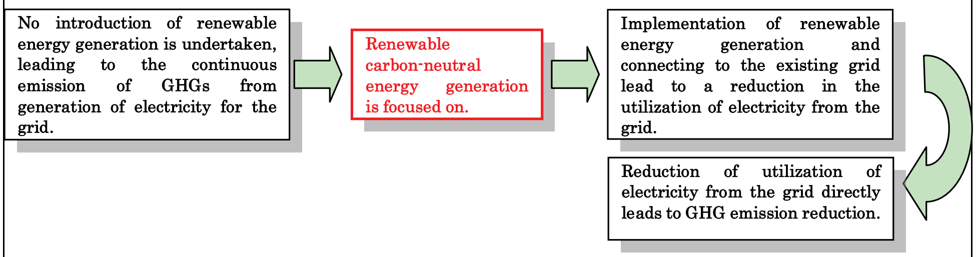
Quantification Sheet

Activity: Photovoltaic Generation, Geothermal Generation, Micro Hydropower Generation, Wind Power Generation (grid-connected)

<table>
<tr><td>Sector</td><td>Natural Resources & Energy Sector</td></tr>
<tr><td>Sub-sector</td><td>Renewable Energy</td></tr>
<tr><td>GHG emission reduction activity</td><td>Photovoltaic Generation, Geothermal Generation, Micro Hydropower Generation, Wind Power Generation (grid-connected)</td></tr>
<tr><td>GHG emission reduction impact</td><td>1: Activity will lead to GHG emission reduction
2: Activity will lead to GHG emission reduction subject to condition(s)
3: Activity will not lead to GHG emission reduction</td></tr>
<tr><td>GHG emission reduction scenarios
(description of how GHG is reduced)</td><td>**<Without the activity>**
No renewable energy generation is introduced, leading to the continuous emission of GHG from the production of electricity for the grid.

<With the activity>
Introduction of renewable energy generation and connecting it directly to the grid leads to a reduction in the utilization of electricity from the grid, and this leads to GHG emission reduction.
</td></tr>
</table>

<table>
<tr><td></td><td>

[Schematics of GHG emission reduction process]



</td></tr>
<tr><td>Calculation of GHG emission reduction</td><td>

[Applicable Conditions]

Project activities for installation and/or improvement/conversion of grid-connected micro hydropower generation, wind power generation, geothermal generation, photovoltaic generation, wave power generation and tidal power generation are applicable.

[Equations]

Quantification is based on the CDM small-scale approved methodology; **I.D.** of **TYPE I – RENEWABLE ENERGY PROJECTS.**

<u>Without the activity</u>

[Grid Electricity]

$\boldsymbol{BE_{grid,y}} = EG_y \cdot EF_{grid,y}$

$BE_{grid,y}$: Baseline emission due to generation of grid electricity in y year (tCO_2/y)

EG_y: Electricity supplied from the grid (MWh)

$EF_{grid,y}$: CO_2 emission factor of Electricity supplied from the grid in y year (tCO_2/MWh)

<u>With the activity</u>

$\boldsymbol{PE_y} = EG_{project,y} \cdot EF_{grid,y}$

PE_y: Project emissions in y year (tCO_2/y)

$EG_{project,y}$: Electricity supplied from the grid by project activity (MWh)

$EF_{grid,y}$: CO_2 emission factor of grid in y year (tCO_2/MWh)

<u>GHG emission reductions</u>

$\boldsymbol{ER_y = BE_y - PE_y}$

$= (EG_y - EG_{project,y}) \times EF_{grid,y}$

</td></tr>
<tr><td>Required data and data source</td><td>

EG_y: Electricity supplied from the grid (MWh)

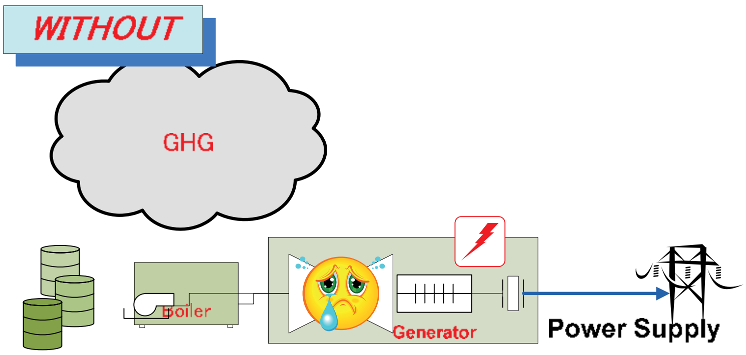
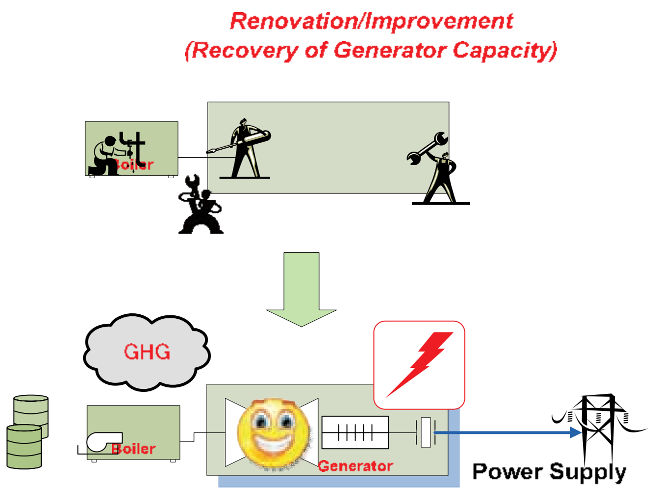
$EG_{project,y}$: Electricity supplied from the grid by project activity (MWh)

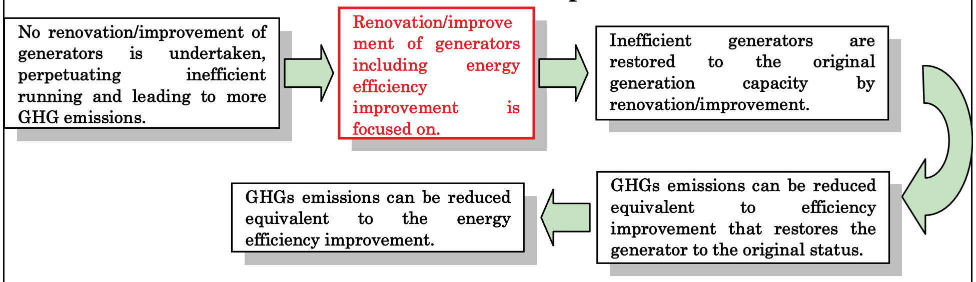
</td></tr>
</table>

	Utilize the results of pilot project and obtain through interviews with operational management body of electricity at the site $EF_{grid,y}$: CO_2 emission factor Electricity supplied from the grid in y year (tCO_2/MWh) Refer to ***Annex 1***
Preconditions	GHG emissions by manufacturing and construction when renewable energy generation is introduced are not considered.
Special notes	CO_2 emission factor of fuel used in the power plant feeding the grid should be referred to the value of the region/state or the IPCC default value.

Quantification Sheet

Activity: Renovation/Improvement of Generators (fossil fuel fired)

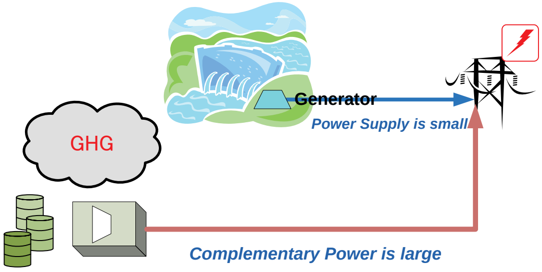
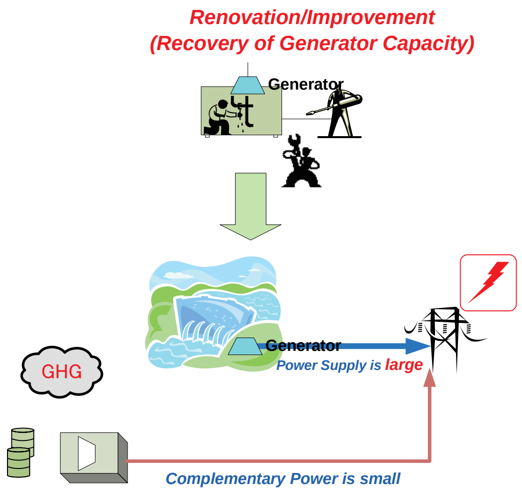
Sector	Natural Resources & Energy Sector
Sub-sector	Improvement of Energy Efficiency
GHG emission reduction activity	Renovation/Improvement of Generators (fossil fuel fired)
GHG emission reduction impact	<u>1: Activity will lead to GHG emission reduction</u> 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** No renovation/improvement of generators is undertaken, perpetuating inefficient running and leading to higher emissions of GHG.  **<With the activity>** Renovating generators to like new status leads to a reduction in GHG emissions equivalent to the efficiency improvement. 

	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	**[Applicable Condition]** Project activities for rehabilitation of fossil fuel-fired generators (or turbines) and/or improvement of energy efficiency are applicable. However, co-generation is not applicable (AM0061, AM0062) **[Equations]** Quantification is based on the CDM approved methodologies ; **AM0061** and **AM0062** **<u>Without the activity</u>** $\boldsymbol{BE_y} = \sum FC_{BL,i} \cdot COEF_{BL,i}$ BE_y: CO_2 emission by combustion of fossil fuel used for the generation before renovation/improvement of generators (tCO_2) $FC_{BL,i}$: Consumption of fuel *i* (mass or volume/y) $COEF_{BL,i}$: CO_2 emission factor of fuel *i* ($kgCO_2$/mass or volume) *i*: Fuel type **<u>With the activity</u>** $\boldsymbol{PE_y} = \sum FC_{PJ,i} \cdot COEF_{PJ,i}$ PE_y: CO_2 emission by combustion of fossil fuel used for the generation after renovation/improvement of generators (tCO_2) $FC_{PJ,i}$: Consumption of fuel *i* (mass or volume/y) $COEF_{PJ,i}$: CO_2 emission factor of fuel *i* ($kgCO_2$/mass or volume) *i*: Fuel type **<u>GHG emission reductions</u>** $\boldsymbol{ER_y = BE_y - PE_y}$
Required data and data source	$\boldsymbol{FC_{BL,I}, FC_{PJ,i}}$: Consumption of fuel *i* (mass or volume/y) Obtain through interviews with operational management body of electricity at the site

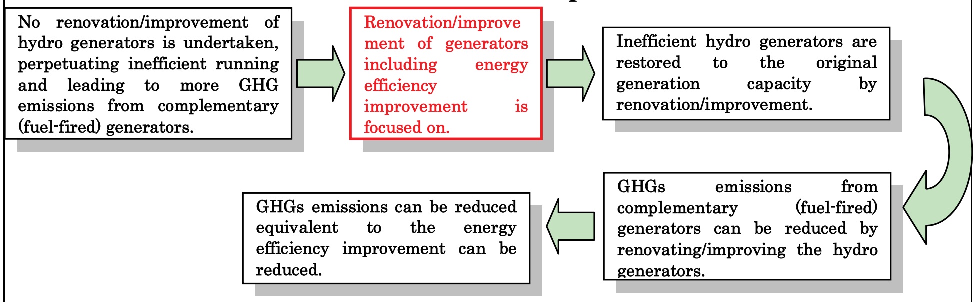
	Or implement monitoring $\boldsymbol{COEF_{BL,I}}$, $\boldsymbol{COEF_{PJ,i}}$: CO_2 emission factor of fuel *i* ($kgCO_2$/mass or volume) Refer to ***Annex 2*** and ***Annex 5***
Preconditions	Monitoring is implemented after renovation/improvement of the generators. The improvement of energy efficiency should be confirmed by numeric conversion.
Special notes	Take notice that the efficiency improvement factor is different according to the generator fuel type. The electric generation capacity is not increased by Renovation/Improvement of Generators.

Quantification Sheet

Activity: Renovation/Improvement of Generators (hydropower generation)

Sector	Natural Resources & Energy Sector
Sub-sector	Improvement of Energy Efficiency
GHG emission reduction activity	Renovation/Improvement of Generators (hydropower generation)
GHG emission reduction impact	1: Activity will lead to GHG emission reduction 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** No renovation/improvement of hydro generators is implemented, leading to the necessity of a much larger amount of electricity being generated by complementary (fossil fuel-fired) generators.  **<With the activity>** Based on the renovation/improvement of the hydro generators, necessary generation of electricity by complementary (fossil fuel-fired) generators decreases, leading to a reduction in fuel consumption. 

[Schematics of GHG emission reduction process]



Calculation of GHG emission reduction

[Calculation method]

ER is calculated from $\boldsymbol{PE_y}$, ***With the activity,*** which is the emission from the complementary electric generation as reduced by the efficiency improvements done to the hydro generators. That quantity is subtracted from $\boldsymbol{BE_y}$ ***Without the activity*** which is the emissions from complementary electric generation by (fuel-fired) generators if no efficiency improvement of the hydro generators is implemented.

Difference obtained is the GHG reduction ***ER*** by efficiency improvements to the hydro generators.

[Applicable Condition]

Project activities for rehabilitation of the hydro generators and/or improvement of energy efficiency are applicable.

[Equations]

Quantification is based on the CDM approved methodologies ; **AM0061** and **AM0062**

<u>Without the activity</u>

$$\boldsymbol{BE_y} = EL_{BL,hydro,y} \cdot EF_{hydro,y} + EL_{BL,FC,y} \cdot EF_{FC,y}$$

BE_y: Baseline CO_2 emission (tCO_2)

$EL_{BL,hydro,y}$: Grid-supplied electricity generated by the hydro generators of the project activity before project implementation in year y (MWh)

$EL_{BL,FC,y}$: Grid-supplied electricity generated by the complementary (fuel-fired) generators before project implementation in year y (MWh)

$EF_{hydro,y}$: CO_2 emission factor of hydro generator (tCO_2/MWh) = 0

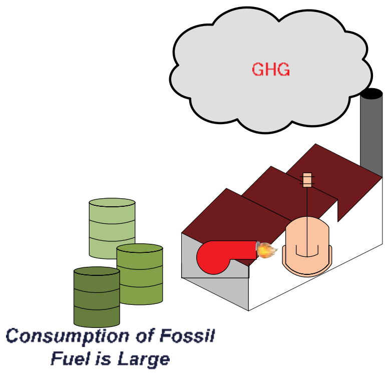
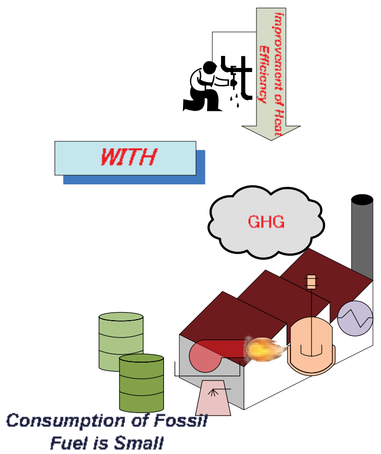
$EF_{FC,y}$: CO_2 emission factor of complementary (fuel-fired) generators (tCO_2/MWh)

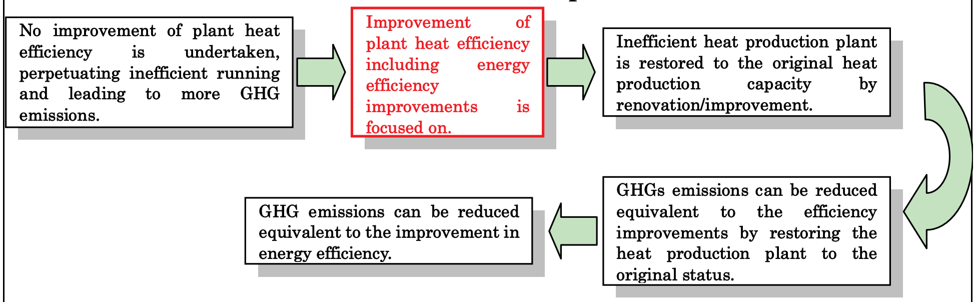
	Consequently, $\boldsymbol{BE_y} = EL_{BL,FC,y} \cdot EF_{FC,y}$ **With the activity** $\boldsymbol{PE_y} = EL_{PJ,hydro,y} \cdot EF_{hydro,y} + EL_{PJ,FC,y} \cdot EF_{FC,y}$ PE_y: Project CO_2 emission (tCO_2) $EL_{PJ,hydro,y}$: Grid-supplied electricity generated by hydro generators of the project activity after project implementation in year y (MWh) $EL_{PJ,FC,y}$: Grid-supplied electricity generated by complementary (fuel-fired) generators after project implementation in year y (MWh) $EF_{hydro,y}$: CO_2 emission factor of hydro generators (tCO_2/MWh) = 0 $EF_{FC,y}$: CO_2 emission factor of complementary (fuel-fired) generators (tCO_2/MWh) Consequently, $\boldsymbol{PE_y} = EL_{PJ,FC,y} \cdot EF_{FC,y}$ **GHG emission reductions** $\boldsymbol{ER_y} = \boldsymbol{BE_y} - \boldsymbol{PE_y}$ $= EL_{BL,FC,y} \cdot EF_{FC,y} - EL_{PJ,FC,y} \cdot EF_{FC,y}$ $= (EL_{BL,FC,y} - EL_{PJ,FC,y}) \cdot EF_{FC,y}$ $= (EL_{PJ,hydro,y} - EL_{BL,hydro,y}) \cdot EF_{FC,y}$
Required data and data source	$\boldsymbol{EL_{BL,hydro,y}}$, $\boldsymbol{EL_{PJ,hydro,y}}$: Grid-supplied electricity generated by hydro generators of the project activity before and after project implementation in year y (MWh) or $\boldsymbol{EL_{BL,FC,y}}$, $\boldsymbol{EL_{PJ,FC,y}}$: Grid-supplied electricity generated by complementary (fuel-fired) generators before and after project implementation in year y (MWh) Obtain through interviews with operational management body of electricity at the site Or implement monitoring $\boldsymbol{EF_{FC,y}}$: CO_2 emission factor of complementary (fuel-fired) generators (tCO_2/MWh) Refer to ***Annex 1***

Preconditions	Monitoring activity will definitely be undertaken after renovation/improvement of the generators and the improvement of energy efficiency should be confirmed by numeric conversion.
Special notes	Take notice of power control range of complementary (fuel-fired) generators. It might be less than the limit of low load operation.

Quantification Sheet

Activity: Improvement of Plant Heat Efficiency

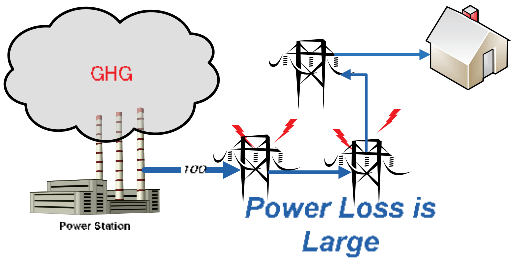
Sector	Natural Resources & Energy Sector
Sub-sector	Improvement of Energy Efficiency
GHG emission reduction activity	Improvement of Plant Heat Efficiency
GHG emission reduction impact	1: Activity will lead to GHG emission reduction 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** No improvement of plant heat efficiency is undertaken, perpetuating inefficient running and leading to more emission of GHG.  **<With the activity>** Renovating heat production plant to like new status leads to reduce GHG emissions by a quantity equivalent to the efficiency improvement. 

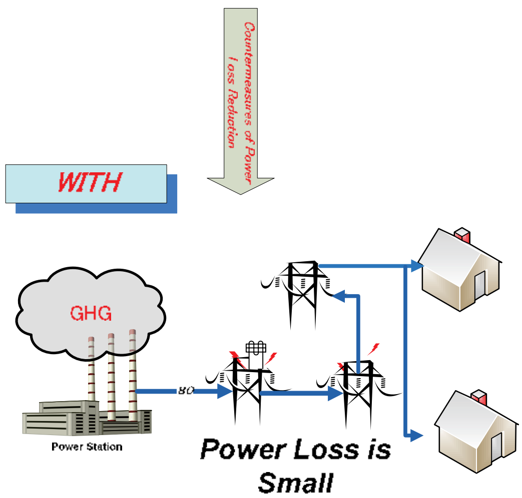
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	**[Applicable Condition]** Project activities for improvement of energy efficiency of the boilers by rehabilitation or replacement are applicable. **[Equations]** Quantification is based on the CDM approved methodology **AM0044.** **<u>Without the activity</u>** $\boldsymbol{BE_{i,y}} = FC_{BL,i,y} \cdot EF_{C,FF,i} \cdot OXID_{FF,i} \cdot 44/12$ $BE_{i,y}$: Baseline CO_2 emission by fossil fuel-fired boiler *i* in year *y* (tCO_2/y) $FC_{BL,i,y}$: Fossil fuel consumption supplied to boiler *i* in year *y* (MJ/y) $EF_{C,FF,i}$: Emission factor of fossil fuel used for boiler *i* (tC/MJ) $OXID_{FF,i}$:Oxidation coefficient of fossil fuel used for boiler *i* (%) **<u>With the activity</u>** $\boldsymbol{PE_{i,y}} = FC_{PJ,i,y} \cdot EF_{C,FF,i} \cdot OXID_{FF,i} \cdot 44/12$ $PE_{i,y}$: Emission by fossil fuel-fired project boiler *i* in year *y* (tCO_2/y) $FC_{PJ,i,y}$: Fossil fuel consumption supplied to project boiler *i* in year *y* (MJ/y) $EF_{C,FF,i}$: Emission factor of fossil fuel used for project boiler *i* (tC/MJ) $OXID_{FF,i}$: Oxidation coefficient of fossil fuel used for project boiler *i* (%) **<u>GHG emission reductions</u>** $\boldsymbol{ER_y = BE_y - PE_y}$
Required data and data source	$\boldsymbol{FC_{BL,i,y}}$: Fossil fuel consumption supplied to boiler *i* in year *y* (MJ/y) $FC_{PJ,i,y}$: Fossil fuel consumption supplied to project boiler *i* in year *y* (MJ/y) Obtain through interviews with operational management body at the site Or implement monitoring

	$\boldsymbol{EF_{C,FF,i}}$: Emission factor of fossil fuel used for boiler *i* (tC/MJ) $\boldsymbol{OXID_{FF,i}}$: Oxidation coefficient of fossil fuel used for boiler *i* (%) $\boldsymbol{EF_{C,FF,i}}$: Emission factor of fossil fuel used for project boiler *i* (tC/MJ) Refer to ***Annex 2***
Preconditions	Monitoring will definitely be implemented after improvement of plant heat efficiency and the improvement of energy efficiency should be confirmed by numeric conversion.
Special notes	Take notice that efficiency improvement factor and carbon emission factor are different according to the fuel used for the plant. The heat generation capacity is not increased by Improvement of Plant Heat Efficiency.

Quantification Sheet

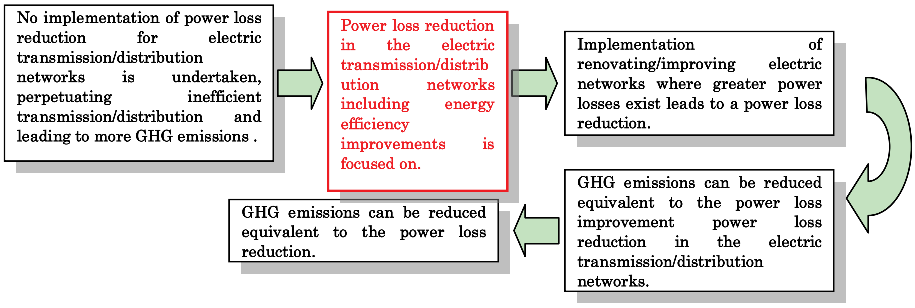
Activity: Power Loss Reduction of Transmission/Distribution Electric Networks

<table>
<tr><td>Sector</td><td>Natural Resources & Energy Sector</td></tr>
<tr><td>Sub-sector</td><td>Improvement of Energy Efficiency</td></tr>
<tr><td>GHG emission reduction activity</td><td>Power Loss Reduction of Transmission/Distribution Electric Networks</td></tr>
<tr><td>GHG emission reduction impact</td><td><u>1: Activity will lead to GHG emission reduction</u>
2: Activity will lead to GHG emission reduction subject to condition(s)
3: Activity will not lead to GHG emission reduction</td></tr>
<tr><td>GHG emission reduction scenarios
(description of how GHG is reduced)</td><td><Without the activity>
No implementation of power loss reduction for transmission/distribution electric networks is undertaken, perpetuating inefficient transmission/distribution and leading to the generation of additional electricity and GHG emissions equivalent to the power loss.


<With the activity>
Reducing the power loss in the transmission/distribution networks leads to a reduction in GHG emission equivalent to the power loss reduction.

</td></tr>
</table>

<table>
<tr><td></td><td>

[Schematics of GHG emission reduction process]



</td></tr>
<tr><td>Calculation of GHG emission reduction</td><td>

[Applicable Condition]

In AM0067, which is a methodology related to the installation of high efficiency transformers, detailed applicable conditions are defined for transformers. In common projects for loss reduction in transmission/distribution electric networks, measures consisting of (1) improvement of imbalance factors, (2) power factor improvement of feeders, and (3) construction of new lines are mainly implemented. Considering all these measures, generalized calculation formulas for emission reduction with reference to the formulas in AM0067 are applied here, which means that GHG reduction is calculated by comparing methods of electric power loss, which is the difference in the customer’s power consumption before and after the improvement in the grid.

[Equations]

Quantification is based on the CDM approved methodology **AM0067**

<u>Without the activity</u>

$\boldsymbol{BE_y} = [(EL_{BL,y} - EL_{aux,y}) - EL_{BL,consump,y}] \times EF_{CO2,grid,y}$

BE_y: Baseline CO_2 emission in year y (tCO_2/y)

$EL_{BL,y}$: Total generated power supplied to the grid (before project implementation) in year y (MWh)

$EL_{aux,y}$: Generated power consumed by auxiliary devices in year y (MWh)

$EL_{BL,consump,y}$: Customer’s power consumption (before project implementation) in year y (MWh)

$EF_{CO2,grid,y}$: CO_2 emission factor for the grid in which project activity was implemented in year y (tCO_2/MWh)

<u>With the activity</u>

$\boldsymbol{PE_y} = [(EL_{PR,y} - EL_{aux,y}) - EL_{PR,consump,y}] \times EF_{CO2,grid,y}$

</td></tr>
</table>

	PE_y: Project CO_2 emission in year *y* (tCO_2/y) $EL_{BL,y}$: Total generated power supplied to the grid (after project implementation) in year *y* (MWh) $EL_{aux,y}$: Generated power consumed by auxiliary devices in year *y* (MWh) $EL_{BL,consump,y}$: Customer's power consumption (after project implementation) in year *y* (MWh) $EF_{CO2,grid,y}$: CO_2 emission factor for the grid, in which project activity was implemented in year y (tCO_2/MWh) **GHG emission reductions** $\boldsymbol{ER_y = BE_y - PE_y}$
Required data and data source	$EL_{BL,y}$: Total generated power supplied to the grid (before project implementation) in year *y* (MWh) $EL_{aux,y}$: Generated power consumed by auxiliary devices in year *y* (MWh) $EL_{BL,consump,y}$: Customer's power consumption (before project implementation) in year *y* (MWh) $EL_{BL,y}$: Total generated power supplied to the grid (after project implementation) in year *y* (MWh) $EL_{aux,y}$: Generated power consumed by auxiliary devices in year *y* (MWh) $EL_{BL,consump,y}$: Customer's power consumption (after project implementation) in year *y* (MWh) Obtain through interviews with operational management body at the site Or implement monitoring $EF_{CO2,grid,y}$: CO_2 emission factor for the grid (tCO_2/MWh) Refer to ***Annex 1***
Preconditions	Monitoring does will definitely be implemented after implementation of measure for power loss reduction and the improvement of energy efficiency should be confirmed by numeric conversion.
Special notes	Take notice that the efficiency improvement factor is different according to the measures (or location) implemented. The annual transmission/distribution amounts of electricity stay constant before and after implementing the measures.

3.1.1 Case studies

№	Project Title	Sector
1	The Project on Energy Conservation in the Republic of Turkey	Natural Resources and Energy
2	Study on Rural Electrification Project by Renewable Energy in Lao People's Democratic Republic	Natural Resources and Energy
3	Study on Electrical Power Loss Reduction of Transmission and Distribution Networks in the Hashemite Kingdom of Jordan	Natural Resources and Energy

Case study No.	1
Project title	The Project on Energy Conservation in the Republic of Turkey
Sector	Natural Resources and Energy
Sub-sector	Energy conservation
Project summary	**[Background]** The government of the Republic of Turkey has been promoting energy conservation since the energy crisis began as the country's oil dependency is extremely high. However, the country's self sufficiency in energy was less than 50% in 1997, which is expected to continue declining due to the rapid growth in energy consumption (the country recorded a 20% increase over the last 5 years). The country stipulated in the 1995 "Energy Efficiency Regulation for Industrial Establishments" that major enterprises must attend management courses related to energy conservation. And thus, it is an urgent issue for National Energy Conservation Centre of Turkey (NECC) to train personnel for the energy manager positions. **[Objective]** To provide project-type technical cooperation for organizing a training course for practical energy managers to improve the current conditions. **[Situation after the project implementation]** NECC provided training courses related to energy conservation as well as conducted energy diagnosis at more than 1,000 enterprises that own large plants. NECC also promoted energy conservation through training of energy managers.
GHG emission reduction scenarios	<Without the activity> Energy conservation measures are not undertaken and a great amount of energy continues to be consumed. <With the activity> Institutions related to energy conservation are established (such as provision of training courses on energy conservation, energy diagnosis, and promotional activities on energy conservation) and energy conservation measures are undertaken, leading to the reduction of energy consumption.
Equations to calculate GHG emissions	1) Provision of training courses related to energy conservation • Energy conserved in a factory (TOE/ year) = Energy conservation

	rate (%) × Amount of total energy consumed at the factory to which the personnel belongs who attended an energy conservation training course (TOE/ year) • Total energy conserved (TOE/ year) = Σ energy conserved in a factory (TOE/ year) • GHG emission reduction (tCO_2/ year) = Total energy conserved (TOE/ year) × CO_2 emission factor (tCO_2/ TOE) 2) Energy diagnosis • Energy conserved in a factory (TOE/ year) = Energy conservation rate (%) × Amount of total energy consumed at a factory where energy diagnosis was undertaken (TOE/ year) • Total energy conserved (TOE/ year) = Σ energy conserved in a factory (TOE/ year) • GHG emission reduction (t-CO_2/ year) = Total energy conserved (TOE/ year) × CO_2 emission factor (tCO_2/ TOE) 3) Promotional activities for energy conservation • Energy conserved in a factory (TOE/ year) = Energy conservation rate (%) × Amount of total energy consumed at a factory where promotional activities for energy conservation were undertaken (TOE/ year) • Total energy conserved (TOE/ year) = Σ energy conserved in a factory (TOE/ year) • GHG emission reduction (tCO_2/ year) = Total energy conserved (TOE/ year) × CO_2 emission factor (tCO_2/ TOE)
Applied data	Following data was applied to the calculation. 1) Provision of training courses related to energy conservation • Number of trainees who were trained at the NECC's energy conservation training courses was 1,016 by the end of 2007.

Table 1 Information of Persons trained in EIE at the end of year 2007

Item	Unit	Total of sector	Industrial Sector						
			Iron and steel	Ceramic	Textile	Food processing	Paper and pulp	Cement	Others
Number of trained persons who attended the Energy Manager Training Course at the end of year 2007	(persons)	1,016	50	25	79	134	26	59	643
Number of factories who attended the Energy Manager Training Course at the end of year 2007	(factories)	577	25	20	55	90	22	39	351
Total amount of energy consumed at a factory where trained persons are staffed	(TOE)	ND	ND	ND	ND	ND	ND	ND	ND

- Energy conservation rate of 7.09 % is applied. The rate is calculated by dividing the total amount of energy consumed in seven energy consuming sectors (5,018,181 TOE) by the total amount of energy conserved in the sectors (356,030 TOE) in the sample 100 factories that participated the training courses.

Table 2 Summary of Questionnaire in Energy Manager Meeting in 2006

Item	Unit	Total of sector	Industrial Sector						
			Iron and steel	Ceramic	Textile	Food processing	Paper and pulp	Cement	Others
Number of trained persons who attended the Energy Manager Meeting in 2006	(persons)	100	2	4	5	31	1	13	44
Number of factories who attended the Energy Manager Meeting in 2006	(factories)	100	2	4	5	31	1	13	44
Total amount of energy consumed at a factory where trained persons are staffed	(TOE)	5,018,181	3,229,459	38,846	43,557	266,283	27,971	997,395	417,291
Total amount of energy saving achieved at a factory after trained persons conducted energy saving activities	(TOE)	356,030	316,447	1911	24	3848	409	26,777	8,110
Energy reduction rate by energy saving activities	(%)	7.09	9.8	4.92	0,06	1.44	1.46	2.68	1.94

2) Energy diagnosis

- Amount of energy conserved from 78 factories that undertook energy diagnosis by the end of 2007 is calculated to be 32,347 TOE based on the responses to the questionnaires. This yields the energy conservation rate of 9.9 % compared with the total amount of energy consumption in the 78 factories.

Table 3 Information of Factory Diagnostics implemented by EIE/NECC at the end of 2007

Item	Unit	Total of sector	Industrial Sector						
			Iron and steel	Ceramic	Textile	Food processing	Paper and pulp	Cement	Others
Number of factories that conducted energy diagnostics	(factories)	78	6	7	17	22	4	ND	22
Total amount of energy consumed at a factory that conducted energy diagnostics	(TOE)	5,018,181	31,238	40,638	94,512	18,004	11,588	ND	132,045
Total amount of energy saving expected due to the energy saving measures identified by energy diagnostics	(TOE)	32,347	652	13,911	7,725	702	1,123	ND	8,235
Energy reduction rate by energy saving activities	(%)	9.9	2.1	34.2	8.2	3.9	9.7	ND	6.2

	3) Promotional activities for energy conservation • No data regarding the promotional activities have been prepared, and thus the energy conservation impacts cannot be calculated.
Calculation of GHG emissions	1) Provision of training courses related to energy conservation GHG emission reductions achieved in the sample 100 factories are calculated based on the information shown in Table 2 above as follows. • Energy conserved in a factory (TOE/ year) = 7.09 % × 5,018,181 TOE/ year • Total energy conserved (TOE/ year) = 356,030 TOE/ year • GHG emission reduction (tCO_2/ year) = 356,030 TOE/ year × 3.101 tCO_2/ TOE[See Note)] = 1,104,049 t-CO_2/ year Note) CO_2 emission per 1 TOE（kgCO_2/TOE）: CO_2 emission factor of Heavy Oil（kgCO_2/TJ）× Net calorific value of Heavy Oil (TJ/Gg) / 1000 = 73300×42.3 / 1000 = 3,101 kgCO_2/TOE 2) Energy diagnosis GHG emission reductions achieved in the 78 factories that undertook energy diagnosis are calculated based on the information shown in Table 3 above as follows. • Energy conserved in a factory (TOE/ year) = 9.9 % × 5,018,181 TOE/ year • Total energy conserved (TOE/ year) = 32,347 TOE/ year • GHG emission reduction (tCO_2/ year) = 32,347 TOE/ year × 3.101 tCO_2/ TOE • = 100,308 tCO_2/ year
Preconditions	Trainees who attend the NECC training courses undertake energy conservation measures in their factory. Energy conservation activities are not limited to those that were included in the training courses, and appropriate measures are taken for each factory. Data to be used to calculate energy conservation impacts is measurable, reportable, and verifiable.

Lessons learned from case study	In order to quantify the energy conservation impacts, monitoring of data such as the amount of energy consumption or the amount of production activity is essential before and after the energy conservation measure is undertaken. It is difficult to directly quantify the energy conservation impacts from the activities of NECC as their activities involve mainly indirect conservation measures such as training and human capacity development. And therefore, it is important to use the data of energy consumption at the concerned facility (such as a factory) as a useful indicator. In addition, it is very useful to identify the value per unit production since this parameter is less affected by external factors such as economic conditions. Furthermore, it is important to enhance technical transfer to developing countries regarding preparation of CO_2 emission factors of the country's electricity grid system.

Case study No.	2
Project title	Study on Rural Electrification Project by Renewable Energy in Lao People's Democratic Republic
Sector	Natural Resources and Energy
Sub-sector	Renewable energy
Project summary	**[Background]** Lao People's Democratic Republic (Lao PDR) is utilizing its abundant hydro-power resources which allow the country to achieve 100% self-sufficiency in its domestic electricity supply and to export excess electricity to neighbouring Thailand. However, various constraints have been preventing electrification in the country including financial constraints in the government, sparse distribution of population, and mountainous land. Electrification rate of the country remains low at 20 to 25%, and rural areas have especially lower rates since they are isolated from the central power grid system. The government sets the nationwide electrification target of 50% by the year 2000 in recognition of the electricity supply as a basic need. In order to achieve this goal, it called for the need of extension of the grid system as well as introduction of decentralized power systems in isolated areas. The government, in recognition of environmental conservation, focuses on renewable energy sources such as photovoltaic (PV) and micro hydropower generation. Especially PV power generation is considered extremely useful as the system is less affected by the location and geography than other sources. However, Laos does not have much experience in PV and related policy is not defined yet. **[Objective]** To install a pilot plant PV system in Lao PDR and to examine the potential of rural electrification using PV and micro hydro power generation. **[Situation after the project implementation]** Lao PDR is further promoting rural electrification in which PV and micro hydro supply electricity to rural houses that is adequate to power basic electric items such as lighting and TVs. At the study phase in the year 2000, 295 PV systems and 8 battery charge stations were installed as pilot projects. As of the end of November 2008, the installed systems have changed to: PV systems in 10,251 households, 8

	battery charge stations, and 2 micro hydro systems are installed in 2 villages for 115 households. Although the number of a battery charge station remains the same, the number of PV systems installed in houses has increased by 35 times (which were facilitated by finance from the World Bank).
GHG emission reduction scenarios	Without the activity : Isolated villages are not connected with national power grid, forcing villagers to use diesel-fuelled battery charging stations or kerosene as a source of lighting. Emissions from the Without scenario are the CO_2 emissions corresponding to the amount of electricity consumed by the households prior to installing the PV systems in November 2008. With the activity : Photovoltaic systems are installed in the households.
Equations to calculate GHG emissions	1) GHG emission reductions (tCO_2/ year) = Amount of annual electricity consumption per household (kWh/ household) × CO_2 emission factor of diesel fuel (tCO_2/kWh) × Number of households that installed PV systems (households) or 2) GHG emission reductions (tCO_2/ year) = Amount of annual kerosene consumption per household (kl/ household) × CO_2 emission factor of kerosene (tCO_2/kl) × Number of households that installed PV system (households)
Applied data	Following data are applied to the quantification. Data were obtained through site surveys. • Amount of electricity consumption and daily usage hours for TV, CD player, and a stereo set. TV : 150W 4 hours use CD player: 30W 2 hours use Stereo set: 30W 2 hours use • Amount of electricity generated using diesel fuel A diesel power generation unit can generate 0.4 kWh of electricity from 1 litter of diesel fuel • CO_2 emission factor of diesel fuel (source) Carbon emission factor: 0.0187 tC/ GJ Calorific value: 38.2 GJ/ kℓ

	CO_2 emission factor: 0.0187 tC/ GJ × 38.2 GJ/ kℓ × 44/12 = 2.62 tCO_2/ kℓ Information source: Ministry of Energy of Japan, Ministry of Economy, Trade and Industry of Japan • Amount of kerosene for lighting 24 litters of kerosene use per year equivalent to lighting up a 20 W lamp for 4 hours per day. • CO_2 emission factor of kerosene Carbon emission factor: 0.0185 tC/ GJ Calorific value: 36.7 GJ/ kℓ CO_2 emission factor: 0.0185 tC/ GJ × 36.7 GJ/ kℓ × 44/12 = 2.49 tCO_2/ kℓ Information source: Ministry of Energy of Japan, Ministry of Economy, Trade and Industry of Japan • Number of households that have installed PV systems by the end of November 2008: 10,251 households
Calculation of GHG emissions	• CO_2 emissions from the use of TV, CD player, and a stereo set: electricity source is diesel Daily electricity consumption TV : 600 Wh/ day CD player: 60 Wh/ day Stereo set: 60 Wh/ day Total: 720 Wh/ day = 262.8 kWh/ year Electric generation by a diesel generation unit: 0.4 kWh/ℓ CO_2 emission factor of diesel fuel: 2.62 tCO_2/ kℓ ÷ 0.4 kWh/ ℓ × 10^{-3} = 0.00655tCO_2/ kWh CO_2 emissions from the use of TV, CD player, and a stereo set: 262.8 kWh/ year × 0.00655 tCO_2/kWh = **1.72 tCO_2/ year/ household** • CO_2 emissions from the use of lighting by burning kerosene Daily electricity consumption for lighting: 80 Wh/ day Amount of kerosene consumption: 24 ℓ/ year or 0.024 kℓ/ year CO_2 emissions from the use of kerosene-fuelled lighting: 2.49 tCO_2/ kℓ × 0.024 kℓ/year = **0.06 tCO_2/ year/ household** Thus,

	• Annual CO_2 emissions from a household: 1.72＋0.06＝**1.78 tCO_2/ year/ household** • Total amount of CO_2 emissions reduced by the project: 1.78 t-CO_2/ year × 10,251 households = **18,247 tCO_2/ year**
Preconditions	Quantification covers only households that have been equipped with PV systems. Those involved with battery charging systems and micro-hydro power generation units are excluded from the calculation. It is assumed the electricity consuming equipment of one household are one TV set, one CD player, one stereo set, and one lighting fixture. It is also assumed that electricity was supplied from diesel-based battery charging systems to power the TV, CD player and stereo set, while light was provided by burning kerosene before the installation of the PV systems.
Lessons learned from case study	It is important to set an appropriate baseline for a renewable energy-based rural electrification project. Especially in Lao PDR, the electricity grid largely consists of hydro power generation, and therefore, GHG emission reduction through a renewable energy project activity tends to be minimal. On the other hand, for a project involving introduction of renewable energy in a rural non-electrified area, thorough and detailed monitoring of electricity use before the project (baseline) is necessary. Since the prior monitoring was not sufficiently undertaken in Lao PDR, identification of a baseline was difficult. To avoid such difficulty, it is recommended to monitor and store critical data such as pre-project electricity consumption at the implementation stage of a JICA project.

Case study No.	3
Project title	Study on Electrical Power Loss Reduction of Transmission and Distribution Networks in the Hashemite Kingdom of Jordan
Sector	Natural Resources and Energy
Sub-sector	Improvement of energy efficiency
Project summary	**[Background]** In the Hashemite Kingdom of Jordan, state-owned NEPCO is in charge of most of the electric generation, transmission and distribution. Two private electricity companies, JEPCO and IDECO, are in charge of distribution outside of the NEPCO's supply area, both of them purchase electricity from NEPCO and supply electricity to customers. Electric loss from transmission and distribution in Jordan was 9.4% on average from 1986 to 1995. Reduction of grid loss is a critical issue in the country to improve energy efficiency as well as to reduce new power generation development in the future. **[Objectives]** To examine the cause of transmission and distribution loss from the power sector in Jordan and to propose measures to reduce grid loss, as well as to enhance technical transfer from Japan to stakeholders in the electricity market of Jordan. **[Situation after the project implementation]** As of January 2009, Jordan's electricity system consists of NEPCO, 3 transmission and distribution companies (JEPCO, EDCO, IDECO), and power generation companies (CEGCO, SEPGCO, AES-Jordan, etc.). Three transmission and distribution companies have continued implementing the grid loss reduction measures up to the present day. Estimated grid loss reduction is calculated as 300 GWh for the 9 years from 1999 to 2007.
GHG emission reduction scenarios	<u>Without the activity</u> : Transmission and distribution loss of the electric grid in Jordan remains 11% (data source: final report of the JICA study in 1997). <u>With the activity</u> : Measures are taken to reduce transmission and distribution loss of the electric grid of Jordan based on the JICA study.
Equations to	GHG emission reduction (tCO_2/ year) = (Amount of electric loss before

calculate GHG emissions	the measure is taken (GWh/ year) －Amount of electric loss after the measure is taken (GWh/ year)) × CO_2 emission factor of the electric grid of the country (tCO_2/MWh) See Annex 1 of this Guidebook for details of the CO_2 emission factor of the electric grid
Applied data	(1) Amount of grid electricity loss, and amount of grid electricity loss that is avoided (for each of the 3 transmission and distribution companies)

JEPCO

Year	Electricity generation (GWh)	Electricity loss (GWh)	Loss Ratio (%)	Loss reduction (GWh)	Loss without measures (GWh)	Loss Ratio (%)	Total Reduction (%)
1999	3,409.00	331.64	9.73%	15.46	347.10	10.18%	0.45%
2000	3,638.00	340.00	9.35%	15.95	355.95	9.78%	0.44%
2001	3,889.00	382.26	9.83%	21.49	403.75	10.38%	0.55%
2002	4,041.00	415.58	10.28%	21.00	436.58	10.80%	0.52%
2003	4,482.00	510.00	11.38%	19.78	529.78	11.82%	0.44%
2004	4,907.00	511.00	10.41%	24.89	535.89	10.92%	0.51%
2005	5,431.00	638.07	11.75%	25.01	663.08	12.21%	0.46%
2006	6,156.00	763.89	12.41%	24.10	787.99	12.80%	0.39%
2007	7,112.00	1,082.18	15.22%	38.79	1,120.97	15.76%	0.55%

EDCO

Year	Electricity generation (GWh)	Electricity loss (GWh)	Loss Ratio (%)	Loss reduction (GWh)	Loss without measures (GWh)	Loss Ratio (%)	Total Reduction (%)
1999	1,026.16	115.70	11.28%	5.49	121.19	11.81%	0.54%
2000	1,030.00	113.35	11.00%	5.10	118.45	11.50%	0.50%
2001	1,107.40	137.70	12.43%	5.60	143.30	12.94%	0.51%
2002	1,151.60	143.87	12.49%	4.46	148.33	12.88%	0.39%
2003	1,283.16	166.53	12.98%	5.67	172.20	13.42%	0.44%
2004	1,489.94	184.73	12.40%	6.43	191.16	12.83%	0.43%
2005	1,633.00	205.11	12.56%	6.53	211.64	12.96%	0.40%
2006	1,793.20	232.86	12.99%	8.86	241.72	13.48%	0.49%
2007	2,022.84	246.79	12.20%	10.52	257.31	12.72%	0.52%

IDECO

Year	Electricity generation (GWh)	Electricity loss (GWh)	Loss Ratio (%)	Loss reduction (GWh)	Loss without measures (GWh)	Loss Ratio (%)	Total Reduction (%)
1999	899.60	129.50	14.40%	3.50	133.00	14.78%	0.39%
2000	960.90	138.20	14.38%	3.70	141.90	14.77%	0.39%
2001	1,030.10	143.50	13.93%	4.00	147.50	14.32%	0.39%
2002	1,107.90	140.30	12.66%	4.00	144.30	13.02%	0.36%
2003	1,156.00	132.90	11.50%	3.20	136.10	11.77%	0.28%
2004	1,263.50	137.90	10.91%	3.30	141.20	11.18%	0.26%
2005	1,355.00	145.10	10.71%	3.10	148.20	10.94%	0.23%
2006	1,481.40	154.90	10.46%	6.10	161.00	10.87%	0.41%
2007	1,649.50	186.00	11.28%	6.00	192.00	11.64%	0.36%

Total JEPCO, EDCO, IDECO

Year	Electricity generation (GWh)	Electricity loss (GWh)	Loss Ratio (%)	Loss reduction (GWh)	Loss without measures (GWh)	Loss Ratio (%)	Total Reduction (%)
1999	5,334.76	576.84	10.81%	24.45	601.29	11.27%	0.46%
2000	5,628.90	591.55	10.51%	24.75	616.30	10.95%	0.44%
2001	6,026.50	663.46	11.01%	31.09	694.55	11.52%	0.52%
2002	6,300.50	699.75	11.11%	29.46	729.21	11.57%	0.47%
2003	6,921.16	809.43	11.70%	28.65	838.08	12.11%	0.41%
2004	7,660.44	833.63	10.88%	34.62	868.25	11.33%	0.45%
2005	8,419.00	988.28	11.74%	34.64	1,022.92	12.15%	0.41%
2006	9,430.60	1,151.65	12.21%	39.06	1,190.71	12.63%	0.41%
2007	10,784.34	1,514.97	14.05%	55.31	1,570.28	14.56%	0.51%
TOTAL		7,829.56	-	302.03	8,131.58	-	-

(2) CO_2 emission factor of the electric grid

Jordan's power generation is primarily undertaken by CEGCO, which took over the duty of the former power generation section of NEPCO, and several other IPPs. Especially SEPGCO, the second largest IPP in Jordan to date, was established in 2004 and it started the power generation business in 2006. Another IPP, AES-Jordan, is currently constructing a 370 MW power plant which is expected to start operation in 2009.

CO_2 emission factor of the grid is calculated based on the data of CEGCO. For the estimation of 2006 – 2007 emission factors, the data of SEPGCO is also included and a weighted average is calculated. The CO_2 emission factor is calculated using the electric generation and fuel consumption.

$$EF_{grid} = \Sigma\, FC_i \times NCV_i \times EF_i / \Sigma\, EG$$

or,

CO_2 emission factor of the grid (tCO_2/MWh) =
Σ (Amount of consumption of fuel, i (mass))
× Net calorific value of fuel, i (GJ/ mass)
× Emission factor of the fuel, i (tCO_2/ GJ)
/ Σ (Amount of grid electricity generation (MWh))

1) Σ EG: Amount of electric generation by fuel source by CEGCO (in GWh)

Electricity generation	2000	2001	2002	2003	2004	2005	2006	2007
Heavy Fuel Oil	6,478	6,604	7,205	6,858	7,168	7,524	5,731	6,525
Natural Gas	742	769	680	746	776	1,206	3,124	3,244
Diesel Oil	113	125	186	340	465	312	70	33
Renewable Energy	42	46	56	44	56	43	40	51
Total	7,375	7,544	8,127	7,988	8,465	9,086	8,965	9,852

Unit: GWh/ year

Source: NEPCO annual reports 2001, 2003, 2007

2) $\Sigma\, FC_i \times NCV_i \times EF_i / \Sigma\, EG$: CO_2 emission factor of the electricity generated by CEGCO (tCO_2/MWh)

Figures in the table below represent the value of total CO_2 emissions (tCO_2) by fuel type in each year from all connected power plants. This value is calculated for each fuel and each year by multiplying fuel consumption (FC_i) and net calorific value of each fuel (NCV_i), and CO_2 emission factor of each fuel (EF_i). And the sum of these values for each year ($\Sigma FC_i \times NCV_i \times EF_i$) is divided by the year's total electric generation by all fuel types, which is calculated in the previous step (Σ EG)

See Annex 1 (Option B) of this Guidebook for detailed information on EF_i.

CO_2 emissions by fuel type (ton-CO_2)	2000	2001	2002	2003	2004	2005	2006	2007
Heavy Oil	50,066	50,594	54,688	46,809	28,073	24,258	19,356	1,926
Natural Gas	5,221	5,078	4,627	10,607	28,310	32,772	47,437	56,858
Diesel Oil	1,159	1,065	1,723	3,070	4,825	7,206	3,196	282
TOTAL (ton-CO_2)	56,446	56,737	61,039	60,487	61,208	64,235	69,989	59,066
CEF (tCO_2/MWh)	0.8737	0.8585	0.8574	0.8644	0.8254	0.8070	0.8912	0.6844

[Calculation process: example of 2007]

Data source: NEPCO Annual Report 2007

a. Electric generation by generation type (in GWh)

Steam Units:	6,525.30 GWh	
Combined Cycle:	2,422.30 GWh	(a)
Gas Turbines (diesel):	32.00 GWh	(b)
Gas Turbines (natural gas):	821.50 GWh	(c)
Diesel Engines:	0.70 GWh	(d)
Hydro: } Renewable energy	47.60 GWh	(e)
Wind: } Renewable energy	2.90 GWh	(f)

Above is then categorized by fuel type as follows:

Heavy fuel oil:	6,525.30 GWh	
Natural gas:	3,243.80 GWh	(a)+(c)
Diesel oil:	32.70 GWh	(b)+(d)
Renewable energy:	50.50 GWh	(e)+(f)
Total generation	9,852.30 GWh	

b. Fuel consumption (TTOE/y)

Heavy fuel oil(HFO):	621 TTOE/y
Natural gas(NG):	2,396 TTOE/y
Diesel Oil:	9 TTOE/y
Total	3,026 TTOE/y

Fuel consumption FC (Gg/y) = fuel consumption (TTOE/y) × Net calorific value of heavy fuel oil NCV_{HFO} (TJ/Gg) × 10^3 / Net calorific value of a fuel NCV (TJ/Gg)

HFO: FC_{HFO}=621×42.30×10^3/42.30=621×10^3

NG: FC_{NG}=2,396×42.30×10^3/43.0=2,357×10^3

Diesel Oil: FC_{diesel}=9×42.30×10^3/48.0=7.93×10^3

	Default carbon content: (kg/GJ)	Effective CO_2 emission factor: EF (kg/TJ)	Net calorific value: NCV (TJ/Gg)
Crude Oil	20.00	73,333	42.30
Natural Gas	15.30	56,100	43.00
Diesel Oil	20.20	74,067	48.00

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CO_2 emissions PE_{FC} (tCO_2/y) (FC×NCV×EF) = fuel consumption FC (Gg/y) × CO_2 emission factor EF (kg/TJ) × net calorific value NCV(TJ/Gg)×10^{-8}

HFO: PE_{HFO}=621×10^3×73,333×42.30×10^{-8}=1,926.342 tCO_2/y

NG: PE_{NG}=2,357×10^3×56,100×43.00×10^{-8}=56,857.80 tCO_2/y

Diesel Oil: PE_{diesel}=7.93×10^3×74,067×48.00×10^{-8}=282.00 tCO_2/y

Total 59,066.10 tCO_2/y

CO_2 emission factor of the grid CEF (tCO_2/MWh) = CO_2 emissions by fuel PE×10^3 / (Total electricity generation EG×8,760 hours/year)

=59,066.10×10^3/(9,852.3×8,760)=**0.6844 tCO_2/MWh**

3) Electric generation by CEGCO and SEPGCO (GWh)

	2006	2007
CEGCO (GWh)	8,966.00	9,852.36
SEPGCO (GWh)	1,660.34	2,732.73
Total (GWh)	10,626.34	12,585.08

4) Weighted average grid CO_2 emission factor of CEGCO and SEPGCO CEF (tCO_2/MWh)

For 2000 to 2005, data from CEGCO is used while for 2006 and 2007, as SEPGCO went into the electricity business, weighted average of CO_2 emission factors of CEGCO and SEPGCO and total electric generation is applied.

<table>
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	2006	2007
CEGCO	0.891	0.684
SEPGCO	0.415	0.405
Total	0.817	0.624

5) CO_2 emission factor of electric grid on Jordan *CEF* (tCO_2/MWh)

	2000	2001	2002	2003	2004	2005	2006	2007
CEF (t-CO_2/MWh)	0.8737	0.8585	0.8574	0.8644	0.8254	0.8070	0.8168	0.6238

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<tr><td>Calculation of GHG emissions</td><td>

GHG emission reduction through this project activity is calculated using the electricity loss reduction and CO_2 emission factor of the grid as shown below.

Year	Electricity Reduction (GWh)				*CEF* (t-CO_2/MWh)	GHG Reduction (t-CO_2)
	JEPCO	*EDCO*	*IDECO*	Total		
1999	15.463	5.49	3.50	24.453	–	
2000	15.954	5.10	3.70	24.754	0.874	21,627.57
2001	21.486	5.60	4.00	31.086	0.859	26,687.33
2002	21.000	4.46	4.00	29.460	0.857	25,259.00
2003	19.777	5.67	3.20	28.647	0.864	24,762.47
2004	24.886	6.43	3.30	34.616	0.825	28,558.20
2005	25.007	6.53	3.10	34.637	0.807	27,952.06
2006	24.099	8.86	6.10	39.059	0.817	31,911.20
2007	38.794	10.52	6.00	55.314	0.624	34,515.94
Total	206.466	58.66	36.90	302.026	–	221,273.77

</td></tr>
<tr><td>Preconditions</td><td>Amount of grid loss reduction represents the reduction achieved through all the measures taken by the three companies (JEPCO, IDECO, and EDCO). Emission reduction from each of the activities/ measures is not contained in this analysis. IPPs other than SEPGCO are excluded from the analysis since they do not have a large power generation capacity. AES-Jordan is excluded as well because their power plant is still under construction.</td></tr>
<tr><td>Lessons learned from case study</td><td>As the Jordanian side does not have sufficient knowledge about the grid emission factor calculation and required data, it took a significant amount of time to collect the data. To avoid such issue, it is recommended to provide technical transfer so that the developing countries can learn systematically how to store necessary data for grid emission factor calculation</td></tr>
</table>

3.2 Forestry and Natural Resource Conservation Sector

3.2.1 Preconditions for the sector

Forestry and forest conservation have important roles in the field of conventional assistance for developing countries. In addition, these activities are effective as global warming mitigation measures through direct carbon sink when trees grow. Concerning the methods to quantify carbon sink by afforestation/reforestation and emission avoidance by forest conservation, some are still under scientific research. However, if appropriate data and information are available, simplified quantification is not very difficult.

On the other hand, this sector ‘Forestry and Natural Resource Conservation’ includes various activities in addition to afforestation/reforestation and forest conservation. It covers agroforestry, which is very close to afforestation/reforestation, to conservation of biodiversity, in which it is difficult to identify the potential of direct effect for mitigation.

Therefore, as a first step of this study, various activities were divided into components and the possibility and difficulty for quantification of each component was considered. Then, necessary conditions were identified for the components which will be quantifiable under certain conditions, or the components which are difficult to quantify.

Forests absorb and stock carbon for decades. After afforestation/reforestation, trees require several years to grow and stock carbon, and the lifetime of a forest itself continues for from several decades to a hundred years and more. This causes a large difference between forestry and other mitigation measures. Forests have a wide range of various stakeholders. Social, economic and cultural activities and customs on which forests depend differ vastly by regions. For example, if paddy field cultivation is introduced as an alternative livelihood to tree harvesting and shifting cultivation, it will be affected by market fluctuation of crop price.

The effect of forestry related assistance activities will be achieved after the activities are sustained in good condition, against various cultural, social and economic backgrounds. The components are not effective as a stand-alone element. They have relationships and should be combined according to an appropriate plan. This means that comprehensive land use planning for the area including the project site is essential to help assistance success as well as to secure the sustainability of the effect produced by the project (Figure 3.2.1).

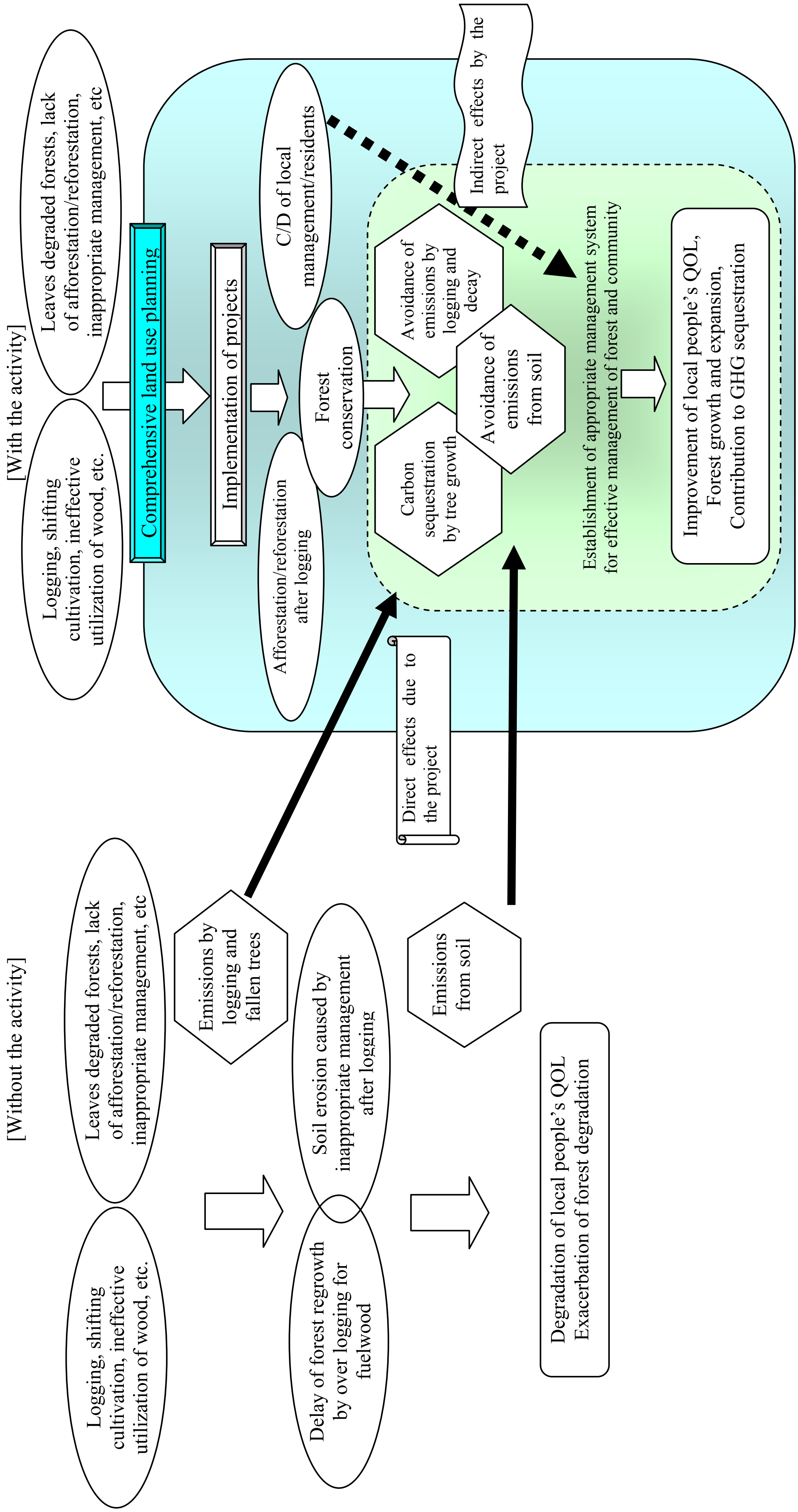


Figure 3.2.1 GHG emission reduction/sequestration by afforestation/reforestation and forest conservation

3.2.2 Summary of quantification methods

In this sector, CO_2 quantification method by activity, including CO_2 sink and avoidance of CO_2 emissions by afforestation/reforestation and forest conservation, followed a JICA study "Contribution of JICA in the global warming countermeasure (Forest sector) – On quantification of CO_2 absorption" implemented in 2007. In this study, they discussed quantification method of the above mentioned activities carried out in Technical Cooperation Projects, Private-Sector Investment Finance, Development Studies, and Grant Aid. The method developed through the study is identified as the most appropriate as follows:

- The study aimed to consider quantification of effects by JICA projects, and the study was implemented by experts involved those projects. Therefore, the study took account of the characteristics of the JICA projects,
- Calculation formulae are simplified and necessary data is limited to minimum requirements, considering the convenience for the JICA staff in charge of the project at the site.
- The method refers to default factors from IPCC Good Practice Guidance for LULUCF, which is used in CDM methodologies as well.

Other activities other than afforestation/reforestation and forest conservation, potential for quantification of project effects will be rather limited though it depends on conditions. For example, scientific studies about carbon sink by soil have progressed significantly. However, there are many difficulties including data collection to simplify such studies and to apply to practical projects. Therefore, this study does not consider those latest study results.

3.2.3 GHG emission reduction activities of JICA projects

Components of GHG emission reduction activities in this sector are categorized in Table 3.2.1. Quantification possibility of each component is indicated as shown in Figure 3.2.2.

Project examples listed in Table 3.2.1 consist of the projects that were recognized to be effective for mitigation of climate change in the research called “JICA’s Assistance for Mitigation to Climate Change – The Co-Benefits Approach to Climate Change JICA”. And they also include the projects that JICA specified as the mitigation projects from JICA project of year 2008.
Therefore, these project examples do not contain all of JICA projects. In other words, there are other JICA projects with other GHG reduction components shown in Table 3.2.1.

Table 3.2.1 Components of GHG emission reduction activities in the forestry and natural resource conservation sector

Project example	Afforestation/reforestation (Industry, village)	Mangrove afforestation/reforestation	Forest conservation	Agro-forestry	Utilization of non-wood resources	Effective utilization of wood resources	Eco-tourism	Introduction of improved kitchen stoves	Establishment of irrigation systems	Introduction of various livelihood alternatives	Monitoring and data collection	Forest fire protection systems	Training and management system support	Awareness raising to local people
National park management plan							○						○	○
Sustainable watershed management plan for a dam upstream region	○			○					○			○		○
Community based sustainable forest management plan			○		○							○	○	
Comprehensive development plan for a village forest	○				○			○					○	
Enhancement of sustainability for mangrove management	○	○			○		○	○		○	○		○	
Community based comprehensive mangrove management plan		○	○							○			○	
Recovery plan for an area devastated by forest fire	○			○	○				○			○	○	
Forest management and community support project (FORCOM)	○		○	○					○	○				
Biodiversity and ecosystem conservation programme			○								○		○	○

Project example	Afforestation/reforestation (Industry, village)	Mangrove afforestation/reforestation	Forest conservation	Agro-forestry	Utilization of non-wood resources	Effective utilization of wood resources	Eco-tourism	Introduction of improved kitchen stoves	Establishment of irrigation systems	Introduction of various livelihood alternatives	Monitoring and data collection	Forest fire protection systems	Training and management system support	Awareness raising to local people
Village growth and forest rehabilitation	○							○			○			○
AR/ CDM staff development course (Training)													○	

3.2.4 Summary of GHG emission reduction scenarios and quantification sheet by activity

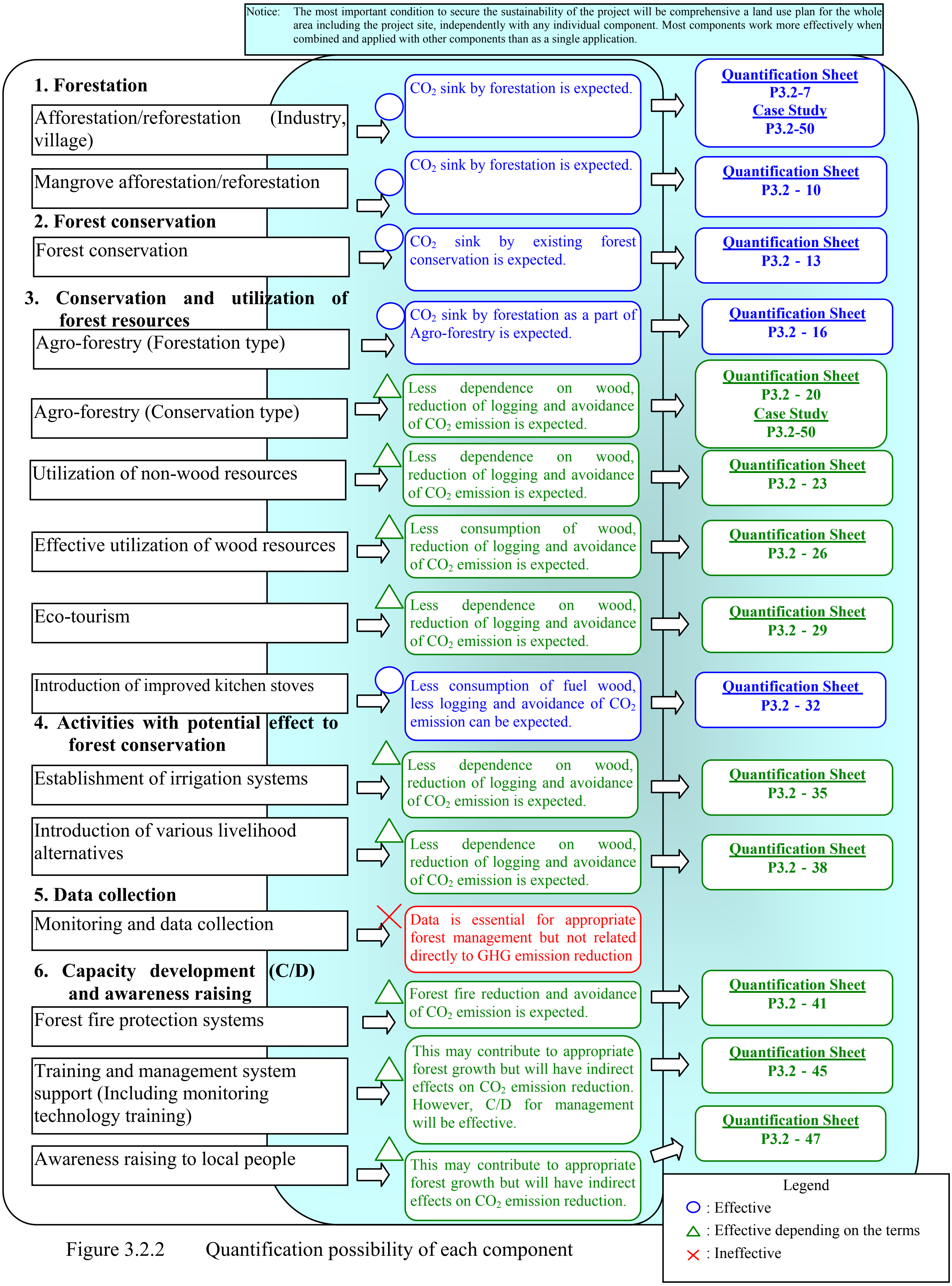
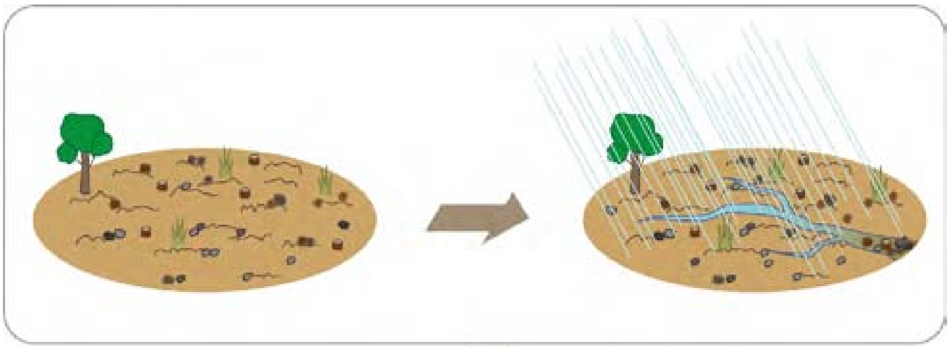
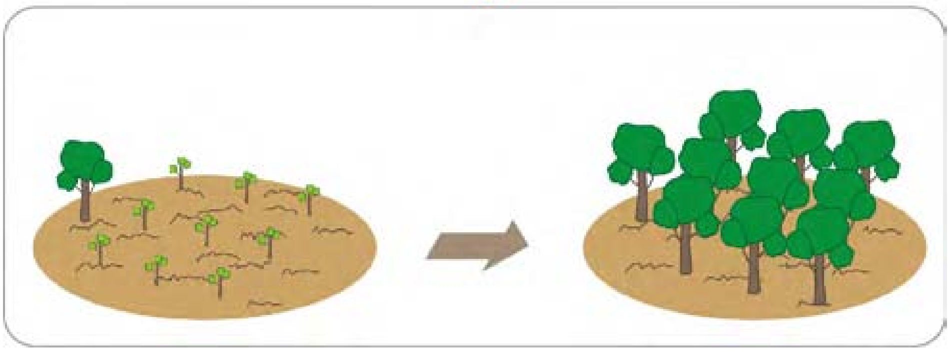
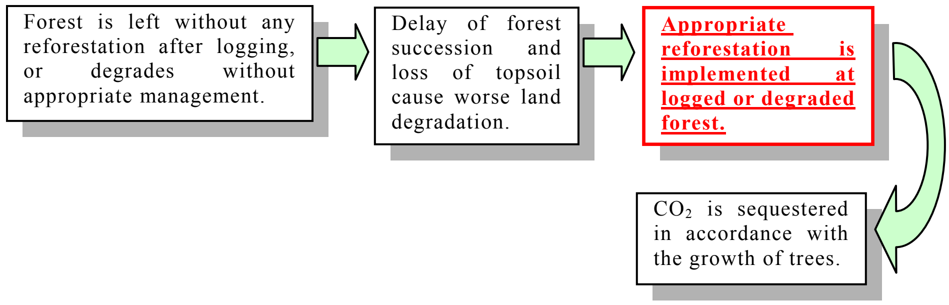


Figure 3.2.2 Quantification possibility of each component

Quantification Sheet

Activity: Afforestation/reforestation (Industry, village)

<table>
<tr><td>Sector</td><td>Forestry and Natural Resources Conservation</td></tr>
<tr><td>Sub-sector</td><td>Forest Conservation</td></tr>
<tr><td>GHG emission reduction activity</td><td>Afforestation/reforestation</td></tr>
<tr><td>GHG emission reduction impact</td><td><u>1: Activity will lead to GHG emission reduction</u>
2: Activity will lead to GHG emission reduction subject to condition(s)
3: Activity will not lead to GHG emission reduction</td></tr>
<tr><td>GHG emission reduction scenarios
(description of how GHG is reduced)</td><td><Without the activity>
- Forest is left without any reforestation after logging, or degrades without appropriate management.
- Delay of forest succession and loss of topsoil cause worse land degradation.

<With the activity>

- Appropriate reforestation is implemented at logged or degraded forest.
- CO_2 is sequestered in accordance with the growth of trees.</td></tr>
</table>

	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	**[Calculation method]** CO_2 sequestration (t/y) = Aboveground biomass A × forestation area B × 1.2 × 0.5 × 44/12 Where: A: aboveground biomass (tonnes dry matter/ha/year) B: forestation area (ha) 1.2 : 1 + belowground/aboveground ratio 0.5: carbon content 44/12: CO_2 conversion coefficient
Required data and data source	(1) Regional climate (region, forest type, annual rainfall) ・ Record at the project implementation stage (2) Tree species for the forestation ・ Record at the project implementation stage (when multi species are used, each area of each type) (3) Area of forestation ・ Record at the project implementation stage, or acquire by aerial / satellite photographs (4) Aboveground biomass ・ Apply value for under 20 years age class from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.6 ・ If the project was finished more than 20 years ago, apply value for over 20 years age class from the same Table.
Special notes	- Calculate the area where forestation was implemented including pilot project area. - Emissions should be counted at the time that the planted trees are harvested or forest area is slashed for cultivation. - It should be confirmed that the project does not cause new slash or cultivation in neighbouring areas. - It is difficult to quantify carbon absorption by organic soil matter. - Local conditions should be accounted for in the baseline scenario setting.

	Accurate forestation area might not be measurable nor recorded during the project.

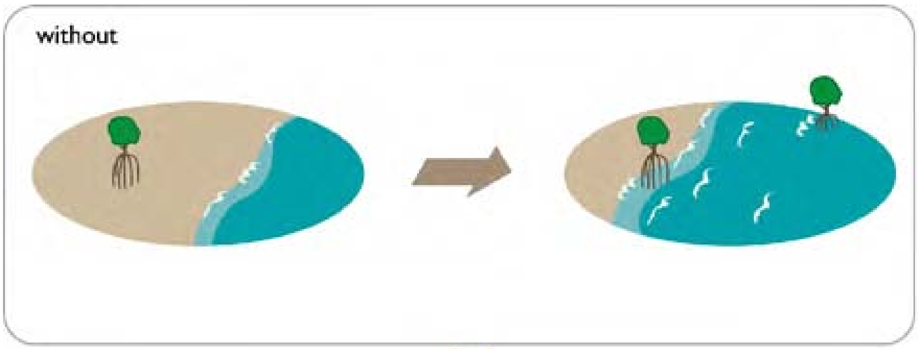
Quantification Sheet

Activity: Mangrove afforestation/reforestation

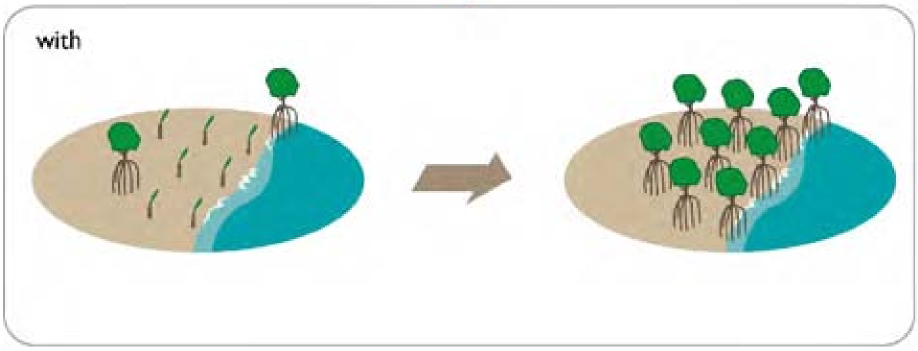
<table>
<tr><td>Sector</td><td>Forestry and Natural Resource Conservation</td></tr>
<tr><td>Sub-sector</td><td>Forest Conservation</td></tr>
<tr><td>GHG emission reduction activity</td><td>Afforestation/reforestation</td></tr>
<tr><td>GHG emission reduction impact</td><td><u>1: Activity will lead to GHG emission reduction</u>
2: Activity will lead to GHG emission reduction subject to condition(s)
3: Activity will not lead to GHG emission reduction</td></tr>
<tr><td>GHG emission reduction scenarios
(description of how GHG is reduced)</td><td>

<Without the activity>

- Mangrove forest is left without any reforestation after logging, or degrades without appropriate management.
- Delay of forest succession and coastal erosion cause worse land degradation.



<With the activity>

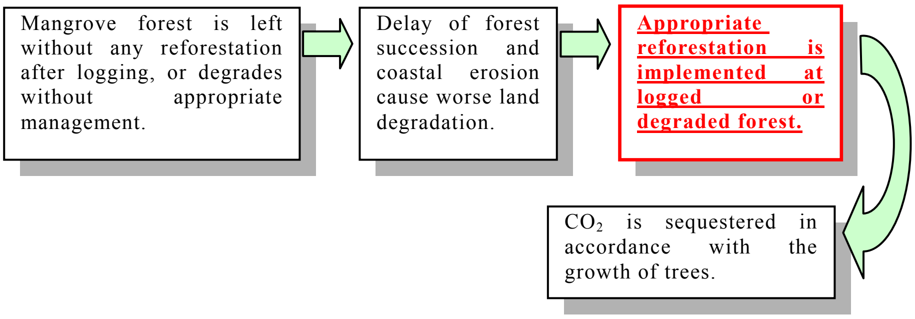


- Appropriate reforestation is implemented at logged or degraded forest.
- CO_2 is sequestered in accordance with the growth of trees.

</td></tr>
</table>

<table>
<tr>
<td></td>
<td>

[Schematics of GHG emission reduction process]



</td>
</tr>
<tr>
<td>Calculation of GHG emission reduction</td>
<td>

[Calculation method]

CO_2 sequestration (t/y) = Aboveground biomass A × forestation area B × 1.2 × 0.5 × 44/12

Where:

A: aboveground biomass (tonnes dry matter/ha/year)

B: forestation area (ha)

1.2 : 1 + belowground/aboveground ratio

0.5: carbon content

44/12: CO_2 conversion coefficient

</td>
</tr>
<tr>
<td>Required data and data source</td>
<td>

(1) Regional climate (region, forest type, annual rainfall)

- Record at the project implementation stage

(2) Tree species for the forestation

- Record at the project implementation stage (when multi species are used, area of each type)

(3) Area of forestation

- Record at the project implementation stage, or acquire by aerial / satellite photographs

(4) Aboveground biomass

- Apply value for under 20 years age class from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.6

If the project was finished more than 20 years ago, apply value for over 20 years age class from the same Table.

</td>
</tr>
<tr>
<td>Preconditions</td>
<td>

- Default values for broad leafed forest are applied for the calculation.
- For *Melaleuca*, the amount of CH_4 (CO_2e) emissions according to soil evaporation are more than the amount of CO_2 sequestration. Therefore, CO_2 sink is not included in the calculation.

</td>
</tr>
<tr>
<td>Special notes</td>
<td>

- Calculate the area where forestation was implemented including pilot project area.
- Emissions should be counted at the time when planted trees are harvested or forest area is slashed for cultivation.

</td>
</tr>
</table>

	- It should be confirmed that the project does not cause new slash or cultivation in neighbouring areas. - There are many technical difficulties to quantify the effect of mangrove forestation and mangrove conservation. - It is difficult to quantify carbon absorption by organic soil matter. - Local conditions should be accounted for in the baseline scenario setting. Accurate forestation area might not be measurable nor recorded during the project.

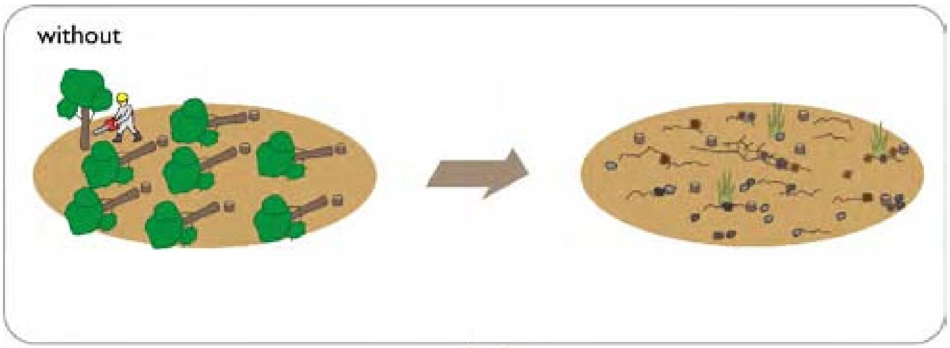
Quantification Sheet

Activity: Forest conservation

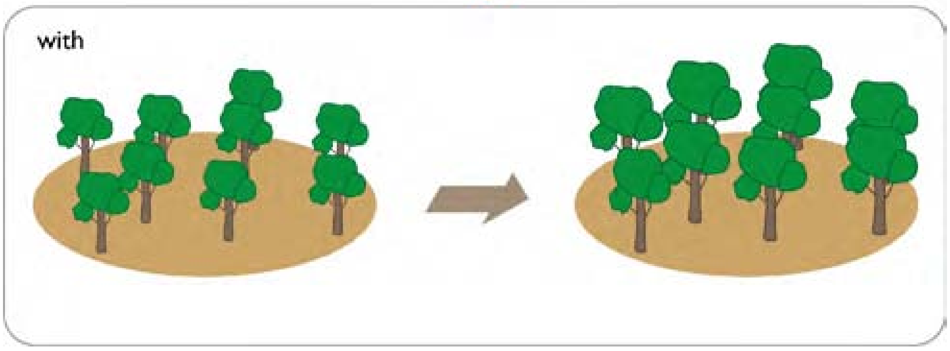
<table>
<tr><td>Sector</td><td>Forestry and Natural Resource Conservation</td></tr>
<tr><td>Sub-sector</td><td>Forest Conservation</td></tr>
<tr><td>GHG emission reduction activity</td><td>Forest conservation</td></tr>
<tr><td>GHG emission reduction impact</td><td><u>1: Activity will lead to GHG emission reduction</u>
2: Activity will lead to GHG emission reduction subject to condition(s)
3: Activity will not lead to GHG emission reduction</td></tr>
<tr><td>GHG emission reduction scenarios
(description of how GHG is reduced)</td><td>

<Without the activity>

- Forest is logged as major livelihood or energy source (legal/illegal). This causes CO_2 emission.
- Forest is left without any reforestation after logging, then soli erosion and land degradation proceeds.

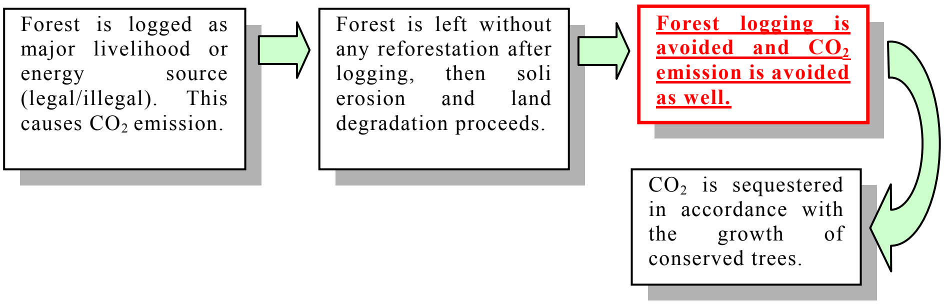


<With the activity>



- Forest logging is avoided and CO_2 emission is avoided as well.
- CO_2 is sequestered in accordance with the growth of conserved trees.

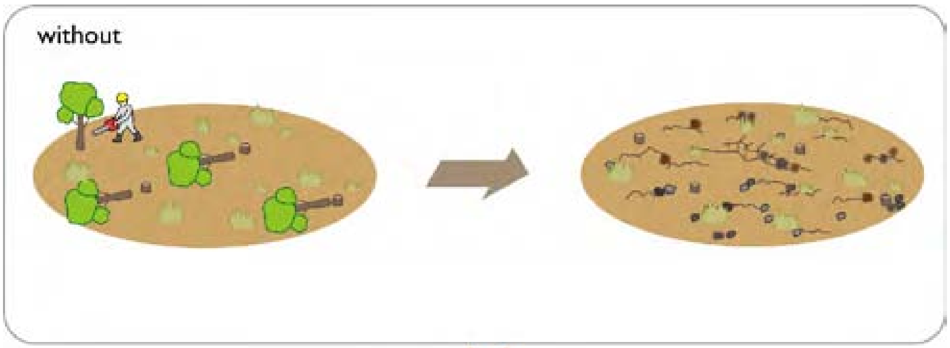
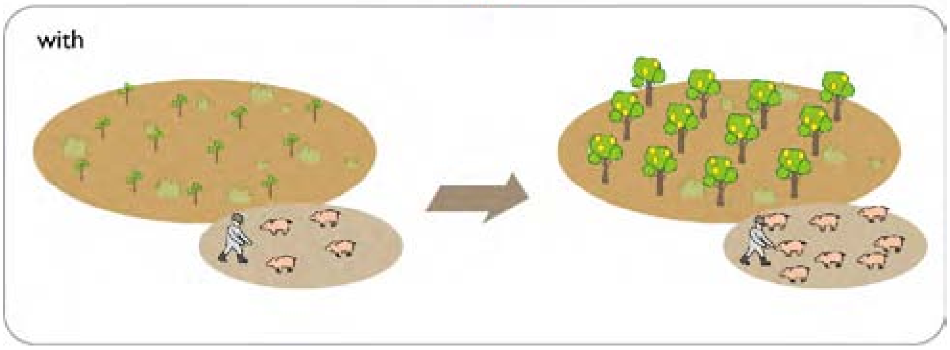
</td></tr>
</table>

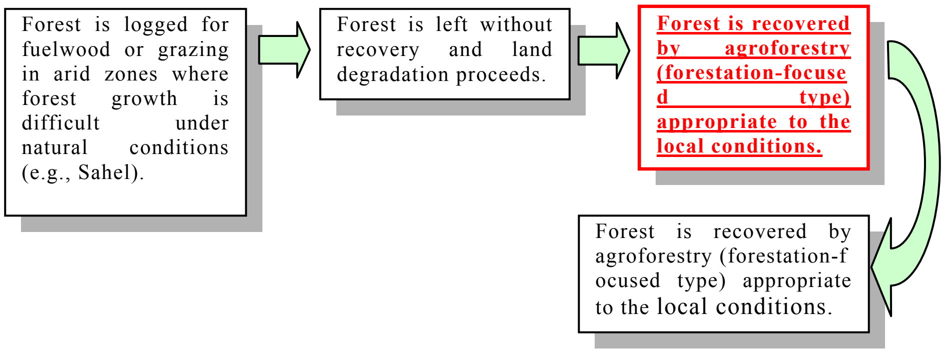
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	CO_2 sink by forest conservation = Amount of annual avoidance of CO_2 emission + amount of annual CO_2 sequestration (1) Annual avoidance of CO_2 emission Avoidance of CO_2 emission (tonnes) = amount of CO_2 accumulation × forest area change ratio (%) Where: Forest area change ratio (%) Amount of CO_2 accumulation (tonnes) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient (2) Annual CO_2 sequestration amount of CO_2 sequestration (t/year) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient
Required data and data source	(1) Regional climate (region, forest type, annual rainfall) ・ Record at the project implementation stage (2) Forest area change ratio

	・ Select default value of the project site country from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.1 (3) Area of forestation ・ Record at the project implementation stage, or acquire by aerial / satellite photographs (4) Aboveground biomass stock ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.2 (5) Aboveground biomass increment ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.5, Table 3A.1.2
Special notes	- Calculate the area where forest conservation and reforestation was implemented including pilot project area. - Emissions should be counted at the time when planted trees are harvested or forest area is slashed for cultivation. - It should be confirmed that the project does not cause new slash or cultivation in neighbouring areas. - It is difficult to quantify carbon absorption by organic soil matter. - Local conditions should be accounted for in the baseline scenario setting. Accurate forestation area might not be measurable nor recorded during the project. - In case of mangrove forest conservation, there are many technical difficulties to quantify the effects.

Quantification Sheet

Activity: Agro-forestry (Forestation focused type)

Sector	**Forestry and Natural Resource Conservation**
Sub-sector	**Forest Conservation**
GHG emission reduction activity	Afforestation/reforestation, Conservation and effective utilization of forest resources
GHG emission reduction impact	<u>1: Activity will lead to GHG emission reduction</u> 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** - Forest is logged for fuelwood or grazing in arid zones where forest growth is difficult under natural conditions (e.g., Sahel). - Forest is left without recovery and land degradation proceeds.  **<With the activity>**  - Forest is recovered by agroforestry (forestation-focused type) appropriate to the local conditions. - Forest is recovered by agroforestry (forestation-focused type) appropriate to the local conditions.

	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	In case forested area is recorded as a part of an agro-forestry activity. CO_2 sequestration by forestation (t/y) = Aboveground biomass A × forestation area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient In case conservation area is also carried out and the area is recorded as a part of agro-forestry activity. CO_2 sink by forest conservation = Amount of annual avoidance of CO_2 emission + amount of annual CO_2 sequestration (1) Annual avoidance of CO_2 emission Avoidance of CO_2 emission (tonnes) = amount of CO_2 accumulation × forest area change ratio (%) Where: Forest area change ratio (%) Amount of CO_2 accumulation (tonnes) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient (2) Annual CO_2 sequestration

	amount of CO_2 sequestration (t/year) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient
Required data and data source	(1) Regional climate (region, forest type, annual rainfall) ・ Record at the project implementation stage (2) Tree species for the forestation ・ Record at the project implementation stage (when multi species are used, each area of each type) (3) Area of forestation ・ Record at the project implementation stage, or acquire by aerial / satellite photographs (4) Aboveground biomass ・ Apply value for under 20 years age class from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.6 ・ If the project was finished more than 20 years ago, apply value for over 20 years age class from the same Table. <In case forest conservation is also carried out:> (5) Forest area change ratio ・ Select default value of the project site country from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.1 (6) Area of forestation ・ Record at the project implementation stage, or acquire by aerial / satellite photographs (7) Aboveground biomass stock ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.2 (8) Aboveground biomass increment ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.5, Table 3A.1.2
Preconditions	- Quantitative data is required concerning change of major livelihood dependence from forest to other income source, income change, forest area change and their correlation. - Monitoring of above mentioned data is required to compare before and

	after project implementation.
Special notes	- Calculate the area where forestation was implemented including pilot project area. - Emissions should be counted at the time planted trees were harvested or forest area is slashed for cultivation. - It should be confirmed that the project does not cause new slash or cultivation in neighbouring areas. - There are many technical difficulties to quantify effect of mangrove forestation and mangrove conservation. - It is difficult to quantify carbon absorption by organic soil matter. - Local conditions should be accounted for in the baseline scenario setting. Accurate forestation/conservation area might not be measurable nor recorded during the project.

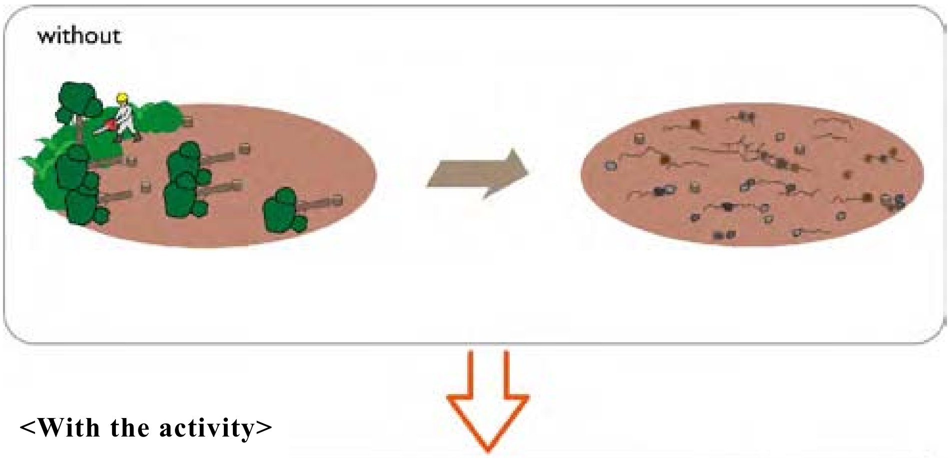
Quantification Sheet

Activity: Agro-forestry (Conservation focused type)

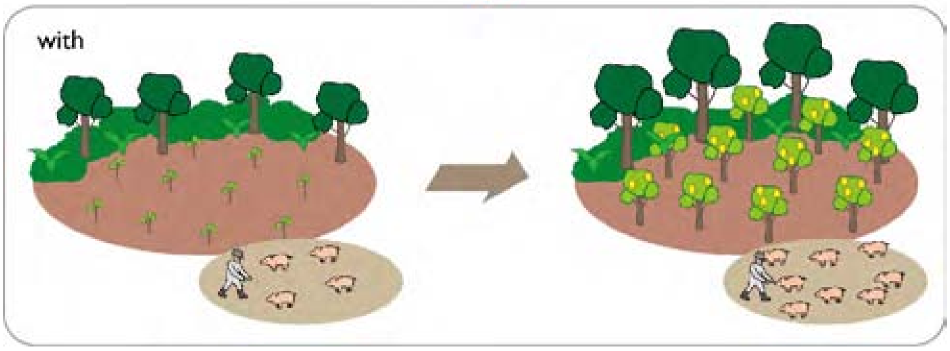
<table>
<tr><td>Sector</td><td>Forestry and Natural Resource Conservation</td></tr>
<tr><td>Sub-sector</td><td>Forest Conservation</td></tr>
<tr><td>GHG emission reduction activity</td><td>Afforestation/reforestation, Conservation and effective utilization of forest resources</td></tr>
<tr><td>GHG emission reduction impact</td><td>1: Activity will lead to GHG emission reduction
<u>2: Activity will lead to GHG emission reduction subject to condition(s)</u>
3: Activity will not lead to GHG emission reduction</td></tr>
<tr><td>GHG emission reduction scenarios
(description of how GHG is reduced)</td><td>

<Without the activity>

- Forest is logged for fuelwood or shifting cultivation in humid zones where forest growth is easy under natural conditions (e.g., Tropical rainforest in the Amazon or Asian regions).
- Forest is left without recovery and land degradation proceeds.

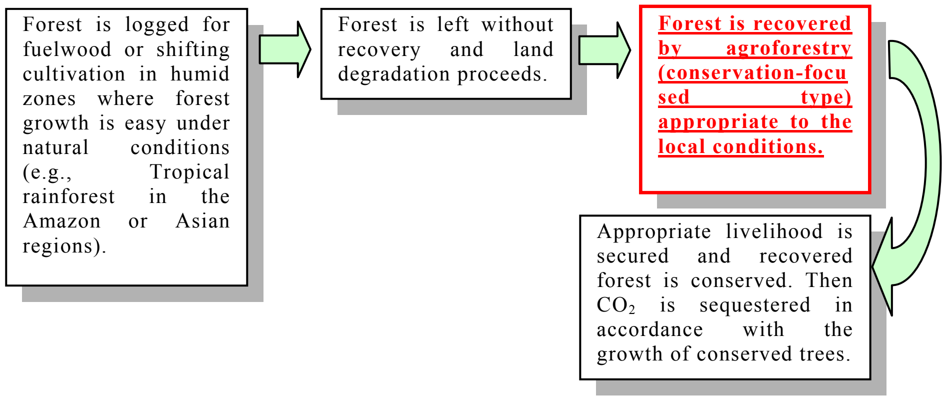


<With the activity>



- Forest is recovered by agroforestry (conservation-focused type) appropriate to the local conditions.
- Appropriate livelihood is secured and recovered forest is conserved. Then CO_2 is sequestered in accordance with the growth of conserved trees.

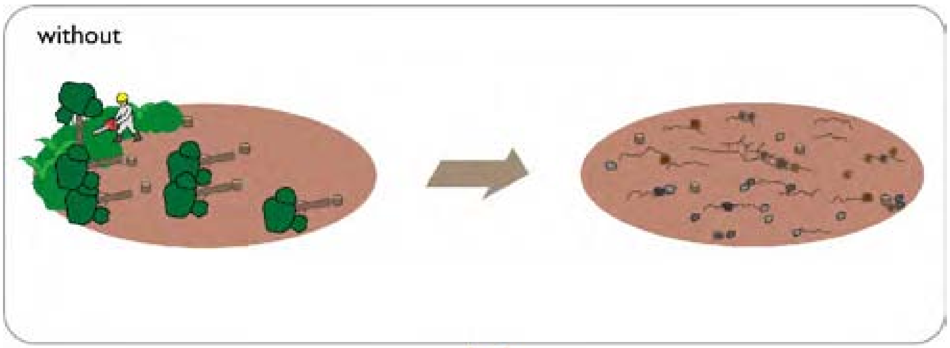
</td></tr>
</table>

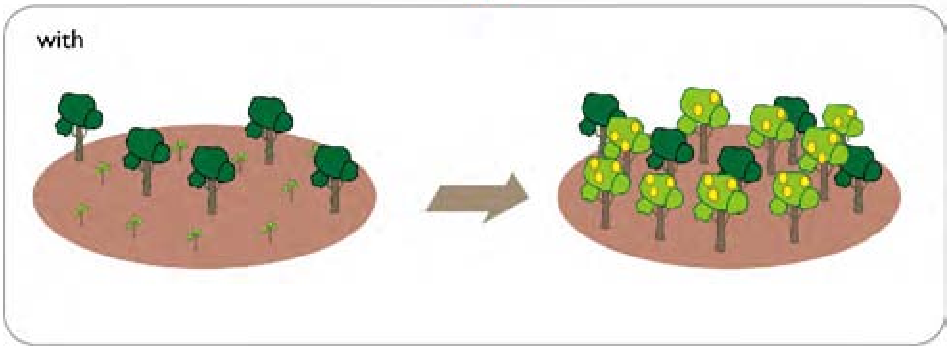
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	In case conservation area is recorded as a part of agro-forestry activity. CO_2 sink by forest conservation = Amount of annual avoidance of CO_2 emission + amount of annual CO_2 sequestration (1) Annual avoidance of CO_2 emission Avoidance of CO_2 emission (tonnes) = amount of CO_2 accumulation × forest area change ratio (%) Where: Forest area change ratio (%) Amount of CO_2 accumulation (tonnes) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient (2) Annual CO_2 sequestration amount of CO_2 sequestration (t/year) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient

Required data and data source	(1) Regional climate (region, forest type, annual rainfall) ・ Record at the project implementation stage (2) Forest area change ratio ・ Select default value of the project site country from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.1 (3) Area of conservation ・ Record at the project implementation stage, or acquire by aerial / satellite photographs (4) Aboveground biomass stock ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.2 (5) Aboveground biomass increment ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.5, Table 3A.1.2
Preconditions	- Quantitative data is required concerning change of major livelihood dependence from forest to other income source, income change, forest area change and their correlation. - Monitoring of above mentioned data is required to compare before and after project implementation.
Special notes	- Local conditions should be accounted for in the baseline scenario setting. Accurate forestation/conservation area might not be measurable nor recorded during the project. - Quantification of emission avoidance might be possible if the amount of wood harvested could be estimated from income due to the harvest.

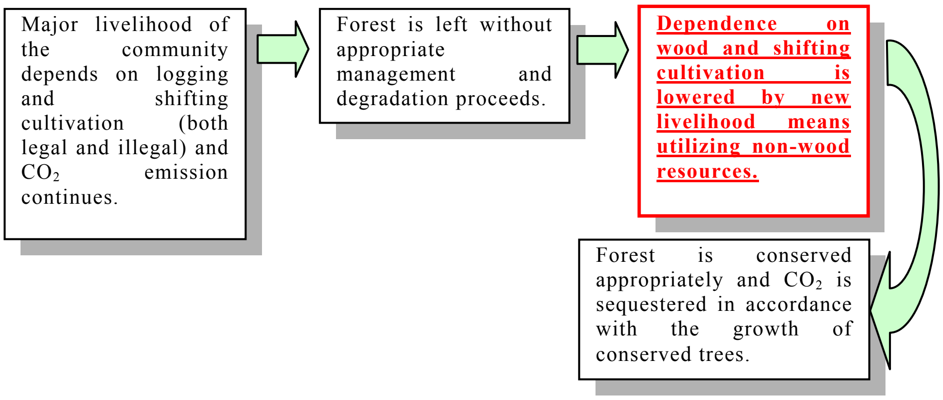
Quantification Sheet

Activity: Effective utilization of non-wood resources

<table>
<tr><td>Sector</td><td>Forestry and Natural Resource Conservation</td></tr>
<tr><td>Sub-sector</td><td>Forest Conservation</td></tr>
<tr><td>GHG emission reduction activity</td><td>Conservation and effective utilization of forest resources</td></tr>
<tr><td>GHG emission reduction impact</td><td>1: Activity will lead to GHG emission reduction
<u>2: Activity will lead to GHG emission reduction subject to condition(s)</u>
3: Activity will not lead to GHG emission reduction</td></tr>
<tr><td>GHG emission reduction scenarios
(description of how GHG is reduced)</td><td><Without the activity>
- Major livelihood of the community depends on logging and shifting cultivation (both legal and illegal) and CO_2 emission continues.
- Forest is left without appropriate management and degradation proceeds.


<With the activity>


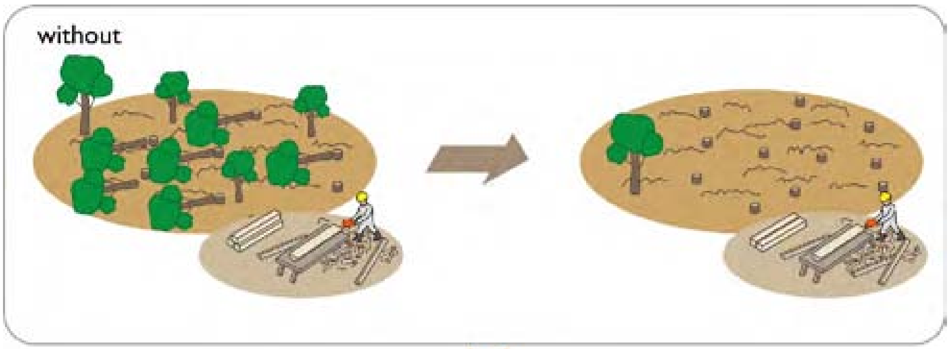
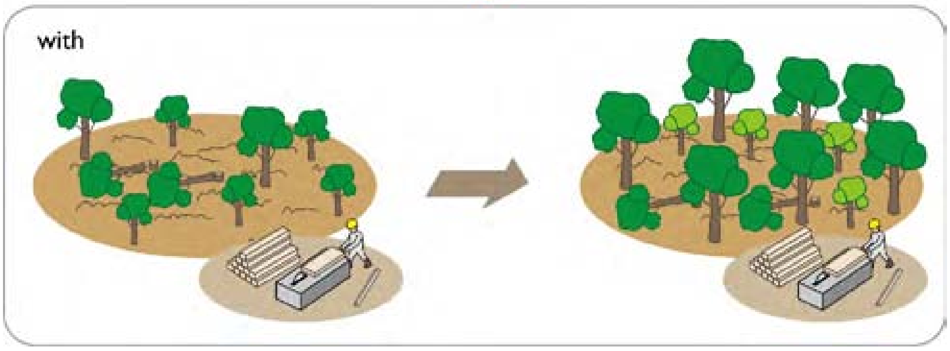
- Dependence on wood and shifting cultivation is lowered by new livelihood means utilizing non-wood resources.
- Forest is conserved appropriately and CO_2 is sequestered in accordance with the growth of conserved trees.</td></tr>
</table>

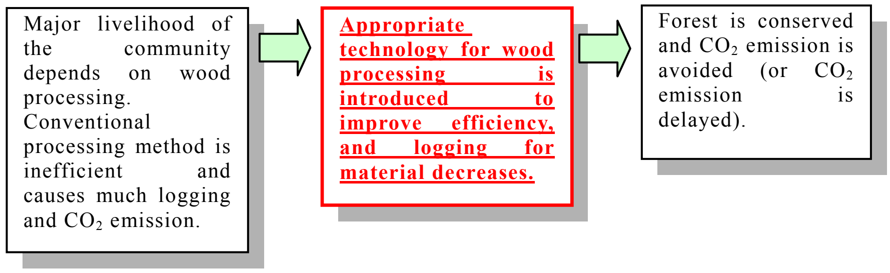
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	In case conservation area is recorded. CO_2 sink by forest conservation = Amount of annual avoidance of CO_2 emission + amount of annual CO_2 sequestration (1) Annual avoidance of CO_2 emission Avoidance of CO_2 emission (tonnes) = amount of CO_2 accumulation × forest area change ratio (%) Where: Forest area change ratio (%) Amount of CO_2 accumulation (tonnes) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient (2) Annual CO_2 sequestration amount of CO_2 sequestration (t/year) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient

Required data and data source	(1) Regional climate (region, forest type, annual rainfall) ・ Record at the project implementation stage (2) Forest area change ratio ・ Select default value of the project site country from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.1 (3) Area of conservation ・ Record at the project implementation stage, or acquire by aerial / satellite photographs (4) Aboveground biomass stock ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.2 (5) Aboveground biomass increment ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.5, Table 3A.1.2
Preconditions	- Quantitative data is required concerning income by new livelihood activities, reduction of dependence on forest, reduction of forest area change and their correlation. - Monitoring of above mentioned data is required to compare before and after project implementation.
Special notes	- Local conditions should be accounted for in the baseline scenario setting. Accurate forestation/conservation area might not be measurable nor recorded during the project. - Quantification of emission avoidance might be possible if the amount of wood harvested could be estimated from income due to the harvest.

Quantification Sheet

Activity: Utilization of wood resources

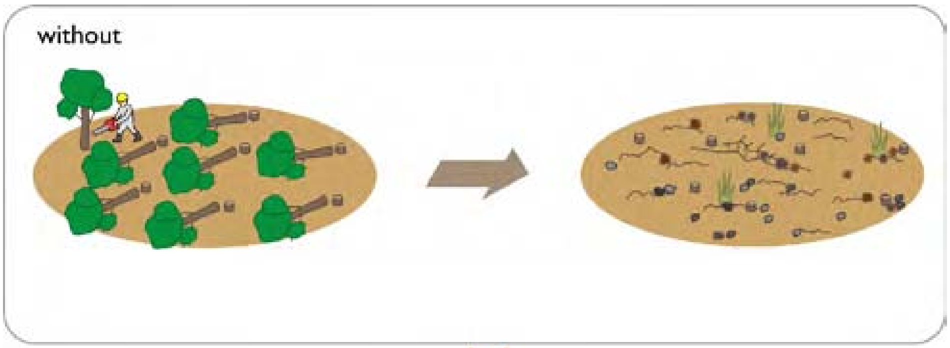
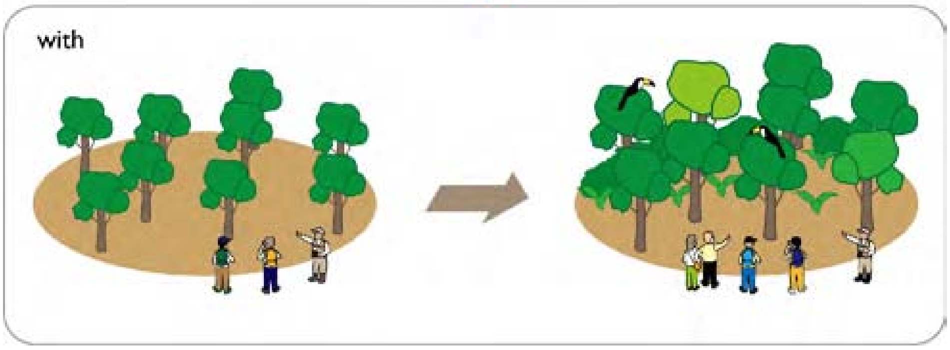
Sector	**Forestry and Natural Resource Conservation**
Sub-sector	**Forest Conservation**
GHG emission reduction activity	Conservation and effective utilization of forest resources
GHG emission reduction impact	1: Activity will lead to GHG emission reduction 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** - Major livelihood of the community depends on wood processing. Conventional processing method is inefficient and causes much logging and CO_2 emission.  **<With the activity>**  - Appropriate technology for wood processing is introduced to improve efficiency, and logging for material decreases. - Forest is conserved and CO_2 emission is avoided (or CO_2 emission is delayed).

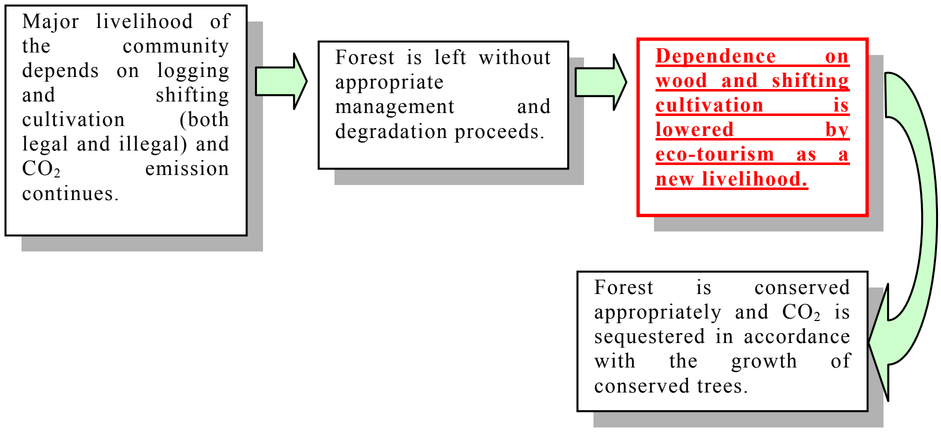
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	In case conservation area is recorded. CO_2 sink by forest conservation = Amount of annual avoidance of CO_2 emission + amount of annual CO_2 sequestration (1) Annual avoidance of CO_2 emission Avoidance of CO_2 emission (tonnes) = amount of CO_2 accumulation × forest area change ratio (%) Where: Forest area change ratio (%) Amount of CO_2 accumulation (tonnes) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient (2) Annual CO_2 sequestration amount of CO_2 sequestration (t/year) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient
Required data and data source	(1) Regional climate (region, forest type, annual rainfall) ・ Record at the project implementation stage (2) Forest area change ratio

	・ Select default value of the project site country from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.1 (3) Area of conservation ・ Record at the project implementation stage, or acquire by aerial / satellite photographs (4) Aboveground biomass stock ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.2 (5) Aboveground biomass increment ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.5, Table 3A.1.2
Preconditions	- Quantitative data is required concerning income due to new technology for wood processing, reduction of wood being processed, reduction of forest area depletion and their correlation. - Monitoring of above mentioned data is required to compare before and after project implementation.
Special notes	- Local conditions should be accounted for in the baseline scenario setting. Accurate forestation/conservation area might not be measurable nor recorded during the project. - Quantification of emission avoidance might be possible if the amount of wood harvested could be estimated from income due to the harvest.

Quantification Sheet

Activity: Eco-tourism

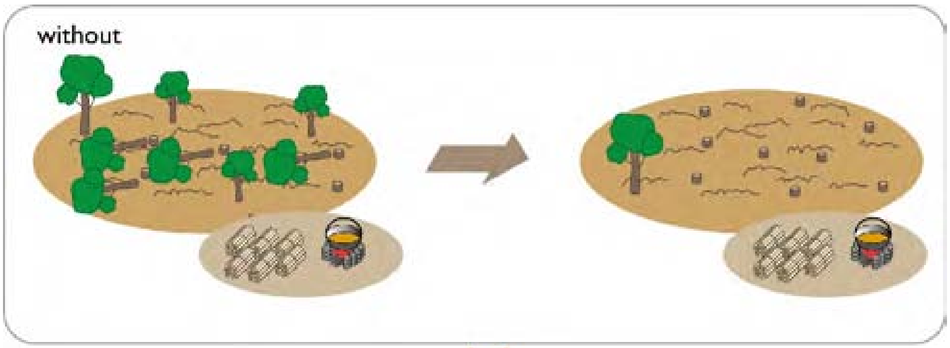
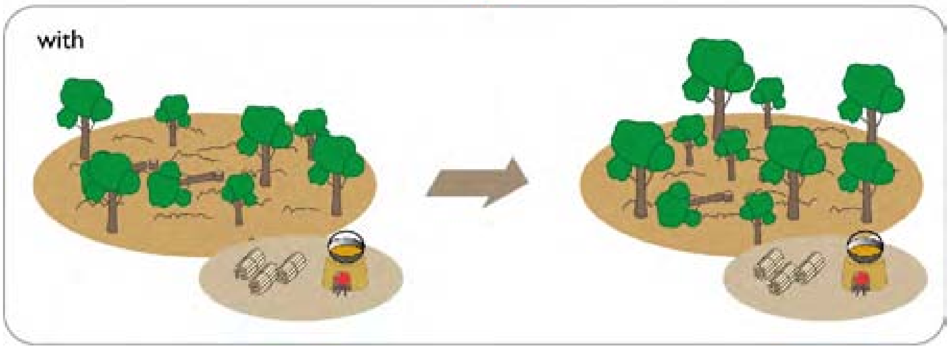
Sector	**Forestry and Natural Resource Conservation**
Sub-sector	**Forest Conservation**
GHG emission reduction activity	Conservation and effective utilization of forest resources
GHG emission reduction impact	1: Activity will lead to GHG emission reduction 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** - Major livelihood of the community depends on logging and shifting cultivation (both legal and illegal) and CO_2 emission continues. - Forest is left without appropriate management and degradation proceeds.  **<With the activity>**  - Dependence on wood and shifting cultivation is lowered by eco-tourism as a new livelihood. - Forest is conserved appropriately and CO_2 is sequestered in accordance with the growth of conserved trees.

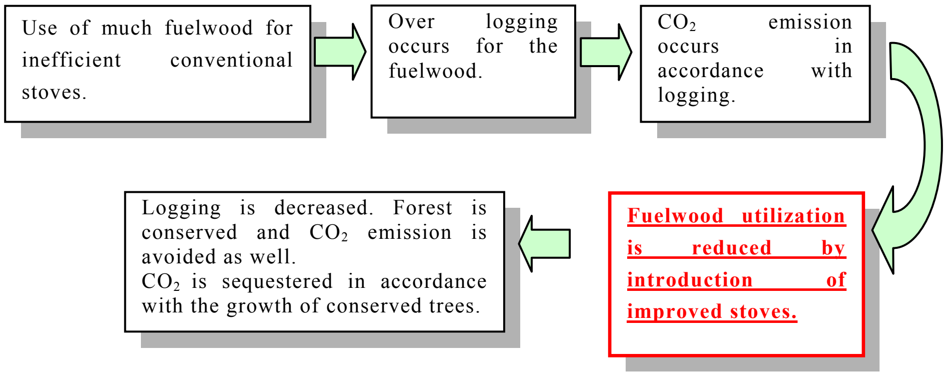
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	In case conservation area is recorded. CO_2 sink by forest conservation = Amount of annual avoidance of CO_2 emission + amount of annual CO_2 sequestration (1) Annual avoidance of CO_2 emission Avoidance of CO_2 emission (tonnes) = amount of CO_2 accumulation × forest area change ratio (%) Where: Forest area change ratio (%) Amount of CO_2 accumulation (tonnes) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient (2) Annual CO_2 sequestration amount of CO_2 sequestration (t/year) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient

Required data and data source	(1) Regional climate (region, forest type, annual rainfall) ・ Record at the project implementation stage (2) Forest area change ratio ・ Select default value of the project site country from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.1 (3) Area of conservation ・ Record at the project implementation stage, or acquire by aerial / satellite photographs (4) Aboveground biomass stock ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.2 (5) Aboveground biomass increment ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.5, Table 3A.1.2
Preconditions	- Quantitative data is required concerning income from eco-tourism as the new livelihood, reduction of dependence on wood and shifting cultivation, reduction of forest area depletion and their correlation. - Monitoring of above mentioned data is required to compare before and after project implementation.
Special notes	- Local conditions should be accounted for in the baseline scenario setting. Accurate forestation/conservation area might not be measurable nor recorded during the project. - Quantification of emission avoidance might be possible if the amount of wood harvested could be estimated from income due to the harvest.

Quantification Sheet

Activity: Introduction of improved kitchen stoves

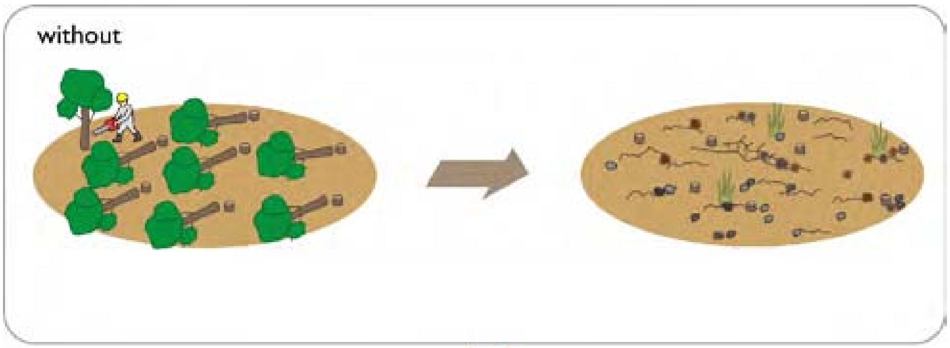
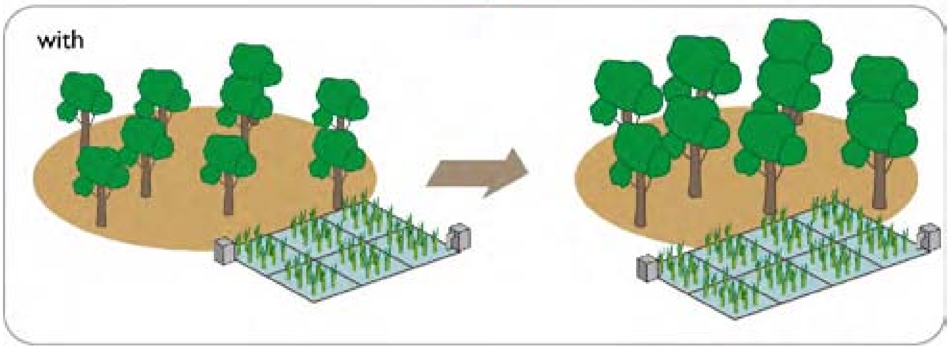
Sector	**Forestry and Natural Resource Conservation**
Sub-sector	**Forest Conservation**
GHG emission reduction activity	Conservation and effective utilization of forest resources
GHG emission reduction impact	<u>1: Activity will lead to GHG emission reduction</u> 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** - Use of much fuelwood for inefficient conventional stoves. - Over logging occurs for the fuelwood. - CO_2 emission occurs in accordance with logging.  **<With the activitv>**  - Fuelwood utilization is reduced by introduction of improved stoves. - Logging is decreased. Forest is conserved and CO_2 emission is avoided as well. CO_2 is sequestered in accordance with the growth of conserved trees.

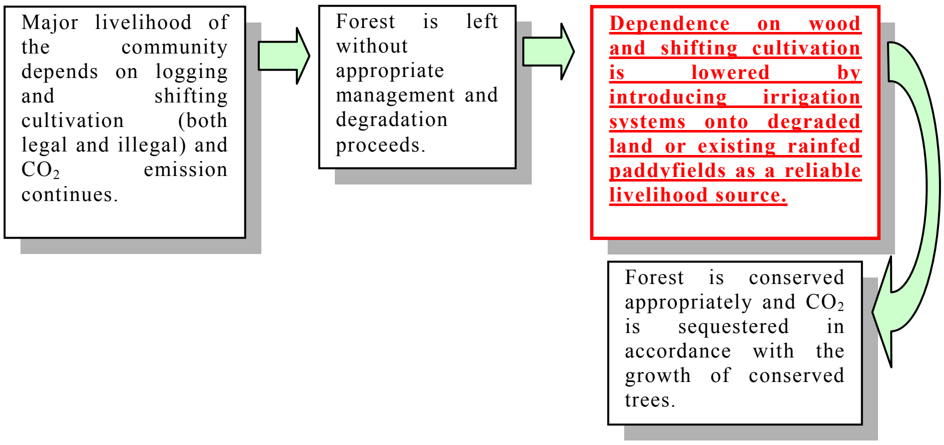
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	**Framework** Calculate CO_2 emission reduction owing to the reduction of cut of timber. Calculation of CO_2 emission of felling refers to the "Contribution of JICA in the global warming countermeasure (Forest sector) – On quantification of CO_2 absorption" **Without the activity** Calculation of CO_2 emission due to felling of trees without introduction of modified stoves. $BE_{Without}$=Fuel wood consumption without modified stoves (t-dry matter)×1.2 (1＋root to shoot ratio: 0.2)×0.5 (carbon fraction of dry matter, default value :0.5) ×44/12 (conversion factor from C to CO_2) **With the activity** Calculation of CO_2 emission due to cutting of trees with modified stove introduction. PE_{With}=Fuel wood consumption with modified stoves (t-dry weight)×1.2×0.5×44/12 **GHG emission reductions** ER(t-CO_2)＝$BE_{Without}$−PE_{With}
Required data and data source	1) Fuel wood consumption with or without adoption of improved kitchen stoves. ▪ Data is obtained by the implementation of pilot project or interview in field study ▪ It is possible for the consumption of fuel wood to have a seasonal change. Therefore, the investigation about the consumption of fuel wood should be

	implemented for an entire year to obtain any seasonal changes. - When the consumption of fuel wood is obtained in volume (m^3), that data has to be converted into weight (t-dry matter). The calculation formula is as follows: Weight of fuel wood(t-dry matter)＝Volume of fuel wood (m^3) × Basic wood density D Basic wood density D is decided according to IPCC Good Practice Guidance (GPG) for LULUCF, Annex 3A.1 Biomass Default Tables for Section 3.2 Forest Land, Tables 3A.1.9-1 and 3A.1.9-2. 2) Tree species of fuel wood - This information is necessary when volume of fuel wood is converted into weight using IPCC GPG for LULUCF, Annex 3A.1, Tables 3A.1.9-1 and 3A.1.9-2. - Data is obtained by the implementation of pilot project or interview in field study
Preconditions	The heat capacity from combustion of fire wood with improved kitchen stoves is the same as with the open-fire
Special notes	- There are various ways of gathering fuel wood such as gathering dead wood, cutting down only branches, cutting down entire trees, etc. From the conservative side, this guidebook assumes that the way of gathering fuel wood is performed by the felling of the whole tree (above ground part + root part), because this way has the biggest influence on forests and increase of GHG emission amount. - Fuel wood consumption should be calculated as weight (t-dry matter) to avoid the trouble of having to convert from volume (m^3) to weight (t-dry weight).

Quantification Sheet

Activity: Establishment of irrigation systems

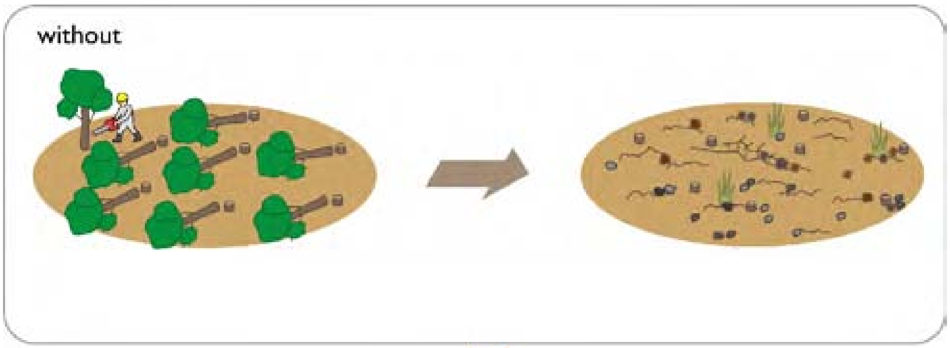
Sector	**Forestry and Natural Resource Conservation**
Sub-sector	**Forest Conservation**
GHG emission reduction activity	Conservation and effective utilization of forest resources
GHG emission reduction impact	1: Activity will lead to GHG emission reduction 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** - Major livelihood of the community depends on logging and shifting cultivation (both legal and illegal) and CO_2 emission continues. - Forest is left without appropriate management and degradation proceeds.  **<With the activity>**  - Dependence on wood and shifting cultivation is lowered by introducing irrigation systems onto degraded land or existing rainfed paddyfields as a reliable livelihood source. - Forest is conserved appropriately and CO_2 is sequestered in accordance with the growth of conserved trees.

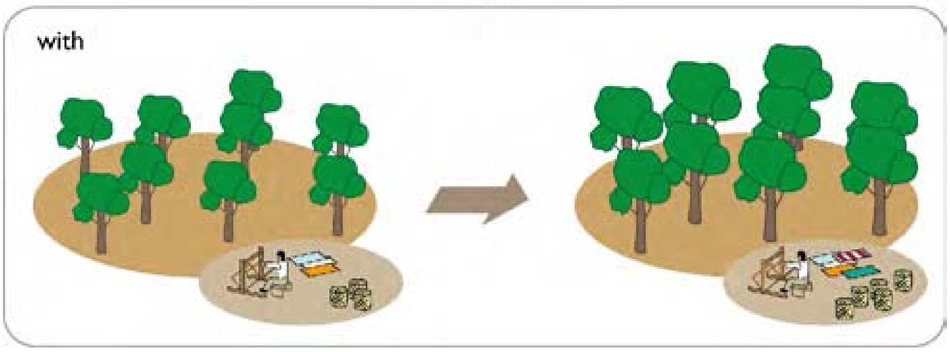
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	In case conservation area is recorded. CO_2 sink by forest conservation = Amount of annual avoidance of CO_2 emission + amount of annual CO_2 sequestration (1) Annual avoidance of CO_2 emission Avoidance of CO_2 emission (tonnes) = amount of CO_2 accumulation × forest area change ratio (%) Where: Forest area change ratio (%) Amount of CO_2 accumulation (tonnes) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient (2) Annual CO_2 sequestration amount of CO_2 sequestration (t/year) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content

	44/12= CO_2 conversion coefficient
Required data and data source	(1) Regional climate (region, forest type, annual rainfall) ・ Record at the project implementation stage (2) Forest area change ratio ・ Select default value of the project site country from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.1 (3) Area of conservation ・ Record at the project implementation stage, or acquire by aerial / satellite photographs (4) Aboveground biomass stock ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.2 (5) Aboveground biomass increment ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.5, Table 3A.1.2
Preconditions	- Quantitative data is required concerning income from paddy cultivation as the new livelihood, reduction of dependence on wood and shifting cultivation, reduction of forest area change and their correlation. - Monitoring of the above mentioned data is required to compare before and after project implementation.
Special notes	- Local conditions should be accounted for in the baseline scenario setting. Accurate forestation/conservation area might not be measurable nor recorded during the project. - Quantification of emission avoidance might be possible if the amount of wood harvested could be estimated from income due to the harvest.

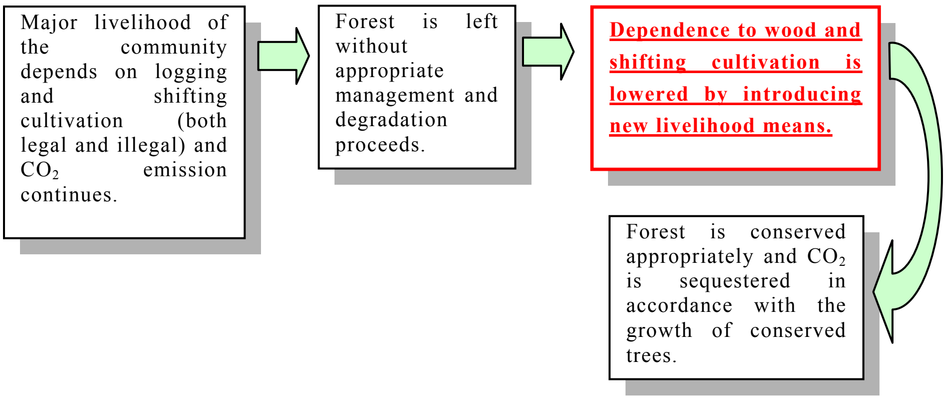
Quantification Sheet

Activity: Introduction of various livelihood means

<table>
<tr><td>Sector</td><td>Forestry and Natural Resource Conservation</td></tr>
<tr><td>Sub-sector</td><td>Forest Conservation</td></tr>
<tr><td>GHG emission reduction activity</td><td>Conservation and effective utilization of forest resources</td></tr>
<tr><td>GHG emission reduction impact</td><td>1: Activity will lead to GHG emission reduction
<u>2: Activity will lead to GHG emission reduction subject to condition(s)</u>
3: Activity will not lead to GHG emission reduction</td></tr>
<tr><td>GHG emission reduction scenarios
(description of how GHG is reduced)</td><td><Without the activity>
- Major livelihood of the community depends on logging and shifting cultivation (both legal and illegal) and CO_2 emission continues.
- Forest is left without appropriate management and degradation proceeds.


<With the activity>


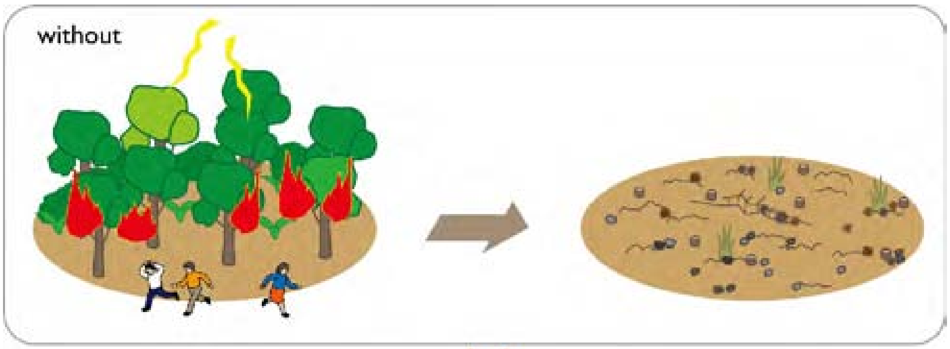
- Dependence to wood and shifting cultivation is lowered by introducing new livelihood means.
- Forest is conserved appropriately and CO_2 is sequestered in accordance with the growth of conserved trees.</td></tr>
</table>

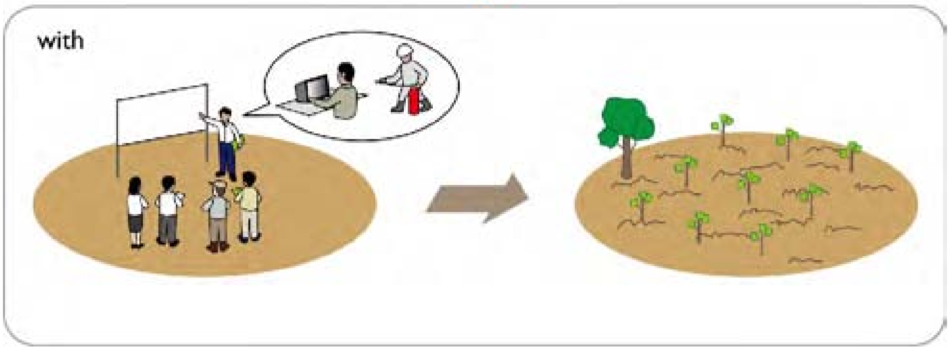
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	In case conservation area is recorded. CO_2 sink by forest conservation = Amount of annual avoidance of CO_2 emission + amount of annual CO_2 sequestration (1) Annual avoidance of CO_2 emission Avoidance of CO_2 emission (tonnes) = amount of CO_2 accumulation × forest area change ratio (%) Where: Forest area change ratio (%) Amount of CO_2 accumulation (tonnes) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient (2) Annual CO_2 sequestration amount of CO_2 sequestration (t/year) = aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation conservation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content

	44/12= CO_2 conversion coefficient
Required data and data source	(1) Regional climate (region, forest type, annual rainfall) ・ Record at the project implementation stage (2) Forest area change ratio ・ Select default value of the project site country from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.1 (3) Area of conservation ・ Record at the project implementation stage, or acquire by aerial / satellite photographs (4) Aboveground biomass stock ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.2 (5) Aboveground biomass increment ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.5, Table 3A.1.2
Preconditions	- Quantitative data is required concerning income by new livelihood, reduction of dependence on wood and shifting cultivation, reduction of forest area change and their correlation. - Monitoring of above mentioned data is required to compare before and after project implementation.
Special notes	- Local conditions should be accounted for the in baseline scenario setting. Accurate forestation/conservation area might not be measurable nor recorded during the project. - Quantification of emission avoidance might be possible if the amount of wood harvested could be estimated from income due to the harvest.

Quantification Sheet

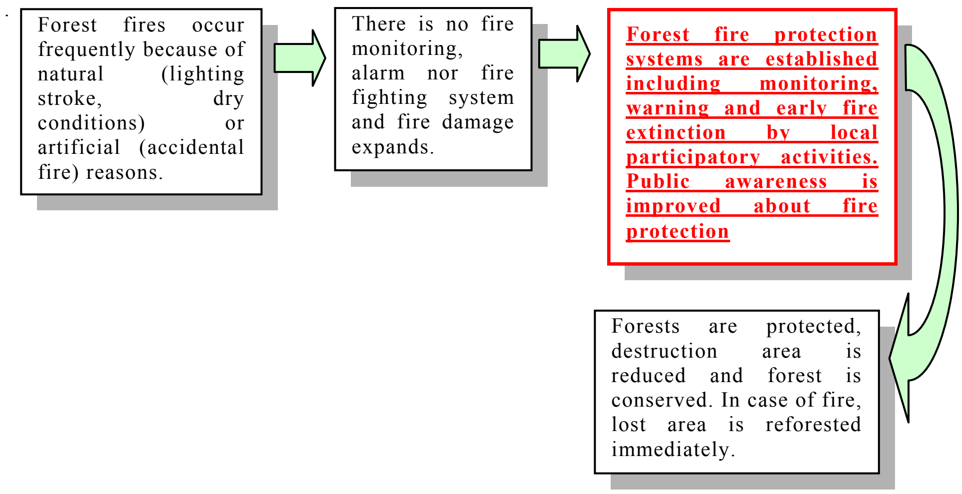
Activity: Forest fire protection systems

<table>
<tr><td>Sector</td><td>Forestry and Natural Resource Conservation</td></tr>
<tr><td>Sub-sector</td><td>Forest Conservation</td></tr>
<tr><td>GHG emission reduction activity</td><td>Capacity development/awareness raising</td></tr>
<tr><td>GHG emission reduction impact</td><td>1: Activity will lead to GHG emission reduction
2: Activity will lead to GHG emission reduction subject to condition(s)
3: Activity will not lead to GHG emission reduction</td></tr>
<tr><td>GHG emission reduction scenarios
(description of how GHG is reduced)</td><td><Without the activity>
- Forest fires occur frequently because of natural (lighting stroke, dry conditions) or artificial (accidental fire) reasons.
- There is no fire monitoring, alarm nor fire fighting system and fire damage expands.


<With the activity>


- Forest fire protection systems are established including monitoring, warning and early fire extinction by local participatory activities. Public awareness is improved about fire protection
- Forests are protected, destruction area is reduced and forest is conserved. In case of fire, lost area is reforested immediately.</td></tr>
</table>

[Schematics of GHG emission reduction process]



Calculation of GHG emission reduction

In case area protected from fire is recorded or estimated.

CO_2 sink by forest protection
= Amount of annual avoidance of CO_2 emission + amount of annual CO_2 sequestration

(1) Annual avoidance of CO_2 emission
Avoidance of CO_2 emission (tonnes)
= amount of CO_2 accumulation × forest area change ratio (%)

Where:

Forest area change ratio (%)

Amount of CO_2 accumulation (tonnes)
= aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12

Where:

A= aboveground biomass (tonnes dry matter/ha/year)
B= forestation conservation area (ha)
1.2 = 1 + belowground/aboveground ratio
0.5= carbon content
44/12= CO_2 conversion coefficient

(2) Annual CO_2 sequestration

amount of CO_2 sequestration (t/year)
= aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12

Where:

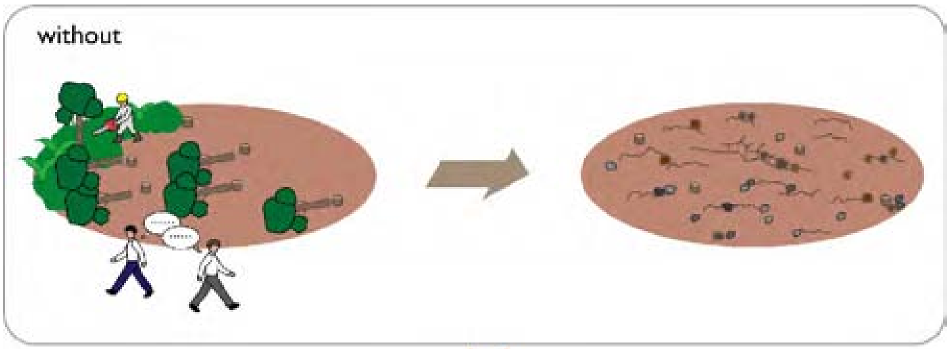
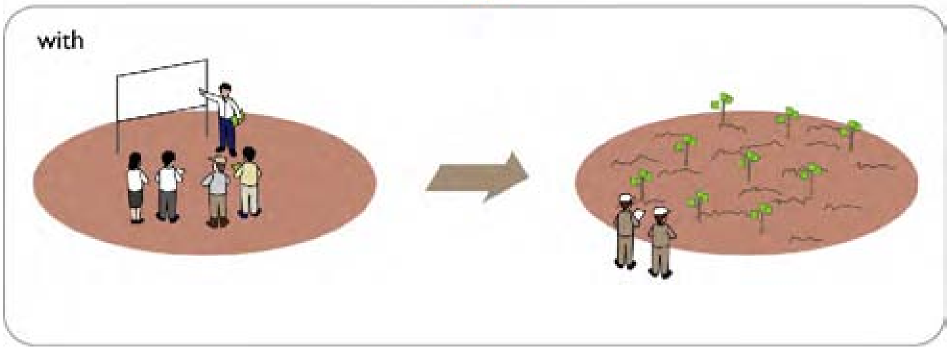
A= aboveground biomass (tonnes dry matter/ha/year)
B= forestation conservation area (ha)
1.2 = 1 + belowground/aboveground ratio

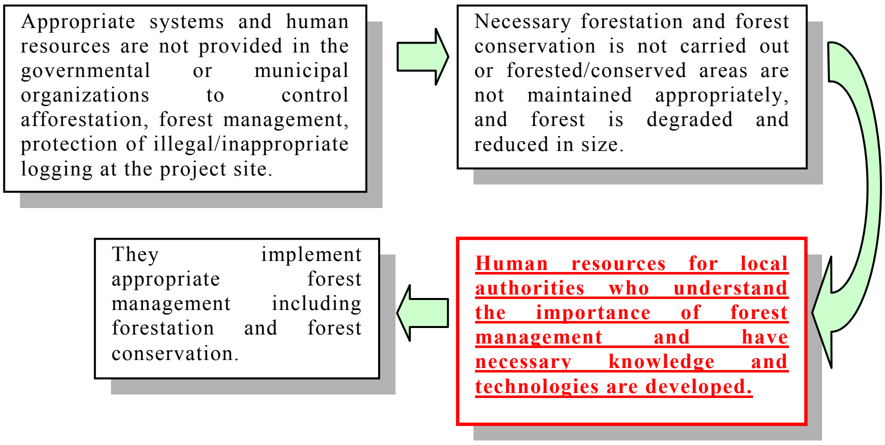
	0.5= carbon content 44/12= CO_2 conversion coefficient In case reforestation is implemented in the damaged area CO_2 sequestration (t/y) = Aboveground biomass A × forestation area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO_2 conversion coefficient
Required data and data source	(1) Regional climate (region, forest type, annual rainfall) ・ Record at the project implementation stage (2) Forest area change ratio ・ Select default value of the project site country from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.1 (3) Area of protection ・ Record at the project implementation stage, or acquire by aerial / satellite photographs (4) Aboveground biomass stock ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.2 (5) Aboveground biomass increment ・ Select default value of the project site region from IPCC GPG for LULUCF Annex 3A.5, Table 3A.1.2 In case reforestation is implemented in the damaged area (6) Tree species for the forestation ・ Record at the project implementation stage (when multi species are used, each area of each type) (7) Area of forestation ・ Record at the project implementation stage, or acquire by aerial / satellite photographs (8) Aboveground biomass ・ Apply value for under 20 years age class from IPCC GPG for LULUCF Annex 3A.1, Table 3A.1.6. ・ If the project was finished more than 20 years ago, apply value for over

	20 years age class from the same Table.
Preconditions	- Forest fire protection systems should be established and their function maintained with the understanding and participation of the local people. - Monitoring of data to affirm the above mentioned conditions have been met is required to compare before and after project implementation.
Special notes	- Local conditions should be accounted for in the baseline scenario setting. Accurate forestation/conservation area might not be measurable nor recorded during the project. - Quantification of emission avoidance might be possible if area damaged by fire could be monitored or estimated.

Quantification Sheet

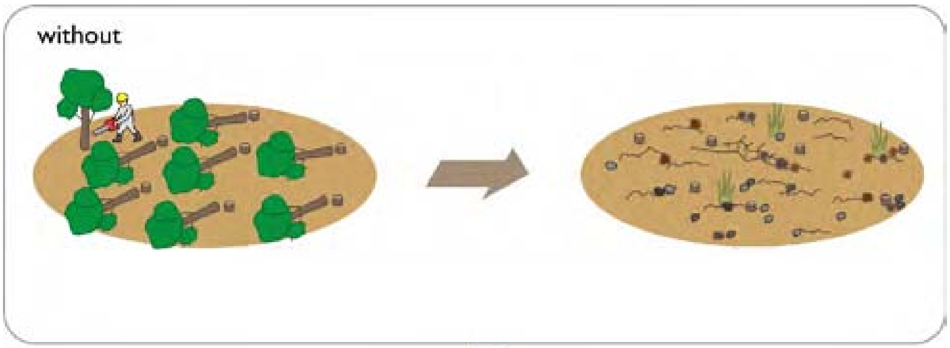
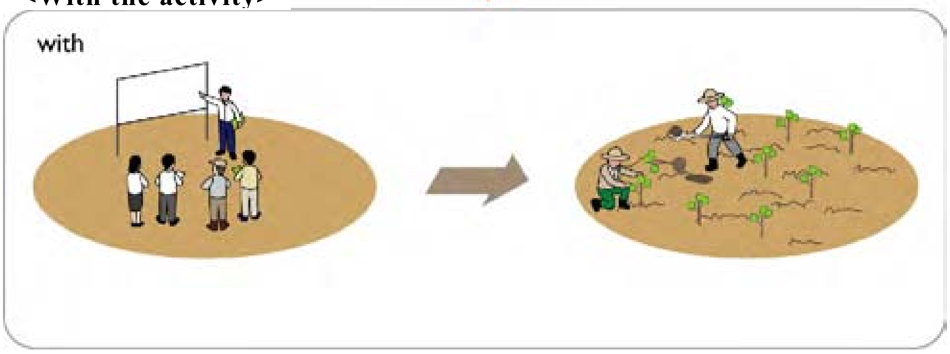
Activity: Training and management system support

Sector	**Forestry and Natural Resource Conservation**
Sub-sector	**Forest Conservation**
GHG emission reduction activity	Capacity development/awareness raising
GHG emission reduction impact	1: Activity will lead to GHG emission reduction 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activity>** - Appropriate systems and human resources are not provided in the governmental or municipal organizations to control afforestation, forest management, protection of illegal/inappropriate logging at the project site. - Necessary forestation and forest conservation is not carried out or forested/conserved areas are not maintained appropriately, and forest is degraded and reduced in size.  **<With the activity>**  - Human resources for local authorities who understand the importance of forest management and have necessary knowledge and technologies are developed. - They implement appropriate forest management including forestation and forest conservation.

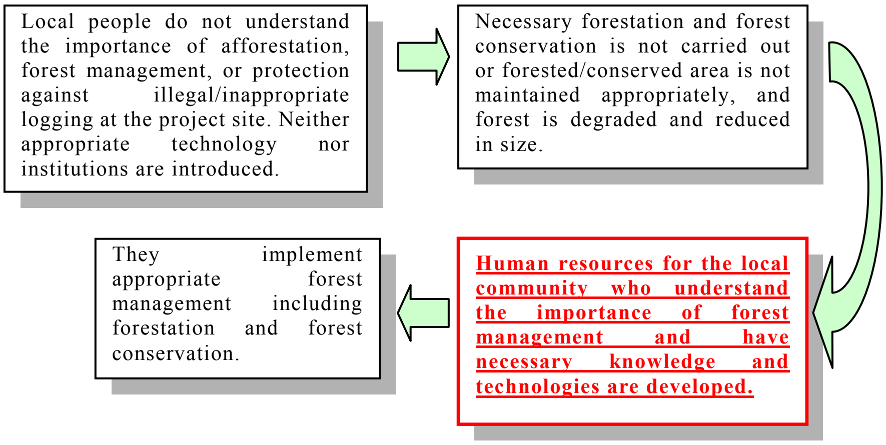
	[Schematics of GHG emission reduction process] 
Calculation of GHG emission reduction	**Without the activity** The targeted area of forest conservation defined by the entity which carries out the technology training and institutional development is the area which would have been lost without the project. **With the activity** The actual area of forestation/conservation being achieved by the technology training and institutional development through the project is the area to be used in the calculation. In case the above mentioned actual area is recorded, refer to the Quantification Sheets: Afforestation/reforestation (Industry, village) or Forest conservation.
Required data and data source	In case the above mentioned actual area is recorded, refer to the Quantification Sheets: Afforestation/reforestation (Industry, village) or Forest conservation.
Preconditions	- Necessity of technology transfer and institutional development is understood by staff in charge from local authorities and such function should be maintained. - Monitoring of above mentioned area data is required to compare before and after project implementation.
Special notes	- Local conditions should be accounted for in the baseline scenario setting. Accurate conservation area might not be measurable nor recorded during the project. - Quantification of emissions of the above mentioned activities might be possible if the conserved area is recorded by trained staff of local authorities, as is essential to implement appropriate forest conservation by managers who have learned adequate monitoring technology.

Quantification Sheet

Activity: Awareness raising of local people

Sector	**Forestry and Natural Resource Conservation**
Sub-sector	**Forest Conservation**
GHG emission reduction activity	Capacity development/awareness raising
GHG emission reduction impact	1: Activity will lead to GHG emission reduction 2: Activity will lead to GHG emission reduction subject to condition(s) 3: Activity will not lead to GHG emission reduction
GHG emission reduction scenarios (description of how GHG is reduced)	**<Without the activitv>** - Local people do not understand the importance of afforestation, forest management, or protection against illegal/inappropriate logging at the project site. Neither appropriate technology nor institutions are introduced. - Necessary forestation and forest conservation is not carried out or forested/conserved area is not maintained appropriately, and forest is degraded and reduced in size.  **<With the activity>**  - Human resources for the local community who understand the importance of forest management and have necessary knowledge and technologies are developed. - They implement appropriate forest management including forestation and forest conservation.

[Schematics of GHG emission reduction process]



Calculation of GHG emission reduction	**<u>Without the activity</u>** The targeted area of forest conservation defined by the entity which carries out the technology training and institutional development is considered as the area which would have been lost without the project. **<u>With the activity</u>** The actual area of forestation/conservation being achieved by the technology training and institutional development through the project is the area to be used in the calculations. In case the above mentioned actual area is recorded, refer to the Quantification Sheets: Afforestation/reforestation (Industry, village) or Forest conservation.
Required data and data source	In case the above mentioned actual area is recorded, refer to the Quantification Sheets: Afforestation/reforestation (Industry, village) or Forest conservation.
Preconditions	- Necessity of technology transfer and institutional development is understood by staff in charge from local authorities and such function should be maintained. - Monitoring of above mentioned area data is required to compare before and after project implementation.
Special notes	- Local conditions should be accounted for in the baseline scenario setting. Accurate conservation area might not be measurable nor recorded during the project.

3.2.5 Case Study

№	Project Title	Sector
4	Forest Management and Community Support Project (FORCOM), Laos	Forestry and Natural Resource Conservation

Case study No.	4
Project title	Forest Management and Community Support Project (FORCOM), Laos
Sector	Forestry and Natural Resource Conservation
Sub-sector	Afforestation/reforestation and forest conservation
Project summary	**[Background]** The agricultural sector produces half of the GDP in Laos and 62% of the population depends on agriculture and forestry. In particular, forestry plays an important role in the national economy, livelihood in rural areas and the environment. In northern Laos, major agriculture production is carried out by shifting cultivation. However, fallow land is increasing rapidly up to 60 % of land use in the region. Forest area change ratio (deforestation ratio) in the northern region is higher than the national average and it is considered to be attributable to the increase of shifting cultivation. **[Objectives]** Objectives of the project are to eliminate over dependence on shifting cultivation, support alternative production activities, contribute to forest conservation as well as poverty alleviation, and develop the capacity of the officials in agriculture dissemination offices in the prefecture and county. It was started as a five-year project in February 2004. **[Condition after the project implementation]** Practical activities include; (1) Pilot implementation of the project activities in some selected project site villages, (2) Capacity development for the agricultural dissemination offices in the prefecture and county, (3) Expansion of the activities to other villages to support sustainable development, and (4) Recommendations to the Ministry of Agriculture concerning the results of the project. Alternative livelihood means supported by the CSP includes livestock breeding such as pigs and goats, aquaculture, agroforestry, weaving, fruit tree cultivation, and expansion of paddy fields. The detailed research regarding household budgets of the community should be noted. It was carried out to collect data about the decrease of dependence on shifting cultivation. JICA's contribution for the planning of such a detailed research scheme, as well as data collection and monitoring was very important.
GHG emission reduction scenarios	If the project would not have occurred, forest logging and shifting cultivation as the livelihood of local community will be continued.

	After logging, the land would be used as farms (in case of shifting cultivation) or left (in case of logging). <Continuation of current condition>
Equations to calculate GHG emissions	JICA implemented a study "Contribution of JICA in the global warming countermeasure (Forest sector) – On quantification of CO_2 absorption" in 2007. In the research, quantification methods were discussed and test estimation was implemented about the amount of CO2 sink by afforestation/reforestation and forest conservation in the Technical Cooperation Projects, Private-Sector Investment Finance, Development Study, and Grant Aid. Through discussions with the JICA task team, application of the methods developed in the above mentioned study was justified as most appropriate as follows: - It was developed by experts of the field to apply to JICA projects, considering the characteristics of such projects, - The method is simplified and data requirements are minimized considering convenience to JICA staff in charge of field work, - For default values, IPCC Good Practice Guidance for LULUCF is referred to, which is often applied to CDM methodologies. The calculation method is described below. In this study, several assumptions were applied using data and information from evaluation reports and final reports, because some of the detailed data such as forestation/conservation area and tree species were not clarified. (1) CO_2 sequestration by afforestation/reforestation CO_2 sequestration (t/y) = Aboveground biomass A × forestation area B × 1.2 × 0.5 × 44/12 Where: A= aboveground biomass (tonnes dry matter/ha/year) B= forestation area (ha) 1.2 = 1 + belowground/aboveground ratio 0.5= carbon content 44/12= CO2 conversion coefficient (2) CO_2 sink by forest conservation = Amount of annual avoidance of CO_2 emission + amount of annual CO_2 sequestration 1) Annual avoidance of CO_2 emission Avoidance of CO_2 emission (tonnes) = amount of CO_2 accumulation × forest area change ratio (%) Where:

Forest area change ratio (%)
Amount of CO_2 accumulation (tonnes)
= aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12

Where:

A= aboveground biomass (tonnes dry matter/ha/year)
B= forestation conservation area (ha)
1.2 = 1 + belowground/aboveground ratio
0.5= carbon content
44/12= CO_2 conversion coefficient

2) Annual CO_2 sequestration

amount of CO_2 sequestration (t/year)
= aboveground biomass A × conserved area B × 1.2 × 0.5 × 44/12

Where:

A= aboveground biomass (tonnes dry matter/ha/year)
B= forestation conservation area (ha)
1.2 = 1 + belowground/aboveground ratio
0.5= carbon content
44/12: CO_2 conversion coefficient

Applied data

Data applied for the calculation are as follows:

Table 1 Data to calculate sink by forestation

Dry weight	7.1t dry matter/ha/year Assume that "Tropical and sub-tropical, Asia, Moist with long dry season, other species" is applicable.
Forested area	518.4ha Calculated from data collected at the site. However, it was not confirmed if all of the area was forested or conservation area was included. Therefore, the entire area was assumed as forested area. The villages or activities in which forestation was carried out at the initial stage but current situation is not confirmed were not applied to the calculation to be conservative. The detailed data are described as shown in the following tables.

Initial site

Village name	Activities	Area (ha)	Remarks
Pongdong	Community forest	1.6	
	School forest (Orchard)	0.33	
Hat Houay	Fruit tree planting	1.94	
	School forest (Orchard)	1.53	
Namon	Fruit tree planting	3.78	
	Water resource forest	20	

	Community forest	1	
	School forest (Orchard)	0.5	
Samton	Water resource forest	0.1	
	School forest	1.1	
Total		**31.88**	

1st Pilot

Village name	Activities	Area (ha)	Remarks
Pangthong	Fruit tree planting	4	
	Community forest		Current na
	School Orchard		Current na
Donkeo	Water source forest	200	
	Water source forest	30	
	School Orchard	2.7	
Phakha	Fruit tree planting	8	
	Watershed Forest	1	
	School forest (Orchard)	0.288	
Namsat	Water source forest	200	
	Community forest	1.5	
	School Orchard	0.5	
Vangheung	Community forest	1	
Phonthon	Fruit tree planting	2.7	
	Community forest	3	
	School Orchard	0.2	
Total		**450.888**	

2nd Pilot

Village name	Activities	Area (ha)	Remarks
Pakhat	Community forest		Current na
	School Orchard		Current na
Tha	Water source forest	30	
	School Orchard	2.7	
Nalang	Community forest	3	
	School Orchard	0.2	
Houayla	Fruit tree planting	0.4	
	Community forest	0.2	
Boampaseng	School forest (Orchard)		Current na
Silimoon	Watershed forest	2	
	School forest (Orchard)	1.09	
Kokieng	Water source forest		Current na
Total		**3.09**	

3rd Pilot

Village name	Activities	Area (ha)	Remarks
Nahom	Community forest		Current na
	School Orchard		Current na
Longseng	Water supply system	1	considered as forestation
Nonhinhea	Community forest		Current na
Houaysala	Water source forest		Current na
Houasakin	Community forest	1.5	
	School Orchard	0.5	
Phonkham	Community forest	1	
	School Orchard	0.25	
Taohom	Community forest	2	
	School forest (Orchard)	1	
Nampung	Water source forest		Current na
Total		**6.25**	

4th Pilot

Village name	Activities	Area (ha)	Remarks
Chaleunday	Community forest		Current na
	School Orchard		Current na
Donkhun	na		na
Nakeng	School Orchard		Current na
Mokkhakang	na		na
Nongnong	na		na
Phonsay	Community forest		Current na
Keomany	na		na
Hatngam	na		na
Total		**6.25**	

Total area of 5 sites	**498.358 ha**

Table 2 Data to calculate emission avoidance (emissions for baseline) and sink by forest conservation

Forest area change	-0.4 % It is said that the value of the project site is higher than the national average. However, -0.4%, the same value as the national average is adopted to be conservative.
Above ground biomass	6.0 t dry matter /ha/year For the project, all forest types were assumed as “Tropical Forest, Asia, Continental” and the age is below 20 years.
Conservation area	73.8ha Field data about the decrease in the area of shifting

cultivation was assumed as the forest conservation area, in accordance with the Terminal Evaluation Study Report, Annex 5, page 2, Table 3. The detailed data are described as shown in the following tables.

Village	Shifting cultivation area (ha)			from 2005 to 2007:	
	2005	2006	2007	Area change	Ratio (%)
Hat Houay	55.70	30.86	31.03	-24.67	-44.3
Samton	34.95	29.61	20.10	-14.85	-42.5
Pongdong	30.07	21.99	22.21	-7.86	-26.1
Namon	20.05	11.09	15.55	-4.50	-22.4
Pangthong	45.60	30.32	33.76	-11.84	-26.0
Pakha	8.08	4.20	4.80	-3.28	-40.6
Namsat	11.05	4.46	4.25	-6.80	-61.5
Total decrease	205.50	132.53	131.70	-73.80	－

Calculation of GHG emissions

Step1: Amount of CO_2 emissions without project

If the project would not have occurred, forestation will not be carried out and logging/shifting cultivation will continue. No sink occurs and emissions only occur according to the amount of forest logging.

Therefore, in the "without case", the same area as the conservation area in the "with case" was assumed to be logged.

Table 1: CO_2 emissions without project case

Items	Calculation
CO_2 emissions by logging	127 × 73.8 ×1.2×0.5×44/12 ＝20,620t/year

Step2: Amount of CO_2 sink and avoidance of emissions with project

This is calculated considering three phases, e.g., CO_2 sink by forestation, avoidance of CO_2 emissions and sink by forest conservation.

Table 2: CO_2 emissions with project case

Items	Calculation
CO_2 sink by forestation	7.1 × 498.4 × 1.2 × 0.5 × 44/12 ＝7,785t/year
CO_2 sink by forest conservation	20,620＋974＝21,594 t/year (Breakdown is as follows :)
1) Annual CO_2 emission avoidance	127 × （24.67 + 14.85 + 7.86 + 4.50 + 11.84 + 3.28 + 6.80 + 0.60） ×1.2×0.5×44/12 ＝20,620t/year
2) Annual CO_2 sink	6 × （24.67 + 14.85 + 7.86 + 4.50 + 11.84 + 3.28 + 6.80 + 0.60） ×1.2×0.5×44/12 ＝974t/year

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Table 3: Calculation results
<table>
<tr><th>Items</th><th>Calculation</th></tr>
<tr><td>GHG emissions without the project</td><td>20,620t/year</td></tr>
<tr><td>GHG emissions with the project</td><td>7,785 + 21,594 = 29,379 t/year</td></tr>
<tr><td>Amount of GHG emission reduction</td><td>29,691－20,620
= 8,759 (tCO_2/yr)</td></tr>
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<td>Preconditions</td>
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− In this study, all areas recorded as Community forest and other forest in the current situation were assumed as forested areas and the amount of sink by those forests was calculated. However, the practical conditions differ in all villages in terms of how much of them was forested area or conserved area.
− Detailed records of such distribution are essential for more detailed calculation of sink/avoidance amount by the project.
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<tr>
<td>Lessons learned from case study</td>
<td>
- It will be possible to carry out detailed research and monitoring if a research plan is developed at the initial stage of the project with a participatory approach.
- However, it is difficult to quantify the effect of newly introduced alternate means of livelihood to increase the forest conservation area. Some supplemental method development would be required.
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