CDM (CLEAN DEVELOPMENT MECHANISM) FOR HYDROPOWER PROJECTS

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By

DEEP CHANDRA PUROHIT

DEPARTMENT OF WATER RESOURCES DEVELOPMENT AND MANAGEMENT
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE -247 667 (INDIA)

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CONDIDATE 'S DECLARATION

I hereby certify that the work which is being presented in the dissertation entitled: **" CDM (CLEAN DEVELOPMENT MECHANISM) FOR HYDROPOWER PROJECTS"** in the partial fulfillment of the requirement for the award of the Degree of Master of Technology in Water Resources Development, submitted in Water Resources Development and Management Department, Indian Institute of Technology Roorkee, is an authentic record of my own work carried out during the period from July 2006 to June 2007, under the supervision and guidance of Prof D Das.

I have not submitted the matter embodied in this Dissertation for the award of any other degree.

Date: June 2007

Place: Roorkee

Deep

(Deep Chandra Purohit)

Certified that the above declaration given by the candidate is correct to the best of my knowledge.

Devadutta Das

PROF. D. DAS

WRD&M, IIT ROORKEE

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(Deep Chandra Purohit)

WRDM, IIT Roorke

ABSTRACT

The CDM (Clean Development Mechanism) component aims to examine the potential application of the CDM and to identify greenhouse gas mitigation projects that could be funded under the CDM. The CDM is one of the three flexibility mechanisms under the Kyoto Protocol.

Through the CDM, GHG (greenhouse gas) mitigation projects that contribute to sustainable development in developing countries can help Annex I countries (developed countries and economies in transition) to meet their commitments under the Kyoto Protocol.

In this Thesis work my aimed to:

- Contribute to the evolving CDM rules and modalities
- enhance understanding about CDM
- evaluate CDM project opportunities
- making of PDD of a project

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CHAPTER 1

1.1 INTRODUCTION

The Clean Development Mechanism (CDM) is an arrangement under the Kyoto Protocol allowing industrialized countries with a greenhouse gas reduction commitment to invest in emission reducing projects in developing countries as an alternative to what is generally considered more costly emission reductions in their own countries.

The CDM allows for a drastic reduction of costs for the industrialized countries, while achieving the same amount of emission reductions as without the CDM. In practice, however the emission reductions may be less with CDM than without it and may lead to unsustainable practices.

The CDM is supervised by the CDM Executive Board (CDM EB) and is under the guidance of the Conference of the Parties (COP/MOP) of the United_Nations Framework Convention on climate Change (UNFCCC).

1.2 History and Purpose

The CDM arose out of the negotiations of the Kyoto Protocol in 1997. The United States government desired that there be as much flexibility in achieving emission reductions as possible and desired a possibility of international emissions trading to achieve the emission reductions where it could be done at least cost. During the time it was considered a controversial element and was opposed throughout by environmental NGOs and initially by developing countries who felt that industrialized countries should put their own house in order first and feared the environmental integrity of the mechanism would be too hard to guarantee below). Eventually, and largely on US insistence, CDM and two other flexible mechanisms were written into the Kyoto protocol.

The purpose of the CDM Apart from helping countries comply with their emission reduction commitments, it must assist developing countries in achieving sustainable development, while also contributing to stabilization of greenhouse gas concentrations in the atmosphere.

1.3 CLEAN DEVELOPMENT MECHANISM (CDM)

The Clean Development Mechanism (CDM) was instituted in 2001, under the Kyoto Protocol to enable developed countries to meet their Green House Gas (GHG) reduction targets at lower cost through projects in developing countries. It is designed as an element of the sustainable development strategy allowing industrialized countries investing in "clean" projects in developing countries and to gain emission credits. These credits are given in the form of certified emission reductions (CERs), which, like all the other Kyoto accounting units, are expressed in tons of carbon dioxide equivalent. The financing country can use these units to offset its own emissions of greenhouse gases during a given period, or sell them to another country. It can also bank them for use during a subsequent period. Since these investments are viewed in a positive light they also add to the reputations of project developers and investors. At the same time the recipient country gains from an increase in investment - which may be from private or public sources in sustainable Development.

The CDM is meant to work bottom up- to proceed from individual proposals to approval by donor and recipient governments to the allocation of "Certified Emission Reduction" (CER) credits. In other words a CDM project has to follow a definite CDM Project Cycle. The CDM is supervised by Executive Board, which comprises 10 members, elected by the Conference of Parties (COP).

All projects must result in a net GHG reduction, as in the case of energy efficiency improvement or power generation from renewable energy. Small-scale CDM projects (renewable energy project activities with a maximum output capacity ≤ 15 MW, energy efficiency improvement project activities which reduce energy consumption, on the supply and/or demand side, by up to the equivalent of 15 GWh per year; and other project activities that reduce anthropogenic emissions by sources, and directly emit less than 15 kilo-tonnes of carbon dioxide equivalent annually) are eligible for fast track clearance.

1.4 KYOTO PROTOCOL

The Kyoto Protocol to the United Nations Framework Convention on Climate Change is an amendment to the international treaty on climate change, assigning mandatory emission limitations for the reduction of greenhouse gas emissions to the signatory nations.

The objective is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

As of December 2006, a total of 169 countries and other governmental entities have ratified the agreement (representing over 61.6% of emissions from Annex countries). Notable exceptions include the United States and Australia. Other countries, like India and China, which have ratified the protocol, are not required to reduce carbon emissions under the present agreement

The Protocol entered into force on February 16, 2005 and targets six main greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), per fluorocarbons

(PFCs), and sulphur hexafluoride (SF_6).

Recognizing that relying on domestic measures alone to meet the emission targets could be difficult, the Kyoto Protocol offers considerable flexibility through following three mechanisms:

- Joint Implementation (JI) which allows countries to claim credit for emission reduction that arise form investment in other industrialized countries, which result in a transfer of 'emission reduction units' between countries;
- Emission Trading (ET) which permits countries to transfer parts of their 'allowed emissions' (assigned amount units); and
- Clean Development mechanism (CDM) through which industrialized countries can finance mitigation projects in developing countries contributing to their sustainable development.

(*Source: http://cdm.unfccc.int/index.html)

CHAPTER 2

2.1.1 CLIMATE CHANGE

Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, which is attributed directly or indirectly to anthropogenic activities that alter the composition of global atmosphere and which are in addition to natural climatic variability observed over comparable time periods. While the world's climate has always varied naturally, the vast majority of scientists now believe that rising concentrations of "greenhouse gases" in the earth's atmosphere, resulting from economic and demographic growth over the last two centuries since the industrial revolution, are overriding this natural variability and leading to irreversible climate change. The implications of "global warming" are far reaching, and include rises in sea levels, changes in rainfall patterns (increasing the threat of drought or floods in many regions) and a greater threat of extreme weather events, such as intense storms and heat waves. Climate change could, therefore, have potentially dramatic negative socio-economic and environmental impacts.

2.1.1 Climate Change Milestones

* Convention Timeline
* Protocol Timeline

Table: 2.1 meetings on climate change

2006	• Kyoto Protocol Compliance Committee Established
	• Post 2012 emission reduction target negotiations agenda agreed
2005	• February-16 Kyoto Protocol come into existence.
2004	• December COP 10 (Buenos Aires, Argentina)

2003	• December COP 9 (Milan, Italy)
2002	• October and November COP 8 (New Delhi, India) Delhi Declarations. • August and September progress since 1992 reviewed at World Summit on Sustainable Development.
2001	• October and November COP 7 (Marrakesh, Morocco) • Marrakesh Accords • April, IPCC Third Assessment Report • July, COP6 resumes (Bonn Germany) • July, Bonn Agreements
2000	• November COP 6 (The Hague, Netherlands) • Talks based on the Plan beak down
1998	• November COP 4 (Buenos Aires, Argentina) • Buenos Aires Plan of Action
1997	• December COP 3 (Kyoto, Japan) • Kyoto Protocol adopted
1995	• March and April COP 1 (Berlin, Germany) • March and April Berlin Mandate
1994	• March, Convention enters into force
1992	• May, Inc adopts UNFCCC text • June, Convention opened for signature at Earth Summit
1991	• First meeting of the INC

1990	• IPCC and second WCC call for global treaty on climate change • September, United Nations General Assembly negotiations on a framework convention
1988	• IPCC established
1979	• First World Climate Conference (WCC)

clean, green image of dams may have been seriously overstated. The global-warming impact of hydropower plants can often outweigh that of comparable fossil-fuel power stations.

The problem lies with the organic matter in the reservoir. Large amounts are trapped when land is flooded to create the dam, and more is flushed in after that. In the warm water of tropical dams, this matter decays to form methane and carbon dioxide. Although both are greenhouse gases, the main worry is methane, which has more than 20 times the warming impact of carbon dioxide over a 100-year period.

Fig 2.1 Formation of organic matter

2.1.2 GREENHOUSE GAS EFFECT

The atmosphere carries out the critical function of maintaining life-sustaining conditions on Earth, in the following way: each day, energy from the sun (largely in the visible part of the spectrum, but also some in the ultraviolet and infra red portions) is absorbed by the land, seas, mountains, etc. If all this energy were to be absorbed completely, the earth would gradually become hotter and hotter. But actually, the earth both absorbs and, simultaneously releases it in the form of infra red waves (which are invisible but can be felt as heat). All this rising heat is not lost to space, but is partly absorbed by some gases present in very small (or trace) quantities in the atmosphere, called green house gases (GHGs).

The main greenhouse gases are water vapour, carbon dioxide, methane, nitrous oxide, and the chlorofluorocarbons (CFCs). Levels of all key greenhouse gases (with the possible exception of water vapour) are rising as a direct result of anthropogenic activities. Concentration of carbon dioxide (mainly from burning coal, oil, and natural gas), methane and nitrous oxide (due to agriculture and changes in land use), and CFCs (produced by industries) are changing at an unprecedented speed. The result is known as the "enhanced greenhouse effect". This could lead to greater warming, which in turn, could have an impact on world's climate leading to the phenomenon Known as "climate Change". The climate system must adjust to rising greenhouse gas levels to keep the global "energy budget" in balance. In long term, the earth must get rid of energy at the same rate at which it receives energy from the sun. Since a thicker blanket of greenhouse gases helps to reduce energy loss to space, the climate must change somehow to restore the balance between incoming and outgoing energy. This adjustment will include a "global warming" of the earth's surface and lower atmosphere. But this is only part of the story. Warming up is the simplest way for the climate to get rid of the extra energy. But even small rise in temperature will be accompanied by many other changes: in cloud cover and wind patterns, for example. Some of these changes may act to enhance the warming, others to counteract it. India scenario @ 1990 shows, total CO_2-equivalent emissions were 1001352 GHGs and this figure was approximately 3% of global emissions. Energy sector contributes the main CO_2 source with 55% of national emissions, which includes the emissions from transport sector, coal mining, and fugitive emissions from oil and natural gas. Second largest source for GHGs in India was from the agriculture sector with 34% of national GHGs; leads from methane emissions from enteric fermentation in domestic animals, manure management, rice cultivation, and burning of agricultural residues. Emissions from land use change and forestry (LULUCF) sector, results in negligible emissions (ADB-GEF-UNDP 1998).

2.1.3 IMPACTS OF CLIMATE CHANGE ON GLOBAL ENVIRONMENT

Global climate is changing drastically w.r.t the anthropogenic activities. Extensive research and computer models have been developed in recent years to get a coherent relationship between the climatic change & various other factors. Industrialized countries contributes to the major part of the responsibility for growing concentration of green house gases and the major burden is on the developing countries that will receive the imminent negative impacts due to their vulnerable socioeconomic, political, and environmental conditions.

The effects of global warming are difficult to quantify because of the complicated relationships between air temperature, precipitation quantity and pattern, vegetative cover and soil moisture. However, it is likely to harm humanity in following ways:

- The most dramatic change has been in the temperature, with measurement records suggesting that warming by 0.3-0.6 °C has already taken place since the 1860s. Over the next hundred years, the earth's surface temperature is projected to increase by 1.4 to 5.8 °C.
- As a result of increased temperature, the large quantities of water locked in the polar ice caps and glaciers will be released as a consequence of warming. This, together with an increase in the thermal expansion of the oceans, will make the global mean sea level rise by 9 cm to 88 cm.
- A rise in sea level could inundate and erode coastal areas, increase flooding and salt-water intrusion; this will affect coastal agriculture, fisheries and aquaculture, freshwater resources, human settlements and tourism.
- The frequency and duration of heat waves will increase, which, combined with greater humidity and urban air pollution, will cause a greater number of heat related illness and deaths.
- A general reduction is expected in potential crop yields in most tropical and sub-tropical regions. Mid-continental areas -- such as the United States' "grain belt" and vast areas of Asia

-- are likely to dry. Where dry land agriculture relies solely on rain, as in sub-Saharan Africa, yields would decrease dramatically even with minimal increases in temperature. Such changes could cause disruptions in food supply.

- By the 2080's, substantial dieback of tropical forests and grasslands is predicted to occur, particularly in parts of South America and Africa.
- The availability of water in the rivers of Australia, India, southern Africa, South America, Europe and the Middle East is expected to decrease. Salt-water intrusion from rising sea levels will further reduce the quality and quantity of freshwater supplies.
- Most of the world's endangered species around 25 per cent of mammals and 12 per cent of birds may become extinct over the next few decades as warmer conditions alter the forests, wetlands, and rangelands they depend on.
- Higher temperatures are expected to expand the range of some dangerous "vector-borne" diseases, such as malaria, which already kills 1 million people annually, most of them children.
- Environmental damage -- such as overgrazed rangeland, deforested mountainsides, and denuded agricultural soils -- means that nature will be more vulnerable than previously to changes in climate.
- World's vast human population, much of it poor, is vulnerable to climate stress as millions live in dangerous places on floodplains or in shantytowns on exposed hillsides around the enormous cities of the developing world.
- Higher summer temperatures will increase the demand for energy for space cooling.

Though, some scientists realise following potential benefits of global warming:

- Some regions at mid-latitudes will have increased crop yields for increases in temperature of a few degrees Celsius.
- An increase in global timber supply from appropriately managed forests.
- More water in some water-scarce regions-for example, in parts of Southeast Asia.
- Reduced winter mortality in mid-and high latitudes.
- Higher winter temperatures will reduce energy demand for space heating.

2.1.4 Environmental concerns

As CDM is an alternative to domestic emission reductions, the perfectly working CDM would produce no more and no less greenhouse gas emission reductions than without use of the CDM. However, it was recognized from the beginning that if projects that would have happened anyway are registered as CDM projects, the use of CDM will result in higher total emissions, as the
Spurious credits will be used to allow higher domestic emissions while not delivering lower emissions in the developing country hosting the CDM project. Similarly, spurious credits may be awarded through overstated baselines.

The NGO CDM Watch argues that a majority of the CDM projects so far (2005) would have happened anyway, referring among other reasons to project activities completed before final approval as CDM projects, and arguing that these would be viable without the CDM financing, and therefore non-additional.

NGOs have also criticized the inclusion of large hydropower projects as CDM projects which they deem unsustainable..

In response to concerns of unsustainable projects or spurious credits, the WWFWorld (Wide Fund for Nature (or World Wildlife Fund), an international wildlife conservation organiza) and other NGOs devised a 'Gold Standard' methodology for certifying projects that used much stricter criteria than required, such as allowing only renewable energy .

2.2 Flexible Mechanisms

These are mechanisms defined under the Kyoto Protocol intended to lower the overall costs of achieving its emissions targets. These mechanisms enable Parties to achieve emission reductions or to remove carbon from the atmosphere cost-effectively in other countries. While the cost of limiting emissions varies considerably from region to region, the benefit for the atmosphere is in principle the same, wherever the action is taken.

Much of the negotiations on the mechanisms has been concerned with ensuring their integrity. There was concern that the mechanisms do not confer a "right to emit" on Annex 1 Parties or lead to exchanges of fictitious credits which would undermine the Protocol's environmental goals.

To participate in the mechanisms, Annex 1 Parties must meet the following eligibility requirements:

1. They must have ratified the Kyoto Protocol.
2. They must have calculated their assigned amount, as a standard.
3. They must have in place a national system for estimating emissions and removals of greenhouse gases within their territory.
4. They must have in place a national registry to record and track the creation and movement of ERUs, CERs, AAUs and RMUs and must annually report such information to the secretariat.
5. They must annually report information on emissions and removals to the secretariat.

Annex I countries (industrialised countries): Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, European Union, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, United States of America

To prevent industrialised countries from making unlimited use of CDM, Article 12 has a provision that use of CDM be 'supplemental' to domestic actions to reduce emissions.
The CDM gained momentum in 2005 after the entry into force of the Kyoto Protocol which was a key risk factor for investors. Nevertheless, the throughput has been less than expected due to understaffing and lack of resources at the EB.

2.3 Effect of CDM on developing countries

At present, developing countries have no obligations to constrain their GHG emissions. But they are still able, on a voluntary basis, to contribute to global emission reductions by hosting projects under the Clean Development Mechanism.

The CDM has two key goals:

- ☐ To assist developing countries who host CDM projects to achieve sustainable development;
- ☐ To provide developed countries with flexibility for achieving their emission reduction targets, by allowing them to take credits from emission reducing projects undertaken in developing countries.

The greenhouse gas benefits of each CDM project will be measured according to internationally agreed methods and will be quantified in standard units, to be known as 'Certified Emission Reductions' (CERs). These are expressed in tons of CO2 emission avoided. When the Kyoto Protocol becomes fully operational, it is anticipated that these 'carbon credits' will be bought and sold in a new environmental market; they are already becoming a commodity.

2.4 CDM relevant to the land use sector:

Rising atmospheric levels of CO_2 are the main driver of climate change. Figure 2.3 illustrates the global carbon budget. The boxes show the stocks of carbon held in different parts of the earth and atmosphere. The arrows indicate the annual flows of carbon between the main components. The largest flows between oceans, forests and the atmosphere occur naturally.

But emissions from burning fossil fuels and producing cement upset the natural balance and increase CO_2 in the atmosphere - leading to climate instability. People's impacts on forests and soils are also a key factor, with almost 25% of annual emissions of CO_2 resulting from forest clearance. However, tree planting or regeneration of forest ecosystems removes CO_2 from the atmosphere as vegetation grows; a process referred to as 'carbon sequestration'. (Around 50% of the dry weight of woody vegetation is carbon.) Soil management is also key, as soils contain substantially more carbon than is contained in the atmosphere. Different land use activities will therefore have different impacts on the carbon balance: some may result in net sequestration and others in net emissions.

The role of forestry in meeting the objectives of the Climate Change Convention has been contentious throughout the negotiations.

Although it is recognized that land use is integral to the carbon cycle there is a diversity of opinions on its exact role in meeting Emission reduction targets - A decision was made in Bonn, in July 2001, to include afforestation and reforestation as the only eligible land use activities in the CDM. These may be large or small-scale, single or multiple species, pure forestry or on farm systems (illustrated in Figure 2.4).

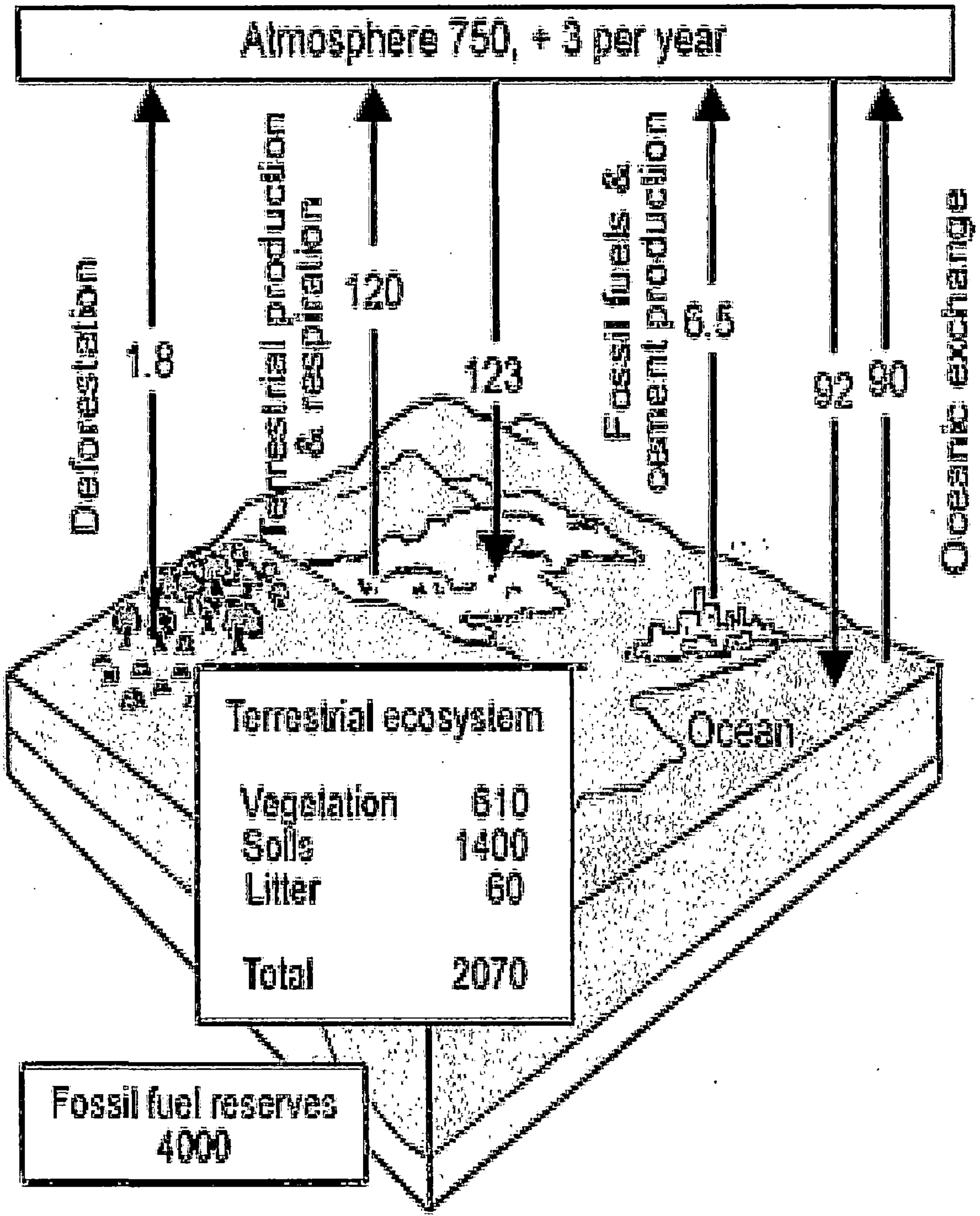

Fig 2.3: Carbon stocks are presented in Gt and carbon Gty-1

- Establishment of woodlots on communal lands.
- Reforestation of marginal areas with native species e.g. riverine areas, steep slopes, around and between existing forest fragments (through planting and natural regeneration).

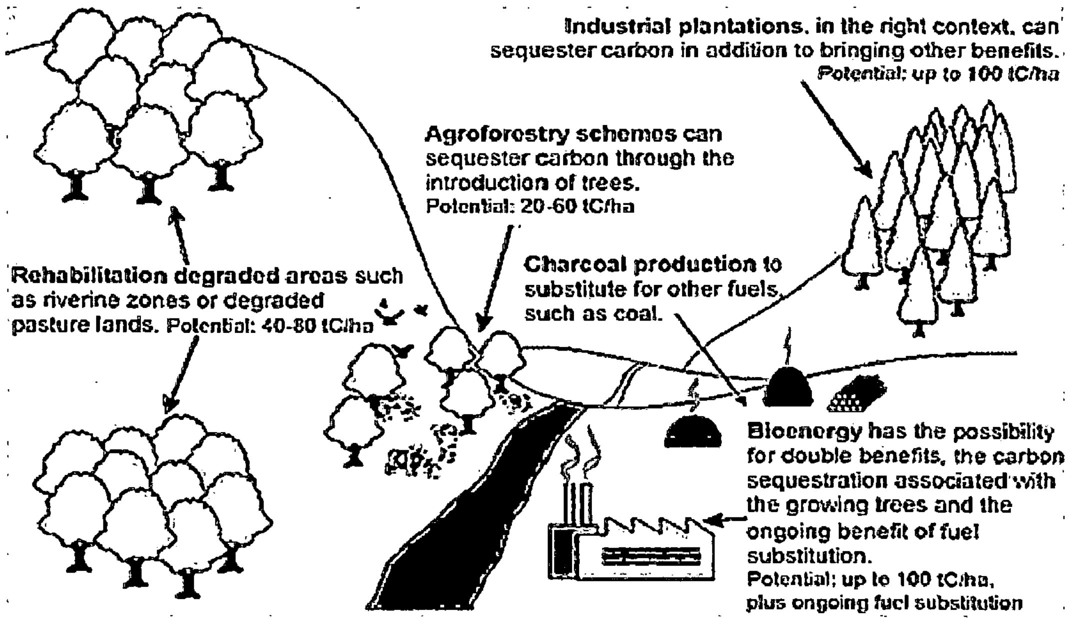

Figure 2.4: Eligible land use activities in the CDM. With an estimate for their potential for generating carbon offsets (In tones of carbon per hectare, (C/ha)

- New, large-scale, industrial plantations.
- Establishment of biomass plantations for energy production and the substitution of fossil fuels.
- Small-scale plantations by landowners.

2.5 Steps involved in a CDM Project

Projects Identification

The process of developing a CDM project starts by identifying an idea that will reduce GHG emissions. The initial steps require the project proponent to examine the emissions reduction resulting from the project and to ascertain if it contributes to the development priorities of the nation.

Government Endorsement

Once the project proponent is convinced the project is relevant under the CDM, a project idea note is prepared and submitted for endorsement to the nodal agency of the country. For India the designated nodal agency is the Ministry of Environment and Forests. After endorsement, the project idea can be developed further.

Project Development

To establish the 'additionality' of a project, it is necessary to first define a baseline against which project emissions can be measured. This baseline study is carried out in accordance with provisions in the Kyoto Protocol and estimates the quantum of GHG reductions in terms of tonnes of carbon dioxide equivalents.

Validation

The project idea note, the baseline study, and other relevant details are submitted for validation by an independent agency identified by the CDM Executive Board as a DOE (designated operational entity).

Validation is the independent evaluation of a project activity against the requirements of CDM

The DOE checks whether the proposed project activity meets all the requirements of the CDM and submits its validation report to the Executive Board.

Registration

Registration is the formal acceptance by the Executive Board of a validated project as a CDM project activity.

Monitoring

Once registered, the project proponents are responsible for monitoring the actual GHG emissions reduced by the project. A DOE may be approached periodically to verify and certify the reduction in GHG emissions.

Verification

Verification is the periodic independent review and ex post determination of monitored emissions reductions.

Certification

Certification is written assurance by the designated operational entity that, during a specified time period, a project activity achieved the GHG emissions reductions as verified.

Issuance of CERs

The DOE along with its certification report submits a request to the Executive Board for the issuance of certified emission reductions (CERs) .

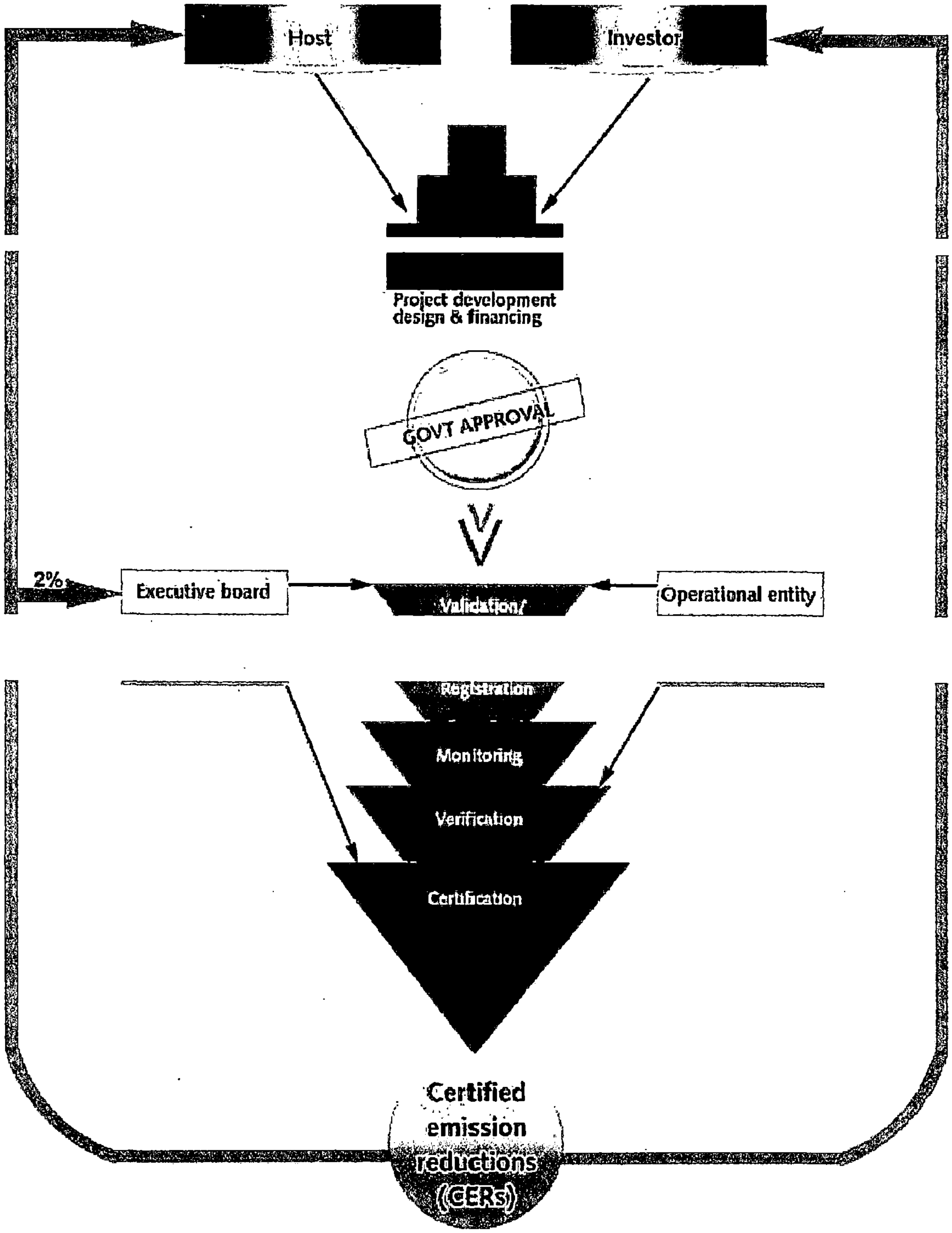

Fig 2.5 Project Cycle

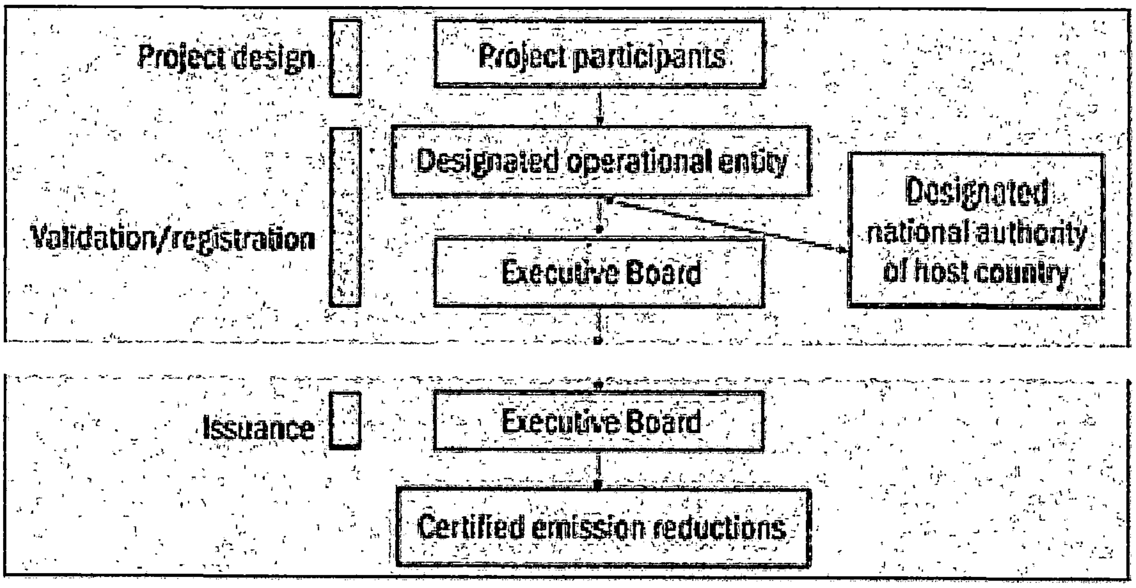

Fig 2.6 Process involved in undertaking CDM projects

(*source: http://envfor.nic.in/cc/cdm/criteria.htm)

CHAPTER 3

3.1 CDM rules and conditions

CDM projects need to seek approval by the CDM Executive Board. A number of rules and conditions will apply, some to all project types and others specifically to afforestation and reforestation projects. While several of the detailed procedures to be applied to CDM forestry projects are still to be agreed, the overall framework is already established for approving projects and accounting for the carbon credits generated:

1. Only areas that were not forest on 31st December 1989 are likely to meet the CDM definitions of afforestation or reforestation.
2. Projects must result in real, measurable and long-term emission reductions, as certified by a third party agency ('operational entities' in the language of the convention). The carbon stocks generated by the project need to be secure over the long term (a point referred to as 'permanence'), and any future emissions that might arise from these stocks need to be accounted for.
3. Emission reductions or sequestration must be additional to any that would occur without the project. They must result in a net storage of carbon and therefore a net removal of carbon dioxide from the atmosphere. This is called 'additionally' and is assessed by comparing the carbon stocks and flows of the project activities with those that would have occurred without the project (its 'baseline'). For example, the project may be proposing to afforest farmland with native tree species, increasing its stocks of carbon. By comparing the carbon stored in the 'project' plantations (high carbon) with the carbon that would have been stored in the 'baseline' abandoned farmland

(low carbon) it is possible to calculate the net carbon benefit. There are stilla number of technical discussions regarding the interpretation of the 'additionality' requirement for specific contexts.

4. Projects must be in line with sustainable development objectives, as defined by the government that is hosting them.
5. Projects must contribute to biodiversity conservation and sustainable use of natural resources.
6. Only projects starting from the year 2000 onwards will be eligible.
7. Two percent of the carbon credits awarded to a CDM project will be allocated to a fund to help cover the costs of adaptation in countries severely affected by climate change (the 'adaptation levy'). This adaptation fund may provide support for land use activities that are not presently eligible under the CDM, for example conservation of existing forest resources.
8. Some of the proceeds from carbon credit sales from all CDM projects will be used to cover administrative expenses of the CDM (a proportion still to be decided).
9. Projects need to select a crediting period for activities, either a maximum of seven years that can be renewed at most two times, or a maximum of ten years with no renewal option.
10. The funding for CDM projects must not come from a diversion of official development assistance (ODA) funds.
11. Each CDM project's management plan must address and account for potential leakage. Leakage is the unplanned, indirect emission of CO2, resulting from the project activities. For example, if the project involves the establishment of plantations

on agricultural land, then leakage could occur if people who were farming on this land migrated to clear forest elsewhere.

3.1.1. Remaining Rule

Many CDM rules and conditions for land-use projects still remain to be agreed. These include approaches for:

- ☐ calculating the net carbon benefit of CDM projects;
- ☐ Dealing with flexible and non-permanent land-use systems;
- ☐ Addressing the social and environmental impacts of projects.

Although decisions will be made at the international level, their impact on the ground and for projects will be significant. Two advisory groups to the Climate Convention, called the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Intergovernmental Panel on Climate Change (IPCC), will be preparing advice. Developing country agencies are still able to contribute to this process, via their National Focus Points or by sending delegations to attend the IPCC and SBSTA meetings. In the meantime, projects can already be developed using existing methodologies, subject to adjustments once final rules are defined. There is also a range of activities that developing countries can do to prepare and facilitate the development of CDM projects.

3.1.2 Preparation for CDM

The success of CDM projects in developing countries will depend on the institutional and policy environment in which they operate. Relevant policies include those on forestry, planning, sustainable development, rural land use, and poverty alleviation.

3.1.3 Development of CDM Projects

Irrespective of whether CDM projects are initiated by the private sector, non-government organizations or government agencies, their development will involve a number of essential steps. This section outlines these requirements, from a project developer's perspective.

3.1.4 Identify project and develop project concept note

The first stage is the identification of the potential CDM project. This will need to take into account any national or regional requirements for project eligibility. Project developers should note that potential investors and verification bodies will also operate their own screening procedures. It is important that local stakeholders' needs and aspirations are considered at this early stage.

3.1.5 Quantify greenhouse gas benefits

Each project plan should include details of how the greenhouse gas benefits are calculated and how they will be monitored over time. In most cases the quantification of benefits will begin prior to submission to the National CDM Authority. Quantification involves the following steps:

- ☐ *Definition of the boundaries of the project* - this will result in a list of all the processes that result in uptake or release of carbon (and other greenhouse gases covered by the Kyoto Protocol) as a result of the project activities.

- ☐ *Description of the baseline and additionally* - the effect of the project is measured relative to a 'baseline scenario' that represents what would happen in the absence of the project. Additionally is the extent to which the activities promoted by the project (e.g. the planting of trees) can only have happened with the project's specific intervention. The precise interpretation of additionally and the methods used to measure it are among the details still under discussion between the parties to the Climate Change Convention.

- ☐ *Quantification of baseline emissions and crediting period* - the emissions that would occur with the baseline scenario, and the number of years over which the project may take credit, will be defined using one of the procedures approved by the CDM Executive Board.

- ☐ *The emissions and uptake of carbon by the project* - in the case of afforestation and reforestation projects, the uptake of carbon will be calculated using forestry growth data. The net benefit of the project is then calculated by subtracting the emissions that would have occurred in the baseline scenario.

- *Adjustment for leakage and risk* - The amount of benefit for which a project will be allowed to take credit may need to be adjusted to take account of leakage and risks. The specific procedures to be applied are still being decided by the CDM Executive Board, but creating a reserve or buffer of carbon offsets is one method that has been proposed for dealing with project risks. The best approach to managing leakage is to avoid it in the first place. This is best done at the project design stage, notably by:
  - Consultation with local stakeholders;
  - Integration of project design with local, regional and/or national priorities and legislation;
  - Participation of landowners or managers in the project, avoiding their exclusion or displacement;
  - Clear and fair benefit sharing through the project;
  - Awareness building of carbon project needs;
  - Effective monitoring of project activities and likely sources of leakage.

3.1.6 Develop a Project Design Document

The results and methodologies used in the quantification of the greenhouse gas benefits will need to be presented in a Project Design Document. A report summarizing comments by local stakeholders and how these are taken into account in the project design must also be included in this document.

3.1.7 Validation of the project

Before projects can produce emission reductions that will be recognized by the CDM, they must be 'validated' by one of the independent companies approved by the CDM Executive Board. The project developer must submit the Project Design Document and any related documentation to the so-called 'operational entity'. The process will involve detailed scrutiny of the institutional capacity of the project stakeholders, the evidence underlying the calculations of carbon benefits, the systems to be used for monitoring, and of course the relevant government approvals. During this period, the Project Design Document will be made publicly available for comments.

(*source http://cdm.unfccc.int/index.html)

CHAPTER 4

4.1 CDM INDIA

CDM-India was established in August 2003, through an agreement between German Technical Cooperation (GTZ) and the Bureau of Energy Efficiency (Ministry of Power), Government of India, under the Indo-German Energy Programme (IGEN) as the capacity building facility that can help reduce transaction costs in the early market development process. It's objective is to foster high quality CDM projects that will successfully complete the project cycle and provide experience through 'learning by doing'. These projects should be widely replicable. Capacity building and providing support to public and private sector institutions for preparation and implementation of internationally acceptable projects under the Clean Development Mechanism is its primary aim. It actively cooperates with the National CDM Authority (NCDMA) of India for institutionalizing CDM projects in India.

The institutional setting concerning CDM approval, Indian National CDM Authority was established with Ministry of Environment & Forests (MoEF), Government of India in December 2003. NCDMA is chaired by Secretary MoEF and managed by Member Secretary, MoEF. It is clearing projects on monthly basis and is in charge of formulating the appropriate guidelines.

Till now 60 project proposals with the potential to generate over 40 million CERs have been received by GTZ. It supported PDD development of 10 projects; of which 6 projects have received host country approval and 3 have signed validator's contracts.

India has major CDM Potential and Challenges & the institutional setting concerning CDM approval.

India is a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and the objective of the Convention is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

To strengthen the developed country commitments under the Convention, the Parties adopted Kyoto Protocol in 1997, which commits developed country Parties to return their emissions of greenhouse gases to an average of approximately 5.2% below 1990 levels over the period 2008-12.

The Kyoto Protocol provides for quantified emission limitations and reduction commitments for the developed countries and mechanisms to facilitate compliance with these targets, reporting and review and it lists six greenhouse gases - Carbon dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydro fluorocarbons (HFCs), Per fluorocarbons (PFCs) and Sulphur hexafluoride (SF_6).

India acceded to the Kyoto Protocol in August 2002 and one of the objectives of acceding was to fulfill prerequisites for implementation of Clean Development Mechanism (hereinafter referred to as CDM) projects, in accordance with national sustainable priorities, where-under, a developed country would take up greenhouse gas reduction project activities in developing countries where the costs of greenhouse gas reduction project activities are usually much lower with the purpose to assist developing country parties in achieving

Sustainable Development and in contributing to the ultimate objective of the Convention and to assist developed country Parties in achieving compliance with their quantified emission limitation and reduction commitments.

4.2 Potential opportunities for India

There are varying estimates of the potential opportunities under the CDM. Earlier studies expected annual flows of as much as 1 billion dollars into India. However, the United States' refusal to ratify the Kyoto Protocol has reduced the demand for CDM considerably. If India can capture a 10% share of the global CDM market, annual CER revenues to the country could range from 10 million to 300 million dollars (assuming that CDM is used to meet 10%–50% of the global demand for GHG emission reduction of roughly 1 billion tonnes of CO_2, and prices range from 1–6 dollars per tonne of CO_2). As the deadline for meeting the Kyoto Protocol targets draws nearer, prices can be expected to rise, as countries/companies save carbon credits to meet stricter targets in the future.

4.3 Effect on Climate of India

In India, climate change could represent additional pressure on ecological and socio-economic systems that are already under stress due to rapid urbanization, industrialization, and economic development. With its huge and growing population, a 7500-km long densely-populated and low-lying coastline, and an economy that is closely tied to its natural resource base, India is considerably vulnerable to the impacts of climate change.

- Most countries in temperate and tropical Asia have already felt the impact of extreme climate events such as droughts and floods. The intensity of extreme rainfall events is projected to be higher in a warmer atmosphere, suggesting a decrease in return period for extreme precipitation events and the possibility of more frequent flash floods in parts of India, Nepal, and Bangladesh.
- Increases in temperature and seasonal variability in precipitation are expected to result in more rapid recession of Himalayan glaciers. In fact, the Gangotri glacier is already retreating at a rate of 18-20 meters a year.
- An increase in rainfall is simulated over the eastern region of India but the northwestern deserts may see a small decrease in the absolute amount of rainfall.
- Warmer and wetter conditions would increase the potential for a higher incidence of heat-related and infectious diseases. The incidence and extent of vector-borne diseases, which are significant causes of mortality and morbidity in tropical Asia, are likely to spread into new regions on the margins of present endemic areas as a result of climate change.

4.4 India plays a major role in combating the global climatic change:

- India signed UNFCCC on 10 June 1992 and ratified it on 1 November 1993.
- India acceded to the Kyoto Protocol on 26 August 2002.
- Ministry of Environment and Forests (Govt. of India), the nodal ministry to deal the climate change issues has a separate cell for climate change and another group known as 'Working group on the UNFCCC and Kyoto Protocol' to deliberate the actions that has to be made with regard to the climatic change issues.
- In accordance with the Annex decision 17/CP.7; the Govt. of India has constituted the National CDM Authority (NCDMA) on 16th April, 2004. The Indian NCDMA is operational since December 2003.
- Ministry of Non-conventional Energy Sources has separate Climatic Change Advisory Committee working to create appropriate methodologies for implementing RETs in the country and thus increasing the CDM potential.
- In addition to the above groups established by MoEF & MNES a separate group is working under the Planning Commission on the PMO advice.

(*Source http://cdmindia.nic.in/)

CHAPTER 5

5.1 General description of project

"Dunao small Hydro Electric Power Project in
Distt-Paurigarhwal, Uttaranchal

The proposed Dunao SHP is located on the River Purvi Nayar Dunao Village. The diversion site is located about 2.5 km upstream of village Dunao.

The Dunao Small hydel Project is proposed to have an installed capacity of 1500 KW with (02) Units of 750 KW project.

The project is located near the village Dunao in Dhumakot Tehsil of District Paurigarhwal at a distance of 150 kms from Kotdwar and 100 km from Ramnagar.

It is proposed to divert the waters of Purvi Nayar at a distance of about 2.5 km upstream of the village Dunao and about 1 km downstream of village silli pakholi.the geographical coordinates of the diversion sites are:

Longitude	– 78^{o}–59′ – 19″
Latitude	– 29^{o}–50′ – 36″

5.1.1 Project activity

Technology to be employed by the project activity:

The project activity comprises of two units of 750 KW capacity each powered by Francis turbine (Horizontal Shaft). As the gross head of the project activity is 48.14 m the Francis turbine is the most suitable turbine type for the project activity.

The main components of the project activity are as follows:

- 15 m long diversion weir on purvi Nayar near village Dunao to divert a design discharge of 4.6 cumecs with intake chamber to exclude shingle,
- desilting tank 49.3 m for removal of 0.20 mm particle size and above,
- 3620 m long head race tunnel,
- 1.2 m dia one surface penstock with thickness of steel liner is 8 m.
- Over ground surface type power house with

(a)	Length:	24 m
(b)	Width:	13.5 m
(c)	Height:	9.3m

Electricity would be generated at 3300 V and will be stepped up to 33 kV by providing one 2000 KVA, 3.3KV /33 kV power transformer connected to each generator. Each of Generators shall be provide with Brushless excitation .The power generated will be evacuated through single circuit 33 kV transmission line up to nearest 33 KV substation at

a distance of 25 Km from power house site.
The project activity will generate power from run of the river hydro electric power plant and will supply to Uttarnchal state electricity grid. There is no GHG emission from the project activity. Therefore the Baseline emission due to the equivalent electricity drawn from the grid would be reduced by implementing The project activity. The project activity will supply 6.72 GWh thereby reduce the GHG emission of about 50450 tons of CO_2 during the ten year crediting period.

In the absence of the project activity, equivalent electrical load would have been drawn from the grid mix, which is mainly dominated by fossil fuel based power plants leading to GHG emissions. Hence the emission reductions would not occur in the absence of the proposed project activity.

Estimated amount of emission reductions over the chosen crediting Period:

The estimated emission reduction due to this project activity is about 50450 tons of CO_2 during the ten Years crediting period.

Table 5.1 Estimation of emission reduction

Years	Annual estimation of emission reductions (in tones of CO_2e)
	5045.84
2007-08	5045.84
2008-09	5045.84
2009-10	5045.84
2010-11	5045.84
2011-12	5045.84
2012-13	5045.84
2013-14	5045.84
2014-15	5045.84
2015-16	5045.84
2016-17	5045.84
Total Estimated reduction(tones of CO_2e)	**50458**
Total number of credit years	**10**
Annual average over the crediting period Of estimated reduction(tons of CO_2 e)	**5045.84**

5.2 Application of a baseline Methodology

The applicability conditions of approved consolidated baseline methodology and the Justifications of the choice e of the methodology are given below:

Applies to electricity capacity additions from

- Run-of-river hydro power plants; hydro power projects with existing reservoirs where the Volume of the reservoir is not increased.
- Wind sources;
- Geothermal sources;
- Wave and tidal sources.

The project activity is run of the river hydro electric power plant.

- This methodology is not applicable to project activities that involve switching from fossil fuels to Renewable energy at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site;

No fossil fuel switch is occurring at the project site.

- The geographic and system boundaries for the relevant electricity grid can be clearly identified and information on the characteristics of the grid is available;

In India, the electrical transmission system is broadly classified into five regions namely Northern Region, North Eastern Region, Eastern Region, Southern Region and Western Region. Northern region grid comprises of Delhi, Punjab, Haryana, Chandigarh, Rajasthan, Jammu &

Kashmir, Uttranchal, Uttar Pradesh and Himachal Pradesh. The location of project activity is in Uttaranchal state which is coming under Northern region. Therefore Northern grid region is selected as grid boundary to estimate the baseline emission factor. Information on the power plants located in northern region, energy generation, their fuel consumption is available. The details are given in annexure.

Description of how the methodology is applied in the context of the project activity:

In the selected approved consolidated methodology two approaches have been suggested for the identification of baseline, as follows:

- "Existing actual or historical emissions, as applicable"

Or

- "Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment"

This project activity has adopted the first approach to identify the baseline. Further, as per the methodology, the baseline scenario for project activities that do not modify or retrofit existing electricity generation facility is electricity delivered to the grid which would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources. Hence the baseline Emission (BEy in tCO_2) is calculated by multiplying the electricity baseline emission factor (EFy) with the electricity exported to the grid (EGy). The electricity baseline emission factor (EFy) is calculated as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) factors.

Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity

As mentioned in above in the absence of project activity, the baseline scenario would be production of equivalent amount of electricity at grid connected power plants which would lead to emission of GHG.

Step1. Identification of Cases to the project activity consistent with current laws and Regulations

Sub-step1a. Define cases to the project activity**:**

The realistic and credible case(s) available with this project activity are:

1. The project activity not undertaken as a CDM project;
2. A diesel based power project with equivalent power output;
3. A gas based power project with equivalent power output;
4. A coal based power project with equivalent power output;
5. Continuation of the current situation in the northern grid with no project activity or cases undertaken.

Sub-step 1b. Enforcement of applicable laws and regulations:

The cases mentioned above are in compliance with the applicable legal and regulatory requirements.

Case 1: The project activity not undertaken as a CDM project
After implementation, the project would be connected to the existing northern region grid. But for Successful implementation, this option has to mitigate the barrier discussed in step 3. Because of the associated barriers, this project cannot be undertaken without CDM consideration.

Case 2: A diesel based power project with equivalent power output
In this scenario, the end users will get electricity from Northern region grid inclusive of diesel based power project. Addition of this project to northern region grid will lead to increase in the GHG emissions from the grid. This option would have resulted in similar power output with increased GHG emission. Further this option is not economically feasible due to high price of diesel and is not available.

Case 3: A gas based power project with equivalent power output
Although this option would have resulted in similar power output, addition of this project to northern region grid would lead to increase in the GHG emissions. Further, due to the location of the project activity, the Gas availability to the project site is difficult. Hence this option is not available.

Case 4: A coal based power project with equivalent power output.
With implementation of this project, northern region grid would supply

electricity to the end user with increased GHG emissions. But the feasibility of this project is questionable as there is difficulty in fuel availability at viable cost at the project site. Hence this option cannot be considered.

Case 5: Continuation of the current situation in the northern grid with no project activity

In this scenario, the end users will draw electricity from the northern region grid, which consists of a mix of Thermal, hydro, nuclear and other renewable energy projects. Although this option would not result in reduction of GHG emissions, this option is likely to exist in the absence of the project activity.

From the above paragraphs, it is clear that the realistic and credible case option to the project activity is:

Case 5 – Continuation of the current situation in the northern
Grid with no project activity

Step 2 Investment analysis

The additionally of the project has been demonstrated by the step 3 - Barrier analysis.

Step 3 Barrier analysis

The barriers associated with the project activity are as follows:

(a) Geological risks –The project area lies in higher seismic zone- V in the seismic zonation map of India. Hence design of all major civil structure shall be designed taking appropriate seismic factors in to consideration.

(b) Transmission risks – The generated power shall be evacuated through 33 kV single circuit transmission lines at a distance 25 kms from power house site. As the line route lies in a hilly terrain, lying of this transmission line requires comparatively higher investments.

Step 4 Common Practice Analysis

During 1950s, the share of hydro power in the total installed capacity was around 37% which continued to rise, crossing 50% in the year 1963. The share of hydro, however, started declining thereafter. Until the late seventies, the share of hydro remained above 40%, considered to be the ideal hydro-thermal mix for meeting the demand in an efficient manner. However, ever since the eighties, the share of hydro power has started declining sharply and at present, the share of hydro power constitutes only about 25% of the overall installed capacity of the country.

Step 5. Impact of CDM registration

In spite of the above-mentioned barriers, the project proponent has taken up the project with consideration of CDM benefit hoping that the carbon credit would help to mitigate these risks. The monetary benefits expected due to approval and registration of the project activity as a CDM activity would certainly improve the sustainability of the project activity and would help to overcome the investment barriers.

Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

The project boundary shall cover all anthropogenic emissions by sources of greenhouse gases (GHG) under the control of the project participants that are significant and reasonably attributable to the CDM project activity.

The project activity boundary covers the point of water supply (Penstock entry) to the point of power export to the grid. Thus the project boundary covers the intake water structures, turbine, generator, control systems, auxiliary units, synchronizer and the power evacuation system.

It supplies electricity to the northern region grid; therefore all the power plants contributing to the northern regional grid are taken for the calculation of baseline emission.

The schematic diagram of the Project boundary is given below

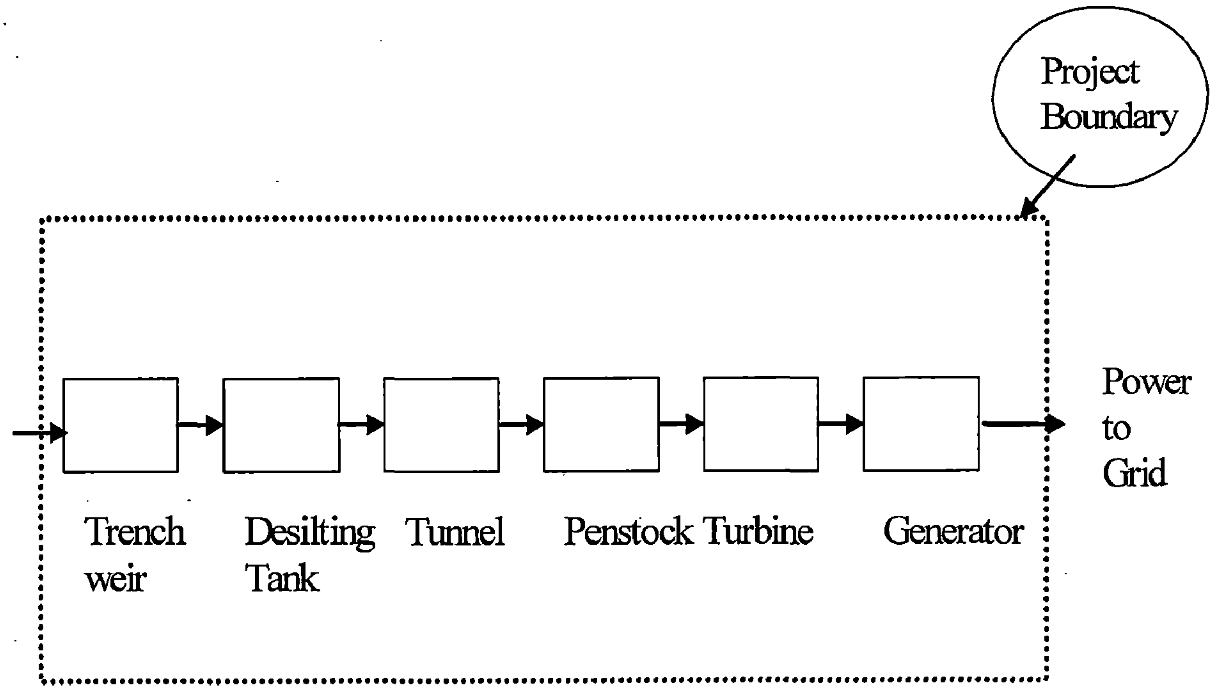

Fig 5.1 Project boundary

5.3 Application of a monitoring methodology and plan

Justification of the choice of the methodology and why it is applicable to the project activity:

- Applies to electricity capacity additions from
- Run-of-river hydro power plants; hydro power projects with existing reservoirs where the volume of the reservoir is not increased.
- Geothermal sources;
- Wave and tidal sources.

The project activity is a run of the river hydro electric power plant and hence meets the above criteria.

- This methodology is not applicable to project activities that involve switching from fossil fuels to renewable energy at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site;

In this project activity, there is no fossil fuel switch over to renewable energy at the project site.

- The geographic and system boundaries for the relevant electricity grid can be clearly identified and information on the characteristics of the grid is available;

As explained in above, based on the location of the project activity Northern region grid is selected as grid boundary to estimate the baseline emission factor. Information* on the power plants located in Northern region, electricity generation and fuel consumption is available. (**It is given in annexure.)

STEP 1.Calculation of the Operating Margin emission factor

Simple OM factor is calculated as under:

$EF_{OM,\ simple,\ y}$ is calculated as the average of the most recent three years:

$$EF_{OM,\ simple\ y,} = \sum_{i,j} F_{I,\ j,\ y} \times COEF_{i,\ j}\ /\ \sum_{j} GEN_{j,\ y}$$

Where

$COEF_{i,\ j}$ is the CO_2 emission coefficient of fuel i (t CO_2/mass Or volume unit of the fuel), calculated as given below and

$GEN_{j,\ y}$ - is the electricity (MWh) delivered to the grid by source j

$F_{i,\ j,\ y}$ - is the amount of fuel I (in a mass or volume unit) consumed by Relevant power sources j in year(s) y, calculated as given below

j –refers to the power sources delivering electricity to the grid, not Not including low-operating cost and must–run power plants, including imports from the grid

The Fuel consumption $F_{i,\ j,\ y}$ is obtained as

$$\sum_{i} F_{i,\ j,\ y} = \left(\sum_{j} GEN_{j,\ y} \times 860\ /\ NCV_{i} \times E_{i,\ j}\right)$$

Where

$GEN_{j,\ y}$ -is the electricity (MWh) delivered to the grid by sources j

NCV_i – is the net calorific value (energy content) per mass Or volume unit of a fuel i

$E_{i,j}$ – is the efficiency (%) of the power plants buy sources j

The CO_2 emission coefficient is obtained as

$COEF_i = NCV_i \times EFco_{2,i} \times OXID_i$

Where

NCV_i - is the net calorific value (energy content) per mass or volume unit of a fuel i

$EFco_{2,i}$ – is the CO_2 emission factor per unit energy of The fuel i

$OXID_i$ – is the Oxidation factor of the fuel

STEP 2.Calculation of the Build Margin emission factor ($EF_{BM,y}$)

It is calculated as the generation-weighted average emission factor (tCO_2 /MWh) of a sample of power plants m of grid, as follows:

$$EF_{BM,y} = \sum_{i,m} F_{I,m,y} \times COEF_{i,m} \; / \; \sum_{m} GEN_{m,y}$$

Where

$F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ – are analogous to the variable described For simple OM method above for plants m.

STEP 3. Calculate the electricity baseline emission factor (EF_y)

It is calculated as the weighted average of the operating Margin Emission factor ($EF_{OM,simple,y}$) and the Build Margin emission factor ($EF_{BM,y}$).

$EF_y = W_{OM} \times EF_{OM,\ simple,\ y} + W_{BM} \times EF_{BM,\ y}$

Where the weights W_{OM} and W_{BM} by default, are 50% (i.e., $W_{OM} = W_{BM} = 0.5$) and $EF_{OM,simple,\ y}$ and $EF_{BM,y}$ are calculated as described above and are expressed in tCO_2/MWh.

$BE_y = EF_y \times EG_y$

Where

BE_y- are the baseline emission due to displacement during the Year y in tons of CO_2

EG_y – is the net quantity of electricity generated by the project Activity during the year y in MWh,

EF_y- is the CO_2 baseline emission factor for the electricity displaced Due to the project activity in the year y in tons CO_2/MWh

Description of formulae used to estimate emission reductions For the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equivalent

Formula used for estimation of the total net emission reductions due to the project activity during a given year y is as under:

$$ER_y = BE_y - PE_y - L_y$$

(*source: Patikari Hydroelectric power project in Himanchal Pradesh)

BE_y - are the baseline emissions due to displacement of electricity during the year y in tons of CO_2

PE_y - are the project emissions associated with the project

L_y - are the emissions sources as leakage

Since PE_y and L_y are zero therefore the equation reduces to

$$ER_y = BE_y$$

5.4. Estimation of GHG emissions by sources

As the project activity is small, run of the river, hydroelectric power project, there are no GHG emissions by sources i.e., $PEy=0$.

Estimated leakage:

In the context of hydro electric power projects, the emission giving rise to leakage are emission arising due to activities such as power plant construction, fuel handling (extraction, processing and Transport), and land inundation. but in this case there is no need To consider these emission sources as leakage in applying this Methodology.

So there will be no emission due to the project activity.

Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

The baseline emissions (BE_y) due to the project activity are Calculated by using the following formula:

$$BE_y = EF_y \times EG_y$$

Where

EG_y = Electricity supplied by the project activity to the Grid.

=6.72 GWh/annum

EF_y= Baseline emission factor

=750.87t CO_2/GWh

The net annual baseline emission are = 5045.84 tonnes of CO_2

Table 5.2 Estimation of baseline emission*

Year	Estimation of Net Electricity supplied to the grid,EGy (GWh/annum)	Estimation of baseline emission factor tCO2/GWh	Estimation of baseline emission (tonnes of CO2e)
2007-08	6.72	750.87	5045.84
2008-09	6.72	750.87	5045.84
2009-10	6.72	750.87	5045.84
2010-11	6.72	750.87	5045.84
2011-12	6.72	750.87	5045.84
2012-13	6.72	750.87	5045.84
2013-14	6.72	750.87	5045.84
2014-15	6.72	750.87	5045.84
2015-16	6.72	750.87	5045.84
2016-17	6.72	750.87	5045.84
Total (tonnes of CO2e)	**67.2**		**50458**

* For calculation refer to annex (page 64)

Emissions reductions (ER_y) of the project activity are calculated by Using the following formula:

$$ER_y = BE_y - PE_y - L_y$$

Since project emissions (PE_y) and leakages (L_y) are zero, the emission reductions are equal to baseline emissions as given in following:

Table 5.3 Estimation of emission reduction*

Year	**Estimation of Project activity emissions (tonnes of CO_2e**	**Estimation of baseline Emissions (tones of CO_2e)**	**Estimation of leakage (tonnes of CO_2e)**	**Estimations of emission reductions (tonnes of CO_2e)**
2007-08	0	5045.84	0	5045.84
2008-09	0	5045.84	0	5045.84
2009-10	0	5045.84	0	5045.84
2010-11	0	5045.84	0	5045.84
2011-12	0	5045.84	0	5045.84
2012-13	0	5045.84	0	5045.84
2013-14	0	5045.84	0	5045.84
2014-15	0	5045.84	0	5045.84
2015-16	0	5045.84	0	5045.84
2016-17	0	5045.84	0	5045.84
Total (tonnes of CO_2e)	**0**	**50458**	**0**	**50458**

* For calculation refer to annex (page 65-67)

5.5 Environmental impacts

The land require for locating the different project structures shall be about 1.70 hectare out of which 1 hectare shall be forest land and 0.70 hectare shall be acquired from the villagers which currently being used for agricultural purpose. The construction of the project would not involve felling up of any major trees. The construction activity would involve in general cutting and clearing up of bushes and a few minor trees without any countable impact.

The scheme does not involve any impounding of water and hence no submergence or rehabilitation activity is needed.

The construction of this project neither alters nor raising of water level In the stream thereby do not inhibit migration of local fauna, if any. This project shall not also effect any change in the aquatic life available in this stream which in any case, at present is insignificant

The area as per ISI classifications falls in Seismic Zone No V. Preliminary design considerations have been based upon design criteria laid down relevant to the International Standard Institute (ISI) codes, geological conditions and seism city of the area.

(*source: Patikari Hydroelectric power project in Himanchal Pradesh)

CHAPTER 6

6.1 RECOMMENDATIONS AND CONCLUSION

Projects seeking approval under the CDM must lead to real, measurable reductions in greenhouse gas emissions, or lead to the measurable absorption (or "sequestration") of GHGs in a developing country.

GHG emissions from a CDM project activity must also be reduced below those that would have occurred in the absence of the project. In fact, it must be shown that the project would not have been implemented without the CDM. Without this "additionally" requirement, there is no guarantee that CDM projects will create incremental GHG emissions reductions equivalent to those that would have been made in Annex I countries, or play a role in the ultimate objective of stabilizing atmospheric GHG concentrations.

In addition, all CDM projects must contribute towards sustainable development in the host country and must also be implemented without any negative environmental impacts. To ensure that these conditions are met, host countries determine whether the CDM project activity meets the sustainable development objectives in their country, and also decide whether an environmental assessment of the project is required.

All CDM projects, therefore, require the estimation or measurement of "baseline" emissions — those that would have occurred without the project — and actual emissions that occur after a project has been implemented. For example, a wind power generation project might displace emissions from an existing fossil fuel power plant in a region or delay the construction of a new plant. The emissions reductions from improved fuel efficiency in an industrial process would be measured against existing plant emissions.

After making project design document of this project i have found that the project activity will supply 6.72 GWh thereby reduce the GHG emission of about 50450 tons of CO_2 during the ten-year crediting period.

ANNEXURES

Annex I countries:

Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, European Union, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, United States of America

A.1 Calculating the Operating Margin

ACM0002 suggest 4 different methodologies to calculate the OM:
Simple OM, or
Simple adjusted OM, or
Dispatch Data Analysis OM, or
Average OM
The c) dispatch data analysis should be the first methodological choice if possible, but to use this methodology, ex post dispatch data are necessary.
The (a) simple OM methodology can only be used if the low-cost/most run resources (all renewable energy and the electricity import from Colombia) are less than 50 % of the total grid generation.
The d) average OM methodology can only be used when there is no dispatch data from the last 3 years public available.

b) Simple adjusted OM methodology

The Simple adjusted OM methodology is using dispatch data from the last three years and is calculated as the generation weighed average emissions per electricity unit (tCO_2/MWh) of all generating sources serving the system, where the power sources – including imports – are separated in low-cost/must run power sources (k) and other power sources (J).

The value of emission factor is in terms of carbon unit. It is converted in terms of CO_2 as below

Fuel	Emission factor	Emission factor
	tC/TJ	tCO2/TJ
Natural gas	15.3	56.1(15.3×44/12)
Non-coking gas	26.13	95.8(26.13×44/12)

Calculation of Operating Margin Emission Factor

The following table gives a step by step approach for calculating the Simple Operating Margin emission factor for Northern Regional electricity grid for the most recent 3 years at the time of PDD submission i.e.2003-2004, 2004-2005 & 2005-2006.

	2003-04	2004-05	2005-06
Generation by coal out of total Generation(GWh)	102704.29	106451.00	112572.8
Generation by Gas out of total Generation(GWh)	20251.12	19890.00	19949.49
Imports from others			
Imports from WREB(GWh)	282.02	1602.84	2153.23
Imports from EREB(GWh)	2334.76	3600.58	4112.67

Table A.1 Calculation of operating margin emission factor

Fuel 1:Coal	2003-04	2004-05	2005-06
Avg. Calorific Value of Coal used (kcal/kg)	3820	3820	3624
Coal consumption (tons/yr)	70,397,000	73,279,000	73,279,000
Emission Factor for Coal (tonne CO_2 /TJ)	95.8	95.8	95.8
Oxidation Factor of Coal-IPCC standard value	1.0	1.0	1.0
COEF of Coal (tonne CO_2/ton of Coal)	1.532	1.532	1.532
Fuel 2:Gas			
Avg. Efficiency of power generation with gas as a fuel,%	45	45	45
Avg. Calorific Value of Gas used (kcal/kg)	11,464	11,464	11,464
Estimated Gas consumption (tons/yr)	3375955	3315755	3325672.3
Emission Factor for Gas- IPCC standard Value (tonne CO_2/TJ)	56.1	56.1	56.1
Oxidation Factor of Gas-IPCC standard Value	1.0	1.0	1.0
COEF of Gas(tonneCO_2/ton of gas)	2.693	2.693	2.693
EF (WREB), tCO_2/GWh	880	890	890

EF (EREB), tCO_2/GWh	1050	1050	1050
EF (OM Simple), tCO_2 /GWh	952.98	960.85	916.99
Average EF (OM Simple),tCO_2/GWh			943.60

Built Margin Emission Factor is calculated as per the following table:

Table A.2 Calculation of built margin emission factor

Sector		
Thermal Coal Based	20003.28	
Thermal Gas Based	4813.33	
Hydro	9927.6	
Nuclear	2864.33	
Total	37608.63	
Built Margin		
Fuel 1 : Coal		
Avg. calorific value of coal used in Northern Grid, kcal/kg		3624
Coal consumption, tons/yr		12952313
Emission factor for Coal,tonne CO_2/TJ		95.8

0		
COEF of coal (tonneCO_2 /ton of coal)		1.0
		1.454
Fuel 2 : Gas		
Avg. efficiency of power generation with gas as a fuel, %		45
Avg. calorific value of gas used, kcal/kg		11464
Emission factor for Gas (as per standard IPCC value)		802405
COEF of gas(Oxidation factor of gas (IPCC standard value)		56.1
COEF of gas(tonneCO2/ton of gas)		1.0
		2.693
EF (BM), tCO_2/GWh		558.13

Therefore the net baseline emission factor as per combined margin

$$(OM + BM)/2 = 750.87\ tCO_2\ /GWh$$

(*Source of Data: Patikari Hydroelectric Power Project in Himanchal Pradesh)

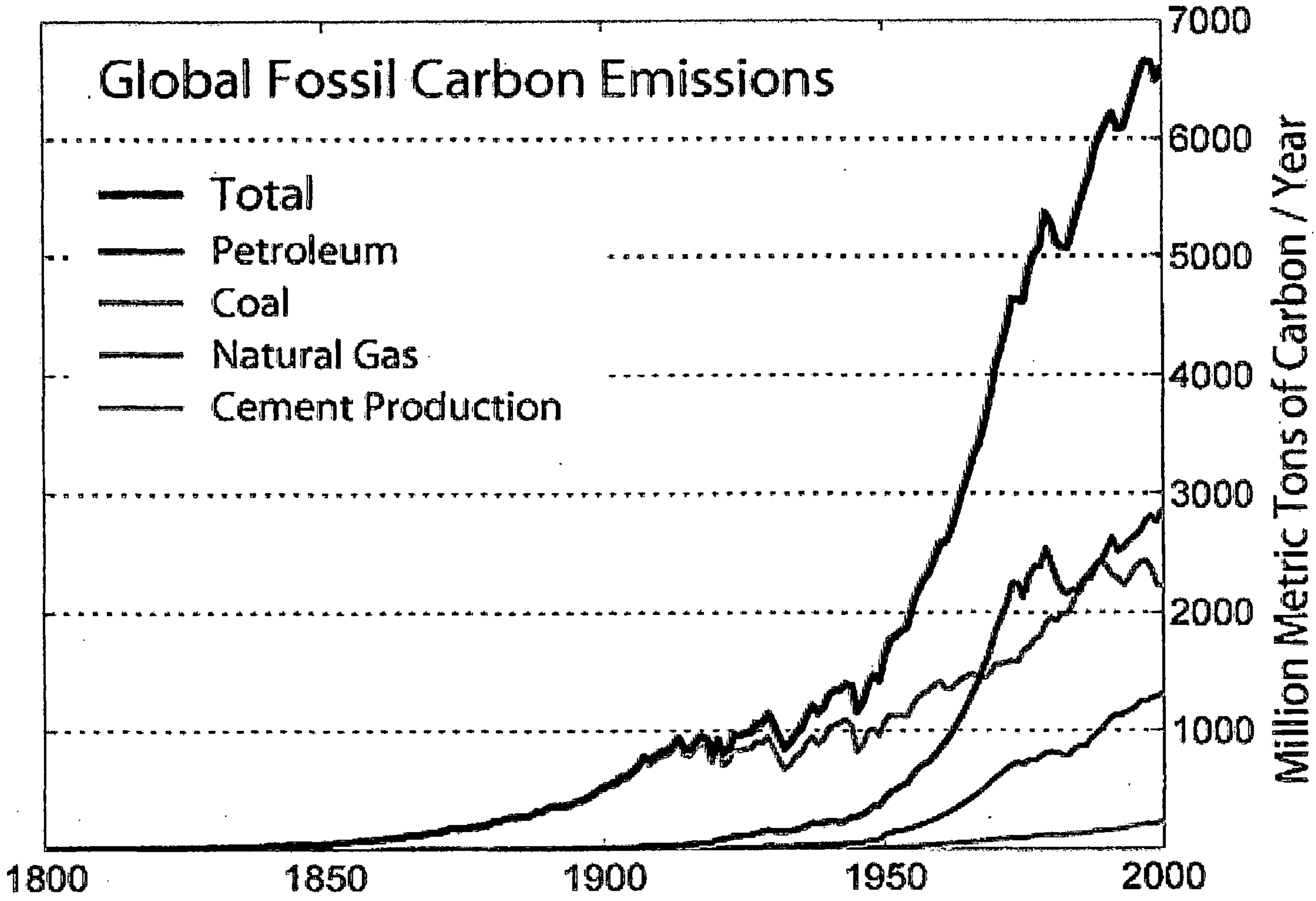

Fig A.1 *Global carbon emission

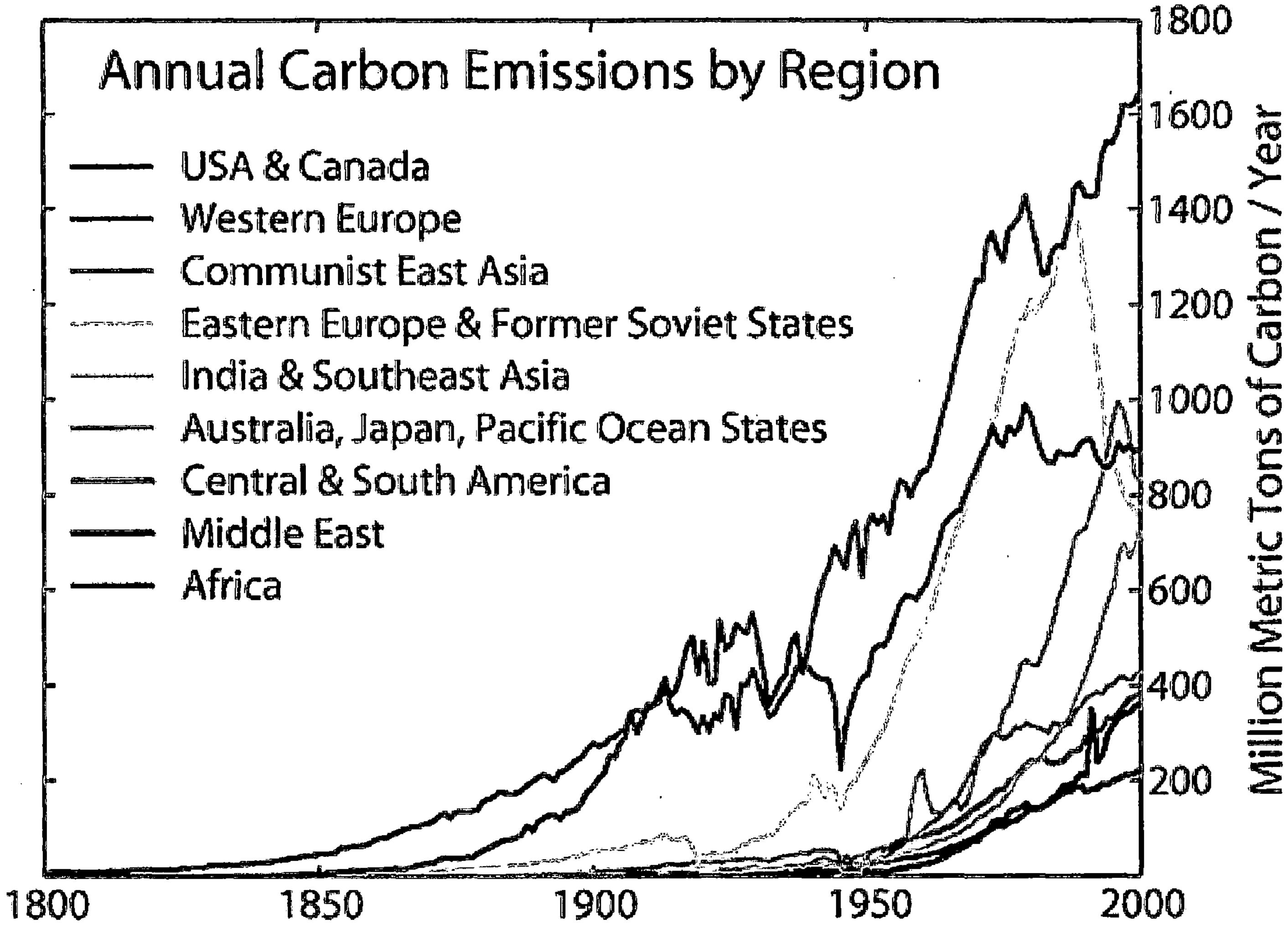

Fig A.2 *Global carbon emission by region

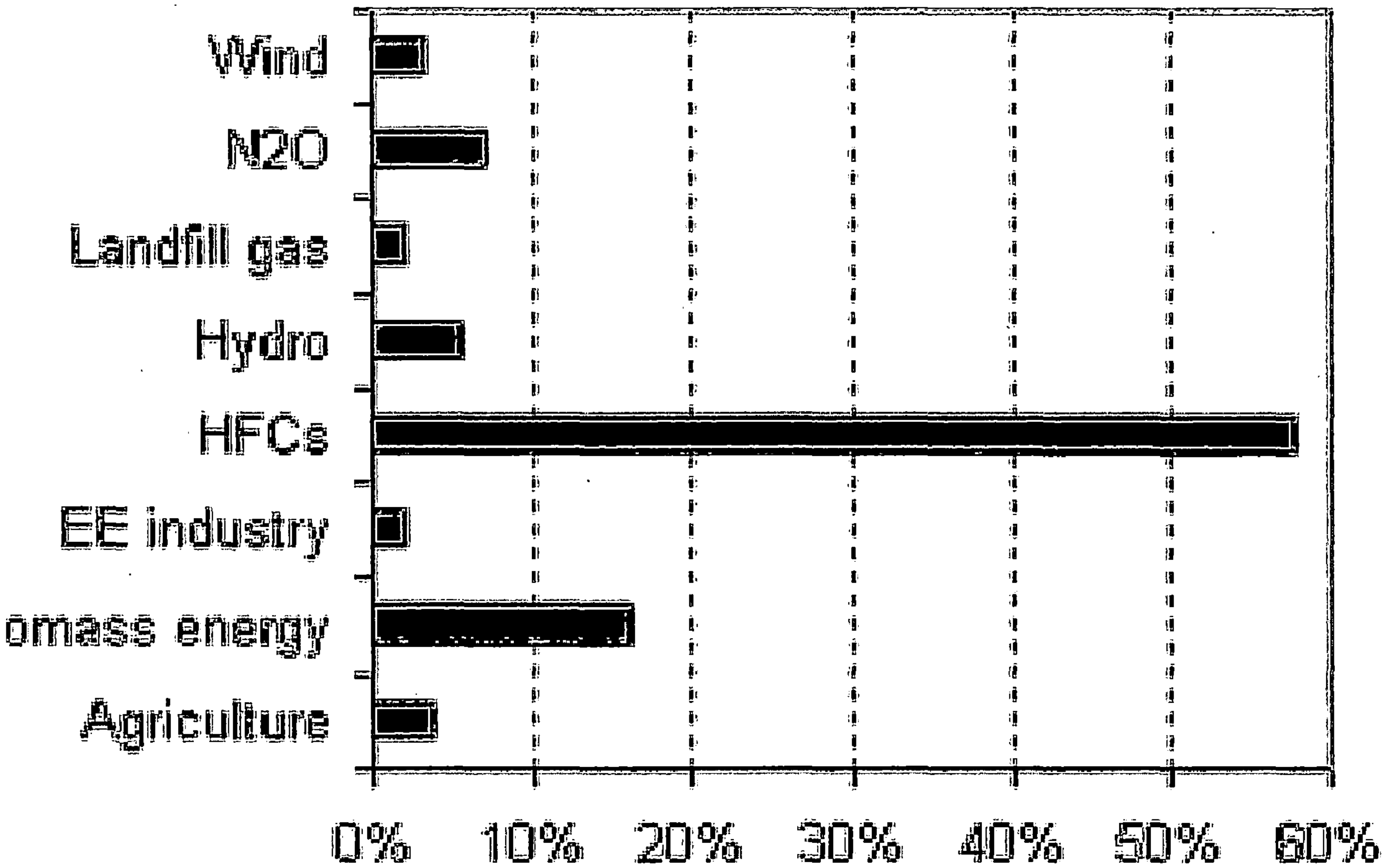

Fig A.3 *CDM cers distribution by projects

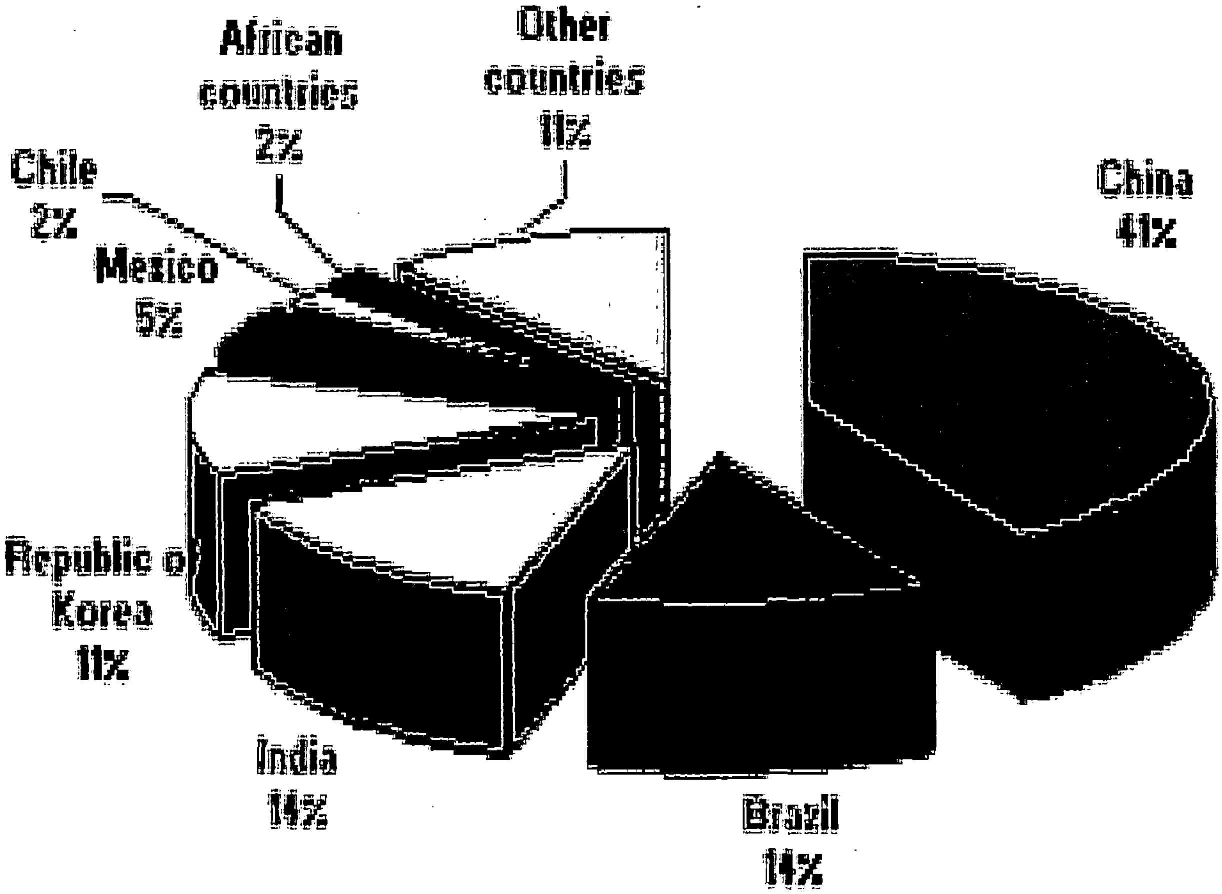

Fig A.4 *CDM CERS distribution by country

(*Souce: http://cdm.unfccc.int/index.html)

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