"EMISSION REDUCTION POTENTIAL BY ENERGY EFFICIENCY IMPROVEMENT PROJECT"

AT
(INDIA GLYCOLS LIMITED, KASHIPUR)

By
Mansoor Shah Khan

College of Engineering
University of Petroleum & Energy Studies
Dehradun
April, 2009

EMISSION REDUCTION POTENTIAL BY ENERGY EFFICIENCY IMPROVEMENT PROJECT

A thesis submitted in partial fulfillment of the requirements for the Degree of
Master of Technology
(Health, Safety and Environment Engineering)

By
Mansoor Shah Khan

Under the guidance of

Mr. R.K.Sharma
Joint General Manager (H.S.E)
India Glycols Ltd., Kashipur (Uttrakhand)

Approved

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College of Engineering
University of Petroleum & Energy Studies
Dehradun
April, 2009

INDIA GLYCOLS LIMITED

ISO 9001
ISO 14001
OHSAS 18001
ISO 22000

A-1, Industrial Area, Bazpur Road, Kashipur - 244713 Distt. Udham Singh Nagar (Uttarakhand)
Phone : +91 5947 269000 / 275320, + 91 9411108202, Fax : 05947-275315, 275192
website : www.indiaglycols.com

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CERTIFICATE

This is to certify that **"Mr. Mansoor Shah Khan"** (M.Tech – Health Safety & Environment Engineering) from University of Petroleum & Energy Studies has completed his project on **"EMISSION REDUCTION POTENTIAL BY ENERGY EFFICIENCY IMPROVEMENT PROJECT"** under my supervision at IGL, Kashipur w.e.f. 20th March 2009 to 28th April 2009

This is an original work and has not been submitted elsewhere for a degree.

For India Glycols Limited

Mr. R.K. Sharma
Joint General Manager (H.S.E)

ABSTRACT

The United Nation Framework Convention on Climate Change (UNFCCC), adopted by most of the world's governments in Rio de Janeiro in June 1992, recognized that it could be a launching pad for stronger action in the future towards achieving the objective of the convention.

The first review of the adequacy of developed country commitments was taken up by the Parties at the first session of the Conference of the Parties (COP 1) in Berlin in 1995, and the main theme was the adequacy of the UNFCCC by the Annex I Parties. Some 10,000 delegates, observers (NGOs), and media personnel participated in this high profile event hosted by Japan in December 1997. The conference resulted in a conscious decision to adopt a new protocol, the Kyoto Protocol, under which industrialized countries (ratifying the protocol) are required to reduce their combined greenhouse gas (GHG) emissions by at least 5.2 percent compared to 1990 levels by the first commitment period (2008–2012. This legally binding commitment promises to produce an historic reversal of the upward trend in emissions that started in the developed countries some 150 years ago.

The Clean Development Mechanism (CDM) is one of the innovative features of the Kyoto Protocol to the UNFCCC. It encourages investments in projects that provide sustainable development in developing countries, while at the same time limiting GHG emissions. The CDM was introduced in Article 12 of the Kyoto Protocol. Under this mechanism, legal entities in developed countries can invest in projects in developing countries that reduce GHG emissions. Once certified, these emission reductions can be used to meet the commitments made by the developed countries under the protocol. Although there are no immediate targets for the developing countries, it can be seen as an additional source of foreign direct investment into national mitigation projects, which would contribute to sustainable development and a decrease in worldwide GHG emission levels.
According to the Kyoto Protocol, project activities that qualify for the CDM are those related to specific GHG types and to the sources and sectors responsible for the majority of emissions, as established in Annex A of the Kyoto Protocol.

Small-scale CDM projects

Although the CDM is devised to foster the sustainable development of host countries, developing small-scale CDM project activities, which are known to be beneficial to the sustainable development of local communities, are often burdened with high costs for low returns. In order to leverage the development of small-scale CDM project activities, the UNFCCC introduced fast-track modalities and

procedures with some preferential treatment. A project activity can be qualified as small-scale CDM if it meets one of the three following conditions (UNFCCC 2001b, paragraph 6[c], 21):

- Type I: renewable energy project activities with a maximum output capacity equivalent to up to 15 megawatts (or an appropriate equivalent)
- Type II: energy-efficiency improvement project activities which reduce energy consumption on the supply and/or demand side by up to the equivalent of 60 giga watt-hours per year
- Type III: other project activities that both reduce anthropogenic emissions by sources and directly emit less than 15 kilo tonnes of CO2 equivalent (CO2e) annually.

ABOUT THE CATEGORY APPLICABLE

MAIN CATEGORY: TYPE II-ENERGY EFFICIENCY IMPROVEMENT PROJECTS

Sub category : ENERGY EFFICIENCY AND FUEL SWITCHING MEASURES FOR INDUSTRIAL FACILITIES

This category comprises any energy efficiency and fuel switching measure implemented at a single industrial or mining and mineral production facility. This category covers project activities aimed primarily at energy efficiency; a project activity that involves primarily fuel switching falls into category III.B.1 Examples include energy efficiency measures (such as efficient motors), fuel switching measures (such as switching from steam or compressed air to electricity) and efficiency measures for specific industrial or mining and mineral production processes (such as steel furnaces, paper drying, tobacco curing, etc.).

The measures may replace, modify or retrofit existing facilities or be installed in a new facility. The aggregate energy savings of a single project may not exceed the equivalent of 60 GWhe per year. A total saving of 60 GWhe per year is equivalent to a maximal saving of 180 GWhth per year in fuel input.

This category is applicable to project activities where it is possible to directly measure and record the energy use within the project boundary (e.g. electricity and/or fossil fuel consumption).

This category is applicable to project activities where the impact of the measures implemented (improvements in energy efficiency) by the project activity can be clearly distinguished from changes in energy use due to other variables not influenced by the project activity (signal to noise ratio)

PROJECT DESCRIPTION

In the process of MEG plant, carbon dioxide is produced as by-product in EO reactor and is removed by treating a portion of cycle gas with a hot potassium carbonate solution, the carbonate is converted to potassium bicarbonate by reaction with carbon dioxide at system pressure. The carbon dioxide rich solution is then regenerated at atmospheric pressure using stripping steam. The contaminated and low pressure steam (heat/thermal energy) is vented to atmosphere, as a result the heat energy is wasted and also it creates pollution.

To recover heat (thermal energy) from vent steam a new packed column is to be installed along with two Vapor Absorption Machines (VAM).This chilled water from the two VAM's is used for process itself and for the centralized air conditioning. Thereby utilizing the energy from waste steam and in turn reducing the consumption of RFO (residual fuel oil) as the load requirement of vapor absorption machines is less than the existing HFC based vapor compression systems.

The main purpose of the project activity is to achieve energy efficiency improvement through Clean Development Mechanism by saving energy (thermal & electrical) that could be utilized towards plant capacity enhancement and simultaneously to achieve reduced specific energy consumption. This would also lead to reduction of green house gas emission.

CALCULATIONS FOR EMISSION REDUCTION

In the absence of the energy study and project initiatives, the process would have continued to vent the waste and contaminated steam and for additional refrigeration requirement installation of another Vapour Compression Refrigerator is required. Therefore the energy baseline will be the displaced fossil fuel, which would have been used to generate power needed by VCR that would have to be implemented otherwise.

The baseline power consumption i.e. Power requirement for Vapor Compression Refrigeration Units is based on the design power consumption of these machines and comparison provided by Bureau of Energy Efficiency as well as VAM vendor.

The emissions baseline (t $CO_{2/year}$) is equal to energy baseline (Ton RFO/year) multiplied by an emission coefficient (t CO_2/ Ton RFO) for the fossil fuel displayed. IPCC default value for emission coefficient is used. The fuel equivalent is calculated based on actual fuel consumed in Captive Power Plant i.e. Tons of RFO per kWh multiplied by power consumption (kWh/year). The baseline power consumption is design specific power consumption (kWh/TR) of the machine multiplied by refrigeration generation (TR/year).

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This is to acknowledge with thanks the help, guidance and support that I have received during the project.

At the outset, it is my duty to express my deep sense of gratitude to the **INDIA GLYCOLS LIMITED, KASHIPUR (U.K)** for extending me the opportunity for undergoing this project and providing all the necessary resources and expertise for this purpose.

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In last but not least I thank to God, my Parents, my brother and my friends.

Mansoor Shah Khan
M.Tech. (H.S.E)

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ABBREVIATIONS

AM	Approved Methodology
AMS	Approved Small-Scale Methodology
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CO2	Carbon dioxide
COP	Conference of the Parties (to the UNFCCC)
COP/MOP	Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol
DOE	Designated Operational Entity
DSM	Demand-Side Management
EB	Executive Board (of the Clean Development Mechanism)
EE	Energy Efficiency
EFDB	Emission Factor Database
ER	Emission Reduction
GOI	Government of India
GHG	Greenhouse Gas
GWh	Gig watt Hour
HFC	Hydro Fluro Carbon
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LoA	Letter of Approval
MEG	Mono-ethylene glycol
Mt CO2e	Million Tons of Carbon Dioxide Equivalent
MP	Methodology Panel (of the CDM Executive Board)
M&V	Monitoring and Verification
RFO	Residual Fuel Oil
SSC	Small-Scale CDM Project
TR	Tons of Refrigeration
UNFCCC	United Nations Framework Convention on Climate Change
VAM	Vapor Absorption Machine
VCR	Vapor Compression Refrigeration.
NCV	Net calorific value of RFO

NOMENCLATURE

Cp	is chilled water specific heat in kcal/ kg deg C
EF_{co2}	CO_2 emission per kWh of power generated, MT CO_2 / MWh
O_1	Operating hours of VAM-1
O_2	Operating hours of VAM-2
Pb	Power that would have required by vapor compressor chiller
P_{cw}	is density of chilled water in kg/m^3
Pm1	Total power consumption by VAM -1
Pm1	Total power consumption by VAM-2
Pp	Total power required by project (VAM-1 + VAM-2)
Q_1	is quantity of chilled water outlet in m^3 / hr from VAM1
Q_1	is quantity of chilled water outlet in m^3 / hr from VAM2
R	Total refrigeration capacity utilization
SN	Sp RFO consumption for power generation
T_{1in}	is inlet temperature of chilled water to VAM-1
T_{2in}	is inlet temperature of chilled water to VAM-2
T_{1out}	is outlet temperature of chilled water from VAM-1
T_{2out}	is outlet temperature of chilled water from VAM-2
TR_1	Refrigeration capacity of VAM 1 in 'tons of refrigeration'
TR_2	Refrigeration capacity of VAM 2 in 'tons of refrigeration'
X_{TRP}	factor for calculating power requirement per Ton of refrigeration, 0.7 kW/ton of refrigeration

Subscripts

b	stands for baseline activity
cw	stands for chilled water
p	stands for project activity

CHAPTER 1

INTRODUCTION

1. Introduction

1.1 .Global warming

The Earth has an atmosphere of the proper depth and chemical composition. About 30% of incoming energy from the sun is reflected back to space while the rest reaches the earth, resulting in warming the air, oceans, and land, and maintaining an average surface temperature of about 15 °C. The chemical composition of the atmosphere is also responsible for nurturing life on our planet. Most of it is nitrogen (78%); about 21% is oxygen, which all animals need to survive; and only a small percentage (0.036%) is made up of carbon dioxide which plants require for photosynthesis. The atmosphere carries out the critical function of maintaining life-sustaining conditions on Earth, in the following way: each day, energy from the sun 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 cannot be seen by our eyes but can be felt as heat, for example the heat that you can feel with your hands over a heated car engine). 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 greenhouse gases (GHGs).

Greenhouse gases (for example, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), water vapor), re-emit some of this heat to the earth's surface. If they did not perform this useful function, most of the heat energy would escape, leaving the earth cold (about -18 °C) and unfit to support life.

However, ever since the Industrial Revolution began about 150 years ago, man-made activities have added significant quantities of GHGs to the atmosphere. The atmospheric concentrations of carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) have grown by about 31%, 151% and 17%, respectively, between 1750 and 2000 (Intergovernmental Panel on Climate Change, IPCC 2001).

As the GHGs are transparent to incoming solar radiation, but opaque to outgoing long wave radiation, an increase in the levels of GHGs could lead to greater warming, which, in turn, could have an impact on the world's climate, leading to the phenomenon known as climate change. Indeed, scientists have observed that over the 20th century, the mean global surface temperature increased by 0.6°C (IPCC 2001). They also observed that since 1860 (the year temperature began to be recorded systematically using a thermometer), the 1990's have been the warmest decade.

Important greenhouse gases are: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydro fluorocarbons (HFC), per fluorocarbons (PFC), and sulfur hexafluoride (SF6). Water vapor is also an important greenhouse gas, but since humans do not generally have a direct affect on water vapor concentration in the atmosphere, it is not included in this paper. Because each greenhouse gas traps different amounts of heat and stays in the atmosphere for different lengths of time, studies use measures of global warming potential (GWP) to compare between gases. Carbon dioxide is used as the benchmark, so all other gases are measured in carbon dioxide equivalence (CO2e).

Table 1.1: The global warming potential of six major greenhouse gases *(This measure takes into account the heat trapping abilities and the time the gas stays in the atmosphere (IPCC 2001a, 2001b*

Gas	**Global Warming Potential**	**Atmospheric Life (years)**
CO_2	1	5 to 200
CH_4	21	12
N_2O	310	114
HFC	140 to 11,700	1.4 to 260
PFC	6500 to 9200	$10{,}000$ to $50{,}000^+$
SF_6	23,900	3200

NATURAL AND ANTHROPOGENIC CAUSES OF GLOBAL WARMING

Another IPCC publication states that there is a "very high confidence" that human activities have caused a net warming of the planet (IPCC 2007a).

1.2. THE KYOTO PROTOCOL

1.2.1. SIGNIFICANCE

Signals of climate change are already visible around the world. Some of the projected impacts, which can adversely affect life, economy and ecosystem, are its impacts on the Asian monsoon (the main source of fresh water), agriculture, and other life-saving systems such as rivers, etc. Climate change will increase vector-borne diseases, extreme weather events, their intensity and frequency, and cause an unprecedented loss of life and property, etc. The Kyoto Protocol is an important step towards stabilization of the concentration of GHGs in the atmosphere to prevent dangerous anthropogenic interference with the Earth's climate system.

The Kyoto Protocol introduced the following three flexibility mechanisms to supplement the domestic activities of the developed (Annex I) countries. The three flexibility mechanisms are:

• Joint implementation (JI)

• Clean Development Mechanism (CDM)

• International carbon trading

Of these three, only the CDM is applicable between developed and developing countries that have ratified the protocol. The certified emission reductions (CERs) that result from CDM project activities have considerable economic use to both the host (developing) and investor (developed) countries. During the last few years the mechanisms have aroused worldwide interest in carbon investment and the carbon market, which is growing as companies and governments have started purchasing emissions credits through voluntary trading schemes, carbon investment funds, and government procurement tenders.

Under the Kyoto Protocol, the developing countries ratifying the protocol are eligible to participate in the CDM. India signed the protocol before COP 8 in 2002, which was hosted by the government of India in New Delhi. India offers a large potential for utilizing the CDM because of its inherent dependence on fossil fuels for development, its proactive government, and the enabling environment in place. Indeed, India is the most favored destination for the CDM.

India is a competitive supplier for cost-effective GHG offset projects. Recognizing the possible benefits derived from such investment flows to India, the government has placed the CDM at the top of its climate change agenda. The designated national authority (DNA) for CDM projects from India has been set up in the Ministry of Environment and Forests (MoEF).

1.2.2. The Kyoto protocol - A brief summary

The Kyoto Protocol to the United Nations Framework Convention on Climate Change strengthens the international response to climate change. Adopted by consensus at the third session of the Conference of the Parties (COP3) in December 1997, it contains legally binding emissions targets for Annex I (developed) countries for the post-2000 period.

By arresting and reversing the upward trend in greenhouse gas emissions that started in these countries 150 years ago, the Protocol promises to move the international community one step closer to achieving the Convention's ultimate objective of preventing "dangerous anthropogenic [man-made] interference with the climate system".

The developed countries commit themselves to reducing their collective emissions of six key greenhouse gases by at least 5%. This group target will be achieved through cuts of 8% by Switzerland, most Central and East European states, and the European Union (the EU will meet its target by distributing different rates among its member states); 7% by the US; and 6% by Canada, Hungary, Japan, and Poland. Russia, New Zealand, and Ukraine are to stabilize their emissions, while Norway may increase emissions by up to 1%, Australia by up to 8%, and Iceland 10%. The six gases are to be combined in a "basket", with reductions in individual gases translated into "CO_2 equivalents" that are then added up to produce a single figure.

Each country's emissions target must be achieved by the period 2008-2012. It will be calculated as an average over the five years. "Demonstrable progress" towards meeting the target must be made by 2005. Cuts in the three most important gases – carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_20) - will be measured against a base year of 1990 (with exceptions for some countries with economies in transition).

Cuts in three long-lived industrial gases – hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), and sulfur hexafluoride (SF_6) - can be measured against either a 1990 or 1995 baseline. (A major group of industrial gases, chlorofluorocarbons, or

CFCs, are dealt with under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer.)

Actual emission reductions will be much larger than 5%. Compared with emissions levels projected for the year 2000, the richest industrialized countries (OECD members) will need to reduce their collective output by about 10%. This is because many of these countries will not succeed in meeting their earlier non-binding aim of returning emissions to 1990 levels by the year 2000; their emissions have in fact risen since 1990. While the countries with economies in transition have experienced falling emissions since 1990, this trend is now reversing.

Therefore, for the developed countries as a whole, the 5% Protocol target represents an actual cut of around 20% when compared with the emissions levels that are projected for 2010 if no emissions-control measures are adopted.

Countries will have a certain degree of flexibility in how they make and measure their emissions reductions. In particular, an international "emissions trading" regime will be established allowing industrialized countries to buy and sell emissions credits amongst themselves. They will also be able to acquire "emission reduction units" by financing certain kinds of projects in other developed countries through a mechanism known as Joint Implementation. In addition, a "Clean Development Mechanism" for promoting sustainable development will enable industrialized countries to finance emissions-reduction projects in developing countries and receive credit for doing so. The operational guidelines for these various schemes are being elaborated under a two-year Plan of Action that is to conclude at COP6.

They will pursue emissions cuts in a wide range of economic sectors. The Protocol encourages governments to cooperate with one another, improve energy efficiency, reform the energy and transportation sectors, promote renewable forms of energy, phase out inappropriate fiscal measures and market imperfections, limit methane emissions from waste management and energy systems, and protect forests and other carbon "sinks".

The measurement of changes in net emissions (calculated as emissions minus removals of CO_2) from forests is methodologically complex and still needs to be clarified.

The Protocol will advance the implementation of existing commitments by all countries. Under the Convention, both developed and developing countries agree to take measures to limit emissions and promote adaptation to future climate change impacts; submit information on their national climate change programmes and inventories; promote technology transfer; cooperate on scientific and technical research; and promote public awareness, education, and training. The Protocol also reiterates the need to provide "new and additional" financial resources to meet the "agreed full costs" incurred by developing countries in carrying out these commitments.

The Conference of the Parties (COP) of the Convention will also serve as the meeting of the Parties (MOP) for the Protocol. This structure is expected to reduce costs and facilitate the management of the intergovernmental process. Parties to the Convention that are not Parties to the Protocol will be able to participate in Protocol-related meetings as observers.

The new agreement will be periodically reviewed. The Parties will take "appropriate action" on the basis of the best available scientific, technical, and socio-economic information. The first review will take place at the second COP session serving the Protocol. Talks on commitments for the post-2012 period must start by 2005.

The Protocol was opened for signature for one year starting 16 March 1998. It will enter into force 90 days after it has been ratified by at least 55 Parties to the Convention, including developed countries representing at least 55% of the total 1990 carbon dioxide emissions from this group. In the meantime, governments continue to carry out their commitments under the Climate Change Convention. In line with a Plan of Action agreed at the fourth COP in Buenos Aires in November 1998, they are working on many practical issues relating to the Protocol and its future implementation at their regular COP and subsidiary body meetings.

The EU and its Member States ratified the Kyoto Protocol in late May 2002, fulfilling the Commission's ambition to enable the Kyoto Protocol to come into force before the World Summit on Sustainable Development which took place in Johannesburg between 24 August and 4 September 2002.

1.3. CARBON CREDITS

The primary purpose of the Protocol was to make developed countries pay for their ways with emissions while at the same time monetarily rewarding countries with good behavior in this regard. Since developing countries can start with clean technologies, they will be rewarded by those stuck with „dirty" ones. This system poises to become a big machine for partially transferring wealth from wealthy, industrialized countries to poor, undeveloped countries. A CER or carbon Credit is defined as the unit related to reduction of 1 tonne of CO2 emission from the baseline of the project activity.

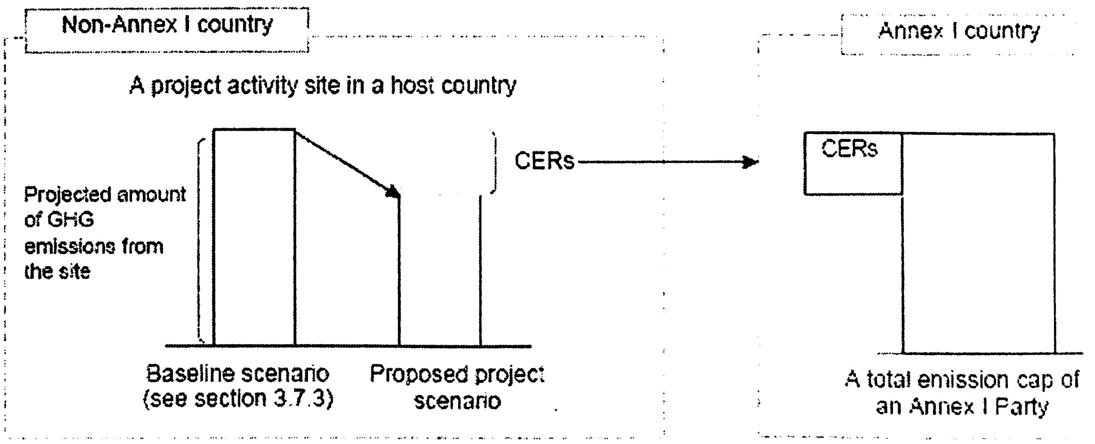

Figure.1.1- Diagram of how the CDM functions

Let us say that India decided to invest in a new process plant, and has decided on a particular technology at the cost of Rs. A crore. An entity from an industrialized country (which could even be a company) offers to provide India with slightly better technology, which costs more (say Rs. B crore), but will result in lower emissions. The industrialised country will only pay the incremental cost of the project – viz. B minus A. In return, the „investing" country will get certified emission reductions" (CERs), or credits, which it can use to meet its Kyoto commitments. This is a very good deal indeed – but for the investing country. Not only do they sell developing countries their technology, but they also meet their Kyoto commitments without lifting a finger to reduce their domestic emissions. Countries like the US can continue to pollute at home, so long as it makes the reductions elsewhere.

1.4. Classification of CDM project activities

CDM project activities can be classified in two main areas: (1) GHG emission reductions and (2) sequestration (sink). Within these two main categories, there are sub-categories based on project size.

Fig.1.2-Classification of sub categories of CDM project activities

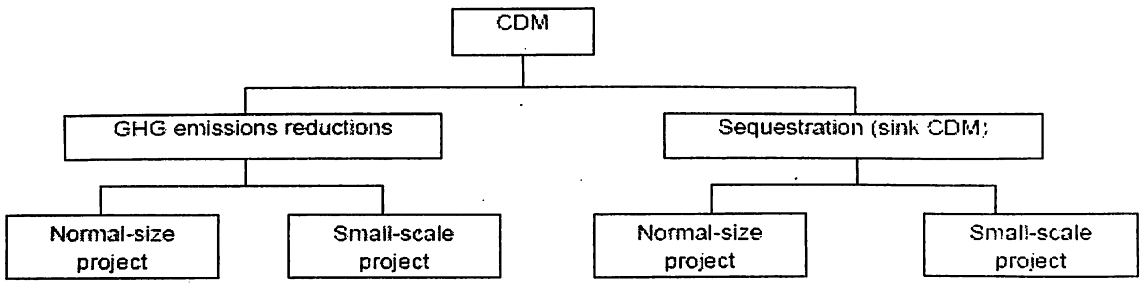

Table.1.2-List of project categories eligible under the CDM

		Sectoral scope	Examples	
1	Emission reductions activities	Energy industries (renewable/non-renewable sources)	Renewable energy	Wind power, solar photovoltaic (PV), hydro, geothermal
			Non-renewable energy	Combined heat and power (CHP), fuel switching from coal or fuel oil to natural gas
2		Energy distribution	Electricity	Transmission and distribution lines
3		Energy demand	Energy efficiency	High-efficiency equipment and lighting
4		Manufacturing industries	Energy efficiency	High-efficiency equipment
			Fuel switching	From coal to natural gas; clean coal technology
5		Chemical industries	Process change	Nitrous oxide abatement
6		Construction	Material substitution	Energy-saving measures; shorter transport distance for trucks
7		Transport	Energy efficiency	Improved vehicle efficiency, transit expansion
			Fuel substitution	Biofuels, natural gas fuels
8		Mining/mineral production	Fuel substitution	Coal mine methane recovery
9		Metal production	Energy efficiency	Improved process efficiency
			Process change	Dry coke quenching
10		Fugitive emissions from fuels (solid, oil, and gas)	Fuel substitution	Recovery and utilization of gas from oil wells
11		Fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride	HFCs	Incineration of HFC-23 waste streams
12		Solvent use	Material substitution	Replacement with less GHG-emitting materials
13		Waste handling and disposal	Fuel substitution	Landfill gas recovery, wastewater treatment, animal waste treatment
14	Sequestration	Afforestation and reforestation	Afforestation	
			Reforestation	
15		Agriculture		Methane production avoidance from biomass decay

Source: UNFCCC 2005a, Pembina Institute 2003; Houghton et al 1997; Shimizu Corporation 2004; editor's contribution

1.4.1 Small-scale CDM projects

Although the CDM is devised to foster the sustainable development of host countries, developing small-scale CDM project activities, which are known to be beneficial to the sustainable development of local communities, are often burdened with high costs for low returns. In order to leverage the development of small-scale CDM project activities, the UNFCCC introduced fast-track modalities and procedures with some preferential treatment. A project activity can be qualified as small-scale CDM if it meets one of the three following conditions (UNFCCC 2001b, paragraph 6[c], 21):

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- *Type III:* other project activities that both reduce anthropogenic emissions by sources and directly emit less than 15 kilotonnes of CO2 equivalent (CO2e) annually.

- I. TYPE I - RENEWABLE ENERGY PROJECTS
- I.A. Electricity generation by the user
- I.B. Mechanical energy for the user
- I.C. Thermal energy for the user
- I.D. Renewable electricity generation for a grid

- II. TYPE II - ENERGY EFFICIENCY IMPROVEMENT PROJECTS
- II.A. Supply side energy efficiency improvements – transmission and distribution
- II. B. Supply side energy efficiency improvements – generation
- II.C. Demand-side energy efficiency programmes for specific technologies
- II.D. Energy efficiency and fuel switching measures for industrial facilities

- II.E. Energy efficiency and fuel switching measures for buildings
- II.F. Energy efficiency and fuel switching measures for agricultural facilities and activities

- III. TYPE III - OTHER PROJECT ACTIVITIES
- III. A. Agriculture
- III. B. Switching fossil fuels
- III. C. Emission reductions by low-greenhouse gas emitting vehicles
- III. D. Methane recovery
- III. E. Avoidance of methane production from biomass decay through controlled combustion

Small-scale CDM project activities benefit from a number of privileges, which allows them to speed up their registration process.

One special feature applicable only to small-scale CDM project activities is bundling and debundling. ***Bundling*** is to cluster projects that are too small to be attractive for investment, even with the additional CER revenues. By using the bundling scheme, small projects can become cost-effective and thus become sufficiently attractive with CER revenues. Many community-based projects (e.g., small hydropower), as well as projects for small- or medium-size enterprises, with significant contribution to local sustainable development often face difficulties in attracting sufficient interest for investment without a substantial level of public support. These projects can use the bundling scheme to improve their overall financial viability. Projects can be bundled into "sub-bundles" based on the small-scale project types (type I, II, or III) and project characteristics, such as technology types, emission reduction measures, location, and baseline methodologies. Furthermore, bundling of one or more sub-bundles is possible and there is no limitation on the number of projects that can be sub-bundled, as long as the total size of the each sub-bundle cluster does not exceed the ceiling set for its small-scale project type (UNFCCC CDM EB 2005d, 1–3). While it is possible to bundle small projects together, however, large projects are not allowed to be ***debundled*** to smaller project sizes well within the range of small-scale CDM rules, in order to avoid anyone taking advantage of the CDM's fast-track and cost-effective scheme for small-scale CDM projects. While the bundling scheme may appear to be an ideal solution for small projects beneficial to sustainable development, there also exists a number of difficulties involved with the practice, for example, in developing a plan for monitoring all bundled project activities.

1.4.2 Forestry and the CDM

The CDM qualifies only afforestation and reforestation (A/R) project activities as credible sink activities under the current ruling, and they are defined as follows (UNFCCC 2001a, paragraph 1[b], [c],58):

- ***Affforestation*** is the direct, human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding, and/or the human-induced promotion of natural seed sources.

- ***Reforestation*** is the conversion of land from being non-forested to forested that was previously forested but then cleared. For the first commitment period, reforestation activities will be limited to reforestation occurring on this type of land that was not forested before December 31, 1989.

For non-Annex I Parties to host afforestation and/or reforestation (A/R) CDM project activities, in addition to the general participation requirements in the *CDM Modalities and Procedures* (annex to Decision 17/CP.7), the DNA of the host Party needs to define and report to the CDM EB on the following thresholds (UNFCCC 2003, paragraph 7–8, 17):

a. A single minimum tree crown cover value between 10 and 30 percent

b. A single minimum land area value between 0.05 and 1 hectare

c. A single minimum tree height value between 2 and 5 meters

1.5. Present study

1.5.1 About the Company

INDIA GLYCOLS LIMITED was incorporated on 19th November 1983 under the name of U.P. GLYCOLS LIMITED. It was renamed as INDIA GLYCOLS LIMITED on 28th August 1986. It started its commercial production of MEG on 25.04.1989, Ethoxylates on 25.04.1995 and Formulation/ specialty chemicals on 01.09.1997.

- INDIA GLYCOL LTD. is an integrated management system certified and listed public limited company, prominent by Bharatiya Group.

- INDIA GLYCOLS LIMITED is the only company in the world to produce MEG, EO and EO derivatives from renewable agro feed stock- Molasses and sugar cane juice.

- INDIA GLYCOLS LIMITED has an integrated manufacturing approach for value addition.

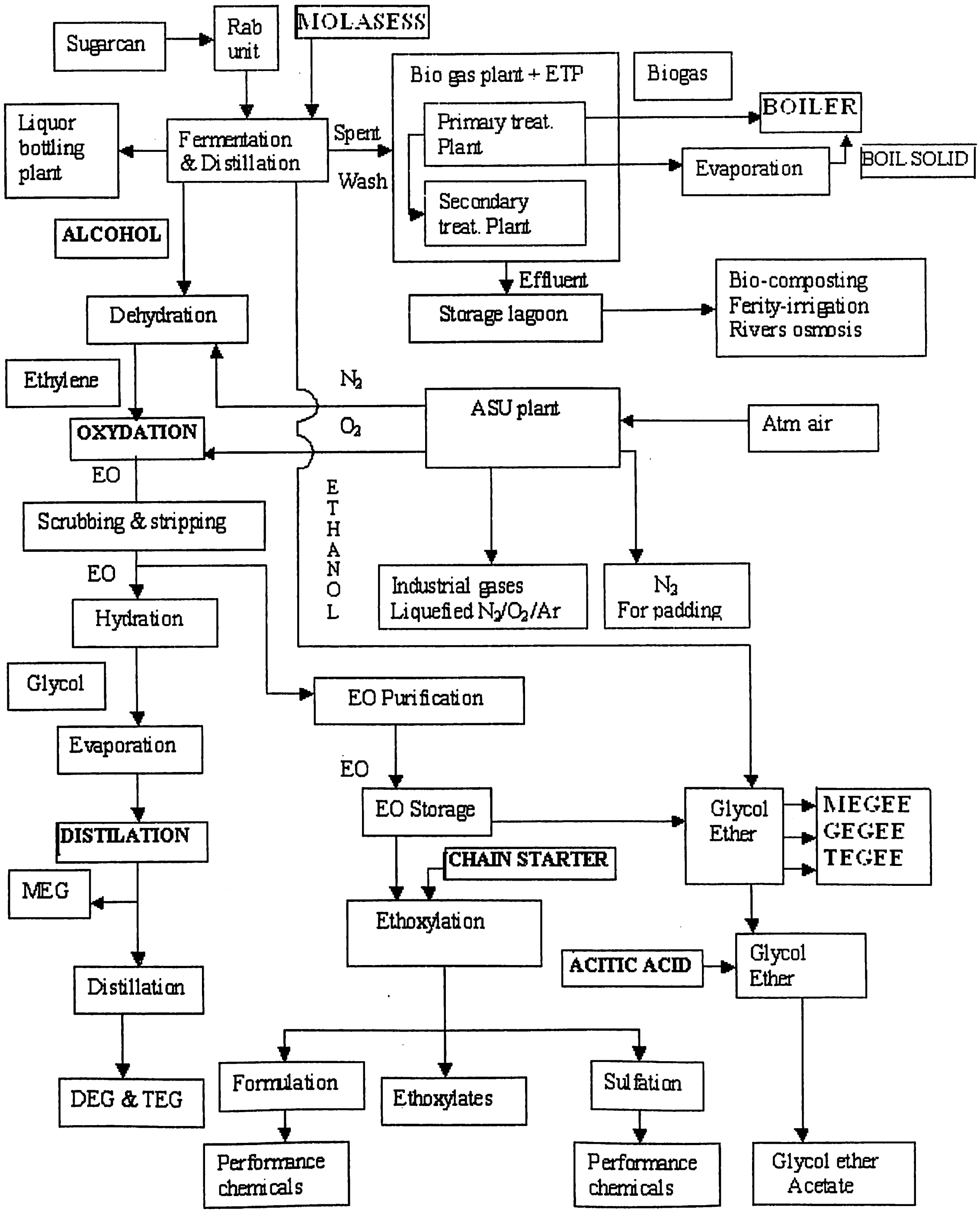
- INDIA GLYCOLS LIMITED is the largest alcohol & EO derivatives producer in INDIA.

- INDIA GLYCOLS LTD. presently have manufacturing sites in sugar cane rich belt of Kashipur (Uttrakhand) & Gorakhpur (U.P.

- INDIA GLYCOLS LTD. is the largest company in uttrakhand region.

- INDIA GLYCOL LTD. has won many prestigious safety awards by national safety council from international certification agencies also.

- INDIA GLYCOLS LTD. is a MAH category industry.



BLOCK DIAGRAM OF MANUFACTURING PROCESS

Fig.1.3 – Block diagram of manufacturing process at IGL, Kashipur (India)

1.5.2. Project description

In the process of MEG plant, carbon dioxide is produced as by-product in EO reactor and is removed by treating a portion of cycle gas with a hot potassium carbonate solution, the carbonate is converted to potassium bicarbonate by reaction with carbon dioxide at system pressure. The carbon dioxide rich solution is then regenerated at atmospheric pressure using stripping steam. The contaminated and low pressure steam (heat/thermal energy) is vented to atmosphere, as a result the heat energy is wasted and also it creates pollution.

To recover heat (thermal energy) from vent steam a new packed column is to be installed along with two Vapor Absorption Machines (VAM).This chilled water from the two VAM's is used for process itself and for the centralized air conditioning. Thereby utilizing the energy from waste steam and in turn reducing the consumption of RFO (residual fuel oil) as the load requirement of vapor absorption machines is less than the existing HFC based vapor compression systems.

The main purpose of the project activity is to achieve energy efficiency improvement through Clean Development Mechanism by saving energy (thermal & electrical) that could be utilized towards plant capacity enhancement and simultaneously to achieve reduced specific energy consumption. This would also lead to reduction of green house gas emission.

1.5.3. PROJECT CATEGORY APPLICABLE

MAIN CATEGORY: **TYPE II-Energy Efficiency Improvement Projects**

Sub category : **Energy Efficiency and Fuel Switching Measures for Industrial Facilities**

1. This category comprises any energy efficiency and fuel switching measure implemented at a single industrial or mining and mineral production facility. This category covers project activities aimed primarily at energy efficiency; a project activity that involves primarily fuel switching falls into category III.B.1 Examples include energy efficiency measures (such as efficient motors), fuel switching measures (such as switching from steam or compressed air to electricity) and efficiency measures

for specific industrial or mining and mineral production processes (such as steel furnaces, paper drying, tobacco curing, etc.).

The measures may replace, modify or retrofit existing facilities or be installed in a new facility. The aggregate energy savings of a single project may not exceed the equivalent of 60 GWhe per year. A total saving of 60 GWhe per year is equivalent to a maximal saving of 180 GWhth per year in fuel input.

2. This category is applicable to project activities where it is possible to directly measure and record the energy use within the project boundary (e.g. electricity and/or fossil fuel consumption).

3. This category is applicable to project activities where the impact of the measures implemented (improvements in energy efficiency) by the project activity can be clearly distinguished from changes in energy use due to other variables not influenced by the project activity (signal to noise ratio)

1.5.4. CALCULATIONS FOR EMISSION REDUCTION

In the absence of the energy study and project initiatives, the process would have continued to vent the waste and contaminated steam and for additional refrigeration requirement installation of another Vapor Compression Refrigerator is required. Therefore the energy baseline will be the displaced fossil fuel, which would have been used to generate power needed by VCR that would have to be implemented otherwise.

The baseline power consumption i.e. Power requirement for Vapor Compression Refrigeration Units is based on the design power consumption of these machines and comparison provided by Bureau of Energy Efficiency as well as VAM vendor.

The emissions baseline (t $CO_{2/year}$) is equal to energy baseline (Ton RFO/year) multiplied by an emission coefficient (t CO_2/ Ton RFO) for the fossil fuel displayed. IPCC default value for emission coefficient is used. The fuel equivalent is calculated based on actual fuel consumed in Captive Power Plant i.e. Tons of RFO per kWh multiplied by power consumption (kWh/year). The baseline power consumption is design specific power consumption (kWh/TR) of the machine multiplied by refrigeration generation (TR/year).

CHAPTER 2
LITERATURE REVIEW

2. LITERATURE REVIEW

2.1 Energy efficiency improvement in power generation at Sajjan India Limited, Ankhleshwar, Gujarat

Sajjan India Limited (SIL) formed in 1983, has aimed at implementation of energy efficient Technology for steam, chilled water and power production, at the company's modern manufacturing facility at Ankhleshwar, Gujarat, India. Sajjan India Limited (SIL) is into business of manufacturing of Specialty chemicals.

The use of grid power (western grid) that is predominantly based on coal, and use of lignite onsite to produce steam, pushed the company to look for alternatives with efficient technologies based on cleaner fuel(s). The project activity has reduced the release of CO2 emissions into the atmosphere and has enabled conservation of environment and natural resources such as lignite and oil.

Purpose

The basic objective of the project is to reduce energy (fuel) consumption per unit of power, steam and refrigeration production through implementation of energy efficient technologies at SIL. The project utilizes natural gas (NG), a cleaner fuel, effectively through the use of highly efficient process of combined heat, power and refrigeration generation. The project partially replaces lignite based process steam and grid power operated compressor based chilled water generation. Further, the project paves way for NG based power generation substituting grid supplied electricity for onsite consumption.

The project was planned to be implemented in three phases. The first two phases are complete with installation of two 1 MW each capacity NG engine generator sets, complete with two waste heat recovery boilers and a vapor absorption machine (VAM). In the third phase, SIL has plans to implement one more 1 MW NG fired engine generator with a waste heat recovery boiler and a VAM for steam and chilled water generation respectively. Besides SIL is in the process of converting a coal fired boiler to 14.5 TPH capacities NG fired one. This third phase is expected to get over by June 2007. The annual demand or requirement of NG for the project is met through piped gas network by Gujarat Gas Company Limited (GGCL).

2.2 Energy efficiency and fuel switch project at Welspun India Limited.

Back ground of the project

Welspun India Ltd. is engaged in the manufacturing of Textiles. The company is located at Vapi, Gujarat – India.

Purpose of the project

This project activity involves installation of an energy efficient 5.9 MW (at 350 C ambient temperature) gas turbine with heat recovery steam generator (HRSG), a 6.79 MW gas engine generator with 1260 TR vapor absorption chillers (VAC). These measures replace use of lower efficient power systems which comprises of FO based Generating sets (2*2MW, 1*4MW and 1 * 6MW) with Exhaust Gas Boiler (EGB) (1*1.5TPH, 1*2.1TPH, 1*1.6TPH) for steam and power generation, FO based boilers (3*6TPH) for steam generation and centrifugal chillers (2*500TR, 1*390 TR) for chilled water generation. The 1260 TR Vapor Absorption Chiller will use the exhaust heat from the gas engine for chilled water generation and in turn replaces use of Centrifugal Chillers thereby reducing the electricity consumption for the equivalent amount of chilled water generation.

The project activity also involves switching of fuel from Furnace Oil to natural gas in electricity and steam generation at above applications and processes. The fuel switch measure is happening due to installation of new Natural Gas based Gas turbine and Gas engine which replaces use of FO based DG set. In addition the other fuel switch measure is happening for steam generation at the existing boilers where switching of fuel from furnace oil to natural gas is done at 2 of the 3 number of boilers. The HRSG in project activity also uses natural gas for additional steam generation in addition to the steam generation from the exhaust heat from the GT.

All these energy efficiency and fuel switch measures primarily aims at reducing GHG emission into the atmosphere per unit of output through increase in efficiency and switching of fuel from Furnace Oil (FO) to natural gas in electricity and, steam generation. Energy efficiency is also happening in chilled water generation.

2.3 Scaling Up Demand–Side Energy Efficiency Improvements through Programmatic CDM, *by Christiana Figueres, Michael Philips, ESMAP Technical Paper120/07*

Improving energy efficiency (EE) is one of the most promising approaches for achieving cost-effective global greenhouse gases (GHG) reductions. However, it is severely underrepresented in the Clean Development Mechanism (CDM) portfolio. Just 10 percent of the emission reduction credits traded in the carbon market are from EE projects. In particular, small, dispersed, end-use EE measures—which entail significant GHG mitigation potential, along with other clear, local, and direct sustainable development benefits—have been largely bypassed by the carbon market.

Under the World Bank's Sustainable Development Network Integration "Challenge Fund Initiative," a joint "ESMAP - Carbon Finance Unit" team examined the synergies and possibilities of scaling up implementation of dispersed, demand-side EE efforts using the emerging programmatic CDM (pCDM) concept. This paper focuses on the key recommendations of this analysis, the potential scaling-up opportunities, and underlying operational synergies between EE programs in developing countries and pCDM.

The modalities of traditional CDM have been set for individual, stand-alone, emission reduction projects that are implemented at a single point in time (e.g., one renewable energy power plant). While CDM rules allow "bundling" of several of these projects together for registration purposes, the specific sites where they will occur must be known ex-ante and they must all occur at the same point in time.
These conditions generally cannot be met by most dispersed demand-side EE programs, whose emission reductions occur over a period of time and in numerous locations (households / industries/cities). In addition, participants in energy-efficiency programs may not be known at the outset because the program may depend on gradual take-up of incentives.

The December 2005 COP/MOP decision to include "programs of activities" (PoAs) in the CDM opens the door to scaling up implementation of dispersed end-use EE activities. A PoA is a program coordinated by a private or public entity that provides the organizational, financial, and methodological framework for emission reductions to occur. The program itself does not achieve the reductions, but rather provides the enabling environment for others to do so. The specific measures through which the emission reductions are achieved are "CDM program activities" (CPAs). These must all apply the same methodology, be implemented in the same type of facility or structure, and be coordinated by the same managing entity. However, they can occur in an unlimited number of places and can be implemented over time up to 28 years.

Many observers have been concerned that the CDM Executive Board has approved few EE methodologies. While the pCDM approach opens the CDM door more widely to energy efficiency, it is likely that not all EE programs, or at least not all aspects of EE programs, will be deemed eligible for the CDM in the short term. In the CDM, project activities have to be "traceable." That is, the resulting emission reductions must be the directly attributable to the project, and measurement of emission reductions must be robust and unambiguous. Our analysis shows that EE programs that can be shown to directly replace inefficient technologies, or provide financing/financial incentives to do so, are more likely to qualify for the CDM. Policy-based EE programs (e.g., raising energy prices or reducing import taxes on energy-efficient equipment) are important for the increased uptake of EE equipment and activities, but may have more difficulty demonstrating direct causality—which is a key CDM criterion.

Our analysis also found that application of many dispersed end-use EE efforts as PoA need not wait for the development of specific CDM baseline and monitoring methodologies. There are three already approved simplified EE methodologies for small-scale CDM (SSC) projects, and these have been modified to account for leakage and are authorized to be used in the context of PoAs. Because the small-scale methodologies must be applied at the CDM Program Activity (CPA) level, the overall program savings level can exceed the small-scale threshold (maximum savings of 60GWh per year) as long as each CPA does not exceed the threshold.

In order to highlight the issues raised in this paper, a Global Environment Facility (GEF) energy efficiency project in Uruguay2 has been selected as an illustrative case study, and is presented in this paper.

CHAPTER 3

THEORETICAL DEVELOPMENT

CHAPTER 3: Theoretical Development

3.1. Vapor Absorption machines

In the process of absorption cycle the refrigeration effect is produced by the use of two fluids and some quantity of heat input, rather than electrical input as in the case of vapor compression cycle.

The manner in which the absorption chiller works is same as of conventional compressor based systems except that the compressor is replaced by an absorber, a solution pump and a generator.

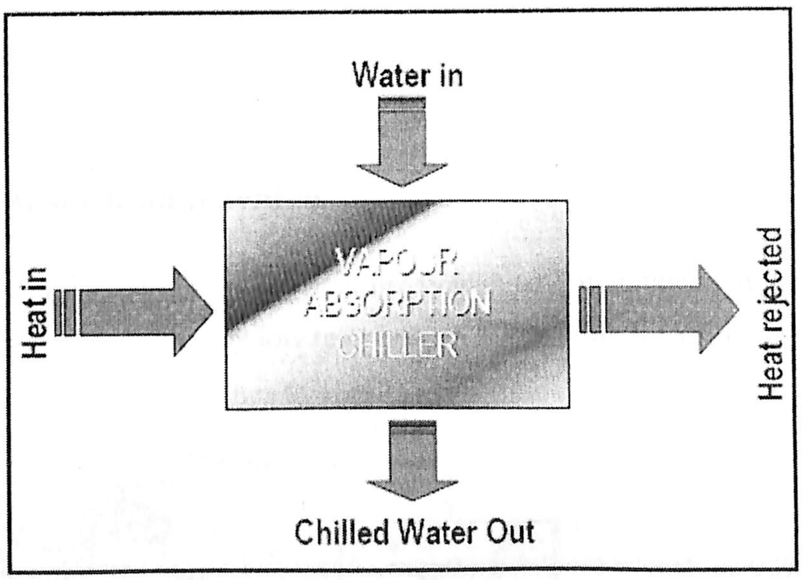


Fig.3.1 Vapor absorption cycle

The principle of absorption cooling

The two basic principles on which all air conditioning and refrigeration plant operates are

1. When a liquid evaporates, it absorbs heat and when it condenses it gives up heat. This heat is called the latent heat of evaporation and latent heat of condensation respectively.
2. Boiling point of liquid changes with pressure
   i.e. Boiling point increases as pressure increases.

Boiling point decreases as pressure decreases.

For example at atmospheric pressure (760 mm of Hg absolute) water boils at 100 ^{0} C and at 6 mm Hg absolute pressure water boils at 3.7^{0} C.

The absorption cooling works on the affinity of some pairs of chemicals to dissolve in one another, for example affinity of lithium bromide solution towards water, water has affinity towards ammonia etc.

The affinity depends on two factors, Temperature and the concentration of the solution.

1. Affinity α 1/temperature

2. Affinity α concentration

Working of absorption machines

In the vapor absorption chillers, a low pressure (vacuum) is maintained in the evaporator, as a result refrigerant boils at very low temperature. For boiling the refrigerant takes heat from the medium being cooled, thus lowers its temperature.

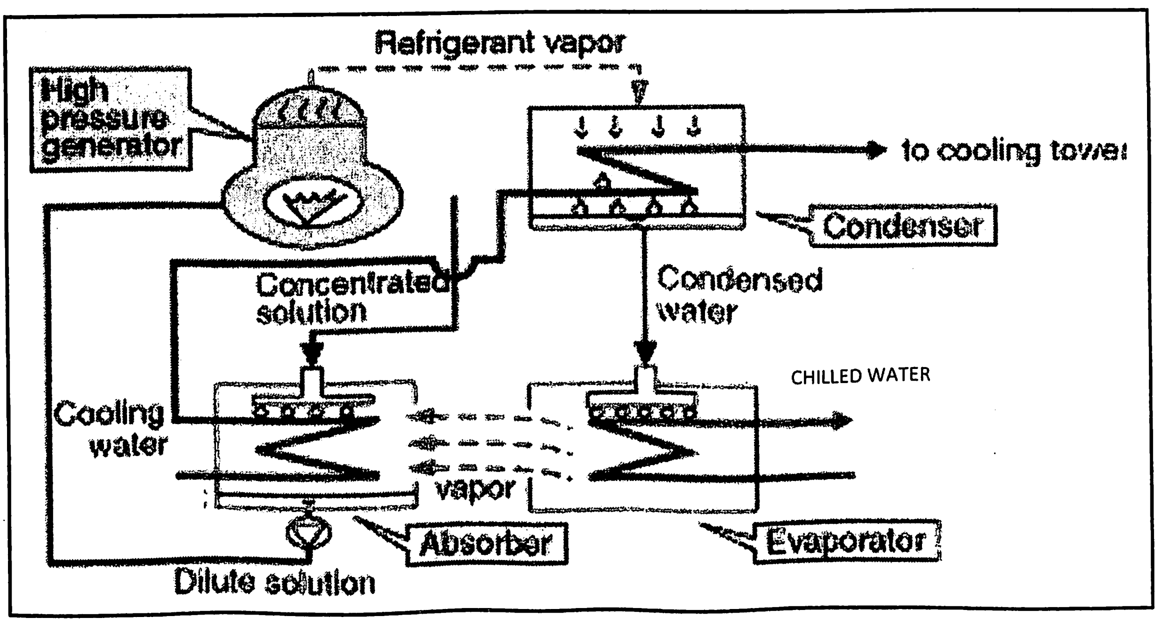


Fig.3.2-Vapor Absorption Refrigeration Unit

Due to the absorption of heat the refrigerant gets vaporized, the pressure of the vessel tends to increase due to the formation of vapors of refrigerant. As a result the boiling temperature is increased and the desired cooling effect will not be achieved, so it is necessary to remove the refrigerant vapor from the vessel.

To maintain low pressure in the shell a liquid having affinity towards the refrigerant vapor is sprayed in the absorber which absorbs the vapor and low pressure is maintained inside the shell. As the absorbent absorbs the refrigerant vapor it becomes dilute and loses its capacity to further absorbs refrigerant vapors.

It is essential that the absorbent is enriched to its original level of concentration and the refrigerant vapors are condensed back to liquid in order to maintain the continuous cycle. This is achieved by pumping the dilute solution from absorber to the generator continuously. In the generator the addition of heat boils off the refrigerant from the absorbent and the absorbent regains its original level of concentration. The reconcentrated absorbent returns to the absorber to resume the absorption process.

The refrigerant vapor which is released in the generator flows to the condenser. In the condenser cooling water is circulated through the coils. Which picks up the heat carried by the refrigerant vapor and vapor condenses back to the liquid phase. The condensed liquid is then returned back to the evaporator thus completing the absorption cycle.

System Description

Vapor Absorption Chillers like any central air-conditioning system will have the following items common:

1. **Air Handling Units (AHUs) or Fan Coil Units (FCUs):**
   In case of central air conditioning the chilled water from the absorption chillers is taken to Air Handling Units (AHUs) or Fan Coil Units (FCUs). In the AHUs/FCUs the hot air from the rooms transfers heat to the chilled water. The cold air is taken back to the rooms through the ducts while the warm water is taken back to the machine. This system is basically same for Compression as well as Absorption Chillers.

NOTE: In case of the process cooling the AHUs/FCUs are not required. The medium being used is directly used in the process

2. Chilled Water Pumps:

Chilled water pumps are required to recirculate the chilled water from the absorption chillers to the AHUs or FCUs or into the process.

3. Cooling Towers:

In the absorption chillers, heat rejected in the condenser is carried away by circulating cooling water through the condenser. This heat is finally rejected to the atmosphere in the Cooling Towers. Cooling Towers are similar for both Compression and Absorption Chillers. For smaller capacity systems like window/split air conditioners or air cooled compressors, air instead of water is passed through the condensers thereby directly dissipating heat to the atmosphere.

4. Cooling Water Pumps:

Cooling water pumps are required to recirculate the cooling water from the Cooling Tower basin through the absorption machine back into the cooling tower.

3.2. CDM CONCEPTS

There are several concepts that are specific to CDM and that need to be understood in order to develop a good CDM project. The most important concepts are therefore explained below.

3.2.1 Project Boundary

In the project description the project developer should identify the geographical extent of the project, the project boundaries. The guidance in this issue states that: "the project boundaries shall encompass all anthropogenic emissions by sources of GHGs under the control of the project participants that are significant and reasonably attributable to the project activity". All CDM projects have to apply an approved baseline and monitoring methodology, and these methodologies often give more guidance on what the project boundaries should encompass.

The project boundaries should be shown schematically in the Project Design Document.

3.2.2 Baseline Emissions

In a CDM project the emission reductions are calculated as the difference between the expected emission resulting in a future baseline scenario (baseline emissions) and the future emissions resulting due to the implementation of the CDM project activities (project emissions + leakage emissions if any).

In calculating emission reductions the historical emissions may thus be irrelevant. Identifying the Baseline scenario in order to determine the baseline emissions is a very central part of the CDM project development.

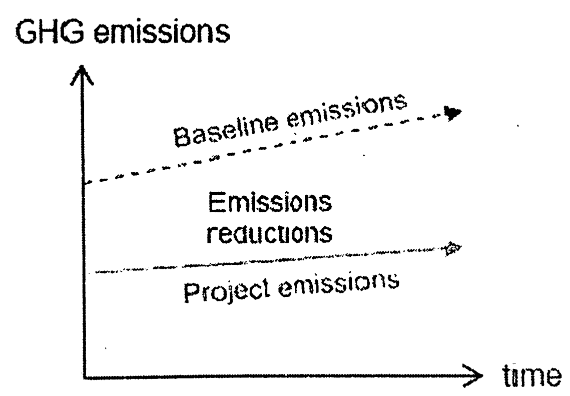


Fig.3.3 Emission reductions (ref CDM in Charts)

The baseline scenario is the scenario that reasonably represents the GHG emissions that would occur in the absence of the CDM project activity.

The general rule is that the baseline scenario and the corresponding baseline emissions shall be established:

- In accordance with the provisions for the use of approved and new methodologies
- In a transparent and conservative manner regarding the approaches, assumptions, methodologies, parameters, data sources, key factors and additionality, taking into account uncertainty
- On a project specific basis

- In the case of small-scale CDM projects, in accordance with simplified procedures for such activities
- Taking into account relevant national and/or sectoral policies and circumstances, such as sectoral reform initiative, local fuel availability, power sector expansion plans, and the economic situation in the project sector

In order to identify the correct baseline scenario several different scenarios may be elaborated as potential evolution of the situation existing before the proposed CDM project activity. The project developer may for instance list the following potential baseline scenarios:

- continuation of existing practice
- implementing the proposed project activity but not as a CDM project
- implementing other measure than what is proposed for the CDM activity

The project design document (PDD) should include a narrative description of all these scenarios and an assessment of these scenarios as a likely course of action in the absence of the CDM project activity. More guidance on identifying scenarios and assessing which is the correct baseline scenario is given baseline methodologies that has been developed for specific technologies and then approved by the CDM EB.

When having identified the most likely course of action without the proposed CDM activity, the inventory of GHG emission occurring within the project boundary in this baseline scenario has to be established. When making an inventory of emissions all "significant" emission sources should be explicitly described. If an emission source is responsible for more than 1% or the total annual baseline emissions it is deemed as "significant". The emissions may result from on-site combustion of fossil fuels in boilers, or in trucks transporting waste biomass to the landfill in a baseline scenario. If the baseline scenario includes electricity consumption which will be reduced due to the project, the baseline emissions resulting from consumption of grid-electricity should be calculated using a grid-emission factor given in ton CO_2e/MWh consumed. There is a specific methodology on how this emission factor is calculated for the grid electricity. This method is given in "Tool to calculate the emission factor for an electricity system". Several non-

Annex I countries have already established this factor using this methodology in order to simplify the work for local project developers. Any baseline emissions of GHGs other than CO_2 must be multiplied with its respective Global Warming Potential (GWP) in order to estimate the total annual baseline emission volumes given in tons of CO_2 equivalents. More guidance on estimating baseline emissions can be found in technology specific baseline methodologies.

After the project is implemented the baseline emissions have to be monitored and confirmed. How this is done is governed by the applied baseline and monitoring methodology approved by the CDM EB. In example a project switching from coal to natural gas in heat generation may monitor the heat output after the project implementation. If the baseline scenario was continued use of the coal fired boilers, this metering could have determined the amount of emissions that would have resulted if the same heat amount was produced by the old coal fired boiler taking into account the efficiency of the old boiler. This would be the monitored baseline emissions.

3.2.3. Additionality

In order to safeguard the actual climate benefit of CDM projects it is a requirement that the proposed CDM activity is "additional". A CDM project and its emission reductions are regarded as additional if the emissions are reduced below those that would have occurred in the absence of the registered CDM activity i.e. if an assessment results in a conclusion that the proposed activities would have been implemented regardless of the CDM project registration, there would be no additional emission reductions as the project emissions would equal the baseline emissions. It is up to the project developer to demonstrate (in accordance with the applied baseline methodology) that the emission reductions are additional and not the baseline scenario. This could be done by demonstrating that the CDM can help overcome some existing barriers for implementation of the given emission reduction activity. When the project is being validated, the Designated Operational Entity will review the additionality explanation in order to confirm towards the CDM EB that the emission reductions in fact are additional.

The approved baseline methodologies give some more technology-specific guidance on how the project developer can demonstrate the additionality of the project. If not the methodologies often refer to the "Tool for demonstration and assessment of additionality" or the "Combined tool to identify the baseline scenario and demonstrate additionality". These tools provide a step-wise approach to demonstrate additionality.

The use of the tool does not replace the need for the baseline methodology, and project developers proposing new methodologies towards should make sure that the suggested methodology is consistent with the guidance on additionality assessment of a project activity and the guidance for determining the baseline scenario. When proposing methodologies the tool may also be incorporated into the methodology.

The Tool for demonstration and assessment of additionality, "vs. 5.02" contains the following steps:

- Identification of alternatives to the project activity;
- Investment analysis to determine that the proposed project activity is either:
- not the most economically or financially attractive, or
- not economically or financially feasible
- Barrier analysis; and
- Common practice analysis.

The flowchart below summarizes the content of these steps.

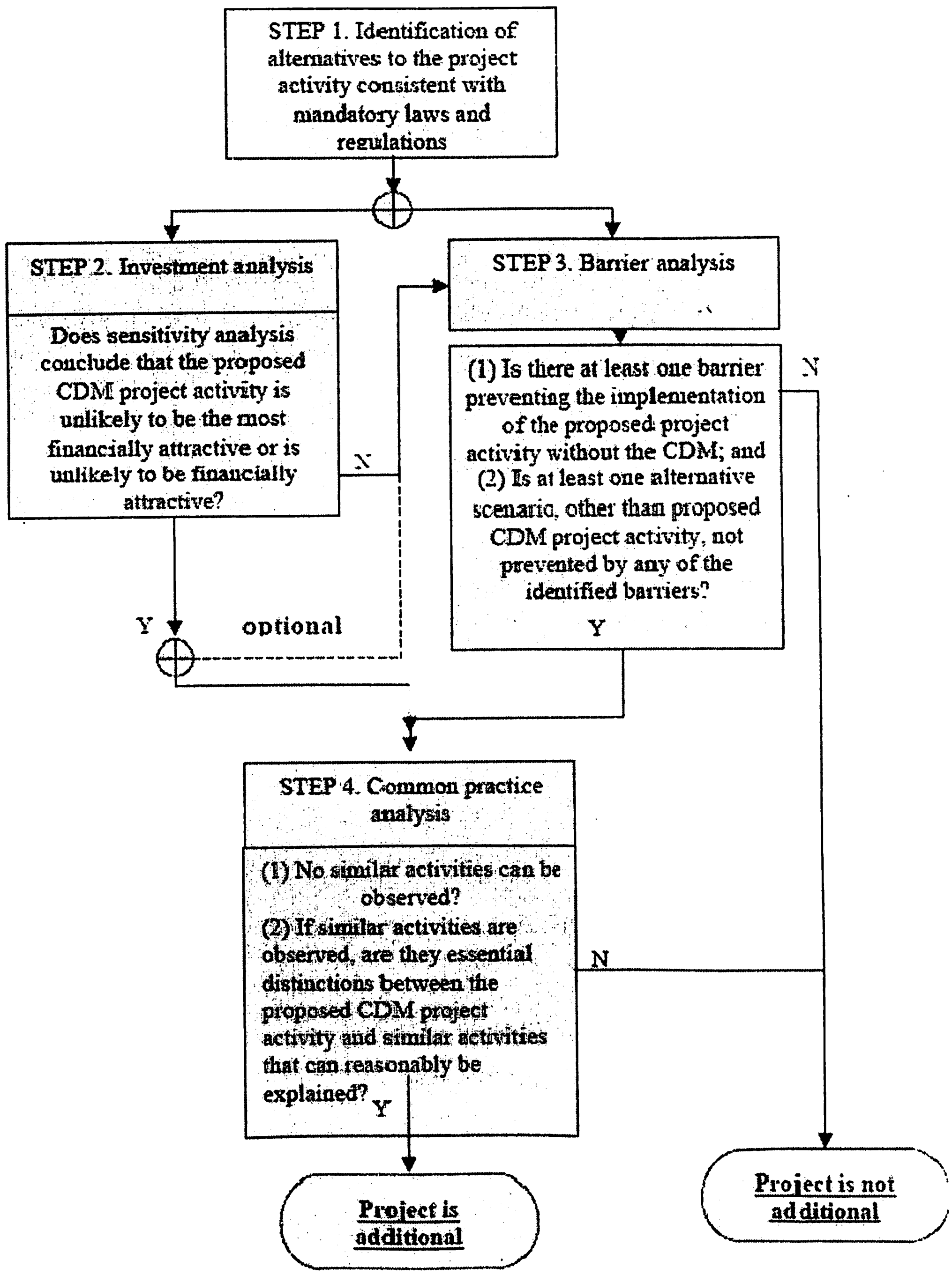


Fig.3.4. Flowchart for proving additionality

The "Combined tool to identify the baseline scenario and demonstrate additionality" provides a stepwise approach to identify the baseline scenario and simultaneously demonstrate additionality. The approach contains four main steps

- Identification of alternative scenarios;
- Barrier analysis;
- Investment analysis (if applicable);
- Common practice analysis

The tool does however have some limitations as to which project activities it is applicable to, and this should be checked before using the tool. The limitations are listed in the tool itself, which can be downloaded on the UNFCCC website. In addition to a flowchart representing a summary of the tool, the tool contains detailed guidance for each of the steps.

3.2.4 Project Emissions

The project emissions are the sum of the emissions resulting within the project boundary after the implementation of the project. The project emissions are usually stated on a per annum basis.

Electricity generation from renewable energy (included biomass) is regarded as zero-emission generation, thus resulting in zero project emissions. In case there are no leakages (ref section 3.2.5) the annual emission reductions from the project would thus equal the baseline emissions from the project.

The project emissions are estimated in the PDD before the implementation of the project. After implementation the project activity must be monitored in order to determine the real emission reductions having taken place. The result from the monitoring will determine the annual emission reductions that the project participant may claim CERs for, and these emissions should be reported to the DOE. The baseline and monitoring methodologies gives guidance on how project emissions should be monitored and on how emission reductions should be calculated following each year of the crediting period.

Emission Reductions = Baseline Emissions – Project Emissions + Leakages

3.2.5 Leakages

In CDM, leakage is defined as "the net change of anthropogenic emissions by sources of GHG which occur outside the project boundary and which are measurable and attributable to the CDM project activity". It does not refer to physical leakages at the installation, but to emissions resulting outside the project boundary because of the project. Leakage can be viewed as off-site effect of the activities under the CDM project.

For example, if a switch from coal to gas is planned within a district heating system, the fuel switch would result in less fugitive emissions from coal mining and additional fugitive emissions from natural gas extraction and distribution (ref illustration below). An assessment should be made as to whether these emissions are measurable and thus be considered as leakages.

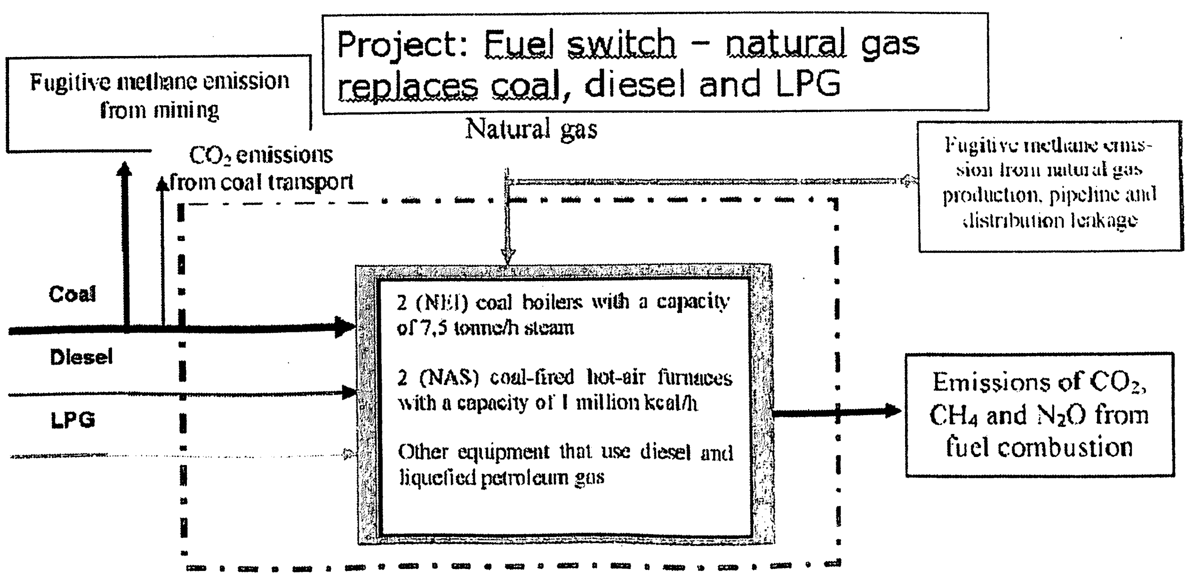


Fig 3.5- Project boundaries and leakage emissions

If applying an already approved methodology when developing a CDM project, the methodology often gives guidance on assessing leakages. The leakage emissions should be should be added to the project emissions, thus reducing the total emission reductions compared to a baseline scenario. This is illustrated in the figure below.

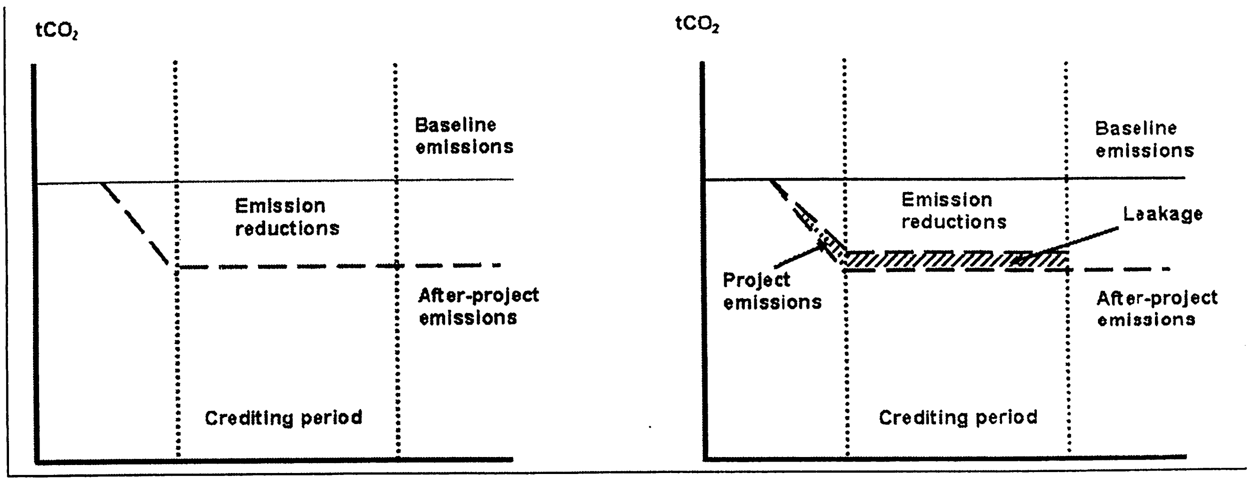


Fig 3.6- Impact of leakage emissions on emission reductions

The Emission Reductions for each year of the crediting period should be estimated in project preparation phase using the following main formula **Emission Reduction (ER) = Baseline Emissions (BE) – Project Emissions (PE) + Leakage (L)** After project implementation the BE, PE and L should be measured and ER should be recalculated and verified in order for CERs to be issued

3.2.6 Crediting Period

The crediting period for a CDM project activity is the period for which reductions from the baseline are verified and certified by a DOE for the purpose of issuance of Certified Emission Reductions (CERs). The crediting period may only start after the date of the registration of the CDM project at the CDM EB, and it can not start before the generation of emission reduction starts. It should be noted that the length of the crediting period can not exceed the operational lifetime of the equipment installed due to the CDM activity.

The project developer may choose between two options for the length of the crediting period

1. Fixed crediting period
2. Renewable crediting period

If choosing a fixed crediting period the CDM project activity can generate CERs for a period up to 10 years. There will be no opportunity of extending the period beyond this. The baseline for the project will be determined during the project planning and approved at validation stage for the whole crediting period. If choosing a renewable crediting period the project baseline is approved for a single period of maximum 7 years. The period may be renewed with 7 more years two times at most. This enables a potential for generating CERs up to 21 years. A condition for renewal is that the DOE either determines that the original baseline is still valid or that the baseline in the end of the first period is updated according to expected baseline scenario for the subsequent period. The DOE has to inform the CDM EB regarding the baseline for the renewed period. The starting date and length of the first crediting period has to be determined before project registration at the CDM EB.

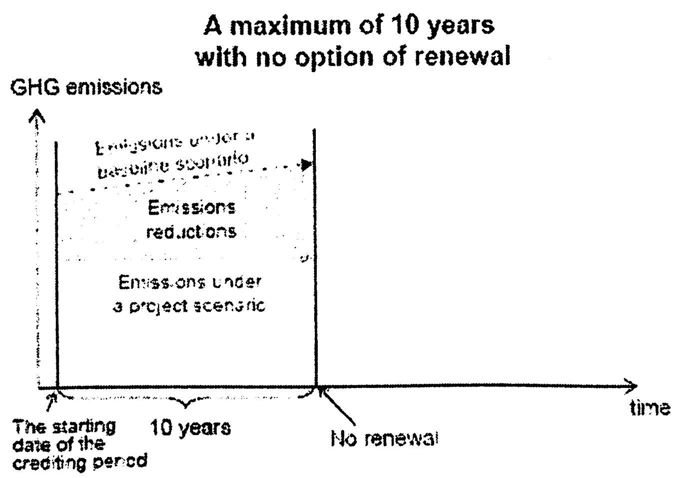


Fig 3.7a fixed crediting period

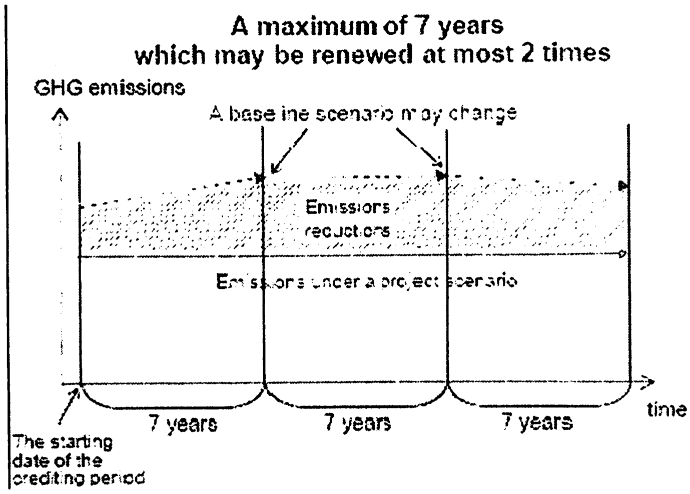


Fig.3.7b Renewable crediting period

The project developer should determine which crediting period is most suitable for the project in question. In case the emission factor for the national electricity grid is expected to decrease dramatically after the first seven years of the crediting period, the option of a single 10 year crediting period with a fixed baseline in this period may be the better option than reassessment after 7 years.

3.2.7 Baseline Methodologies

The CDM regulations state that the emissions under the selected baseline scenario shall be calculated in accordance with approved methodologies (AM) or new methodologies (NM). No methodology is excluded a priori so the project developer has the opportunity to propose any methodology.

Using an approved methodology requires the project developer to follow the guidance given in the methodology 100%, including procedures for determining baseline scenarios. setting of project boundaries, calculation of emission reductions etc.

If it is unclear whether the methodology selected is applicable to the CDM project or not, or if the baseline methodology is ambiguous or unclear, the DOE can on behalf of the project developer submit queries to the CDM EB regarding the applicability of approved methodologies.

In case where a selected methodology is determined not applicable, but the proposed CDM project activity is broadly similar to the project activities for which the approved methodology (AM) is applicable, the project developer may request a revision of the approved methodology. A revision may also be requested if the procedures provided in the methodology for estimating emission from sources are not applicable because of slight variations in the project approach, flow of events or structures chosen in the project activity.

The request for revision shall not include changes in the AM that would result in the exclusion, restriction or narrowing down the applicability conditions of AM for other CDM project activities. Should a desired revision result in the above, the project developer is advised to submit a new methodology (NM) instead. If there are no approved methodologies applicable to the CDM project, and the revision of an approved methodology are not appropriate, a new methodology can be proposed. In this case the DOE, on behalf of the project developer forwards the proposed methodology to the CDM EB for review, i.e. consideration and approval, prior to the registration of the project activity.

3.2.8 Monitoring

The CDM project activity should be monitored in order for the DOE to verify and certify the emission reductions. Monitoring refers to the collection and archiving of all relevant data necessary for determining the baseline, measuring anthropogenic emission by sources of GHGs within the project boundary of the CDM project activity and leakage. as applicable.

A plan on how the monitoring will be done should be included in the project design document (PDD) for the proposed CDM project. This monitoring plan should be based on an approved monitoring methodology or a new methodology. Any revisions to an approved monitoring methodology, to improve its accuracy and/or completeness of information, have to be justified by the project developer and submitted for validation to a DOE.

The monitoring plan should indicate the methods used for assessing emission reductions after the project is implemented. The plan should describe which procedures will be used in order to collect the data needed to determine annual baseline emissions, project emissions and leakages (i.e., by actual measurements, calculations, use of emission coefficients etc.) and how it will be stored. An approved monitoring methodology would facilitate the development of the plan by stating what needs to be measured. Otherwise. a new methodology appropriate to the proposed methodology should be elaborated and accepted by the CDM EB. If the project participant decides to propose a new monitoring methodology however, it has be a new baseline and monitoring methodology proposed and approved together (ref procedures 'for suggesting new baseline and monitoring methodologies in the previous sub-section.)

Quality management of data collection and monitoring accuracies should be included in the monitoring plan. This could include aspects as internal audits, personnel training, and calibration routines of measuring equipment. When using measurement instruments in the monitoring the following conditions apply

- The specific uncertainty levels, methods and associated accuracy level of measuring instruments and calibration procedures to be used for various parameters and variables should be identified in the PDD, along with detailed quality assurance and quality control procedures
- Standards recommended shall either be national or international standards
- The verification of the authenticity of the uncertainty levels and instruments are to be undertaken by the DOE during the verification stage
- A zero check cannot be considered as a substitute for calibration of measurement instrument

In most industrial activities some monitoring would be undertaken regardless of the CDM activity, i.e. natural gas consumption, energy production etc. The owner of the site will thus have routines on how this information is recorded and stored, and the monitoring activities needed for the CDM project should then be linked to the existing operations and quality management systems in order to reduce the costs of monitoring.

3.3. CDM PROJECT CYCLE

The CDM cycle includes several activities which can be classified in project stages. Here the classification used by "CDM in Charts" has been chosen. In addition the table below suggests activities that could be performed by the project developer at each stage. Most of these activities are described in detail in the following sub-sections. Activities marked in *italic* are not required by the CDM procedure, but are conventional project development activities that also play an important role in CDM project development.

Table 3.1 CDM project cycle

Stage	Stage activity	Suggested activities for the project developer
1	Planning a CDM Activity	• Research and screening of project possibilities • Screen approved methodologies • Check host country procedures and priorities • Select project activity • Prepare Project Idea Note (PIN) • Obtain Letter of Endorsement/No Objection • Screen for potential CER buyers • Market PIN towards buyers and investors - *Perform feasibility study* - *Prepare Business Plan*
2	Preparing the project design document (PDD)	- Collect all data needed to develop the PDD - Arrange opportunity for stakeholders to comment on the project - Agree on contract conditions with CER buyer - Receive payment for a share of the CERs if upfront payment has been agreed - *Obtain necessary permits of construction* - *Perform EIA if required by national legislation*
3	Getting approval from each Party involved	Obtain Letter of Approval from host country Obtain Investor country approval
4	Validation	Select DOE Submit PDD to DOE for validation If any Corrective Action Requests (CARs)

		from the DOE, update the PDD and re-submit.
5	Registration	(Request for registration is done by DOE) Pay registration fee to CDM EB *Implement the project*
6	Monitoring the CDM project activity	Collect and archive all relevant data necessary for calculating GHG emission reductions by the CDM project activity, in accordance with the approved monitoring plan in the PDD
7	Verification and Certification	Invite a (second) DOE to verify and certify the emission reductions
8	Issuance of CERs	Send CER distribution agreement to CDM EB Pay SOP-Admin to CDM EB
9	Distribution of CERs	(CDM EB distributes the CERs to Annex-I parties) Receive payment for CERs

3.3.1. Preparing a Project Design Document (PDD)

In order for the project to be registered by the CDM EB a project design document (PDD) must be developed. The PDD is the key document in the CDM project describing the project in details using an approved template provided by the CDM EB. The PDD should be in English, in full adherence to the recommended format and include a version number and the date of the document at the beginning of the first section. The DNA may also require the PDD in the native language before issuing the Letter of Approval. All PDDs are to be made publicly available as a part of the validation process. If information that is considered confidential is required to complete the PDD, the PDD should be presented in two versions, one having the confidential information omitted and the second being complete, marked as strictly confidential. The confidential version will be read by the DOE and the CDM EB, but not published.

There are several PDD templates produced by the CDM EB and the project developer should use the latest version of the template that is suitable to the project type. Only the standard CDM-PDD and the simplified PDD for small-scale projects (CDM-SSC-PDD) are considered here, as afforestation and reforestation projects are outside the scope of this Manual. If the project is considered a small-scale CDM project (ref section 5) and thus apply the simplified provisions for small-scale projects, the CDMSSC- PDD can be used. If not the CDM-PDD should be used. The main chapters are the same in the two PDDs however.

Table 3.2- Chapters in the Project Document Design

Content of the PDD
MAIN CHAPTERS A. General description of project activity B. Application of a baseline and monitoring methodology C. Duration of the project activity/crediting period D. Environmental impacts E. Stakeholders' comments
ANNEXES Annex 1 Contact information on participants in the project activity Annex 2 Information regarding public funding Annex 3 Baseline information Annex 4 Monitoring plan

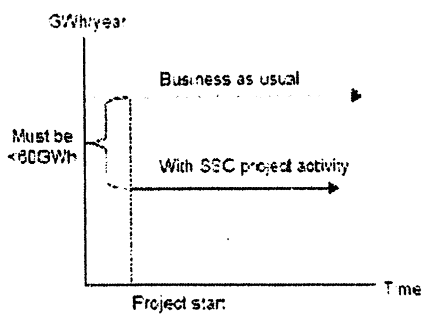
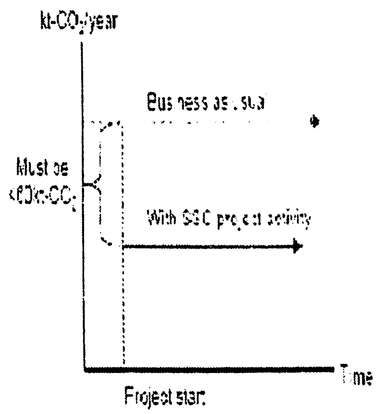
3.4. SMALL-SCALE CDM PROJECTS

Due to the transaction costs involved in developing CDM projects, small projects may not even generate sufficient CERs to pay for developing the CDM component of the project. In rural areas there are few opportunities of developing large scale project, while the potential for small scale project with significant local benefits may be large. In order to facilitate that also these small projects can benefit from the CDM, simplified modalities and procedures have been developed for small-scale (SSC) project activities.

3.4.1 Thresholds for SSC Projects

Small scale CDM project can be grouped into three categories/types and each type has threshold that should be used to assess whether the project is SSC or not.

Table3.3 Classification of Small Scale CDM projects

TYPE I	**TYPE II**	**TYPE III**
Renewable energy project activities with a maximum output capacity of 15 MW(el) (or an appropriate equivalent) "Maximum output" is defined as installed/rated capacity, as indicated by the manufacturer of the equipment or plant, disregarding the actual load factor • For biomass, biofuel and biogas activities, the maximum limit of 15 MW(el) is equivalent to 45 M W thermal output of the equipment or boiler • For thermal applications of solar energy projects, 'maximum output' shall be calculated using a conversion factor of 700 Wth/m2 of aperture area of glazed flat plate or evacuated tubular collector, i.e. eligibility limit in terms of aperture area is 64000 m2 of the collector.	Project activity that improve energy efficiency, reducing energy consumption, on the supply and/or demand side, by up to an equivalent of up to 60 GWh per year • 60 GWh electricity per year is equivalent to a maximal saving of 180 GWh(th) 	Other project activities that result in emission reductions of less than or equal to 60000 tCO2e per year. Should a project include more than one project type, the project has to satisfy both/all the relevant thresholds in order be using the simplified procedures for SSC projects. 

3.4.2. Special Provisions for SSC Projects

When developing small-scale CDM project the project participant still need to follow all stages of the CDM project cycle, but individual steps will be simpler and less time consuming to finalize.

- Reduced PDD requirements
- Simplified baseline methodologies
- Reduced monitoring plan to reduce monitoring costs

- Additionality for the project activity could be explained with only one of either type of the barriers, i.e., investments, technology, prevailing practices, other:
- The same DOE may undertake validation, verification and certification:
- Shorter time needed for appraisal and registration of projects
- Several project activities could be bundled and treated as a single project through the CDM project cycle

3.5 The CDM – key terms:

3.5.1 Adaptation Fund

Two percent of the CERs from every CDM project are deposited in a special registry run by the Executive Board. Revenues from their sale will be used to fund climate change adaptation projects in developing countries. Projects in Least Developed Countries are exempt.

3.5.2 Annex I Countries:

Countries that have committed to emission restraints under the UNFCCC as listed in Annex I of the UNFCCC (generally developed countries and countries undergoing the process of transition to a market economy).

3.5.3 Annex B Countries:

Those countries listed in Annex B to the Kyoto Protocol, being a list of Annex Countries that have committed to a quantitative emission reduction target under Article 3.1 of the Kyoto Protocol.

3.5.4 Designated National Authority (DNA) for the CDM:

The DNA is the focal point for CDM matters in your country. It is frequently a unit in a government ministry that is responsible for administering CDM implementation and overseeing approval of projects.

3.5.5 Designated Operational Entity:

DOEs are accredited by the Executive Board and perform two functions: validating CDM projects, and verifying and certifying emissions reductions from projects. The same DOE cannot perform both functions for one project unless it is a small-scale project.

3.5.6 Emissions Trading:

The trading of emission allowances between Parties who have a reduction commitment under the Kyoto Protocol. It is expected that various national and regional trading schemes will be established.

3.5.7 Executive Board:

The CDM Executive Board supervises the CDM and makes the final decision about project registration and the issuing of carbon credits. The Board also makes the final decision whether to approve new baseline and monitoring methodologies and must approve new DOEs. The Board was elected at the Marrakech Conference of Parties in 2001 and has 10 members from Parties to the Protocol. The Board must meet no less than three times a year. Members are elected for a term of two or three years.

3.5.8 Joint Implementation:

Joint Implementation is one of the three so-called flexible mechanisms of the Kyoto Protocol, and like the CDM is project based – i.e. industrialized countries get reduction credits for investing in emission reducing projects in another country. In the case of JI projects, however, both countries have to have a reduction commitment under the Kyoto Protocol, unlike the CDM where the projects happen in countries without a reduction commitment. JI will mostly involve projects in Eastern European countries and those of the former Soviet Union, funded by the EU, Canada or Japan.

3.5.9 Marrakech Accords:

The Marrakech Accords set out the rules for CDM projects, with the exception of those involving forestry projects. The Accords are named after the meeting at which they were agreed – the seventh Conference of Parties to the Climate Convention in Marrakech, Morocco, in 2001.

3.5.10 Monitoring and Verification:

The reduction in emissions achieved by a CDM project must be monitored by the project operator consistently with the monitoring plan outlined in the Project Design Document (PDD). This data is then verified by a designated operational entity, which then certifies that the reductions have taken place and recommends that the Executive Board issues carbon credit.

3.5.11 Registration:

Registration is the final approval of a CDM project by the Executive Board, meaning the project can begin to generate carbon credits.

3.5.12 Stakeholders:

Stakeholders are defined in the Marrakech Accords as "the public, including individuals, groups or communities affected or likely to be affected, by the proposed clean development mechanism project activity"

CHAPTER 4

EXPERIMENTAL AND COMPUTATIONAL

4. EXPERIMENTAL AND COMPUTATIONAL

4.1 DESCRIPTION OF FORMULAE

Calculation of Tonnes of refrigeration

The cooling effect produced is quantified as tons of refrigeration (TR).

1 TR of refrigeration = 3024 kCal / hr heat rejected.

The refrigeration TR is assessed as TR = Q x density x C_p x ($T_i - T_0$) / 3024

Where:

Q is flow rate of chilled water in m^3 / hr

P_{cw} is density of chilled water in kg/m^3

C_p is chilled water specific heat in kcal/ kg deg C

T_i is inlet temperature of chilled water

T_0 is outlet temperature of chilled water

The above TR is also called as chiller tonnage

The specific power consumption kW/TR is a useful indicator of the performance of refrigeration system. By measuring refrigeration duty performed is TR and the kilowatts inputs, kW/TR is used as a reference energy performance indicator.

Calculation of tonnes of Refrigeration

$TR_1 = Q_1 \times P_{cw} \times Cp\,(T_{1\,in} - T_{1\,out}) / 3024$

$TR_2 = Q_2 \times P_{cw} \times Cp\,(T_{2\,in} - T_{2\,out}) / 3024$

In a centralized chilled water system, apart from compressor unit, power is also consumed by the chilled water (secondary) pump as well as condenser water (for heat rejection to cooling tower) pump and cooling tower fan in the cooling tower.

Effectively the over energy consumption would be towards:

- Chilled water pump kW
- Condenser water pump kW
- Hot water pump kW
- Rated power of machine

The specific power consumption for certain TR output would therefore have to include

- Chilled water pump kW
- Condenser water pump kW
- Hot water pump kW
- Rated power of machine
- The overall kW/TR is the sum of the above.

Formulae used

CO_2 emission reduced or CER = [(TR1 + TR_2) x X_{TRP}] x operating hours x (NCV/1000) x EF_{co2}/1000

Where

CER = CO_2 emission reduced or CER

TR_1 = Refrigeration capacity of machine 1 in 'tons of refrigeration'

TR_2 = Refrigeration capacity of machine 1 in 'tons of refrigeration'

X_{TRP} = factor for calculating power requirement per Ton of refrigeration, 0.7 kW/ton of refrigeration

EF_{co2} = CO_2 emission per kWh of power generated, MT CO_2 / MWh

NCV = Net calorific value of RFO

4.2 CALCULATONS

Net calorific value of RFO = 40.19 Tj/1000T IPCC default ID 110712 (*source:* Emission Factor Database)

Density of chilled water, P_{cw} = 1000 kg/ m^3

Emission Factor for power generation of northern grid = 0.71 ton of CO_2 / MWh (vide cea.nic.in)

Carbon Emission Factor of RFO = 21.1 tC/tj (ref-1) (table 1.1 page 1.13 IPCC reference manual)

Specific power consumption of power driven vapor chillers = 0.7 kWh / TR

Power that would have required by vapor compression chillers P_b= 0.7 x R kWh / year

Actual consumption of RFO at Captive Power Plant (CPP) = 362.61 ton

Total electricity generated = 1637.60 MWh

Specific RFO consumption for electricity generation	= Actual value of RFO consumed/ Electricity generated = 362.61/1637.60 = 0.22 ton/ MWh
CO2 emission factor	= IPCC default RFO: 21.1 tC/ TJ Lower heating value basis, Multiply the factor by (44/12) Convert to t CO2/TJ = 77.37
Total refrigeration capacity utilization (R) = (685+465)	= 1150 TR/hr
Total operating hours per annum	= 8000 hrs (ref. annex 1)
Total refrigeration capacity utilization per annum	= 1150 x 8000 = 9200000 TR/annum
Power required by VCR for equivalent refrigeration	= total TR per annum x specific power consumption of VCR = 9200000 x 0.7 = 6440000 kWh = 6440 MWh

Baseline emission	= Pb x SN x (NCV /1000) x CO_2 emission factor of RFO = 6440 x 0.22 x (40.19/1000) x 77.37 = 4405.54 MTCO_2/ annum
Total power consumption by VAM -1 (Pm1)	= 20.5* 8000 + 14.5 * 8000 = 279936 = 279936 Kwh / yr
Total power consumption by VAM-2 (Pm2)	= 14.8* 8000 + 14.5* 8000 = 118592 + 116000 = 234592 Kwh /yr
Power consumption of the complete project (Pp)	= 279936 + 234592 = 514528 Kwh/yr = 514.528 MWh/yr
Project emission	= Pp x SN x (NCV /1000) x CO_2 Emission factor of RFO = 514.528 x 0.22 x (NCV/1000) x 77.37 = 351.96 MT CO_2/ annum
Emission Reduction	= Baseline Emission – Project Emission = 4405.54 - 351.96 = 4053.58 MT CO_2/ annum

4.1 THE PROJECT DOCUMENT DESIGN

CLEAN DEVELOPMENT MECHANISM
SIMPLIFIED PROJECT DESIGN DOCUMENT
FOR SMALL SCALE PROJECT ACTIVITIES (SSC-CDM-PDD)
Version 03- in effect as of: 22 December 2006

CONTENTS

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2005	Initial adoption
02	16 April 2009	• The Board decides to prepare the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM .The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.

SECTION A. General description of small-scale project activity

A.1 Title of the small scale project activity:

Demand side energy conservation & reduction measures at M/s India Glycols Ltd (IGL) Kashipur, Uttaranchal., India

A.2. Description of the small scale project activity:

Introduction

IGL is a leading entity in corporate circles of India. It has manufacturing facilities for Glycols, EO, Glycol Ether, Ethoxylates, and Formulated products.

Purpose

PRE PROJECT SCENARIO:
In the process of MEG plant, Carbon dioxide is produced as by-product in EO reactor is removed by treating a portion of the cycle gas with a hot potassium carbonate solution. The Carbonate is converted to potassium bicarbonate by reaction with the carbon dioxide at system pressure. The carbon dioxide rich solution is then regenerated at atmospheric pressure using stripping steam. **The contaminated & low pressure steam (heat/thermal energy) vented to atmosphere.**

PROJECT SCENARIO:
To recover heat from vent steam **(thermal energy)** a new packed column is installed. In this column heat is recovered by water. This hot water is pumped to two different VAM. Return Hot water is again recalculated to packed column.

Heat of this vent steam **(thermal energy)** is utilised to run Vapour Absorption Machines (VAM), which meet chilled water requirement in different processes.

Chilled water from one machine is used in process itself (a) to improve new catalyst life and (b) improve yield of the reaction also.

Chilled water produced from the other machine is used for other process requirement & Centralised air conditioning and. This system is to be used for replacing existing HFC based Vapour compression system to replace R11, R12 etc.

The project activity was taken up as CDM project as the investment was not attractive.

The main purpose of the project activity was to achieve energy efficiency improvement through Clean Development Mechanism by saving energy (Thermal & Electrical) that could be utilized towards plant capacity enhancement and simultaneously to achieve reduced specific energy consumption. . This would also lead to reduction of greenhouse gas emission,

The measures adopted under energy efficiency programme are as follows:

1. Recovery and use of contaminated waste process steam (very low-pressure steam of 90°C) to produce chilled water at MEG (Mono-ethylene glycol) plant by installing Vapour Absorption Refrigeration Machines (VAM).

Salient feature of project:
IGL at Kashipur Manufacturing Complex is consciously working in the field of energy conservation and management to reduce Green House Gas emission. The main purpose of the project activity was to achieve energy efficiency improvement through Clean Development Mechanism by saving energy (Thermal & Electrical) that could be utilized towards plant capacity enhancement and simultaneously to achieve reduced specific energy consumption. . This would also lead to reduction of greenhouse gas emission,

ACHIVEMENT OF POWER CONSUMPTION:

The measures adopted under energy efficiency program are as follows:

- Recovery and use of contaminated waste process steam (very low-pressure steam of 90°C) to produce chilled water at MEG (Mono-ethylene glycol) plant by installing Vapour Absorption Machines.

Recovery and use of contaminated / dirty waste by installing Vapour Absorption Refrigeration unit to produce chilled water at MEG (Mono Ethylene Glycol) plant.

Contaminated steam was not possible to utilize for process heating application. Hence management decided to install Vapor Absorption Machines (VAM) to be run by this steam, which would cater to the chilled water requirement (1150TR) for the process up gradation of MEG plant. The additional chilled water requirement could have been met by installing Vapor Compression Refrigeration Unit (VC), which is in practice in IGL. Thus the alternative to the project activity would have consumed additional electric power to the tune of 6.4 GWh/year and hence would have resulted into higher GHG emissions.

The average life of the installed equipment i.e. VAM's is estimated to be 15 years. The energy saving and GHG emission reduction have been calculated based on the difference between in electric energy consumption of VCR system and VAM system. Though power to Kashipur complex is supplied through Captive Power Plant (CPP) having DG & TG as well as from State Electricity Board, GHG emissions reduction is calculated based on CPP power, which is a conservative estimate.

Project activity's contribution to sustainable development

The project contributes to sustainable development in the following manner in terms of environmental, socio-economic, technological development:

- Reduction in GHG emission mainly (CO2) and other pollution occurring due to fossil fuel extraction, processing and transportation.
- Encouraging other large facilities irrespective of sector to adopt small but effective energy efficient measures to save energy and protect the environment.
- Stoppage of steam venting also benefits the environment in terms of heat.

Community Development

The project proponent is committed to improving social well being by providing following facilities to all nearby villages:

- Provided infrastructure and supply of potable drinking water to villages near Kashipur
- Expenses on housing, living, education, transportation by additional persons directly employed and their dependents.
- Support for Environment preservation / upgradation, Construction of Primary Health Centers, providing ambulances and training to people in primary health care.

- Camps organized for social welfare and family welfare.
- Fire / disaster relief measures

Environmental impact:

As the project activity has reduced consumption of fossil fuel for power generation based on RFO, the emissions in the form of NOx, SO_2 and CO_2 are reduced. Reduction in the GHG emissions mainly (CO2) and other pollution occurring due to fossil fuel extraction, processing, transportation and combustion. Stoppage of steam venting also benefits the environment in terms of heat conservation. This contributes to the sustainable development of environment.

Social impact:
The project activity generated employment during the erection and commissioning of the project. Also the interaction with technical experts enhanced the skill sets of manpower.

Economical impact:
The project activity reduces fuel consumption in the boilers, thus reducing the variable cost of production. Though the quanta of savings are negligible as compared to total turnover of the company, directionally the project contributes to economical development.

Technological impact:
Encouraging other large facilities irrespective of sector to adopt small but effective energy efficient measures to save energy and protect the environment.

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	**Private and/or public entity(ies)project participants (*) (as applicable)**	**Kindly indicate if the Party involved wishes to be considered as project participant**
Government of India	**M/s India Glycols Limited** Kashipur, Dist: Udham Singh Nagar, State : Uttaranchal Pin: 244713 Country: India	**No**

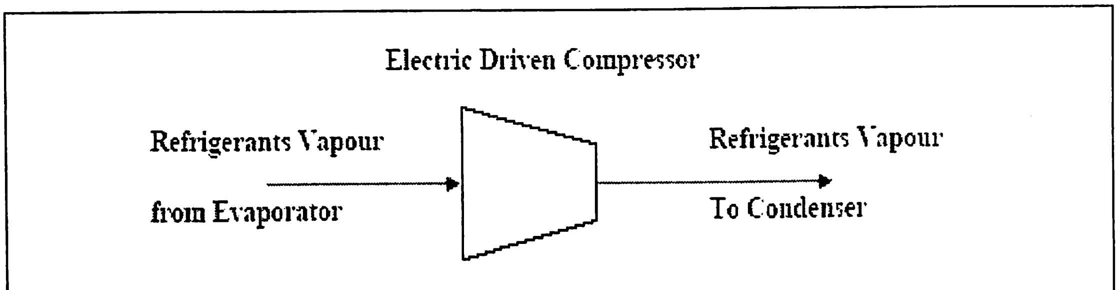
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.

Note: *When the PDD is filled in support of a proposed new methodology* at least the host Party(ies) and any known project participant (e.g. those proposing a new methodology) shall be

A.4. Technical description of the small scale project activity:

A study was carried out in-house for the available energy conservation potential at the complex to identify possibilities to adopt new technologies / modifications to minimize the energy losses and reduce specific energy consumption.

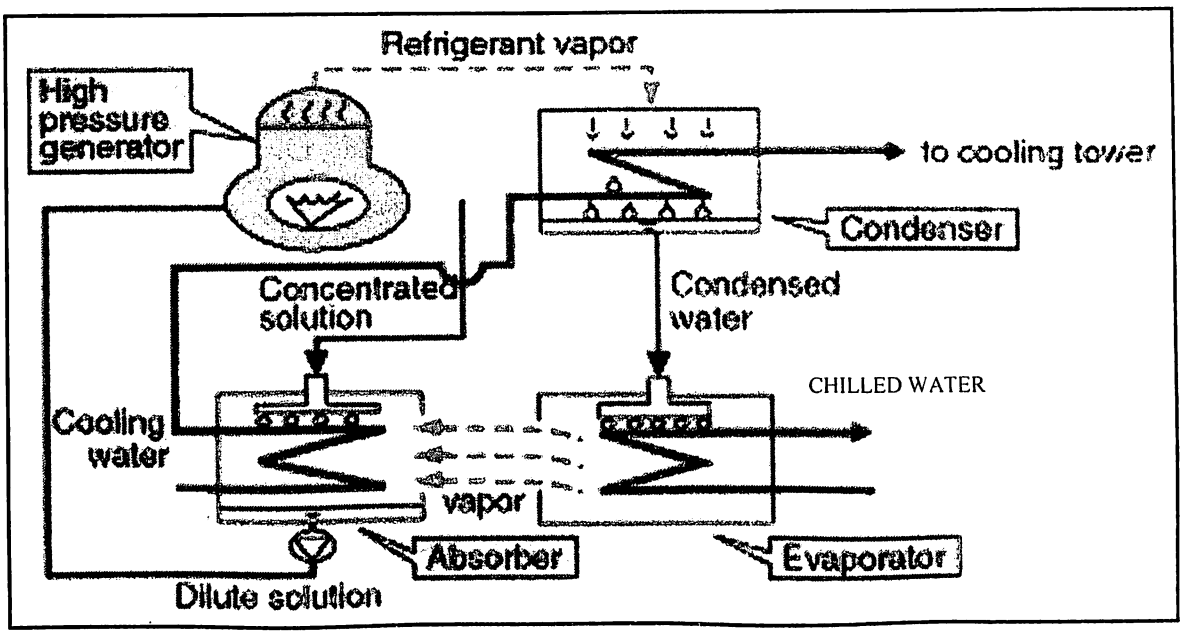
The demand for refrigeration at MEG plant was met by adopting specific technology to recover and use the steam which was waste / contaminated. The project involved installation of VAM along with associated equipment, piping, thermal insulation, civil work, electrical, instrumentation, structure & installation / erection. The system is provided proper interlocks to take care of safe operation measures.



Commonly used Mechanical Vapour Compressor Machine.

Vapour compression machines use secondary energy in the form of electricity. Moreover these machines use CFC (Chloro Fluoro Carbons) based refrigerant such as Freon R-11, R-12, R-123 etc. which may cause harm to environment, owing to ozone layer depletion.

Vapour Absorption Refrigeration Unit



VAPOUR ABSORPTION MACHINE OPERATION:

Absorption chillers use heat, instead of mechanical energy, to provide cooling. The thermal compressor consists of an absorber and a generator pump. The refrigerant vapor from the evaporator is absorbed by a solution mixture in the absorber. This solution is then pumped to the generator where the refrigerant is re-vaporized using a waste steam heat source. The refrigerant-depleted solution is then returned to the absorber. The rich refrigerant solution will then pass thru' the evaporator where refrigerants evaporates by exchanging heat return chilled water and refrigerate vapor goes to absorber. The two most common refrigerant / absorbent mixtures used in absorption chillers are water / lithium bromide.

Previously from the commencement of MEG plant of IGL contaminated & low pressure & temperature steam was being vented to atmosphere. In MEG plant process design, carbon dioxide produced by the process reaction is removed by treating a portion of the cycle gas with a hot potassium carbonate solution. The Carbonate is converted to potassium bicarbonate by reaction with the carbon dioxide at system pressure. The carbon dioxide rich solution is then regenerated at atmospheric pressure using stripping steam. Carbon dioxide reaches waste steam exhaust through column.

To recover heat from vent steam a packed column is installed .In this column heat is recovered by direct contact of water. This hot water is pumped to two VAM. Return Hot water is again re-circulated to same packed column.

USE OF CHILLED WATER FROM VAM:

Chilled water from VAM is used in MEG Plant itself to cool process gas. Cooling of Process gas is done in other packed column. Cooling of gas is done by direct contact of chilled water with process gas. By cooling of process gas moisture content present in Process gas is knocked down to lower level which results in longer catalyst life and improvement in yield of the reaction also.

Chilled water produced from another machine is used for Centralised air conditioning and other process requirement. This system is to be used for replacing existing HFC based Vapour compression system.

Heat from vent steam is recovered by a new packed column. In this column heat is recovered by direct contact of water, due to this direct contact contaminants will be there in hot water & cannot be used anywhere else.
In house study was taken up with the vendor to select the material of construction (MOC) for VAM. The standard design of pipeline, instruments, VAM was modified for stability in MOC to deal with the contaminants in the hot water. Installing VAM is not a common practice for higher requirement such as 1150 TR due to perceived loss of reliability and prone to corrosion & leakage of Lithium Bromide (LiBr) after few (4-5 years) years of operation and higher capital required.

A.4.1. Location of the project activity:

The MEG unit is located on the southern side of M/s India Glycols Ltd plant, located at A-1, Industrial Area on Bajpur Road, 8 km from Kashipur. Kashipur is in District Udham Singh Nagar (U. S. Nagar) of state of Uttaranchal. Kashipur is 270 km from New Delhi, the capital of India & 60 km from Moradabad and is located on NH - 74 (National Highway). The geographical location of India Glycols Limited is 29°10'22" N & 79°00'40" E.

.A.4.1.1. Host Party (ies):

India is the host party for this project

A.4.1.2.Region/State/Province etc.:

Uttarakhand

A.4.1.3.City/Town/Community etc:

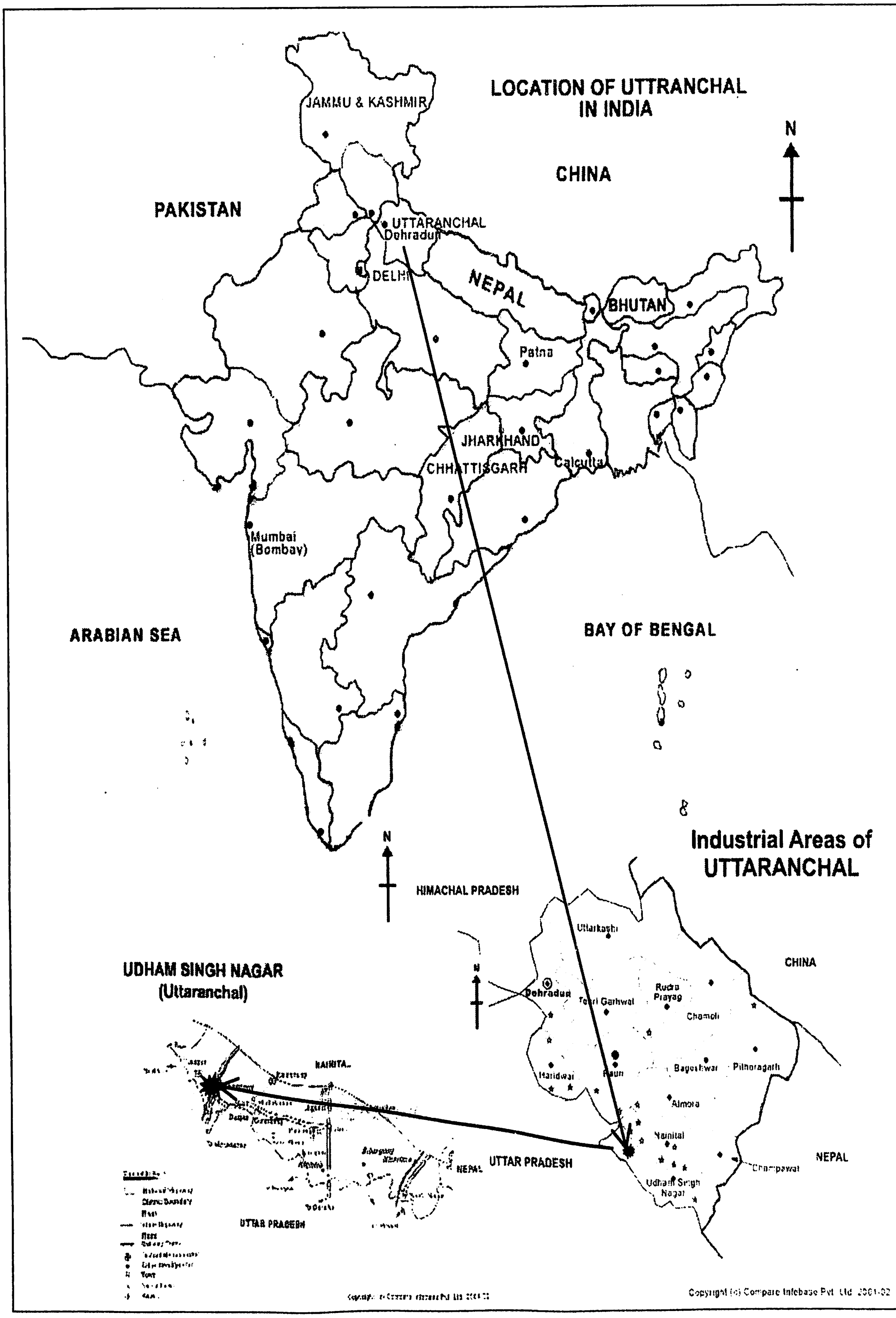
Kashipur, Dist: Udham Singh Nagar

A.4.1.4.Detail of physical location, including information allowing the unique identification of this small scale project activity

The Project Site has the following physical address

M/s India Glycols Ltd.,
Kashipur, Dist: Udham Singh Nagar,
State: Uttaranchal
Country: India
Pin Code: 244713

The geographical location is detailed in map given below,



A.4.2. Type & Category (ies) and Technology of the small-scale project activity:

Type II D: Energy efficiency and fuel switching measures for industrial facilities

A.4.3. Estimated amount of emission reductions over the chosen crediting period:

Years	Annual estimation of emission reduction tonnes CO_2 e
Jan 2010 - Dec 2010	4053
Jan 2011 - Dec 2011	4053
Jan 2012 - Dec 2012	4053
Jan 2013 - Dec 2013	4053
Jan 2014 - Dec 2014	4053
Jan 2015 - Dec 2015	4053
Jan 2016 - Dec 2016	4053
Jan 2017 - Dec 2017	4053
Jan 2018 - Dec 2018	4053
Jan 2019 - Dec 2019	4053

A.4.4. Public funding of the small-scale project activity:

No public funding has been sought for the project activity and the project proponent made entire investment.

A.4.5. Public Confirmation that the small-scale project activity is not a debundled component of a larger project activity:

Appendix C, paragraph 2 of the Simplified Modalities and Procedures for Small-Scale CDM project activities states:

"A proposed small-scale project activity shall be deemed to be debundled component of a large project activity if there is a registered small scale CDM project activity or an application to register another small scale CDM project activity:

- With the same project participants;
- In the same project category and technology/measure; and
- Registered within the previous 2 years; and
- Whose project boundary is within 1 Km of the project boundary of the proposed small-scale activity at the closest point."

As there is currently no registered CDM project at the site either large scale or small scale, the project meets the criteria on debundling.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline methodology applied to the small-scale project activity:

>>
Type II D: Energy efficiency and fuel switching measures for industrial facilities

B.2. Justification of the choice of the project activity:

The CDM project is an outcome of Energy conservation programs initiated at IGL Kashipur with an aim of reducing demand side energy consumption. According to Appendix B of the simplified modalities and procedures for small –scale CDM project activities, the project activity is categorized as -

Type II D: Energy efficiency and fuel switching measures for industrial facilities

The methodology applicability criteria are as follows: -

1. Energy efficiency measures (such as efficient motors),
2. Fuel switching measures (such as switching from steam or compressed air to electricity) and efficiency measures for specific industrial processes (such as steel furnaces, paper drying, tobacco curing, etc.).
3. The measures may replace, modify or retrofit existing facilities or be installed in a new facility. Reducing energy consumption, on the supply and/or demand side, by up to an equivalent of up to 60 GWh per year, 60 GWh electricity per year is equivalent to a maximal saving of 180 GWh (th)

These criteria in the context of the project are point-wise addressed in the following table :

Criteria	Applicability to the project
Any energy efficiency and fuel switching measure implemented at a Single industrial facility.	Project involves energy efficiency measure through installation of vapor absorption chillers at single site, i.e., Kashipur Manufacturing Complex. Hence Type II D - Energy efficiency and fuel switching measures for industrial facilities is applicable to project activity.
This category covers project activities aimed primarily at energy efficiency.	The project activity is an energy efficiency measure
The measures may replace existing equipment or be installed in a new facility.	The project involves installation of two new equipments (VACs) for energy efficiency.
The aggregate energy savings by a single project may not exceed the equivalent of 60 GWh per year.	The aggregate energy saving achieved by this programme is about 6.4 GWh / year (<< 60 GWh) of electricity per annum. Calculation enclosed as Annexure

From the above discussion, it can be concluded that the project meets all the applicability criteria set out under the selected small-scale methodology and hence the project category is applicable to the project. The project proponent regularly carries out in-house monitoring & data analysis to identify sustainable development / energy conservation potential at the complex and identify possibilities to adopt new technologies / modifications to minimize the energy losses / reduce specific energy consumption.

The project activity was identified during in-house monitoring & data analysis.

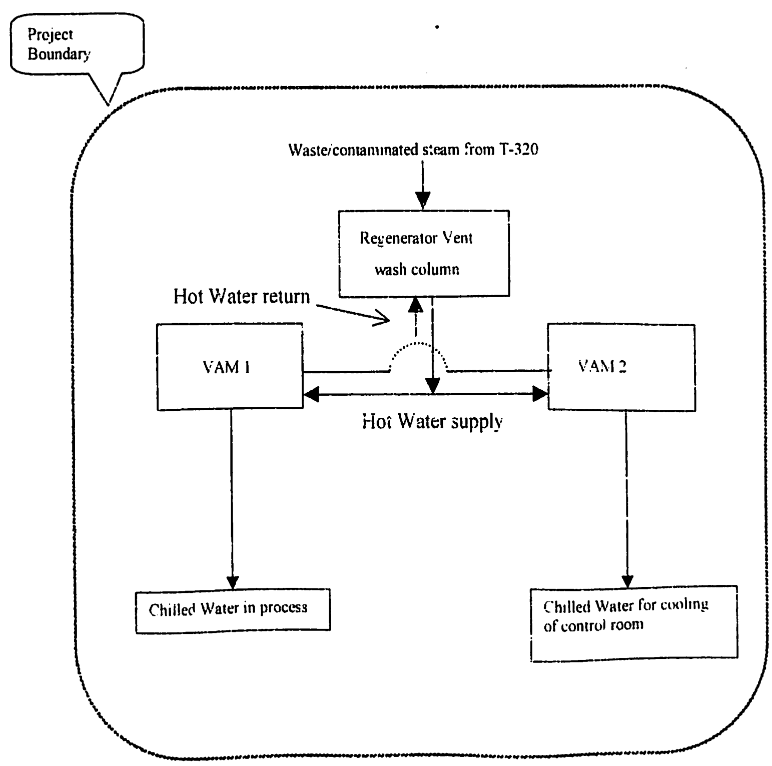
Normal LP steam operated VAM is installed in IGL in 2000-2001at very small level.

The best utilization of steam venting was being identified after long time continuous analysis. During same period refrigeration demand was indicated for the process of MEG plants for new catalyst requirement which it was proposed to install vapor compression chillers. The management however suggested making use of this vented steam, in spite of technical difficulties.

In India, more than 70% of the baseline scenario is identified as installation of Vapor Compression Chillers, which run on electrical power. IGL is also having number of Vapor Compression Chillers for process & other requirement. Equipment installed in project activity has reduced the electrical consumption and additionally it has also discouraged manufacturing of CFC based refrigerant such as Freon R-11, R-12, R-123, R-22 which are CFCs (Chloro Fluoro Carbons) etc. which are used in commonly preferred Vapour compression machine. These CFC are known to cause ozone depletion.

B.3. Description of Project boundry:

As per the selected approved project category AMS II.D, the project boundary has been described as the physical, geographical site of the industrial facility, processes or equipment that are affected by the project activity.



B.4. Description of baseline and its development:

>>

Specification of the baseline for the proposed project activity using a methodology specified in the applicable project category for small-scale CDM project activities contained in appendix B of the simplified M&P for small-scale CDM project activities:

In the absence of the energy study and project initiatives, The process would have continued to vent the waste & contaminated steam and for the additional refrigeration requirement, the company would have installed VCR Unit. Therefore the energy base line will be displaced fossil fuel, which would have been used to generate power needed by the VCR that would have been implemented otherwise.

There are VCR machines already installed in EO Storage. The baseline power consumption i.e. Power requirement for Vapour Compression Refrigeration Units to generate equal amount of refrigeration is estimated based on the design power consumption of these machines. Thus baseline power consumption is design specific power consumption (kWh/TR) of the machine multiplied by refrigeration generation (TR/yr). The fuel equivalent is calculated based on actual fuel consumed in the Captive Power Plant i.e. Tons of RFO per kWh multiplied by power consumption (kWh/year).

The emissions baseline (t CO_2/year) is equal to energy baseline (Tons RFO/year) multiplied by an emission coefficient (t CO_2/Ton RFO) for the fossil fuel displaced. IPCC default value for emission coefficient is used.

Date of completing the final draft of this baseline section:
14/10/2007

Name of person/entity determining the baseline:
Name of entity: **India Glycols Ltd.**
Contact details are given in Annexure 1.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

>>

As explained above, the project initiatives qualify under Type II, D- Energy efficiency and fuel switching measures for industrial facilities of small scale CDM simplified modalities and procedure. The project additionally is analyzed below.

In accordance with paragraph 28 of the simplified modalities and procedures for small scale CDM projects, a simplified baseline and monitoring methodology is listed in Appendix B may be used if the project participant can demonstrate that project activity would otherwise not be implemented due to the existence of one or more barrier (s) listed in the attachment A to Appendix B. Similarly, for the identified CDM project, following barriers have been overcome:

Steps	Additionality Requirements	Status of Additionality Check
Preliminary screening based on the starting date of the project activity	The project proponent is actively participating in efforts towards Green House Gases emission reduction. The company has contributed to sustainable development initiatives of the country through various boards, advisory committees. The backup papers can be furnished to the validator if so desired. The procurement of the equipments for the project activity started since January 2008. The project is being commissioned since September 2009 in phases. CDM fund was considered before starting the planning of project. There are sufficient evidences available in the form of documents that show that the CDM incentive played an important role in the decision making process before the Project was approved by Management for implementation. The evidences are available with the project proponent and may be produced to the validator, if so desired. Thus the CDM revenue played an important role in the decision to implement the project. The Additionality check has crossed.	The additionality check has crossed

Alternatives to the project activity	**Investment barrier**
	• Heat absorber system, piping and recovered heat as hot water supply to VAM, these all are extra in comparison to any vapor compression chiller.
	• Investment cost of hot water supply to VAM and differential cost of Vapor Absorption Machine v/s Vapor absorption chiller is very high and IRR of the project without CDM is 14.55% and with CDM is 16.42%.
	• In the project activity the chilled water can be met by conventional chiller (centrifugal chiller)
	• Payback period without CDM is high.
	• An absorption chiller system (VAM) requires heat, instead of mechanical energy or electrical energy to provide chilled water. Heat is being provided as hot water by installing complete new column for heat recovery known as regenerator vent wash column. Here regenerator vent is absorbed by water in regenerator vent wash column.
	Technological barriers
	An absorption chiller system performs cooling using the same basic vapor compression cycle except that the mechanical compressor of the vapor compression system is replaced with components that provide compression by heating the solution.
	The concerns identified are as follows
	• Usually VAM are being supplied heat by steam but the VAM at MEG Plant, IGL had to be specially designed
	    • To recover heat from vent steam (to atmosphere) a new packed column is installed. In this column heat is recovered by water. This hot water is pumped to two different VAM. Return Hot water is again re-circulated to this packed column.
	    • Based on special alloy for protection against deterioration
		The additionality check has crossed

	and damage as it was using contaminated hot water. The results of the same are not known. • Coefficient of performance (C.O.P) of a VAM is less than VAC. • C.O.P is the efficiency of the refrigeration system. For the said VAM capacity the COP is in the range of 1.2 whereas for the same capacity COP of VAC is 5.6 – 6.14. • Land requirement of VAM system is more than VAC. • Other Concerns related to operation & maintenance. • Another consideration deals with corrosion of the instrument, pipe line, used in • Corrosion can occur inside the chiller due to the nature of the LiBr or on exterior components due to the heat source used to drive the system. • As one might expect the corrosive action of the LiBr solution increases with its temperature. In general, as the number of stages in an absorption system increases the temperature at the first generator also increases. • This implies that special care must be used to combat corrosion in multiple-stage of complete process. • Steam generated from this water contains carbon dioxide, which forms carbonic acid in the condensate. Acid corrosion of valves and fittings in the condensate return lines have been a major maintenance problem. • The operating cost for Vapor Absorption chillier is less than Vapour Compressor, as the maintenance cost is higher that Vapour compressor, Life of VAC is lesser that VC , • Lesser efficiency then VAC and further no vendors take the responsibility of the quality & quantity of steam used hence, risk of all the above cost lies with the project proponent. • The increase in equipment maintenance time may disturb normal production conditions. • Project proponent has to train the employees of MEG, IGL as they are neither experienced nor trained to handle such issues. • Chilling requirement of the plant before implementation of Project was being fulfilled through VCRs. VAM is installed as project activity to cater to the chilling requirement in the plant, which is due to new catalyst requirement for capacity enhancement of the plant. • In case of failure of the machines, there would be upset in supply of chilling requirement and may result into loss of catalyst (Very costly) life as well as production because no dedicated VCR machines is installed to cater to this additional load. This will result into financial loss due to production loss. The financial gain due to energy saving is very less as compared to such losses due to plant disturbance In spite of the above technical difficulties project proponent has implemented this CDM project, which would reduce GHG emission.	

	Barrier due to prevailing practice: In discussions with present Indian vendors viz. Thermax, etc. • who is pioneer in the filled of chillers, and based on information available on the web it can be seen that in India, use of Vapour Absorption Machine/ Refrigeration (VAMS) in industrial market is restricted to a niche sector of the entire market for such application. • Sale of VAMs in Indian market is less than ~20 % of the total Industrial market of refrigeration and VAMs of higher capacity would be still less. • In a market and business analysis report of M/s Voltas, the author mentions that in India Electric chillers are more preferred over Vapour Absorption Chillers (Report available on Internet). • The project proponent regularly initiate energy efficiency programmes at their all manufacturing sites also have taken voluntary initiatives to realize the potential of Clean Development • Mechanisms under the Kyoto Protocol at by organizing workshop / Energy Conservation meet. Such initiative needs considerable investment, highly skilled & trained personnel and dedicated technical personnel to monitor the energy utilized. • Awareness and systematic approach towards energy conservation and reduction of GHG emission is not a common practice in the country. • It is also not a common practice in Indian industries to carry out such major modifications in the process on ground of energy conservation alone.	
Impact of CDM registration	The approval and registration of the project activity as a CDM activity would result inter alias in the following benefits: • Reduction in GHG emissions. • CDM fund will provide additional coverage to the risk due to failure of project, shut down of plant and loss of production. • CDM funds will provide the training support to MEG, IGL employees in understanding operational accuracies and mitigation of risks associated. • The fund will stimulate sustainable development in IGL to find methods of mitigating risks and enhance replication of such projects in Petrochemical industry, to promote GHG abatement. • Publicity of the efforts taken by the project proponent towards energy efficiency and hence sustainable development • The social status of the company would be enhanced	As a result of the above, the project activity is not a baseline scenario, and hence is additional.

B.6.1 Explanation of methodology choices:

The monitoring is the part of baseline methodology. As explained in section B.2, the baseline methodology is perfectly applicable to the project activity and hence the monitoring protocol given in the methodology is applicable to the project activity.

The emissions baseline (t CO_2/year) is equal to energy baseline (Tons RFO/year) multiplied by an emission coefficient (t CO_2/Ton RFO) for the fossil fuel displaced. For calculation purposes IPCC default value for emission coefficient is used.

The baseline power consumption is design specific power consumption (kWh/TR) of the machine multiplied by refrigeration generation (TR/yr). The fuel equivalent is calculated based on actual fuel consumed in the Captive Power Plant i.e. Tons of RFO per kWh multiplied by power consumption (kWh/year).

In the case of a new facility, the methodology requires monitoring of:

(a) Metering the energy use of the equipment installed;
(b) Calculating the energy savings due to the equipment installed.

As the power from captive power plant is located within the complex, technical transmission and distribution losses are not considered.

The parameters required for monitoring as per methodology are included in the monitoring plan. As per the requirement of monitoring methodology, following parameters are monitored:

- The output Ton of refrigeration (TR) of both VAM 1 & 2 ($TR_1 + TR_2$)
- Operating Hours.
- Factor for calculating power requirement per Ton of Refrigeration (X_{TRP}), 0.7 kW / Ton of refrigeration
- EF_{CO2} = CO_2 emission per MWh of power generated, 0.68 MT CO2 / MWh
- Down time of the machines.
- Fuel consumption / MW for power generation
    - Input fuel to DG
    - Energy Meters
- The fuels calorific value of RFO as it is the fuel used at CPP II – IPCC default value*

$$E = [(R_1 + R_2) \times X_{TRP}] \times \text{Operating Hours} \times EF_{CO2} / 1{,}000$$

E	=	CO_2 emission by sources of GHGs
R_1	=	Refrigeration capacity of Machine 1 in 'Tons of Refrigeration'
R_2	=	Refrigeration capacity of Machine 2 in 'Tons of Refrigeration'

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	Q_1 (Quantity of Chilled water outlet from VAM-1)
Data unit:	m^3/Hr
Description:	Chilled water flow rate monitoring through VAM_1. Recording is hourly basis.
Source of data used:	MEG
Value applied:	
Justification of the choice of data or description of measurement methods and procedures actually applied :	Chilled water flow rate monitoring is required for Ton of refrigeration (TR) calculation from VAM_1. The monitoring of Quantity is simple. Measurement by flow transmitter. Recording in paper as well as in electronic media
Any comment:	Measured in plant premises, continuous monitoring & recorded hourly

Data / Parameter:	Q_2 (Quantity of Chilled water outlet from VAM-2)
Data unit:	m^3/Hr
Description:	Chilled water flow rate monitoring through VAM_2 Recording is hourly basis.
Source of data used:	MEG
Value applied:	Refer B.6.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	The measurement of Quantity is required for Ton of refrigeration (TR) calculation from VAM_2. The monitoring of Quantity is simple. Measurement by flow transmitter. Recording in paper as well as in electronic media
Any comment:	Measured in plant premises, continuous monitoring & recorded hourly

Data / Parameter:	T_{1in} (Chilled water inlet Temperature)
Data unit:	Degree C
Description:	Temperature of chilled water inlet to VAM_1 is monitoring on a continuous basis to keep it consistent. Recording is hourly basis.
Source of data used:	MEG
Value applied:	Refer B.6.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	The measurement of Temperature is required for Ton of refrigeration (TR) calculation from VAM_1. Recording in paper
Any comment:	Measured in plant premises, continuous monitoring & recorded hourly

Data / Parameter:	T_{1out} (Chilled water outlet Temperature)
Data unit:	Degree C
Description:	Chilled water outlet temperature from VAM_2 is monitoring on a continuous basis to keep it consistent. Recording is hourly basis.
Source of data used:	MEG
Value applied:	Refer B.6.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	The measurement of Temperature is required for Ton of refrigeration (TR) calculation. Recording in paper

Any comment:	Measured in plant premises, continuous monitoring & recorded hourly

Data / Parameter:	**T_{2in} (Chilled water inlet Temperature)**
Data unit:	Degree C
Description:	Temperature of chilled water inlet to VAM_2 is monitoring continuous basis to keep it consistent. Recording is hourly basis.
Source of data used:	MEG
Value applied:	Refer B.6.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	The measurement of Temperature is required for Ton of refrigeration (TR) calculation from VAM_2. Recording in paper
Any comment:	Measured in plant premises, continuous monitoring & recorded hourly

Data / Parameter:	**T_{2out} (Chilled water outlet Temperature)**
Data unit:	Degree C
Description:	Chilled water outlet temperature from VAM_2 is monitoring on continuous basis to keep it consistent. Recording is hourly basis.
Source of data used:	MEG
Value applied:	Refer B.6.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	The measurement of Temperature is required for Ton of refrigeration (TR) calculation. Recording in paper
Any comment:	Measured in plant premises, continuous monitoring & recorded hourly

Data / Parameter:	**R_1 (Tons of Refrigeration)**
Data unit:	TR
Description:	Tons of Refrigeration Calculation & Recording is on daily basis in logbook.
Source of data used:	MEG/CDM
Value applied:	685
Justification of the choice of data or description of measurement methods and procedures actually applied :	Tons of Refrigeration Calculation is- The cooling effect produced is quantified as tons of refrigeration (TR). 1 TR of refrigeration = 3024 kCal/hr heat rejected. The refrigeration TR is assessed as $TR = Q \times P_{CW} \times C_p \times (T_i - T_o) / 3024$
Any comment:	Measured in plant premises, continuous monitoring & recorded hourly

Data / Parameter:	**R_2 (Tons of Refrigeration)**
Data unit:	TR
Description:	Tons of Refrigeration Calculation & Recording is on daily basis in logbook.
Source of data used:	MEG/CDM
Value applied:	465

Justification of the choice of data or description of measurement methods and procedures actually applied:	Tons of Refrigeration Calculation is - The cooling effect produced is quantified as tons of refrigeration (TR). 1 TR of refrigeration = 3024 kCal/hr heat rejected. The refrigeration TR is assessed as $TR = Q \times P_{CW} \times C_p \times (T_i - T_o) / 3024$
Any comment:	Measured in plant premises, continuous monitoring & recorded hourly

Data / Parameter:	O_1 **(Operating Hours)**
Data unit:	Hr
Description:	Operating Hours of VAM_1 is measured.
Source of data used:	MEG in Electronic media
Value applied:	Refer Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	This is operating hours of VAM_1 in hours.
Any comment:	Continuous monitoring through DCS values

Data / Parameter:	O_2 **(Operating Hours)**
Data unit:	Hr
Description:	Operating Hours of VAM_2 is measured.
Source of data used:	MEG in Electronic media
Value applied:	Refer Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	This is operating hours of VAM_2 in hours.
Any comment:	Continuous monitoring through DCS values

Data / Parameter:	**NCV (Net Calorific value of RFO)**
Data unit:	TJ per 10^3 tonn
Description:	Estimated value for baseline emission factor calculation
Source of data used:	IPCC default ID 110712 (*source:* Emission Factor Database)
Value applied:	40.19
Justification of the choice of data or description of measurement methods and procedures actually applied :	It is used for baseline emission factor calculation
Any comment:	IPCC default = 40.19 TJ/1000T

Data / Parameter:	**EF (Carbon emission factor of RFO)**
Data unit:	tC/TJ
Description:	Estimated value for baseline emission factor calculation
Source of data used:	IPCC default ID 110660 (*source:* Emission Factor Database)
Value applied:	21.1

Justification of the choice of data or description of measurement methods and procedures actually applied :	It is used for baseline emission factor calculation
Any comment:	IPCC default RFO: 21.1 tC/ TJ Lower heating value basis. Multiply the factor by (44/12) Convert to t CO_2/TJ = 77.37.

Data / Parameter:	P_{CW} **(Density of chilled water)**
Data unit:	kg/m^3
Description:	Estimated value
Source of data used:	-
Value applied:	1000
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	-

B.6.3 Ex-ante calculation of emission reductions:

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Actual refrigeration generated would be monitored. Actual operating hours would be monitored for each machine.

Total refrigeration (R) = (R1 + R2) TR/yr

The specific power consumption of power driven vapor compressor chillers is 0.7 kWh/TR.

Power that would have required by vapor compressor chiller Pb = 0.7 x R kWh/yr

Project proponent had earlier installed Vapour compression machines at EO storage.

VCM are consuming power more than 0.7 kWh/TR ie. Approx.1.0 kWh/TR(Bureau of Energy Efficiency). Project proponents have considered 0.7 kWh/ TR in order to keep the **estimation conservative.**

EOEG plant is catered by captive power plant and power supply from state grid is incidental during the emergency.

The thermal energy used in TG is steam having emission factor more than DG and Grid.

The incremental fuel used at DG is RFO, therefore actual specific consumption of RFO is considered.

While calculating the GHG emission reductions, India Glycols Ltd Manufacturing Complex falls in Northern Region Power Grid. The emission factor for power generation at Northern Grid is 0.71 tonne of CO_2/ MWh (vide cea.nic.in).The emission factor for power generation with RFO is 0.69 tonne of CO_2/ MWh considering actual specific consumption.

Calculation for emission factor for power generation with RFO is as follows:
Emission Factor (tonne of CO_2/ MWh) = Actual Specific Consumption tonnes / MWh X LHV of RFO (vide IPCC default Table 1-3 on page 1.23 of reference Manual) X CO_2 emission factor i.e 77.37 t CO_2/TJ.
CO_2 emission factor = 21.1 (IPCC Default ID 110660) X 0.99 (IPCC Default ID 110715) X 44/12 = 0.22 X .04019 X 76.59 = 0.68 tonne of CO_2/ MWh

As the Emission Factor considered in PDD is less that Emission Factor of state grid, the calculation is a conservative approach.
Specific consumption of RFO for power generation (S_N) = 0.22 T/MW
Calculation for specific RFO consumption by DG at ISO condition:

Calorific value of RFO (IPCC default) **= 45.01 TJ/1000T**
CO_2 emission factor for RFO (IPCC default) **= 72.6 t CO_2 / TJ**
Baseline emission (BE) **= (P_B/1000) x S_N x 45.01 x 77.37 t CO_2 / yr**

**Reference: Table 1 (Net calorific values and emission factors for oils as found in the 1996 IPCC guidelines) of Chapter 2 (CO2 emissions from stationary combustion of fossil fuels) of "Good Practice Guidance and Uncertainty Management in National Green House Gas Inventories".*

Sample calculation for emission due to project

Total power consumption by VAM -1 (Pm1) = 20.5* 8000 + 14.5 * 8000
= 279936
= 279936 Kwh / yr

Total power consumption by VAM-2 (Pm2) = 14.8* 8000 + 14.5* 8000
= 118592 + 116000
= 234592 Kwh /yr

Power consumption of the complete project (Pp) = 279936 + 234592
= 514528 Kwh/yr
= 514.528 MWh/yr

RFO consumption for power generation = 362.61 MT
Power generated at CPP2 (EG_{GEN}) = 1637.60 MWH

Sp RFO consumption for power generation (S_N) = 0.22 MT/MWH

Total refrigeration capacity utilization (R) = (685+465) = 1150 TR/hr
i.e. = 21216000 TR/yr

Total refrigeration capacity utilization (R)	TR	1150
I. E. =	TR/annum	9200000
Sp power consumption of VCR	kWh/TR	0.7
Power required by VCR for equivalent refrigeration	KWhr	6440000
	MWhr	6440
Baseline emission 6440*0.22*(40.19/1000)*77.37	MT CO2/ Annum	4405.54
Project emission 514.5*0.22*(40.19/1000)*77.37	MT CO2/ Annum	351.96
Emission reduction = 4405.54 - 351.96	MT CO2/ Annum	4053.58

B.6.4 Summary of the ex-ante estimation of emission reductions:

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Description of formulae:

Calculation of Tonnes of Refrigerant:

- The cooling effect produced is quantified as tons of refrigeration.(TR).

1 TR of refrigeration = 3024 kCal/hr heat rejected.

- The refrigeration TR is assessed as TR = Q x·Density x C_p x· ($T_i - T_o$) / 3024

Where Q is flow rate of chilled water in m^3/hr

P_{CW} is density of chilled water in kg/ m^3

C_p is chilled water specific heat in kCal /kg deg C

T_i is inlet, temperature of chilled water to evaporator (chiller) in ^{0}C

T_o is outlet temperature of chilled water from evaporator (chiller) in ^{0}C.

The above TR is also called as chiller tonnage.

The specific power consumption kW/TR is a useful indicator of the performance of refrigeration system. By measuring refrigeration duty performed in TR and the kiloWatt inputs, kW/TR is used as a reference energy performance indicator.

Calculation of Tonnes of Refrigerant:

$TR_1 = Q_1 P_{CW} Cp (T_{1\,in} - T_{1\,out})/3024$

$TR_2 = Q_2 P_{CW} Cp (T_{2\,in} - T_{2\,out})/3024$

In a centralized chilled water system, apart from the compressor unit, power is also consumed by the chilled water (secondary) chilled water pump as well condenser water (for heat rejection to cooling tower) pump and cooling tower fan in the cooling tower.

Effectively, the overall energy consumption would be towards:

- Chilled water pump kW
- Condenser water pump kW
- Hot water pump KW
- Rated power of machine KW

The specific power consumption for certain TR output would therefore have to include:

- Chilled water pump kW
- Condenser water pump kW
- Hot water pump KW
- Rated power of machine KW
- The overall kW/TR is the sum of the above.

Formulae Used

CO2 emission reduced or CER = [(TR_1 + TR_2) x X_{TRP}] x Operating Hours x EF_{CO2} /1,000

EF_{CO2}	=	S_N x (NCV /1000) x CO_2 emission factor of RFO
CER	=	CO2 emission reduced or CER
TR_1	=	Refrigeration capacity of Machine 1 in 'Tons of Refrigeration'
TR_2	=	Refrigeration capacity of Machine 2 in 'Tons of Refrigeration'
X_{TRP}	=	Factor for calculating power requirement per Ton of Refrigeration, 0.7 kW / Ton of refrigeration
EF_{CO2}	=	CO2 emission per MWh of power generated,

B.7 Application of a monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:	
(Copy this table for each data and parameter)	
Data / Parameter:	**Q_1 (Chilled water Quantity)**
Data unit:	m^3/Hr
Description:	Chilled water flow rate monitoring through VAM_1. Recording is hourly basis.
Source of data to be used:	MEG
Value of data	Refer B.6.4
Description of measurement methods and procedures to be applied:	Chilled water flow rate monitoring is required for Ton of refrigeration (TR) calculation from VAM_1. The monitoring of Quantity is simple. Measurement by flow transmitter. Recording in paper as well as in electronic media
QA/QC procedures to be applied:	Monitoring systems would follow relevant procedures under the ISO 9001:2000 certified Quality Management System of the Unit.

Any comment:	-

Data / Parameter:	**Q_2 (Chilled water Quantity)**
Data unit:	m^3/Hr
Description:	Chilled water flow rate monitoring through VAM_2 Recording is hourly basis.
Source of data to be used:	MEG
Value of data	Refer B.6.4
Description of measurement methods and procedures to be applied:	The measurement of Quantity is required for Ton of refrigeration (TR) calculation from VAM_2. The monitoring of Quantity is simple . Measurement by flow transmitter. Recording in paper as well as in electronic media
QA/QC procedures to be applied:	Monitoring systems would follow relevant procedures under the ISO 9001:2000 certified Quality Management System of the Unit.
Any comment:	

Data / Parameter:	**T_{1in} (Chilled water inlet Temperature)**
Data unit:	Degree C
Description:	Temperature of chilled water inlet to VAM_1 is monitoring continuous basis to keep it consistent. Recording is hourly basis.
Source of data to be used:	MEG
Value of data	Refer B.6.4
Description of measurement methods and procedures to be applied:	The measurement of Temperature is required for Ton of refrigeration (TR) calculation from VAM_1. Recording in paper
QA/QC procedures to be applied:	Monitoring systems would follow relevant procedures under the ISO 9001:2000 certified Quality Management System of the Unit.
Any comment:	

Data / Parameter:	**T_{1out} (Chilled water outlet Temperature)**
Data unit:	Degree C
Description:	Chilled water outlet temperature from VAM_2 is monitoring on continuous basis to keep it consistent. Recording is hourly basis.
Source of data to be used:	MEG
Value of data	Refer B.6.4
Description of measurement methods and procedures to be applied:	The measurement of Temperature is required for Ton of refrigeration (TR) calculation. Recording in paper
QA/QC procedures to be applied:	Monitoring systems would follow relevant procedures under the ISO 9001:2000 certified Quality Management System of the Unit.
Any comment:	

Data / Parameter:	**T_{2in} (Chilled water inlet Temperature)**
Data unit:	Degree C
Description:	Temperature of chilled water inlet to VAM_1 is monitoring continuous basis to keep it consistent. Recording is hourly basis.
Source of data to be used:	MEG

Value of data	Refer B.6.4
Description of measurement methods and procedures to be applied:	The measurement of Temperature is required for Ton of refrigeration (TR) calculation from VAM_1. Recording in paper
QA/QC procedures to be applied:	Monitoring systems would follow relevant procedures under the ISO 9001:2000 certified Quality Management System of the Unit.
Any comment:	

Data / Parameter:	**T_{2out} (Chilled water outlet Temperature)**
Data unit:	Degree C
Description:	Chilled water outlet temperature from VAM_2 is monitoring on continuous basis to keep it consistent. Recording is hourly basis.
Source of data to be used:	MEG
Value of data	Refer B.6.4
Description of measurement methods and procedures to be applied:	The measurement of Temperature is required for Ton of refrigeration (TR) calculation. Recording in paper
QA/QC procedures to be applied:	Monitoring systems would follow relevant procedures under the ISO 9001:2000 certified Quality Management System of the Unit.
Any comment:	

Data / Parameter:	**R_1 (Tons of Refrigeration)**
Data unit:	TR
Description:	Tons of Refrigeration Calculation & Recording is on daily basis in logbook.
Source of data to be used:	MEG/CDM
Value of data	685
Description of measurement methods and procedures to be applied:	Tons of Refrigeration Calculation is- The cooling effect produced is quantified as tons of refrigeration (TR). 1 TR of refrigeration = 3024 kCal/hr heat rejected. The refrigeration TR is assessed as TR = Q x·P_{CW} x C_p x· (T_i – T_o) / 3024
QA/QC procedures to be applied:	Monitoring systems would follow relevant procedures under the ISO 9001:2000 certified Quality Management System of the Unit.
Any comment:	

Data / Parameter:	**R_2 (Tons of Refrigeration)**
Data unit:	TR
Description:	Tons of Refrigeration Calculation & Recording is on daily basis in logbook.
Source of data to be used:	MEG/CDM
Value of data	465
Description of measurement methods and procedures to be applied:	Tons of Refrigeration Calculation is- The cooling effect produced is quantified as tons of refrigeration (TR). 1 TR of refrigeration = 3024 kCal/hr heat rejected. The refrigeration TR is assessed as TR = Q x·P_{CW} x C_p x· (T_i – T_o)

	/ 3024
QA/QC procedures to be applied:	Monitoring systems would follow relevant procedures under the ISO 9001:2000 certified Quality Management System of the Unit.
Any comment:	

Data / Parameter:	**O_1 (Operating Hours)**
Data unit:	Hr
Description:	Operating Hours of VAM_1 is measured.
Source of data to be used:	MEG in Electronic media
Value of data	Refer Annex 3
Description of measurement methods and procedures to be applied:	This is operating hours of VAM_1 in hours.
QA/QC procedures to be applied:	Monitoring systems would follow relevant procedures under the ISO 9001:2000 certified Quality Management System of the Unit.
Any comment:	

Data / Parameter:	**O_2 (Operating Hours)**
Data unit:	Hr
Description:	Operating Hours of VAM_2 is measured.
Source of data to be used:	MEG in Electronic media
Value of data	Refer Annex 3
Description of measurement methods and procedures to be applied:	This is operating hours of VAM_1 in hours.
QA/QC procedures to be applied:	Monitoring systems would follow relevant procedures under the ISO 9001:2000 certified Quality Management System of the Unit.
Any comment;	

Data / Parameter:	**NCV (Net Calorific value of RFO)**
Data unit:	TJ per 10^3 tonn
Description:	Estimated value for baseline emission factor calculation
Source of data to be used:	IPCC default ID 110712 (*source:* Emission Factor Database)
Value of data	40.19
Description of measurement methods and procedures to be applied:	It is used for baseline emission factor calculation
QA/QC procedures to be applied:	-
Any comment:	IPCC default = 40.19 TJ/1000T

Data / Parameter:	**EF (Carbon emission factor of RFO)**
Data unit:	tC/TJ

Description:	Estimated value for baseline emission factor calculation
Source of data to be used:	IPCC default ID 110660 (*source:* Emission Factor Database)
Value of data	21.1
Description of measurement methods and procedures to be applied:	It is used for baseline emission factor calculation
QA/QC procedures to be applied:	-
Any comment:	IPCC default RFO: 21.1 tC/ TJ Lower heating value basis. Multiply the factor by (44/12) Convert to t CO_2/TJ = 77.37.

Data / Parameter:	P_{CW} **(Density of chilled water)**
Data unit:	kg/m^3
Description:	Estimated value
Source of data to be used:	-
Value of data	1000
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	

B.7.2 Description of the monitoring plan:

>>

The Project has adopted Operational Control Procedure. The primary object of the procedure is to "establish system for monitoring, measuring, and recording, reporting, and reviewing the performance of project. The procedure clearly delineates roles and responsibility for all activities required to undertake under the project and report on it performance on the periodic basis to the management of India Glycols Ltd.

The process conform to the Management System as per ISO 9001:2000, ISO 14001:2004 & OHSAS 18001:1999 requirements.

Project proponent have established a project specific GHG Emission Reduction Management System IGL/CDM/0607/002 which mentions QC & QA details, this is hooked up to Plant ISO system. This has made the CDM project system driven and not person specific this document gives detailed responsibility matrix, emergency preparedness, calibration / measuring/ monitoring and reporting parameters, control of records, internal audits, performance review, and corrective action for sustaining the CDM project.

The Site Head & HOD of MEG is responsible for monitoring and recording all parameters mentioned under the monitoring plan. The data are archived electronically and reviewed by manager on weekly and monthly basis. The monthly compiled data is also reviewed by the in-plant management.

B.8 Date of completion of the application of the baseline and monitoring methodology and the name of the responsible person(s)/entity(ies)

>>

India Glycols Ltd.

SECTION. C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>> The installation and measures were started from year January 2008 & continued till date and expected to get completed (VAM 1 & VAM 2) by 1st October 2009.

C.1.2. Expected operational lifetime of the project activity:

>> 15 year

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

>> N/A

C.2.1.2. Length of the first crediting period:

>> N/A

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>> 01/03/2010

C.2.2.2. Length:

>> 10 Years

SECTION D. Environmental impacts

>>

There is no requirement of conducting environmental impact assessment study by any governmental authority for this type of small-scale project. The potential sustainable development contribution of the project to be brought about by the project has been delineated below.

These projects have resulted from IGL's visualization of the waste steam utilization. The Energy conservation measures are initiated across Kashipur Unit with the twin objectives of becoming energy efficient and reducing the ill effects of global warming. The resultant energy conservation programme thus led to the reduction of GHG emissions from the fossil fuel energy generation indirectly attributable to the operations. Following are the environmental benefits derived from the project's energy efficiency measures:

- Reduction in GHG emission from combustion of fossil fuel;
- Conservation of fossil fuel (natural resource of commercial energy); Sustainable Development in keeping with IGL's role as a responsible corporate;
- Indirect reduction of environmental deterioration due to extraction (dust and acid mine drainage), processing (dust and wastewater) and procurement of fossil fuel (poor ambient air quality);

D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

>>

There is no requirement of conducting environmental impact assessment study by any governmental authority for this type of small-scale project. The potential sustainable development contribution of the project to be brought about by the project has been delineated below.

These projects have resulted from IGL's visualization of the adverse impacts of inefficient energy use in their facility. The Energy conservation measures are initiated across Kashipur Unit with the twin objectives of becoming energy efficient and reducing the ill effects of global warming. The resultant energy conservation programme thus led to the reduction of GHG emissions from the fossil fuel energy generation indirectly attributable to the operations.

Following are the environmental benefits derived from the project's energy efficiency measures:

- Reduction in GHG emission from combustion of fossil fuel;
- Conservation of fossil fuel (natural resource of commercial energy); Sustainable Development in keeping with IGL's role as a responsible corporate;
- Indirect reduction of environmental deterioration due to extraction (dust and acid mine drainage), processing (dust and wastewater) and procurement of fossil fuel (poor ambient air quality);

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

>> NA

SECTION E. Stakeholders' comments

>> NA

E.1. Brief description how comments by local stakeholders have been invited and compiled:

>> The following categories of Stakeholders have been identified by India Glycols Limited:

- India Glycols Ltd. employees
- Contractors
- Labours
- Supplier
- Representatives from State Pollution Control Board
- Villagers from nearby villages

The village Panchayat /local villagers are true representative of the local population. They have been informed through *munadi* (announcement by a hired person in the village/localities) about the project and requested to attend the meeting to give their comments. IGL has already completed the necessary stake holder consultation in January 2008 and documented their approval for the project.

It has been informed to all concerned stakeholders by issuing invitation card from India Glycols Ltd. prior to the stakeholder consultation meeting. The meeting was held at IGL complex. The stakeholders have been informed about the proposal of India Glycols Ltd. to embark upon Clean Development Mechanism through a presentation and have been asked for their feedback on such initiatives.

E.2. Summary of the comments received:

>>

The matter was discussed at length in the floor by various members present in the meeting as well as. Specific concerns and questions are delineated as below.

1. Local villagers appreciated the movement taken by IGL in order to reduce CO_2 emission and asked IGL to help them through local campaign in order to make more local villagers aware about the abatement measures.
2. Stakeholders questioned about how the energy efficiency measures contributes to Clean Development Mechanism.
3. Stakeholders have also expressed their queries about the CDM modalities.

E.3. Report on how due account was taken of any comments received:

>>

All specific queries have been answered in detail. The CDM modalities have also been explained accordingly. Please note that there are no negative comments received that require the project proponent to take any corrective action.

Year	Estimation of project activity emission (tCO_2e)	Estimation of baseline emission (tCO_2e)	Estimation of Leakage (tCO_2e)	Estimation of overall Emission reduction (tCO_2e)
2010	351.96	4405.54	**0**	4053(approx)
2011	351.96	4405.54	**0**	4053(approx)
2012	351.96	4405.54	**0**	4053(approx)
2013	351.96	4405.54	**0**	4053(approx)
2014	351.96	4405.54	**0**	4053(approx)
2015	351.96	4405.54	**0**	4053(approx)
2016	351.96	4405.54	**0**	4053(approx)
2017	351.96	4405.54	**0**	4053(approx)
2018	351.96	4405.54	**0**	4053(approx)
2019	351.96	4405.54	**0**	4053(approx)
Total (tons of CO_2 e)	**3519.6**	**44055.4**	**0**	**40530**

CHAPTER 5

RESULTS AND DISCUSSIONS

5. RESULTS AND DISCUSSIONS

5.1 RESULTS

The project activity is an Energy efficiency measure which will help in reducing the emission of green house gases by reducing the consumption of Residual Fuel Oil in the Captive Power Pant inside the IGL complex, the total amount of CER generated as a result of this particular activity is around 4053 which means a reduction of about 4053 MTons of CO_2 e per annum, as the project activity is having a crediting period of 10 years, so the total amount of emission reduction is about 40530 MTons of CO_2 e .Besides this the project activity also helps in contributing towards the following.

TABLE 5.1Annual Estimation of Emissions Reductions

Years	Annual estimation of emission reduction tonnes CO2 e
Jan 2010 - Dec 2010	4053
Jan 2011 - Dec 2011	4053
Jan 2012 - Dec 2012	4053
Jan 2013 - Dec 2013	4053
Jan 2014 - Dec 2014	4053
Jan 2015 - Dec 2015	4053
Jan 2016 - Dec 2016	4053
Jan 2017 - Dec 2017	4053
Jan 2018 - Dec 2018	4053
Jan 2019 - Dec 2019	4053
TOTAL	4053 * 10 = 40530

Sustainable development

The project contributes to sustainable development in the following manner in terms of environmental, socio-economic, technological development:

- Reduction in GHG emission mainly (CO2) and other pollution occurring due to fossil fuel extraction, processing and transportation.
- Encouraging other large facilities irrespective of sector to adopt small but effective energy efficient measures to save energy and protect the environment.
- Stoppage of steam venting also benefits the environment in terms of heat.

Community Development

The project proponent is committed to improving social well being by providing following facilities to all nearby villages:

- Provided infrastructure and supply of potable drinking water to villages near Kashipur
- Expenses on housing, living, education, transportation by additional persons directly employed and their dependents.
- Support for Environment preservation / upgradation, Construction of Primary Health Centers, providing ambulances and training to people in primary health care.
- Camps organized for social welfare and family welfare.
- Fire / disaster relief measures

Environmental impact:

As the project activity has reduced consumption of fossil fuel for power generation based on RFO, the emissions in the form of NOx, SO_2 and CO_2 are reduced. Reduction in the GHG emissions mainly (CO2) and other pollution occurring due to fossil fuel extraction, processing, transportation and combustion. Stoppage of steam venting also benefits the environment in terms of heat conservation. This contributes to the sustainable development of environment.

Social impact:

The project activity generated employment during the erection and commissioning of the project. Also the interaction with technical experts enhanced the skill sets of manpower.

Economical impact:

The project activity reduces fuel consumption in the boilers, thus reducing the variable cost of production. Though the quanta of savings are negligible as compared to total turnover of the company, directionally the project contributes to economical development.

Technological impact:

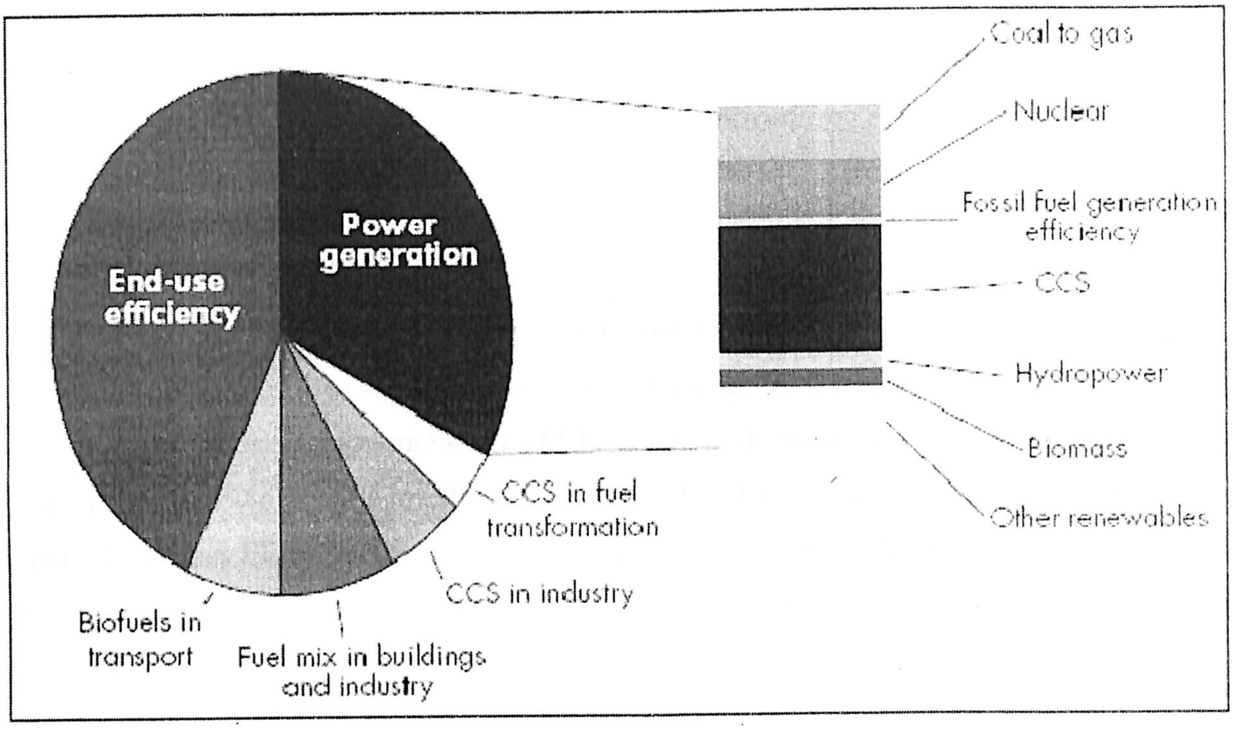
Encouraging other large facilities irrespective of sector to adopt small but effective energy efficient measures to save energy and protect the environment.

5.2. PRESENT AND FUTURE PROSPECTS OF EE IMROVEMENT PROJECTS

Improving energy efficiency (EE) is one of the most promising approaches for achieving cost-effective global greenhouse gases (GHG) reductions. However, it is severely underrepresented in the Clean Development Mechanism (CDM) portfolio. Just 10 percent of the emission reduction credits traded in the carbon market are from EE projects. In particular, small, dispersed, end-use EE measures—which entail significant GHG mitigation potential, along with other clear, local, and direct sustainable development benefits—have been largely bypassed by the carbon market.

Energy efficiency (EE) is widely recognized as one of the lowest-cost "sources" of energy. It is often more cost-effective to invest in energy-efficiency improvements, particularly on the end-use or demand side, than to increase energy supply to meet the growing demand for energy services. In addition to making energy more affordable, energy efficiency contributes to energy security, economic growth, and environmental sustainability through local emissions reductions and mitigation of global greenhouse gases (GHGs).

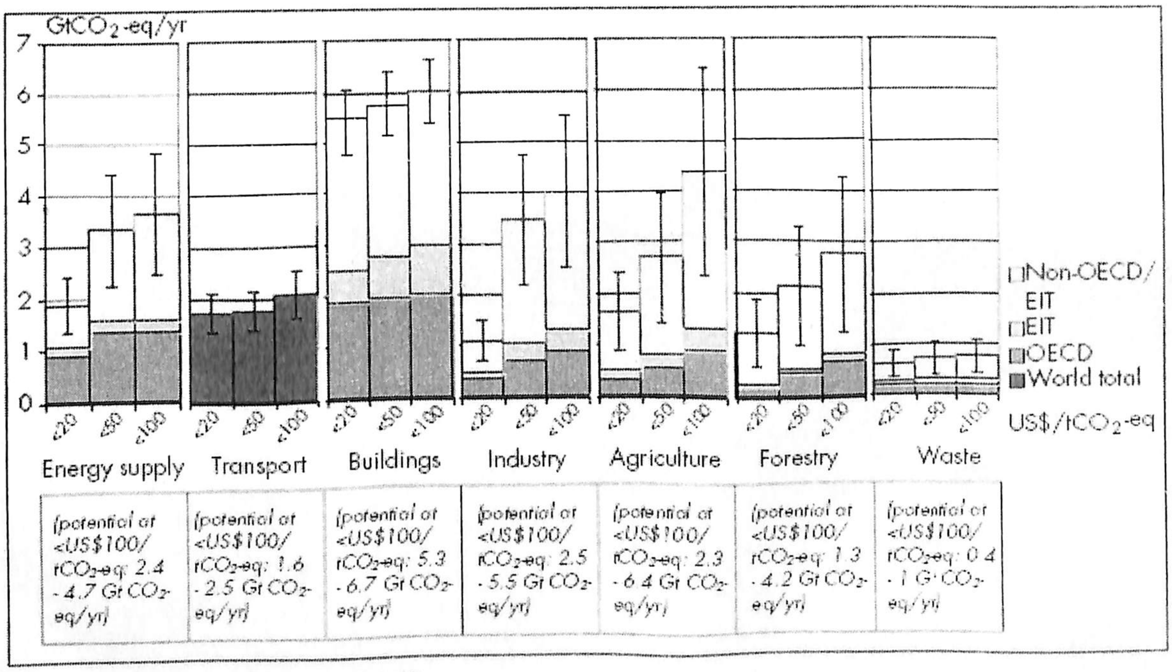
The projected potential of EE measures for mitigation of GHG over the next several decades is the highest among the other available options, as estimated by the climate change scientific community and energy sector practitioners. Energy efficiency could potentially account for more than half of the energy-related emission abatement potential achievable within the next 20–40 years, as identified by the International Energy Agency (IEA) World Energy Outlook (2006), the Fourth Assessment of the Intergovernmental Panel on Climate Change (2007), and the McKinsey Cost Curve (2007).



Source: IEA Energy Technology Perspectives 2006.

Fig.5.1- Potential GHG Emission Reduction by Technology Areas - Scenario through 2050

Improved end-use (demand side) EE is the most important contributor to potential reduced emissions



Source: IPCC 4th Assessment Report, WG III, 2007.

Figure 5.2: GHG Mitigation Measures – 2030

Some of the highest GHG reduction potential is in EE sectors and are in the form of dispersed smaller measures (transport, buildings, industry)

The Clean Development Mechanism (CDM) under the Kyoto Protocol seeks to promote sustainable development in developing countries, to contribute to the stabilization of GHG concentrations in the atmosphere, and to assist industrialized countries (Annex I Parties under the UNFCCC) meet their quantified emission commitments. However, the CDM has bypassed the opportunity to support the delivery of energy savings across the economies of developing countries. The volume share of EE, in terms of emission reduction credits traded in the carbon market, currently stands at less than 10 percent. In particular, small, dispersed, end-use EE measures—which entail significant GHG mitigation potential, along with other clear, sustainable development benefits—have been largely bypassed by the carbon market.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6. Conclusion and Recommendations

The present energy efficiency project at IGL kashipur helps in supplying chilled water for the process requirement of the MEG plant as well for the requirement of chilled water for air- conditioning, the total capacity of the two Vapor Absorption Machines comes out to be 1150 TR/hr. The chilled water from VAM-1 is used in process to maintain the temperature the catalyst used in the process, thereby helps to improve new catalyst life and to increase the yield of the reaction also, besides this it also helps in generating considerable amount of CERs to the tune of about 4053 CERs/ year. It also helps in providing the employment directly or indirectly to the laborers. This project helps in upgrading the knowledge and skills of the employees and also creates an awareness of the various energy efficiency measures in industrial processes.

The project proponent has to follow certain recommendations such as

- ✓ Monitoring system should be done and recorded as per the instructions given in the monitoring plan.
- ✓ More in-house activities are to be carried to identify processes as well as activities where energy efficiency measures can be implemented.
- ✓ Trainings as well as workshops should be organized for the employees in order to make them aware of the ill effects of global warming and also about various green house gases mitigation measures.

- IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.
- Clean Development Mechanism (CDM) and carbon trading in India. By Kumar Singh Jitendra.
- http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html.
- Environmental Impact Assessment Report, Document: CIPL/ EIA/ Rep – 01 Chapter: X SUMMARY & CONCLUSION.
- CDM Project Development Manual, Macedonia, December 2008
- Revised 1996 IPCC Guidelines for national green house gas inventories: Reference Manual.
- Scaling up demand side energy efficiency improvements through programmatic CDM, ESMAP Technical Paper 120/07, December 2007
- www.thermaxindia.com
- Emission Factor Database
- http://cdmindia.nic.in
- http://unfccc.com

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	M/S INDIA GLYCOLS LTD.
Street/P.O.Box:	A-1 Industrial Area
Building:	M/S INDIA GLYCOLS LTD.
City:	Kashipur
State/Region:	Uttaranchal
Postfix/ZIP:	244713
Country:	India
Telephone:	+91-5947-275320
FAX:	+91-5947-275315
E-Mail:	cdmcell@indiaglycols.net
URL:	-
Represented by:	cdmcell@indiaglycols.com
Title:	**Demand side energy conservation & reduction measures at** M/s India Glycols Ltd (IGL) Kashipur, Uttaranchal., India
Salutation:	
Last Name:	
Middle Name:	
First Name:	
Department:	
Mobile:	
Direct FAX:	+91-5947-275315
Direct tel:	+91-5947-275320 (111)
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Annex 3

BASELINE EMISSION CALCULATION SHEET

	VAM (Vapor Absorption Machine)		
Location	Unit	Capacity	
MEG 1	TR	685	Refrigerant: Water
MEG 2	TR	465	Absorbent :LiBr
(Total)	TR	**1150**	
OPERATING HOURS	hrs	8000.0	
Power saving for 685 TR VAM	**Unit**	**VAM**	
ENERGY CONSUMP.			
a) HOT WATER PUMPING	kW	20.5	
b) MACHINE	kW	14.5	
Power 465 TR VAM	**Unit**	**VAM**	
ENERGY CONSUMP.			
a) HOT WATER PUMPING	kW	14.8	
b) MACHINE	kW	14.5	
PROJECT POWER CONSUMPTION			
a) HOT WATER PUMPING	KW/Annum	163936	VAM 1
b) MACHINE	KW/Annum	116000	VAM 1
Sum	KW/Annum	279936	
a) HOT WATER PUMPING	KW/Annum	118592	VAM 2
b) MACHINE	KW/Annum	116000	VAM 2
Sum	KW/Annum	234592	
Total power consumed by machine 1& 2	**MWhr**	**515**	**VAM 1 & VAM 2**
BASE LINE POWER CONSUMPTION			
Total refrigeration capacity utilization (R) =	TR	1150	
	TR/annum	9200000	
Sp power consumption of VCR (X_{TRP})	kWh/TR	0.7	
Power required by VCR for equv refrigeration	KWhr	6440000	
Total power required by VCR of 1150 TR	**MWhr**	**6440**	
Northern Grid CO_2 emission factor is 0.71 MT / MWhr (www.cea.nic.in)			
Most conservative side CO_2 emission factor 0.68 MT / MWhr is taken for calculation			
Emission Factor Calculation sheet			
Carbon Emission of RFO	IPCC default ID 110712(source:Emission Factor Database)	0.99	
Calorific value of RFO	IPCC default	40.19	$Tj/10^3$Tonnes
Carbon Emission of RFO	IPCC default ID 110660(source:Emission Factor Database)	21.1	tC/TJ
CO_2 Emission of RFO	21.1x(44/12)	77.37	tCO_2/TJ
Specific RFO consumption in DG	(ISO)	0.22	MT/MWh
Emission factor (EF_{CO2})		**0.68**	**tCO_2/MWh**
Baseline emission		4405.54	MT CO2/ Annum
Project emission		351.96	MT CO2/ Annum
Emission reduction		**4053.58**	**MT CO2/ Annum**

Annex 4

MONITORING INFORMATION

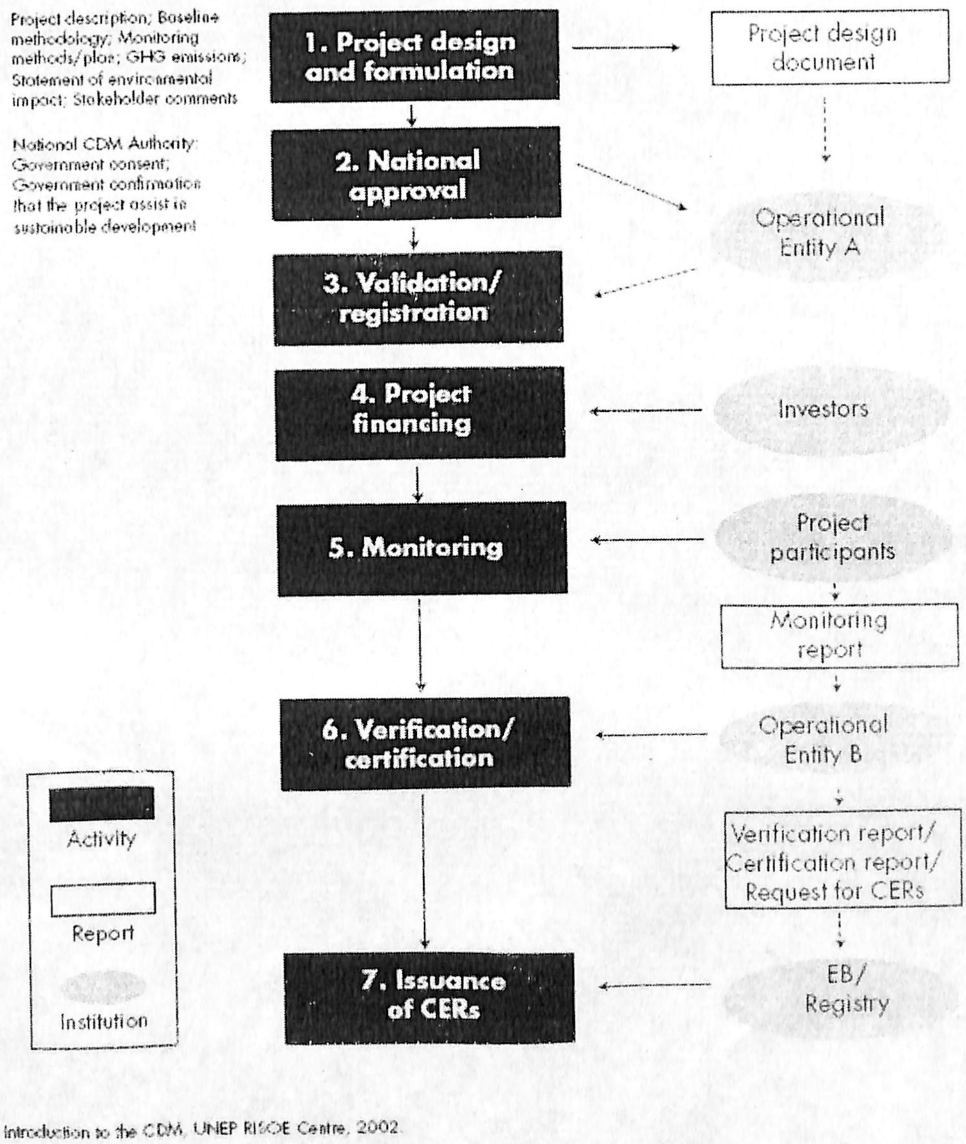
Annex 5

TABLE 1-3 NET CALORIFIC VALUES FOR OTHER FUELS ($TJ/10^3$ tonnes)	
Refined Petroleum Products	
Gasoline (aviation and auto)	44.80
Jet Kerosene	44.59
Other Kerosene	44.75
Shale Oil	36.00
Gas/Diesel Oil	43.33
Residual Fuel Oil	40.19
LPG	47.31
Ethane	47.49
Naphtha	45.01
Bitumen	40.19
Lubricants	40.19
Petroleum Coke	31.00
Refinery Feedstocks	44.80
Refinery Gas	48.15
Other Oil Products	40.19
Other Products	
Coal Oils and Tars derived from Coking Coal	28.00
Oil Shale	9.40
Orimulsion	27.50
Source: OECD/IEA, Paris, 1996a.	

Table 1.3. revised 1996 IPCC guidelines for national greenhouse gas inventories: Refrence manual

ANNEX 6

CDM Project Cycle



Source: Introduction to the CDM, UNEP RISOE Centre, 2002

ANNEX 7

TABLE 1-1 (CONTINUED)
IPCC REFERENCE APPROACH
ENTRIES AND CALCULATIONS FOR STEPS (3) TO (6)

Fuel	(8) Apparent Consumption (TJ)	(9) Carbon Emission Factor(f) (t C/TJ)	(10) Carbon Content (Gg C)	(11) Carbon Stored (Gg C)	(12) Net Carbon Emissions (Gg C)	(13) Actual Carbon Emissions (Gg C)	(14) Actual CO_2 Emissions (Gg CO_2)
A) Liquid Fossil	sum		sum	sum	sum	sum	sum
Primary Fuels							
1) Crude Oil	calc	20.0	calc		calc	calc	calc
2) Orimulsion	calc	22.0	calc		calc	calc	calc
3) N. Gas Liquids	calc	17.2	calc		calc	calc	calc
Secondary Fuels / Products							
4) Gasoline	calc	18.9	calc		calc	calc	calc
5) Jet Kerosene	calc	19.5	calc		calc	calc	calc
6) Other Kerosene	calc	19.6	calc		calc	calc	calc
7) Shale Oil	calc	20.0	calc		calc	calc	calc
8) Gas / Diesel Oil	calc	20.2	calc	Table 1-5	calc	calc	calc
9) Residual Fuel Oil	calc	21.1	calc		calc	calc	calc
10) LPG	calc	17.2	calc	Table 1-5	calc	calc	calc
11) Ethane	calc	16.8	calc	Table 1-5	calc	calc	calc
12) Naphtha	calc	(20.0)	calc	Table 1-5	calc	calc	calc
13) Bitumen	calc	22.0	calc	Table 1-5	calc	calc	calc
14) Lubricants	calc	(20.0)	calc	Table 1-5	calc	calc	calc
15) Petroleum Coke	calc	27.5	calc		calc	calc	calc
16) Refinery Feedstocks	calc	(20.0)	calc		calc	calc	calc
17) Other Oil	calc	(20.0)	calc		calc	calc	calc
B) Solid Fossil	sum		sum	sum	sum	sum	sum
Primary Fuels							
18) Anthracite(c)	calc	26.8	calc		calc	calc	calc
19) Coking Coal	calc	25.8	calc	Table 1-5	calc	calc	calc
20) Other Bit. Coal	calc	25.8	calc		calc	calc	calc
21) Sub-bit. Coal	calc	26.2	calc		calc	calc	calc
22) Lignite	calc	27.6	calc		calc	calc	calc
23) Oil Shale	calc	29.1	calc		calc	calc	calc
24) Peat	calc	28.9	calc		calc	calc	calc
Secondary Fuels							
25) BKB & Patent Fuel	calc	(25.8)	calc		calc	calc	calc
26) Coke Oven/Gas Coke	calc	29.5	calc		calc	calc	calc
C) Gaseous Fossil	sum		sum	sum	sum	sum	sum
27) Natural Gas (Dry)	calc	15.3	calc	Table 1-5	calc	calc	calc
Total(e)	sum		sum	sum	sum	sum	sum
Information Entries							
Biomass Total	sum		sum		sum	sum	sum
28) Solid Biomass	calc	29.9	calc		calc	calc	calc
29) Liquid Biomass	calc	(20.0)	calc		calc	calc	calc
30) Gas Biomass	calc	(30.6)(g)	calc		calc	calc	calc