CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

CONTENTS

SECTION A. General description of small-scale project activity

A.1. Title of the small-scale project activity:

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4 MW Rice Husk based Cogeneration Project at Pragati Paper Industries Ltd., Handesra, Punjab.
Version-01
Date: 24-01-2008

A.2. Description of project activity:

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Pragati Paper Industries Limited (PPIL), a leading supplier and manufacturer of news print paper, and started its operation in 2003-04 in a region called Handesra , in Punjab. The present annual production capacity of plant is 54,000 tonnes of news print paper.

Purpose:

The paper manufacturing is a continuous process, which requires thermal energy as well as electrical energy for drying of papers and running of dryers respectively. The purpose of project activity is to have combined heat and power (CHP) generation to meet the energy requirements and improve overall energy efficiency of the manufacturing facility. The project activity utilises the available rice husk in the region to generate electricity and steam for captive consumption, thereby avoiding the use of non-renewable energy resources such as coal and hence conserving them.

Project Description:

PPIL has implemented a 4 MW cogeneration power project based on rice husk with the baggase as co-firing option. The power is produced by 4MW extraction-cum-condensing steam turbine with alternator. Major equipment of the power project comprises of 25 tonne per hour (TPH) capacity fluidized bed combustion type boiler.

Turbine is extraction-cum-condensing turbine. The average inflow of extraction steam is 15 tonne per hour, which is used for process steam requirement in the paper machine section.

The fuel being used for project activity is rice husk which is available in plenty in the nearby region. The rice husk required for project activity is being procured from the Rice Mills and other vendors available in the near by region, which is then transported to the project site using motor vehicle (trucks). The project proponent has developed an infrastructure in terms of manpower and financial resources, in order to ensure continuous fuel availability. The project proponent also uses small quantity of coal during heavy rain, when moisture content of rice husk increases.

Contribution of the project activity to sustainable development
Ministry of Environment and Forests, Government of India has stipulated the social well being, economic well being, environmental well being and technological well being as the four indicators for sustainable development in the host country approval eligibility criteria for Clean Development Mechanism (CDM)

projects[1]. Some of the socio-economic benefits that would happen due to the implementation of the project activity are:

Social well being

The Project activity increases the local employment by involving skilled and unskilled personnel for operation and maintenance of the equipment. The project activity also generates employment opportunity for transporters for transporting rice husk from nearby areas to the project site.

Environmental well being

The project activity is a renewable energy power project, which utilizes waste biomass generated in the local region as a fuel for power generation, which otherwise would have been generated using fossil fuel (coal). Hence the project activity helps in reduction of the green house gases emission and air pollutants.

The project activity helps in conservation of depleting fossil fuels such as coal, oil, which at present are predominantly used for power generation

Economic well being

The increase in demand of rice husk exerted by the project has local effect on its price and hence generates additional revenue for the rice millers, which in turn has benefited the local farmers.

The project has catalyzed the development of local economy by creating job and employment opportunities, particularly in rural areas, which is a priority concern of the Government of India. The project activity has also brought additional investment consistent with the need of people.

Technological well being

The project activity has adopted an advanced and sustainable technology for long term benefits. The project has adopted cleaner technology which utilizes biomass to generate steam and power thereby avoiding use of fossil fuel e.g. coal.

A.3. Project participants:

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Name of the party(ies) involved ((Host) indicates 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(yes/No)
Government of India (Host)	Pragati Paper Industries Limited	No

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

[1] http://cdmindia.nic.in/host_approval_criteria.htm

CDM – Executive Board

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A.4.1. Location of the small-scale project activity:

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A.4.1.1. Host Party(ies):

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India

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

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Punjab

A.4.1.3. City/Town/Community etc:

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Vill-Handesra, Distt-Mohali

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

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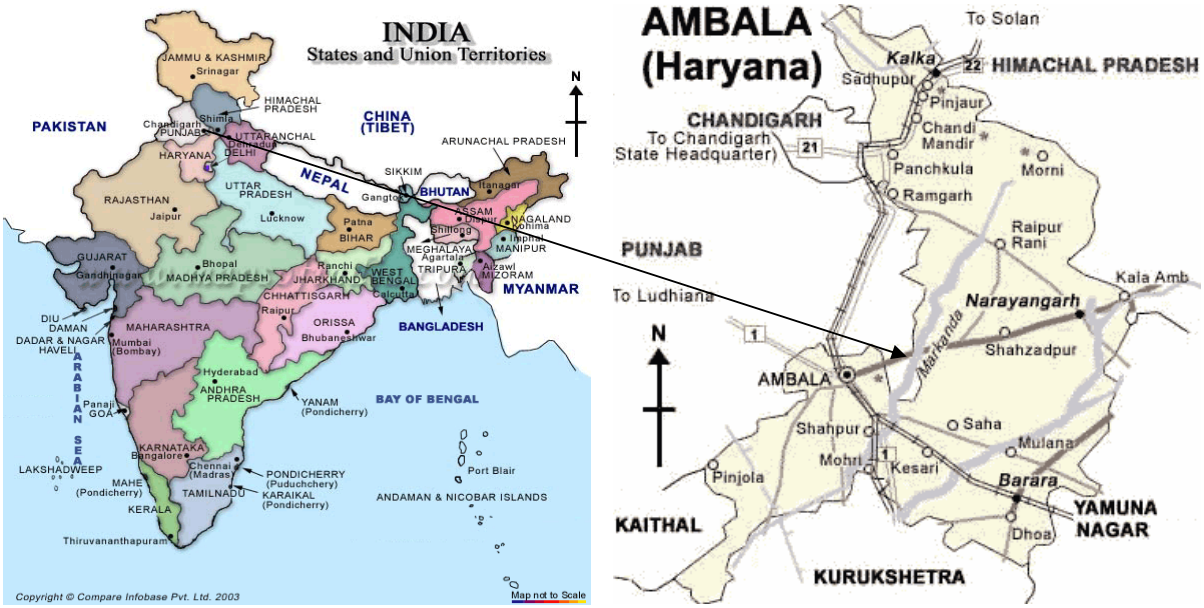
The project site is well connected through road and railway. The project activity is located at NH-72, 11 km from Ambala cant, within the premises of PPIL at Village-Handesra, District- Mohali, Punjab. The nearest railway station is Ambala cant. The geographical location of the project site are 29-40"-45' North latitude and 76-42"-52' East longitude.



A.4.2. Type and category (ies) and technology/measure of the small-scale project activity:

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As defined under Appendix B of simplified modalities and procedure for small-scale CDM project activities, the project activity proposes the apply following project type and category-

Type	Project category
Renewable energy projects	I.C. Thermal energy for user with or without electricity

Technology to be employed:

The steam required for the process is 15 TPH for dryer at a pressure of 4 kg/cm^2. The project activity is a rice husk based cogeneration plant where high pressure steam turbine configuration has been used. Fluidized bed combustion technology has been used for steam generation, which represents best available technology as compared to pile burning and stoker fired boiler. Since the paper manufacturing process requires steam as well as power, so the extraction-cum-condensing turbine has been used for the project activity.

The specifications of the systems in the project activity are as follows:

Boiler:

Type: Fluidized bed combustion (FBC) Boiler

Pressure: 65 kg/cm^2(g)

Temperature: 485+/-5^{o}C

Capacity: 25 tonnes per hour (tph)

Fuel: Fuel firing option:
100% Rice husk firing (overbed)
70% Rice Husk + 30% Bagasse (Overbed)

Efficiency: The efficiency for Rice husk 75% + Bagasse 25%: 77.5 +/-2%

Turbine:

Type: Multistage, extraction-cum-condensing, Horizontal, Impulse type

Capacity: 4 MW

Inlet steam pressure: 63 Kg./Cm^{2}g

Temperature: 485+/- 5^{o}C

Gear Box Output speed: 1500 RPM

Alternator:

Rating: 4 MW

Speed: 1500 RPM

Frequency: 50 Hz

Condenser:

Condenser Capacity: Max. 10 TPH

Type of extraction: Controlled, Max. 18TPH, Min. 9 TPH

Cooling water inlet temperature: 32^{o}C

Cooling water outlet temperature: 40^{o}C

Cooling water flow rate: 712 M^3/H

The plant installed one condensing cum extraction turbine along with 25 TPH high-pressure boiler with steam parameters of 63 kg/cm^2 and 485 ^{0}C. This boiler is of modern design with fluidized bed combustion suitable for indoor installation with water scrubber for dust collection. In case of exigencies of biomass fuel scarcity, PPIL purposes to use baggase as fuel to the extent of 30%. For generating maximum of 100% steaming capacity of the boiler at rated parameters, about 600 TPD of rice husk (100%rice husk firing) is required. The plant has Distributed Control System (DCS)/Supervisory Control and data acquisition for operation and generates a gross output of 4000 KW at the generator terminals. The power generation in the cogeneration plant is at 440V level.

The plant is designed with all other auxiliary plant systems like:

1. Rice husk and baggase handling system.

2. Ash handling system

3. Air pollution control devices

4. Water system consists of following sub-systems:

5. Raw water system
   5.1 Condensate system
   5.2 Fire protection system

The rice husk is supplied by vendors on continuous basis hence the storage of rice husk is less than 30 days hence there is no significant GHG emission from storage of rice husk. Also the ash resulting from the firing of rice husk is dumped to a specified site. The operation of the rice husk based power plant will lead to mitigation of emission of carbon di-oxide, as husk is a carbon neutral fuel. The project apart from mitigating the emission of GHG will reduce the local emissions of sulfur and other pollutants associated

with the burning of fossil fuels. Hence technology employed in project activity is environmentally safe and sound.

No technology transfer is involved in the project activity, as the technology used and know how required for the project activity is available in India.

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

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The estimated emission reduction over chosen crediting period is **492350 tCO_2.** The annual estimation of emission reductions are furnished in the table below:

Year	Estimation of annual emission reductions in tonnes of CO_2 e
Year 1*	49235
Year 2	49235
Year 3	49235
Year 4	49235
Year 5	49235
Year 6	49235
Year 7	49235
Year 8	49235
Year 9	49235
Year 10	49235
Total estimated reductions	**492350**
Total number of crediting years	**10 Year**
Annual average of estimated emission reductions over the crediting period	49235

(* Starting from the date of registration of project)

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

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The total project cost is funded through equity investment and debt (long-term) from nationalised banks in India. The funding details for the project are provided below.

- **Equity Investment:** Rs. 265.84 Lacs by Pragati paper industries limited.
- **Debt (LT Loans @ 10.75% p.a.):** From bank (Rs.620.2 Lacs);

No public funding or overseas development assistant has been used in this project activity.

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

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As mentioned under Appendix C of the *Indicative Simplified Modalities and Procedures for Small-Scale CDM project Activities*, the "Debundling" is defined as the fragmentation of a large project activity into smaller parts. A small-scale project activity that is part of a large project activity is not eligible to use the

simplified modalities and procedures for small-scale CDM project activities. The guideline for debundling mentioned in paragraph 2 of appendix C is given as follows:

A proposed small-scale project activity shall be deemed to be a 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.

The proposed project activity is not a debundled component of a large project activity as the project proponent neither have registered any project activity within the previous 2 years for the same project category nor do they propose to set up another biomass based cogeneration plant within 1 km radius of the proposed small-scale activity.

SECTION B. Application of a baseline and monitoring methodology

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

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Type	Category
Type I- Renewable Energy Projects	AMS-1.C. Thermal Energy for the user with or without electricity, Version 12, EB 33

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

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As defined under the applicability criteria of AMS I C for small-scale CDM project activities (Version 12, EB 33), this category includes **"Biomass-based co-generating systems that produce heat and electricity".** Also for co-fired systems the aggregate installed capacity (specified for fossil fuel use) of all systems affected by the project activity shall not exceed 45 $MW_{th.}$ Cogeneration projects that displace/ avoid fossil fuel consumption in the production of thermal energy (e.g. steam or process heat) and/or electricity shall use this methodology. The capacity of the project in this case shall be the thermal energy production capacity i.e. 45 MWth.

The project activity is a rice husk based 4 MW cogeneration project which produces thermal energy and electricity to meet captive energy requirement of PPIL. The project activity avoids consumption of fossil fuel for production of thermal energy and electricity. Also the net thermal energy output from the project

Steam generated for project activity:

Steam	25	TPH

Temperature	485	^0C
Pressure	63	Kg/cm^2
Enthalpy	2938.27[2]	KJ/kg
Consumption of thermal energy per day	73456750	KJ
	73456.750	MJ
Thermal energy	20.42	MW_{th}

activity is approximately 20 MW_{th} which is less than the specified limit 45 MW_{th}, hence he project activity clearly qualifies in the above category.

B.3. Description of the project boundary:

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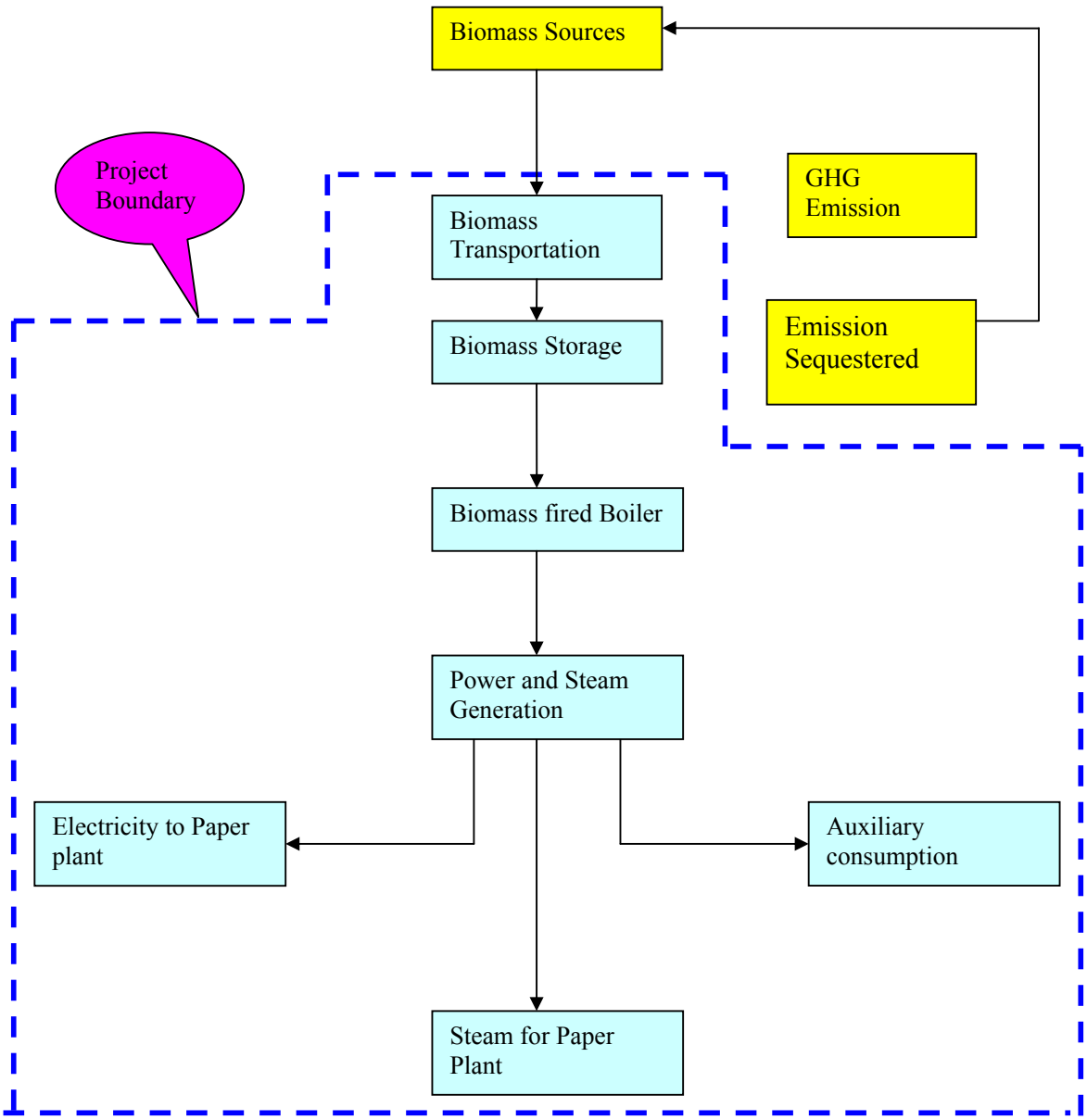
As mentioned under Type I.C. of *"Annex –B" of the Indicative simplified baseline and monitoring methodologies for selected small scale CDM project activity categories,* Project boundary encompasses the physical and geographical site of the renewable generation sources. For the proposed project activity the project boundary is from the point of fuel storage to the point of electricity and steam supply to the paper mill where the project proponent has a full control. Thus, project boundary covers fuel storage, boiler, steam turbine generator and all other accessory equipments.

	Source	Gas	Included	Justification/Explanation
Baseline	Displacement of fossil fuel (coal)	CO2	Yes	In absence of project activity PPIL would have gone for coal based captive power plant.
		CH4	No	
		N2O	No	
Project Activity	Leakage due to transfer of energy generating equipment	CO2	No	No transfer of equipment takes place
		CH4	No	
		N2O	No	
	Emissions through Biomass transportation in the year "y"(tCO2e)	CO2	Yes	Emissions from liquid fossil fuel used in vehicles will take place due to transportation of rice husk from the near by areas,
		CH4	No	
		N2O	No	
	Emissions through electricity or diesel consumption in the year "y"(tCO2e)	CO2	Yes	The auxiliary consumption is deducted from the net power.
		CH4	No	
		N2O	No	
	Emission due to use of coal in boiler	CO2	Yes	Emission from the use of coal in boiler

[2] http://www.spiraxsarco.com/esc/SH_Properties.aspx

		CH4	No
		N2O	No

Flow chart and project boundary is illustrated in the following diagram:



B.4. Description of baseline and its development:

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The baseline methodology has followed the one specified in the Project Category I.C. in Para 6 & 7 of the "Annex –B" of the *Indicative simplified baseline and monitoring methodologies for selected small scale CDM project activity categories*.

The steam and electricity required for the operating process of plant at PPIL is 15 TPH and 3.2 MW respectively. PPIL has set up the rice husk based cogeneration plant to meet its steam and power requirement from captive sources. The project activity displaces fossil fuel based generation of electrical energy as well as fossil fuel based generation of thermal energy.

As mentioned in Para 7 of AMS IC version 12 to determine baseline for cogeneration projects, the most plausible and credible alternative available for the project activity are identified below:

Identification of alternatives:

1. Low pressure boiler based on fossil fuel (coal) and electricity from grid
2. High pressure boiler based on fossil fuel (coal) and 4MW turbine on site
3. Project activity without CDM benefit

The levelised cost comparison of different scenario brings out the following:

Alternative-I: shows that first alternative fossil fuel (coal) based low pressure boiler and electricity from grid is not feasible due to high price of per unit electricity charged by PSEB.

The use of other possible fossil fuel ruled out due to high cost (Diesel) or unavailability[3] of natural gas in the region.

Alternative-II: shows that levelised cost per unit production of heat is lowest for coal fired high pressure boiler and 4 MW turbine onsite, hence is financially most attractive option for the project.

Alternative-III: shows that fuel cost for biomass based cogeneration power plant is very high due to lower plant efficiency and low calorific value of biomass used. Also the annual price escalation of rice husk leads to increase in working capital required for day to day operation. The levelised cost for per unit (Gcal) heat production is higher than coal based captive power plant.

Scenario	Levelised cost per unit (INR/Gcal)
Low pressure boiler based on fossil fuel (coal) and electricity from grid*	1286.17
High pressure boiler based on fossil fuel (coal) and 4MW turbine on site*	906.98
Project activity without CDM benefit*	1375.96
Project activity with CDM benefit	1137.85

*See appendix-B, levelised cost calculation

[3] http://punjabgovt.nic.in/ECONOMY/INDUSTRY_ENERGYSECTOR.HTM (Energy)

The project activity is not financially most attractive option for project proponent.

From the above discussion it can be concluded that the baseline scenario for the given project activity would comprise of a coal based cogeneration captive power plant. Considering this, we have proposed to use the **option (d)** as suggested in Para 7 of AMS IC version 12 for baseline emission, which reads as:
d) Electricity and steam/heat are produced in a cogeneration unit, using fossil fuel.

Also as suggested in Para 13 of AMS IC version 12 the method of determining the efficiency of the baseline units as one of the following:
(a) Highest measured efficiency of a unit with similar specifications,
(b) Highest of the efficiency values provided by two or more manufacturers for units with similar specifications,
(c) Maximum efficiency of 100%.

The highest measured efficiency of a unit with similar specification (85%) has been taken to determine the efficiency of baseline for the calculation of emission reductions

The parameter required to estimate baseline emissions are:

Parameter	**Unit**
Enthalpy of steam supplied to the process	Kacl/kg
Total heat supplied to the process	TJ
NCV of coal	Kcal/kg
Emission factor of coal	tCO2/TJ
Efficiency of boiler (baseline)	%
Net electricity generated per annum	GWh
Number of operational days	day
NCV of rice husk	Kcal/kg
Density of diesel	%
NCV of diesel	Kcal/kg
Emission factor for diesel	tCO_2/TJ
Average distance traveled for the biomass transportation	km
Mileage of truck	Km/liter

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:

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The project activity is a rice husk (carbon neutral fuel) based co-generation plant, which produces electricity and steam to meet PPIL's captive consumption requirement thereby displacing fossil fuel based cogeneration power plant. Project activity leads to the saving of coal that could have otherwise been used for steam and power generation by coal fired cogeneration power plant. Hence the project activity contributes to long term GHG reduction by avoiding use of coal which have a much higher carbon emission factor. Hence, the emission reductions achieved by the project activity is additional, real and measurable during the complete lifetime of the project activity.

While choosing the alternatives available for cogeneration plant, the most economical option is coal-fired cogeneration captive power plant. The levelised cost of steam produced using coal fired boiler is much lower than that of biomass fired boiler due to higher calorific value of coal as compared to biomass and the higher boiler efficiency described in Annex-3.

According to UNFCCC guidelines for small scale CDM project activities, the projects applies simplified modalities and procedures needs to demonstrate the additionally of the project activity as per Attachment A to Appendix B. The Attachment A describes various options; out of them at least one of the barriers should be selected to demonstrate that the project activity is additional.

Additionality analysis:

The attachment A to appendix B mentions various barriers and requires explanation to show that project activity would not have occurred due to at least any one barrier in the following category:

- Investment barrier
- Prevailing practice barrier
- Technological barrier and
- Other barriers

Investment Barrier:

The project activity is rice husk based cogeneration project for captive consumption. The project proponent has invested with a view to generate power and utilise same for captive consumption. The levelised cost for per unit production of steam has been taken as a basis to compare the financial attractiveness of identified alternatives, since there is no direct revenue from the project activity. The levelised cost for the different alternative was computed based on the investors' expected return on equity and total capital cost required. The levelised cost per Gcal (heat) for identified alternative is:

Scenario	Levelised cost per unit (INR/Gcal)
Low pressure boiler based on fossil fuel (coal) and electricity from grid	1286.17
High pressure boiler based on fossil fuel (coal) and 4MW turbine on site	906.98
Project activity without CDM benefit	1375.96
Project activity with CDM benefit	1137.85

Further per unit production cost by different alternative shows that levelised cost for biomass based cogeneration plant is higher due to escalation in prices of biomass used for the project activity and is not financially most attractive option for the project. Though project proponent has taken risk considering environmental benefit and CDM revenue related to the project activity.

Technological barrier:

Rice husk ash contains high percentage of silica[4] which leads to rapid erosion of the equipments. Due to high silica content and the pointed nature of the rice husk (biomass) particle, the equipment like ID fan, cone portion of air pre-heater and top portion of the stack would be eroded and lead to high maintenance cost, frequent breakdown and increased downtime. The equipment supplier had agreed that erosion problem is higher in rice husk based cogeneration compared with coal based system Further, in rice husk fired boiler, escape of fluidized bed thickness, fluidizing media required to be added at regular interval of time. This leads to variation into air requirement; also the fuel flow control with respect to steam output is difficult in biomass fired boiler. Hence, operation and control of biomass fired boiler requires skilled boiler operator.

Due to this risk, PPIL had disinclination to absorb this new technology; however they had taken the initiative to implement the project activity considering carbon benefits.

Other barriers

Fuel price:

One of the major constraints associated with the project is annual increment in the price of rice husk as the current price ranges from Rs. 2500 to Rs. 3000 in Punjab. This will lead to increase in working capital required for day to day operation and will impact the viability of the project activity.

Impact of CDM Revenue:

Registering the project activity as a CDM activity provides a significant amount of revenue, improving the project's cash flow and minimizes the levelised cost. The revenues from sale of the Certified Emission Reductions would enhance the viability of the project and would partially offset the risks associated with the possible changes in price of rice husk, project implementation risks (time and cost overruns), etc.

B.6. Emission reductions:

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B.6.1. Explanation of methodological choices:

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Baseline emission:

For thermal energy generation using renewable technologies that displace technologies using fossil fuels, the simplified baseline is the fuel consumption of the technologies that would have been used in the absence of the project activity times an emission coefficient of the fossil fuel displaced (Bitumen coal in this case). IPCC default value for emission coefficient may be used. Emission factor for Coal is 94.6 tones of carbon dioxide per TJ of energy consumed.

Since the baseline scenario in case of this project activity is coal based cogeneration unit to produce the thermal energy and electricity, the following formula shall be used to calculate the baseline emissions:

$BEy = (HGy + EGy*3.6) * EF\ CO_2 / \eta_{cogen}$ .....(1)

[4] cgpl.iisc.ernet.in/site/Portals/0/Technologies/Precipitated**Silica**.pdf

Where:

BEy: the baseline emissions from electricity and steam displaced by the project activity during the year y in tCO2e.

EGy: the amount of electricity supplied by the project activity during the year y in GWh

3.6: conversion factor, expressed as TJ/GWh.

HGy: the net quantity of steam/heat supplied by the project activity during the year y in TJ.

$EFCO_2$: the CO2 emission factor per unit of energy of the fuel that would have been used in the baseline cogeneration plant in (tCO2 / TJ) obtained from reliable local or national data if available, otherwise IPCC default emission factors are used.

η_{cogen}: the total efficiency (thermal and electrical both included) of the cogeneration plant using fossil fuel that would have been used in the absence of the project activity. Efficiency should be calculated as total energy produced (electricity and steam/heat extracted) divided by thermal energy of the fuel used.

Project Emissions-

The GHG emission due to the burning of rice husk is assumed to be nil since biomass is accepted as a carbon neutral fuel.

The project emissions due to combustion of coal in the boiler is calculated as

PE,y_1= quantity of coal used(TJ)*EF_{coal}

EF_{coal}: emission factor of coal

The project emissions from the combustion of diesel during delivery of Biomass to the facility can be estimated. The estimated daily input of biomass required allows for the estimation of diesel fuel consumed, since the distance from suppliers is known. The fuel consumed multiplied with the emission factor of the fuel would indicate the emissions from the project activity caused due to transportation.

The following formula will be used.

$PE,y_2 = (Q_{bio}*Dp*Ny*Dn*Cf*EF_{diesel})/Ct*M$

PE,y = Project emission (tCO2/year)

Q_{bio} = Total Quantity of biomass transported in the year (T)

Dp = Maximum distance covered per trip

Ny= no. of days of operation in a year

Dn = Density of diesel

Cf= Calorific value of diesel (kcal/kg)

EF_{diesel} = emission factor of diesel (tC/TJ)

Ct = capacity of truck (T)

M = mileage (kms/l)

Total project emission $PE_{,y} = PE_{,y1} + PE_{,y2}$

The following parameter will be needed to calculate the project emissions due to transportation of biomass:

Sr.No	Calculation for transportation	Unit
1	Average daily biomass input	T
2	Average truck load	T
3	No of daily truck loads required (both way)	Nos
4	Maximum Distance Covered	Kms
5	Distance covered	Kms
6	Mileage	Km/l
7	Total diesel consumption	litres
8	No of days of operation	Days
9	Diesel consumption / year	Litres
10	Density of diesel	kg/L
11	Actual Diesel consumption / year	kg
12	Calorific value of diesel	kCal / kg
13	Total energy consumption from burning of diesel	Kcal/year
14	Total energy consumption from burning of diesel	TJ/year
15	CO2 emissions from diesel	t CO2/ TJ
16	Annual CO2 emission from transport	t CO2e

Leakage
According to appendix B, I.C paragraph 17, leakage is to be considered if the energy generating equipment is transferred from aother activity or if the existing equipment is trasfered to another activity. Since the transfer of energy generating equipment is not involved, the proposed project activity does not quantify leakage effects.

Total emission reduction caused by project activity:
The emission reduction by the project activity is calculated as the difference between the baseline emission and the sum of the project emissions and the leakage.

$$\mathbf{ER_y = BE_{hy} - (PE_y + Leakage_y)} \quad \textbf{(2)}$$

$\mathbf{ER_y}$ = Emission reduction in the year "y" ($\mathbf{tCO_2e}$).

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

(Copy this table for each data and parameter)

Data / Parameter:	**EF_{fuel}**
Data unit:	tCO2/TJ
Description:	Emission factor for fuel (other Bituminous coal) used in baseline
Source of data used:	IPCC (TABLE 1.3 DEFAULT VALUES OF CARBON CONTENT, 2006 IPCC Guidelines for National Greenhouse Gas Inventories)
Value applied:	94.6
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value can be used in absence of National data.
Any comment:	

Data / Parameter:	**EF_{coal}**
Data unit:	tCO2/TJ
Description:	Emission factor for diesel used in for calculation of emission from transportation
Source of data used:	IPCC (TABLE 1.3 DEFAULT VALUES OF CARBON CONTENT, 2006 IPCC Guidelines for National Greenhouse Gas Inventories)
Value applied:	74.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default value can be used in absence of National data.
Any comment:	

Data / Parameter:	NCV_{fuel}
Data unit:	Kcal/Kg
Description:	Standard value
Source of data to be used:	CEA (CO2 baseline database for power sector)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3755

Description of measurement methods and procedures to be applied:	Referred annually
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$NCV_{rice\ husk}$
Data unit:	Kcal/kg
Description:	Net calorific value of rice husk
Source of data to be used:	Laboratory test
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3200
Description of measurement methods and procedures to be applied:	Laboratory test
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	**NCV_{diesel}**
Data unit:	kcal/kg
Description:	Gross calorific value of diesel
Source of data used:	IPCC
Value applied:	10886
Justification of the choice of data or description of measurement methods and procedures actually applied :	data is needed to calculate project emission due to transportation of biomass
Any comment:	

Data / Parameter:	**D_d**
Data unit:	%
Description:	density of diesel
Source of data used:	Report of expert committee on fuels for power generation
Value applied:	82.64

Justification of the choice of data or description of measurement methods and procedures actually applied :	the data is required to calculate mass of diesel used
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

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The baseline emission is calculated as follows:

To calculate the baseline emission for fossil fuel displaced, the formula used is as follows

$BE_y = (HG_y + 3.6 * EG_y)$

Where:

BEy: the baseline emissions from electricity and steam displaced by the project activity during the year y in tCO2e.

EGy: the amount of electricity supplied by the project activity during the year y in GWh (25.63)

3.6: conversion factor, expressed as TJ/GWh.

HGy: the net quantity of steam/heat supplied by the project activity during the year y in TJ (290.23).

$EFCO_2$: the CO_2 emission factor per unit of energy of the fuel that would have been used in the baseline plant in (tCO_2 / TJ), obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used (94.6 tCO_2/TJ for coal, Table-1.4 Default CO_2 Emission Factors For combustion, 2006 IPCC Guidelines for National Green Gas House Inventory).

ηCogen: the efficiency of the plant using fossil fuel that would have been used in the absence of the project activity (taken 85% as per guideline of AMS I C Version-12, para 13 b.).

BE_y = (290.23 *+ 3.6*25.63)*94.6/72% = 50186 tCO_2/year

Project emission

Emission due use of coal:

PEy1= 7.51*94.6
= 710.44 tCO_2/year

Emissions due to transportation of rice husk:

Total biomass required (approx.)	46130	tonnes/year
Biomass transported by truck	46130	tonnes/year

Biomass load per truck	8	tonne
Total no. of trips	5766	
Max. distance between project site and collection centers	30	Km
Consumption of diesel per trip (to and fro) (@ 4 km/lit)	15	Liter
Total diesel consumption	86494	Liters
Density of diesel	0.83	Tonnes/(1000)liter
Mass of diesel used	71.48	Tonnes
Calorific value of diesel	0.046	TJ/tonne
Emission factor for diesel	74.1[5]	tCO_2 /TJ
Emission due to transportation of biomass	241	tCO_2

Project emissions are calculated as follows

$PE,y2 = (Q_{bio}*Dp*Ny*Dn*Cf*EF_{diesel})/Ct*M$

$= 46130*15*0.83*.046*74.1/(8*1000)$
$= 241\ tCO_{2e}$/year

Total project emissions
$PE_{,y} = 710+241$
$= 951\ tCO_2$/year

The total estimated emission reduction due to project activity is

$\mathbf{ER_y = BE_y - (PE_y + Leakage_y)}$
$= 50186-(951+0)$
$= 49235\ tCO_2$/year.

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

>>

Year	Estimation of project activity emissions (tCO_2 e)	Estimation of baseline emissions (tCO_2 e)	Estimation of Leakage (tCO_2 e)	Estimation of overall emission reductions (tCO_2 e)
Year A	951	50186	0	49235
Year B	951	50186	0	49235
Year C	951	50186	0	49235
Year D	951	50186	0	49235
Year E	951	50186	0	49235
Year F	951	50186	0	49235
Year I	951	50186	0	49235

[5] CEA CO_2 user database for India power sector

Year J	951	50186	0	49235
Year K	951	50186	0	49235
Year L	951	50186	0	49235
Total (tonnes of CO_2 e)	**9510**	**501860**	**0**	**492350**

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

>>

B.7.1 Data and parameters monitored:

Data / Parameter:	EG_y
Data unit:	GWh
Description:	Net electricity generated per year
Source of data to be used:	Plant site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	25.63 (estimated for calculation of emission reduction)
Description of measurement methods and procedures to be applied:	Will be measured electronically on continuous basis
QA/QC procedures to be applied:	As the data are critical in calculating emission reductions by project activity, these variables are monitored at the site by means of accurately calibrated instruments dedicated for the intended purpose.
Any comment:	Data will be kept for crediting period + 2 year

Data / Parameter:	HG_y
Data unit:	TJ
Description:	Net Steam supplied by project activity per year
Source of data to be used:	Plant site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	292.23
Description of measurement methods and procedures to be applied:	Measured electronically continuously through out the year
QA/QC procedures to	As the data are critical in calculating emission reductions by project activity, will

be applied:	be monitored on continuous basis.
Any comment:	

Data / Parameter:	T_{steam}
Data unit:	^0C
Description:	Average temperature of steam required for process
Source of data to be used:	Plant site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	165 ^0C
Description of measurement methods and procedures to be applied:	This data will be monitored daily from the thermometer and recorded in the logbooks.
QA/QC procedures to be applied:	
Any comment:	The data will be archived either electronically or in paper and will be available upto two years after crediting period.

Data / Parameter:	P_{steam}
Data unit:	Kg/cm^2
Description:	Average pressure of steam supplied to the process
Source of data to be used:	Plant site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	4
Description of measurement methods and procedures to be applied:	This data will be monitored daily from the pressure gauge and recorded in the logbooks.
QA/QC procedures to be applied:	
Any comment:	The data will be archived either electronically or in paper and will be available upto two years after crediting period.

Data / Parameter:	$NCV_{rice\ husk}$
Data unit:	Kcal/kg
Description:	Net calorific value of rice husk

Source of data to be used:	laboratory test
Value of data applied for the purpose of calculating expected emission reductions in section B.5	3200
Description of measurement methods and procedures to be applied:	Laboratory test, sample will be send for test on periodical interval.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	Q_D
Data unit:	Liters
Description:	Quantity of diesel consumed for transportation of biomass
Source of data to be used:	Plant site fossil fuel (diesel) used for transportation of biomass
Value of data applied for the purpose of calculating expected emission reductions in section B.5	15 (Liters per trip)
Description of measurement methods and procedures to be applied:	Will be calculated on the basis of number of trips and diesel consumed per trip. Measured at monthly intervals through out the year Assumed mileage of truck= 4 Km/liter Average distance traveled = 20 Km
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$\acute{\eta}_{boiler}$
Data unit:	%
Description:	Efficiency of boiler
Source of data to be used:	Manufacturer specification

Value of data applied for the purpose of calculating expected emission reductions in section B.5	75
Description of measurement methods and procedures to be applied:	data is needed to calculate fuel required for the project activity
QA/QC procedures to be applied:	The efficiency of boiler will be monitored on monthly basis
Any comment:	

Data / Parameter:	D_D
Data unit:	%
Description:	density of fuel (Diesel) used for transportation of biomass
Source of data to be used:	Report of expert committee on fuels for power generation
Value of data applied for the purpose of calculating expected emission reductions in section B.5	82.46
Description of measurement methods and procedures to be applied:	Will be calculated on the basis of mileage of truck and distance travelled on daily basis. data is needed to calculate the project emissions
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	NCV_{diesel}
Data unit:	Kcal/kg
Description:	Calorific value of diesel used for transportation of biomass
Source of data to be used:	The report of export committee on fuel for power generation
Value of data applied for the purpose of calculating expected emission reductions in section B.5	10866

Description of measurement methods and procedures to be applied:	data is needed to calculate project emissions
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	Q_{bio}
Data unit:	Tonnes/year
Description:	Quantity of biomass transported per annum
Source of data to be used:	Plant site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	46,130
Description of measurement methods and procedures to be applied:	Will be measured on the basis of daily consumption
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	Capacity of truck
Data unit:	tonnes
Description:	Loading capacity of trucks
Source of data to be used:	Manufacturer specification
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8
Description of measurement methods and procedures to be applied:	data is needed to calculate the fuel consumption for transportation
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	Mileage of truck
Data unit:	Km/liter
Description:	Average fuel consumption per kilometre
Source of data to be used:	Daily consumption
Value of data applied for the purpose of calculating expected emission reductions in section B.5	4
Description of measurement methods and procedures to be applied:	Data is needed to calculate fuel consumed for transportation of biomass
QA/QC procedures to be applied:	Will be checked periodically for consistency
Any comment:	

Data / Parameter:	$\eta_{b\text{-}boiler}$
Data unit:	%
Description:	Efficiency of baseline boiler
Source of data to be used:	From manufacturer specification
Value of data applied for the purpose of calculating expected emission reductions in section B.5	85%
Description of measurement methods and procedures to be applied:	The value provided by manufacturer for similar specification has been used. The data is needed to determine efficiency of baseline boiler
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	Q_{coal}
Data unit:	tonnes
Description:	Quantity of coal used in project activity
Source of data to be used:	Plant site

Value of data applied for the purpose of calculating expected emission reductions in section B.5	2000
Description of measurement methods and procedures to be applied:	The value will be recorded and will be entered in log book separately.
QA/QC procedures to be applied:	
Any comment:	

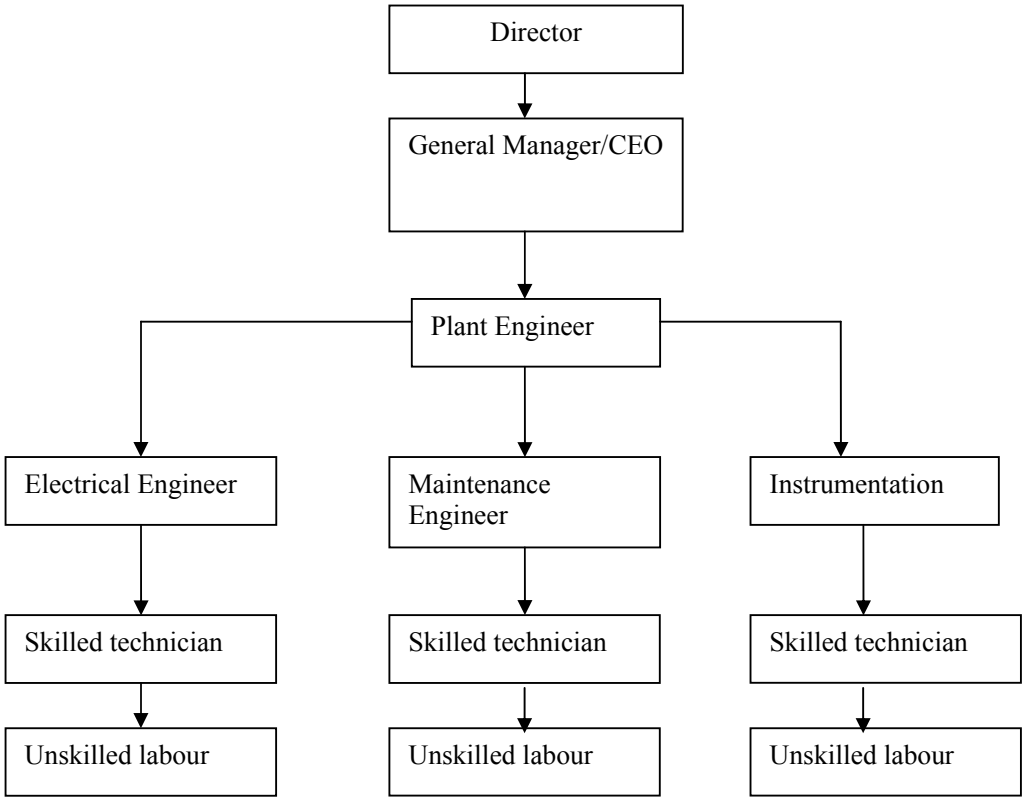
B.7.2 Description of the monitoring plan:

>>

The project proponent has well structured monitoring plan in place. This monitoring protocol, which will be registered with the CDM EB as a part of the Project Design Document, describes about the monitoring organisation, parameters and variables, monitoring practices, QA and QC procedures, data storage and archiving etc.

The Managing Director has assigned the responsibility of monitoring and recording to a team. The team will be responsible for recording, monitoring and preparing necessary document as per guidelines. The team will also prepare the audit reports, which will be presented to independent DOE to whom verification of monitoring process has been assigned. There is a backup plan for the recorded data. In the team, a special group of operators would be formed who would be assigned the responsibility of monitoring different parameters and record keeping as per the set procedures. Reviews would be done on a regular basis to ensure conformance with the industry standards.

As per guidelines the thermal and electrical meter shall be calibrated /maintained as per their schedule and standard. In case if calibration becomes difficult or operational life of the instrument is over, it will be replaced immediately. The schedule for this has already been drawn out and maintained by PPIL



The data will be monitored and recorded on daily basis by skilled technician of respective department as per the monitoring plan.

The recorded data will be checked and compiled in daily log book by engineer of respective department. Also it will be checked for integrity and completeness before sending it to monitoring supervisor.

The operational condition of all the equipments used in the project activity will be checked on regular basis by the skilled technician and report will be prepared and submitted to the respective department.

The general manager will act as a monitoring supervisor and will review the monthly report before sending it to managing director.

The director will ensure the proper implementation of the monitoring plan and will provide necessary resources required. Also the final report prepared will be checked and verified by the managing director for its completeness and correctness. He will also arrange training on regular interval to the personnel involved in CDM team by the industry expert.

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

>>

24-01-2008
Pragati Paper Industries Limited

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:

>> 13-03-2002

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

>> 25 yrs

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

The project activity will use a fix crediting period of 10 years.

C.2.1. Renewable crediting period

Not selected

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

>>NA

C.2.1.2. Length of the first crediting period:

>>
NA

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
01-07-2008 (expected)

C.2.2.2. Length:

>> 10 years , 0 months

SECTION D. Environmental impacts

>>

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

>>
As per Environment Impact Assessment Notification S.O.60[6] (e), dated 27/01/1994 by Ministry of Environment and Forests, India the project activity is not categorized to conduct EIA. The environmental clearance was obtained from the authorities as recommended by the procedures followed by the host government.

[6] http://www.envfor.nic.in/legis/eia/so-60(e).html

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:

>>

There were no significant Environmental impacts of project activity on environment.

SECTION E. Stakeholders' comments

>>

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

>>

Pragati Paper Industries Limited identified local communities, NGOs, state government and governmental agencies, employees, contractors and consultants/ advisors as the most important stakeholders, with an interest in the CDM activities. Accordingly, PPIL displayed a notice to representatives of various stakeholder groups with a brief on the project informing them of the proposed meeting at 12.30 PM on 31st September, 2007, at Pragati Paper Industries Limited, Handesra, Distt-Mohali, requesting all to attend meeting or depute representatives.

There were about 27 participants presenting various groups of the local communities, NGOs & GoM employees, contractors, villagers from the vicinity also showed interest in the project and related social & environmental development activities.

This stakeholder meeting involved

a) Welcome address to the representatives by Mr. P.N.Tailor.
b) Election of Chairperson for the meeting by the villagers & representatives from amongst themselves.
c) Introduction of project by Mr KV Srinath, from CantorCO2e on request from Chair.
d) Open house discussion on the merits of the projects with permission of Chair.
e) Summation of the concerns expressed by the stakeholder groups & commitments to address the concerns made by Mr Gurdev Singh, Chairperson.
f) Preparation & circulation of draft minutes of meeting & signing of MoM.

The agenda of the meeting was fixed as follows:

- Welcome
- Description of the project details
- Queries and responses from the proponent and the stakeholders
- Vote of thanks

E.2. Summary of the comments received:

>>

After a brief discussion regarding the pros and cons of this project the comment pertaining to project activity were received and were answered in the meeting. The stakeholders viewed PPIL as a reputed company contributing to the local economy. The participants sought clarifications on Kyoto Protocol and Clean Development Mechanism processes. Overall there was agreement that the proposed project is a beneficial project

A brief summary of the queries raised by the local stakeholders are presented below:

Stakeholders concerns/questions/comments	Answer /clarifications
Does the project lead to discharge of any effluents?	No the project does not lead to any discharge of the effluents.
Please explain the process of CDM in brief.	The process was elaborated in English and Hindi to the satisfaction of stakeholders present.
Does the project activity affect the surrounding agricultural crops?	No as there are no effluents being discharged. The management itself has done plantation in the surrounding areas.
What are the benefits to local villagers?	It was informed that the villagers have been benefited by employment opportunity.

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

>>

The stakeholders were given clarification on the issues raised as above to their satisfaction by providing relevant evidence of the project claims. A summary of responses provided in the meeting is presented below:

Local resident appreciated the project activity as it has generated source of employment and revenue for them during O&M and procurement of raw material for project activity. Overall there was unanimous agreement that the project activity was a good initiative undertaken by the Project proponents which contributes, to the sustainable development of the area and world. None of the concerns expressed by the stakeholders required an action to be taken by the PPIL during the project operation and at any other stage.

ANNEX 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Pragati Paper Industries Limited
Street/P.O.Box:	10/5, East Patel Nagar
City:	New Delhi
State/Region:	Delhi
Postfix/ZIP:	110008
Country:	India
Telephone:	91 11 25887489, 25886711, 25883512
Fax:	91 11 25882940
E-Mail:	Pragati@airtelbroadband.in, pragati@vsnl.net
URL:	
Contact person:	Mr. P. N. Tailor
Title:	President
Salutation:	Mr.
Last Name:	Tailor
Middle Name:	
First Name:	Parmanad
Department:	Finance and Business Development
Mobile:	91 9312219727
Direct Fax:	91 11 25882940
Direct Tel:	91 11 25883512
Personal E-Mail:	

ANNEX 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding as part of project financing from Parties included in Annex 1 to the convention is involved in the project activity.

ANNEX 3

BASELINE INFORMATION

Baseline Emission Estimation		
		Unit
Enthalpy calculation		
Feed water temperature	105	°C
Feed water specific enthalpy	444.77	kcal/kg
Steam Generation		
Steam temperature	485	°C
Steam pressure	63	kg/cm2
Net enthalpy	2938.27	KJ/kg
Steam Generation		
Steam temperature	165	°C
Steam pressure	4	kg/cm2
Specific steam enthalpy	2763.28	kJ/kg
Net enthalpy		
Efficiency of boiler	85	%
NCV of Coal	3755	kcal/kg
CER calculatios		
Total heat supplied to the process per year	292.23	TJ
Emission factor of Coal per unit energy	94.6	t CO_2/TJ
Total electricity generated per year	25.63	GWh

Specification of Boiler:

Type of boiler	Fluidized bed
Capacity of boiler	25 TPH
Fuel	Rice Husk
Steam parameter	65 Kg/cm^2 and 485±5 °C
Feed water temperature	105 °C
Calorific value of fuel	3200 kcal/kg
Thermal efficiency	75±2%

ANNEX 4

MONITORING INFORMATION

The general conditions set out for metering, recording, meter readings, meter inspections, Test & Checking and communication shall be as per the standard practice followed.

Metering: The Delivered Energy shall be metered at the high voltage side of the step up transformer installed at the Project Site.

Metering Equipment: Metering equipment shall be electronic meters of accuracy class 0.2% required for the Project. Dedicated core of both CT's and PT's of required accuracy shall be made available by the Company to concerned authority. The metering equipment shall be maintained in accordance with electricity standards. Such equipment shall have the capability of recording half-hourly and monthly readings. The Company shall provide such metering results of the Corporation. The meters installed shall be capable of recording and storing half hourly readings of all the electrical parameters for a minimum period of 35 days with digital output.

Meter Readings: The monthly meter readings shall be taken on the first day of the following month at 12 Noon. At the conclusion of each meter reading an appointed representative of the Company shall sign a document indicating the number of Kilowatt-hours indicated by the meter.

Inspection of Energy Meters: All the main and check energy meters and all associated instruments, transformers installed at the Project shall be of 0.2% accuracy class. Each meter shall be jointly inspected and sealed on behalf of the Parties and shall not be interfered with by either Party except in the presence of the other Party or its accredited representatives.

Steam Flow Meter: Steam generated from the boilers, most important parameter, would be measured by the steam flow meters installed at boilers as well as at various places in the plant. Steam generated by the boilers can also be validated by preparing steam balance using other steam flow meters at varous usage points.

Meter Test Checking : All the main and check meters shall be tested for accuracy every calendar quarter with reference to a portable standard meter which shall be of an accuracy class of 0.2%. The portable standard meter shall be owned by the Corporation at its own cost and tested and certified at least once every year from an accepted laboratory standard meter in accordance standards. The meters shall be deemed to be working satisfactorily if the errors are within specifications for meters of 0.25 accuracy class. The consumption registered by the main meters alone will hold goods for the purpose of billing as long as the error in the main meters is within the permissible limits. If during the quarterly tests, the main meter is found to be within the permissible limit of error and the corresponding check meter is beyond the permissible limits, then billing will be as per the main meter as usual. The check meter shall, however, be calibrated immediately.

If during any of the monthly meter readings, the variation between the main meter and the check meter is more than the permissible limit for meters of 0.2% accuracy class, all the meters shall be re-tested and calibrated immediately.

Quality of Steam Produced: The pressure and temperature of steam at inlet of turbine will be monitored regularly.

Quantity of Biomass used: Biomass input is monitored through the weighbridge log and the bills/invoices to the biomass traders. This is also subject to the annual audit. Currently the annual maintenance contract for the weighbridge is in place and it will be renewed repeatedly.

Appendix-A

Table-1: CER Calculation

Baseline Emission estimation		
Electricity generated		**Unit**
electrictity generated	78766	kwh/day
Operating Days/year	350	days/year
power generation per year	27568.1	MWh/year
Auxilary consumption	7%	%
Net Generation	25638.333	MWh/year
	25.638333	GWh/year
Total Heat supplied		
Average steam supplied to process	15.0	TPH
Enthalpy of steam supplied to the process at 4	2319.28	kJ/kg
daily thermal energy consumption	834940800.00	kJ/day
Number of operational days per annum	350.00	day
Annual consumption	292.23	TJ/yr
Net Calorific value of fossil fuel (coal)	3755.0000	Kcal/kg
Overall efficiency of coal based cogeneration unit	72.48%	%
Input fuel required per year	40317.44	TJ/yr
Emission factor-Coal	25.8000	tC/TJ
Emission factor-coal	94.6000	tCO_2/TJ
Emission due to displace of fuel oil displacement	**50187**	tCO_2/yr
Total Baseline emissions	**50187**	tCO_2/yr
Project Emisssions		
Quantity of coal used	2000	tonne
	7.51	TJ/yr
Project emisssions due to use of coal	710.446	tCO_2/yr
Leakage due to transportation of biomass	241	tCO_2/yr
Total project emissions	951	tCO_2/yr
Emission Reduction		
Emission reduction due to project activity	**49235**	tCO_2/yr
Total CER for ten years crediting period	**492350**	tCO_2/yr

Appendix-B
Levelised cost calculation

Table-1: Levelised cost calculation for Biomass based Cogeneration unit without CDM revenue

Total Installed Capa	17,550,000	kcal																			
Heat Generation	315900000	Kcal/day																			
Operating days	350	days																			
Total Heat Generati	110565000000	Kcal/year																			
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Total Heat Generation (Gcal/year)		110565	110565	110565	110565	110565	110565	110565	110565	110565	110565	110565	110565	110565	110565	110565	110565	110565	110565	110565	110565
Total Biomass Consumption (MT)		48493	48493	48493	48493	48493	48493	48493	48493	48493	48493	48493	48493	48493	48493	48493	48493	48493	48493	48493	48493
Total Cost fuel (lakh INR/year)		679	747	821	904	994	1093	1203	1323	1455	1601	1761	1937	2131	2344	2578	2836	3120	3432	3775	4152
Repair and Mainten	4.0%	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Overheads (lakh INR	3.0%	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Insurance	1.5%	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Depreciation (lakh INR)		44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
Interest on term loa	12.0%	17	67	84	53	41	29	17	5	0	0	0	0	0	0	0	0	0	0	0	0
Interest on Working	13.0%	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Return on Equity (la	0.0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Cost (lakhs INR)		816	934	1006	1077	1155	1242	1340	1448	1575	1721	1881	2057	2251	2464	2698	2956	3240	3552	3895	4272
Cost(INR)/Gcal		737.78	844.42	909.91	973.93	1,044.69	1,123.62	1,211.55	1,309.36	1,424.91	1,556.53	1,701.32	1,860.58	2,035.78	2,228.49	2,440.47	2,673.65	2,930.15	3,212.29	3,522.86	3,864.05
Discount Factor @12%		0.89	0.80	0.71	0.64	0.57	0.51	0.45	0.40	0.36	0.32	0.29	0.26	0.23	0.20	0.18	0.16	0.15	0.13	0.12	0.10
Discounted Cost /Gcal		658.74	673.17	647.65	619.95	592.78	569.26	548.04	528.83	513.84	501.16	489.09	477.57	466.55	455.99	445.86	436.13	426.76	417.73	409.00	400.57
Levelised Cost (INR)/Gcal		1375.9629																			

Table-2: Levelised cost calculation coal based cogeneration unit

Total Installed Capacity	17,550,000	kcal																			
Heat Generation	379080000	Kcal/day																			
Operating days	350	days																			
Total Heat Generation	132678000000	Kcal/year																			
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Total Heat Generation (Kcal/year)		132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000	132678000000
Total Coal Consumption (MT)		41569	41569	41569	41569	41569	41569	41569	41569	41569	41569	41569	41569	41569	41569	41569	41569	41569	41569	41569	41569
Total Cost of Coal (lakh INR/year)		769	807	848	890	935	981	1031	1082	1136	1193	1253	1315	1381	1450	1523	1599	1679	1763	1851	1943
Repair and Maintenance (lakhs)	4.00%	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
Overheads (lakhs)	3%	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Depreciation (lakhs)		42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42
Interest on term loan (lakhs)	12%	16	63	81	50	38	27	16	4	0	0	0	0	0	0	0	0	0	0	0	0
Insurance	1.50%	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Interest on Working Capital (lakhs)	13%	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Return on Equity (lakhs)	0%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Cost (lakhs)		897	983	1021	1053	1086	1121	1159	1199	1249	1305	1365	1428	1493	1562	1635	1711	1791	1875	1963	2056
Cost/Gcal		676.2363	740.9910	769.7950	793.8161	818.4927	845.0488	873.3623	903.5271	941.0541	983.8722	1028.8312	1076.0381	1125.6054	1177.6510	1232.2990	1289.6793	1349.9267	1413.1906	1479.6154	1549.3615
Discount Factor @12%		0.89	0.80	0.71	0.64	0.57	0.51	0.45	0.40	0.36	0.32	0.29	0.26	0.23	0.20	0.18	0.16	0.15	0.13	0.12	0.10
Discounted Cost /Gcal		603.7024	590.7135	547.8049	504.3574	464.4348	428.1270	395.0647	364.8195	339.3535	318.7805	295.7644	278.1922	257.9587	240.8707	225.1364	210.3748	196.6095	183.7707	171.7934	160.6173
Levelised Cost (INR)/Gcal		906.9618																			

Table-3:Levelised cost calculation for heat generation in coal based boiler and electricity from grid

Total Installed Capacity	9,900,000	kcal																			
Heat Generation	213840000	Kcal/day																			
Operating days	350	days																			
Total Heat Generation	74844000000	Kcal/year																			
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Total Heat Generation in boiler (Kcal/year)		74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000	74844000000
total electricity imported (Kcal/year)		11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000	11558400000
total cost of electricity		442	442	442	442	442	442	442	442	442	442	442	442	442	442	442	442	442	442	442	442
Total Coal Consumption (MT)		23449	23449	23449	23449	23449	23449	23449	23449	23449	23449	23449	23449	23449	23449	23449	23449	23449	23449	23449	23449
Total Cost of Coal (lakh INR/year)		434	456	479	502	527	554	581	610	641	673	707	742	779	818	859	902	947	994	1044	1096
Repair and Maintenance (lakhs)	4.00%	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Overheads (lakhs)	3%	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Depreciation (lakhs)		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Interest on term loan (lakhs)	12%	8	23	23	19	14	10	6	2	0	0	0	0	0	0	0	0	0	0	0	0
Insurance	1.50%	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Interest on Working Capital (lakhs)	13%	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Return on Equity (lakhs)	14%	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Total Cost (lakhs)		940	980	1002	1021	1042	1064	1088	1113	1142	1174	1207	1243	1280	1319	1360	1403	1448	1495	1545	1597
Cost/Gcal		1088.3096	1132.7280	1159.1639	1182.2242	1206.3608	1231.9501	1259.0653	1287.7924	1321.2598	1358.3498	1397.2944	1438.1063	1481.1228	1526.2060	1573.5435	1623.2478	1675.4374	1730.2364	1787.7754	1848.1813
Discount Factor @12%		0.89	0.80	0.71	0.64	0.57	0.51	0.45	0.40	0.36	0.32	0.29	0.26	0.23	0.20	0.18	0.16	0.15	0.13	0.12	0.10
Discounted Cost /Gcal		971.7050	903.9010	825.0700	751.3249	684.9214	624.1443	569.5372	520.1137	476.4595	437.3523	401.8868	369.1486	339.4351	312.2920	287.4805	264.7868	244.0180	224.9992	207.5728	191.5960
Levelised Cost (INR)/Gcal		1286.1795																			