CLEAN DEVELOPMENT MECHANISM
SIMPLIFIED PROJECT DESIGN DOCUMENT
FOR SMALL-SCALE PROJECT ACTIVITIES (SSC-CDM-PDD)
Version 02

CONTENTS

A. General description of the small-scale project activity

B. Baseline methodology

C. Duration of the project activity / Crediting period

D. Monitoring methodology and plan

E. Calculation of GHG emission reductions by sources

F. Environmental impacts

G. Stakeholders comments

Annexes

Annex 1: Information on participants in the project activity

Annex 2: Information regarding public funding

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.

SECTION A. General description of the small-scale project activity

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

>>

Title of project activity : RREPL-14MW Rice Husk Power Project

CDM document version No : Version 02

Date of the CDM document : 24 Dec.2005

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

>>

purpose of the project activity

The purpose of the project activity is to generate electricity using Biomass like rice husk for generation of power to achieve better energy efficiency, produce eco-friendly power; achieve sustainable development of the industry by reducing CO2 emission and other GHG emissions due to degeneration and uncontrolled atmospheric burning of biomass. Biomass is used in the boiler for producing high pressure steam which will be fed into a turbine generator to generate electricity of 14 MW generating capacity. This generated electricity will be sold to CSEB grid who are the only state wide grid in Chhattisgarh state for distribution of electricity.

The fuel proposed is biomass like rice husk which is abunduntantaly available in Raigarh District and adjoining areas of Chhattisgarh and Orissa state where the project activity is situated. As the farmers in the state grow two crops of rice in a year as the state receives rains from both the monsoons; the rice husk availability is through out the 12 months of the year. Other biomass which can be used are like wood chips; agricultural residues; bushes, de-oiled cakes of Sal seed and Dori seed and other de-oiled cakes which do not have any economically valuable use other than combustion.

Rice Husk quality procured for generation of electricity may not be consistent and hence it is proposed to use small percentage of fossil fuel like coal to ensure consistent generation of electricity. We estimate that 5-10% fossil fuel is likely to be co-fired. *The Ministry of Non-conventional Energy sources (Power Group) has given the provision for using fossil fuel upto 25% along with primary fuel biomass.*

RREPL will generate electricity and supply to CSEB grid which meets the demand of its consumers for electricity by producing and importing electricity from power stations generating electricity based on fossil fuel. Hence the project activity displaces the electricity from CSEB distribution system that would have otherwise been supplied by fossil fuel fired power generating units. Hence achieves reduction in GHG emissions indirectly.

The main activity of RREPL will be to produce electricity and sell it to Chhattisgarh state electricity board (CSEB) as CSEB is the only available state wide grid network and statutory agency to distribute power within Chhattisgarh state.

A power supply Agreement will be signed with CSEB by RREPL for supply of 14 MW power to CSEB.

The main carbon benefit to the project arises from the replacement /displacement of an equivalent amount of electricity which would have been generated in the absence of this project activity. The CSEB grid electricity has high carbon intensity as 85% power drawn into the grid is from coal based generation.

The total emission reduction for the entire crediting period of 10 years have been calculated as 596420 Tonne CO_2 –equivalent. The other benefits being reduction of GHG emissions considering global scenario, Sustainable development through better energy efficiency and also leads to improvement of local environment.

The Project activity achieves the following goals.

- Utilisation of Biomass like rice husk which would be wasted otherwise and allowed to either decay and/ or burn in open or partially used inefficiently to generate heat in small or mini industries.
- Generation of eco friendly green power
- Meet the power requirement, even though in small way, of CSEB which has power shortage and CSEB has to import electricity from other sources
- Helps CSEB to become eco friendly and become less dependant on fossil fuel generated electricity.
- Upgraded technology to achieve sustainable Industrial growth in State.
- Conserve natural resources and environment.
- Reduce the disparity between demand and supply of grid electricity.
- Reduction of CO2 emissions and other GHG emissions.
- Reduces the fugitive-uncontrolled combustion of Rice Husk at Sporadic location, which cause local environmental problem.
- Fetches fair economic return to the farmers and National Economy, otherwise waste biomasses which are not fetching any value economically.

View of project participant towards the contribution of the project activity to sustainable development.

The project activity will lead to sustainable development and promote sustainable Industrial growth by conserving natural resources like coal and producing green power which is the most important requirement for growth of economy.

Reduces the fugitive-uncontrolled combustion of Rice Husk at Sporadic location, which cause local environmental problem.

SOCIAL BENEFIT TO STATE

The small farmers who grow paddy have made India self sufficient in food .But due to rising price of input like of fertilisers; seeds etc the farmers do not realise proper returns for their efforts.

The project activity adds income to the farmers by providing added economic value to the produce of farmers by procuring rice husk from the rice mills, which they would have otherwise burnt or left in open to natural decay. This will definitely help the millers to pay

better price to the farmers for their paddy crop. This will lead to overall development of society in economic health; education etc.

At procurement price of rice husk @ Rs 1000/Tonne and procured quantity of rice husk of 98223 tonnes/year will fetch the total earning of 98 million rupees which will definitely make significant contribution to the income of farmers.

The rice husk transportation to site will provide employment opportunities to a number of trucks and other similar vehicles will be making trips to project site throughout the year. This will increase the transport related income and employment.

The transportation earning of biomass which involves 9820 trips of 100 kilometer average distance is likely to generate an income of approx Rs.19 million

At current consumption rates, CSEB projects Power deficiency between generating capacity and demand in supply of electricity from grid leading to import of power from central grid and others. The project shall enable the CSEB to satisfy more consumers leading to more employment for skilled and professional people in the state,

The project activity shall provide direct employment to 200 temporary workers during project execution. After commissioning, it will provide employment to at least 50 unskilled; 25 skilled workers and 10 professionals.

Economical Benefits to State.

The sale agreement between RR ENERGY and CSEB shall provide for 100% generated power to be sold to CSEB at the rate of Rs.2.67 per unit (these rates have been raised from Rs.2.25/KWh at present and shall be applicable to the project). This is substantially lower than CSEB charges for their HT customers. Hence CSEB is likely to generate Rs.50.00 million profits due to this deal at reasonable assumption that the board will save Rs.0.50 to Rs.1.00 per unit.

The project activity invests more than 400 million rupees in green field project. This will lead to overall economic growth of state economy and also state will earn by way of sales tax and other applicable levies.

Environmental Benefit:

The Power generation in India / Chhattisgarh is mainly fossil fuel Coal based.

The Project activity uses `Biomass based Power Plant and thus effectively saving environment of CO_2;NO_X;CH_4 emission.

Reduces the fugitive-uncontrolled combustion of Rice Husk, at Sporadic location, which cause local environmental problem.

The adoption of new advanced air cooled technology for cooling and condensing of turbine exhaust steam will help to save water resources and reduce water wastage.

Reduction in T & D Losses of Power

CSEB State grid has almost 37%T & D losses. The Power generated by Project activity is much nearer to industrial belt of Chhattisgarh state where power demand is maximum. This will enable CSEB to cut down T&D losses by supplying power received from this project activity to near by area consumers. The approximate saving to CSEB may be up to Rs.18.00 million.

Reduction in Waste Water .

The Water consumption and Waste Water generation will be minimised by using the advanced Air Cooled condenser system. The generated waste water will be used for in house activities like fire fighting, road sprinkling for fugitive dust emission Control, and green belt development etc.

Reduction in SPM level in the environment and additional Economic benefit.

ESP (Electrostatic Precipitator) provided shall arrest the ash which will be collected in Ash hoppers. This Ash will be given free of cost to cement plants & brick manufactures for further Economic benefit.

Use of Ash in Cement making will save the Natural limestone resources. Similarly production of Ash bricks will help to reduce the fertile soil consumption, used in clay brick making.

Saving of foreign exchange

The project activity does not involve any imports involving foreign exchange since most capital equipment is manufactured in India. This contributes to national policy of self reliance.

Indian industry growth

The project activity is green field project and hence investment of 424 million rupees involves capital equipment purchase of 360 million rupees from all India level and hence will lead to growth of capital equipment manufacturer adding employment opportunities to professionals and workers.

Technology up gradation

The project activity uses the latest technology in the equipment design construction and specifications.

A.3. Project participants:

>>

Name of the Party Involved (host) host party	Private and/or Public entity (es) Project Participant as applicable	Kindly indicate if the party involved wishes to be Considered as project participant (Yes/ No)
India (host) Ministry of Environment and Forest	Public entity	No
	RR ENERGY RIVATE LIMITED - Private Entity	Yes

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

>>

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

>>

A.4.1.1. Host Party(ies):

>>

India

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

>>

Chhattisgarh State

A.4.1.3. City/Town/Community etc:

>>

Garh Umaria , Darramuda ; Raigarh District, Chhattisagarh state

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

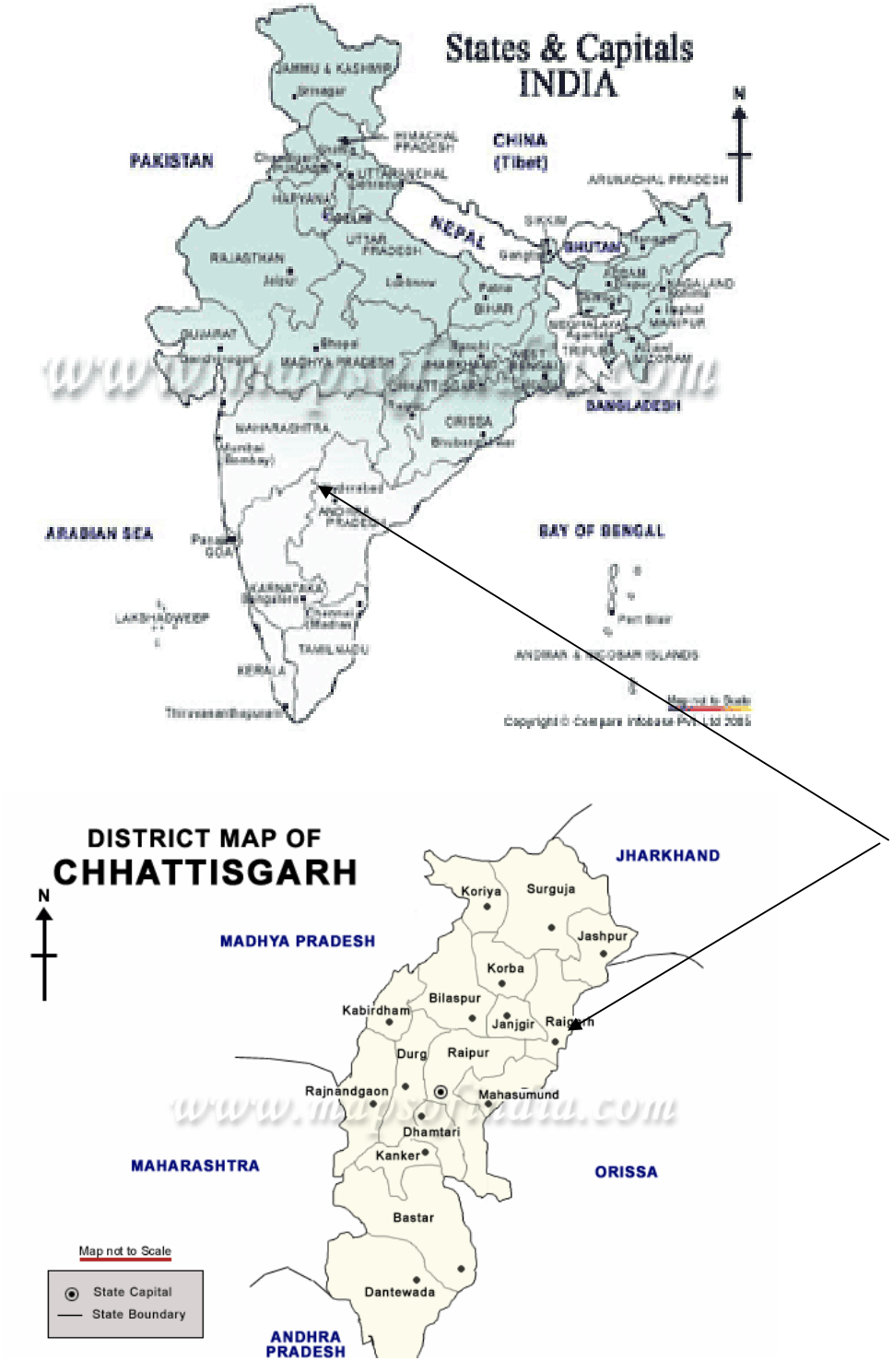
>>

Physical location :

Project activity is located at Village-Garh Umaria , Darramuda; Raigarh District of Chhattisagarh State at about 8 Kilo meters from Raigarh city on the Jharsuguda Road.

Unique identification :

Longitude 85 degree 24.5 minutes East ; Latitude 21 degree 51.2 minutes North. This is the only major industry located in the village Garh Umaria, Tahsil- Raigarh, District- Raigarh, which is located 8 Km away from the Raigarh on Raigarh- Jharsuguda connecting Hi-way. There is no other major plant or Industrial unit in this village. The Kirodimal Institute of Technology is located at about 1 Km distance before the project site.


States & Capitals
INDIA
N
PAKISTAN
CHINA
(Tibet)
NEPAL
BHUTAN
BANGLADESH
ARABIAN SEA
BAY OF BENGAL
ANDHRA PRADESH
ORISSA
MAHARASHTRA
DISTRICT MAP OF
CHHATTISGARH
JHARKHAND
MADHYA PRADESH
Koriya
Surguja
Jashpur
Korba
Bilaspur
Kabirdham
Janjgir
Raigarh
Durg
Raipur
Rajnandgaon
Mahasumund
Dhamtari
Kanker
Bastar
Dantewada
Map not to Scale
State Capital
State Boundary

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

>>

In line with paragraph 6I of decision 17/CP.7 on the modalities and procedures for the CDM, and 'Appendix B' of the simplified modalities and procedures for small-scale CDM project activities; "Indicative simplified base line and monitoring methodologies for small-scale CDM project activity categories" of Annexure II to decision 21/ CP.8 . The applicable type and category is :

Type-I RENEWABLE ENERGY PROJECTS
Category I.D. Grid connected renewable electricity generation
I.D./ Version 08 Scope ## 03 March 2006

1. This category comprises renewable energy generation units, such as photovoltics, hydro, tidal/wave, wind, geothermal and renewable biomass, that supply electricity to and /or displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generation unit.
2. If the unit has both renewable and non renewable components; the eligibility limit of 15 MW for a small-scale CDM project activity only applies to the renewable component. If the unit added co fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.
3. Biomass combined heat and power (co-generation) system that supply electricity to and/or displace electricity from a grid are included in this category. To qualify under this category, the sum of all forms of energy output shall not exceed 45 $MW_{thermal}$. E.g. for a biomass based co-generating system the rating for all the boilers combined shall not exceed 45 $MW_{thermal.}$
4. **Project activities adding renewable energy capacity should consider the following cases:**
   1) **Adding new units;**
   2) **Replacing old units for more efficient units.**

   To qualify as a small scale CDM project activity, the aggregate installed capacity after adding the new units (case 1) or of the more efficient units (case 2) should be lower than 15 MW.
5. **Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category. To qualify as a small scale project, the total output of the modified or retrofitted unit shall not exceed the limit of 15 MW.**

How the project activity conforms with the project type and category selected

1. Project activity proposes to generate 14 MW electricity using renewable biomass like rice husk
2. Project activity proposes to sell the 14 MW electricity generated to CSEB grid electricity distribution system which distributes electricity generated from fossil fuel based power plants to the extent of 85%. CSEB generates 62% of the electricity distributed in Electricity distribution system from CSEB owned three coal based generating plants and balance power is imported from other sources which are also mainly fossil fuel fired generation units.

3. Rice Husk quality procured for generation of electricity may not be consistent and hence it is proposed to use small percentage of fossil fuel like coal to ensure consistent generation of electricity. We estimate that 5-10% fossil fuel is likely to be co-fired. However electricity generated from the project activity will not exceed 14 MW.
4. Project activity is only for renewable electricity generation and not co-generation type.
5. Project activity is a new unit, green field project activity and the project activity does not seek to retrofit or modify any existing facility.
6. Hene our project activity confirms to type I.D. and in accordance to point No.3 under technology/ measure of approved methodology.

Hence the small-scale project activity conforms to selected project category

Demonstrate that capacity of the project activity will not increase beyond 15 MW

RREPL will ensure that capacity of the proposed small scale project activity will not go beyond 15 MW due to following reasons:

1. A board resolution passed by the Board of the Directors of the company restricts that the capacity of the plant will not be increased beyond 15 MW during the entire credit period. This will be binding RREPL not to enhance its power generation capacity.
2. The licensed capacity sanctioned by CREDA of Chhattisgarh government is only for 15 MW. Any increase requires fresh sanction/ licence, which may not be available due to commitment of RREPL.
3. Technologically, installed equipment like boiler and steam turbo generator have the capacity to generate 14 MW power and hence, it will not be possible to generate more than 14 MW power .
4. The generated electricity will be sold to CSEB grid and the units sold will be monitored by CSEB grid who are government agency and pay for the electricity received at fixed rate per unit of electricity i.e KWh and hence the electricity generated and sold is easily monitored by government sanctioning authorities. The present agreement for power selling with CSEB grid will be for 14 MW and hence additional power generation will need fresh agreement with CSEB.
5. RREPL will put in place a very reliable and transparent monitoring of electricity generation in line with small scale CDM monitoring methodology.

Technology of small scale project activity

The biomass is mainly rice husk. However the boiler is designed to take other type of biomasses like crop residues and bushes.

The electricity generating system comprises of

1. Stroker fired furnace
2. Fluidised bed type boiler
3. Steam drum
4. Super heater
5. 14 MW STG electromagnetic induction type
6. Air cooled condensers

7. De-mineralised water plant
8. Fuel handling system
9. Ash handling system
10 Air dryer etc.
11. Air preheater and Economizer.

The biomass is burnt in fluidised bed boiler where sand is used as inert bed to produce 62T/hr of steam at 66 kg/ cm^2 pressure and 490±5^{0}C temperature.

Rice Husk quality procured for generation of electricity may not be consistent and hence it is proposed to use small percentage of fossil fuel like coal to ensure consistent generation of electricity. We estimate that 5-10% fossil fuel is likely to be co-fired.

The outlet box of the FBB leads to ESP to remove SPM from exhaust gases. The exhaust gas temperature is kept at 160^{0}C or lower.

The steam from boiler at 66 kg/cm^2 pressure and 490^{0}C temperature is taken to high efficiency extraction cum condensing multi stage Steam Turbine and Generator (STG) and operated to generate 14 MW Electricity.

Ash collected from hoppers & ESP is conveyed to Ash Silo. The ash will be given free to cement plants and brick manufactures as well as to the farmers, who also use it as Soil amelioration agent.

Other system used is circulating water, Demineralised water plant, Instrument Air Compressor; air dryer.

Steam from FBB passes through steam turbine rotor and exhausted in water cooled condenser and water is cooled air cooled heat exchanger.

Only Demineralised water is used in FBB to avoid Scale formation on boiler tubes. Make up DM water is de-aerated.

Total Waste water is recycled and reused after treatment.

The 14 MW power will be generated at 11 KV and shall be boosted to 33 KV to synchronise with the CSEB grid power. The entire 14MW power after using a part of 14 MW for in-house consumption for equipment will be sold to CSEB grid who will further distribute to their consumers.

The technology is environmentally safe and abides all legal norms and standards for SPM, emissions.

The project activity will be working 330 days in a year .

The project activity uses environmentally safe and sound technology by providing the following features during the project stage only

1. Air cooled heat exchanger is used to cool the circulating water. This reduces water wastage and losses that would have occurred in water based cooling tower.
2. The conveying of biomass in the plant to boiler will be done through closed type conveying system.

3. The ash generated will be collected and conveyed to the closed silo so that no ash will be affecting the environment.
4. The boiler uses latest technology and controls so that maximum heat will be recovered.
5. ESP will be provided to control point sources emissions below accepted standards
6. The waste water will be used for green belt irrigation.

There is no know-how transfer involved to the host party as all equipments and technology is indigenous.

A.4.3. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed small-scale project activity, including why the emission reductions would not occur in the absence of the proposed small-scale project activity, taking into account national and/or sectoral policies and circumstances:

>>

The project activity will generate 14 MW power using the biomass based steam generating system and sold to CSEB grid who will supply this power to their consumers. In the absence of Project activity, the equivalent power would be generated in fossil fuel based power plants connected to CSEB grid. The grid power is 85% thermal; that is fossil fuel based . As the project activity generates power based on renewable biomass and the power generated is actually and effectively reducing the demand on CSEB grid (generation), the CO_2 emission reduction is achieved in reduction of corresponding CO_2 emission in CSEB power.

This project activity is carried out by RREPL while there exists no legal binding for power generation to use biomass which otherwise would have been allowed to decay or burnt as waste or may be used by some consumers in utilising the heat in most inefficient manner for purposes other than electricity generation. The project activity is over and above national or state requirement.

The project activity is carried out by RREPL by overcoming the barriers explained in section B 3

However, in spite of all the barriers, RREPL has decided to conduct the project activity BIOMASS based power plant.

The project activity will generate an estimated annual average of 59642 tonnes CO_2 emission reduction.

A.4.3.1 Estimated amount of emission reductions over the chosen crediting period:

>>

Chosen credit period = 10 years.

2006-2007	59642
2007-2008	59642
2008-2009	59642
2009-2010	59642
2010-2011	59642
2011-2012	59642
2012-2013	59642
2013-2014	59642
2014-2015	59642
2015-2016	59642
Total estimated reduction	596420
Total numbers of crediting years	10
Annual average over the crediting period of estimated reduction	tonnes CO_2 e 59642

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

>>

No public funding from parties included in Annex-I is available for the project activity

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

>>

As per appendix "C" to the simplified modalities and procedures for small scale CDM project activities, debundling is defined as fragmentation of a large project activity in to smaller parts. A small scale project activity that is a party of large project activity is not eligible to use simplified modalities and procedures for small scale CDM project activities

A proposed small scale project activity shall be deemed to be a de-bundled component of 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.
* Registered within the previous 2 years;
* whose project boundary is within 1 KM of the project boundary of the proposed small-scale project activity at the close point.

This small scale project activity does not fall under the de-bundled category as:

1 . RREPL is not having any other registered CDM activity any where and also they have not applied for Registration for CDM project activity as a party of any other large project activity for any other project activity.

2. There is no biomass based electricity generating unit within 1 kilometer of this small scale project activity.

3. This project activity is totally green field and RREPL is established with the aim of producing 14 MW electricity from rice husk and to sell electricity generated to CSEB grid.

Hence this project activity is not a de-bundled component of larger project activity.

SECTION B. Application of a baseline methodology:

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

>>

Applicable baseline methodology

In line with paragraph 6(c) of decision 17/CP.7 on the modalities and procedures for the CDM, and 'Appendix B' of the simplified modalities and procedures for small-scale CDM project activities; "Indicative simplified base line and monitoring methodologies for small-scale CDM project activity categories" of Annexure II to decision 21/ CP.8 .

Type-I RENEWABLE ENERGY PROJECTS
Category I.D. Grid connected renewable electricity generation I.D./ Version 08 Scope ## 03 March 2006

B.2 Project category applicable to the small-scale project activity:

>>

In line with paragraph 6(c) of decision 17/CP.7 on the modalities and procedures for the CDM, and 'Appendix B' of the simplified modalities and procedures for small-scale CDM project activities; "Indicative simplified base line and monitoring methodologies for small-scale CDM project activity categories" of Annexure II to decision 21/ CP.8 . The applicable type and category is :

Type-I RENEWABLE ENERGY PROJECTS
Category I.D. Grid connected renewable electricity generation
I.D./ Version 08 Scope ## 03 March 2006

1. This category comprises renewable energy generation units, such as photovoltics, hydro, tidal/wave, wind, geothermal and renewable biomass, that supply electricity to and /or displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generation unit.
2. If the unit has both renewable and non renewable components; the eligibility limit of 15 MW for a small-scale CDM project activity only applies to the renewable component. If the unit added co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.
3. Biomass combined heat and power (co-generation) system that supply electricity to and/or displace electricity from a grid are included in this category. To qualify under this category, the sum of all forms of energy output shall not exceed 45 $MW_{thermal}$. E.g. for a biomass based co-generating system the rating for all the boilers combined shall not exceed 45 $MW_{thermal}$.
4. Project activities adding renewable energy capacity should consider the following cases:
   a. Adding new units;
   b. Replacing old units for more efficient units.

   To qualify as a small scale CDM project activity, the aggregate installed capacity after adding the new units (case 1) or of the more efficient units (case 2) should be lower than 15 MW.
5. Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category. To qualify as a

small scale project, the total output of the modified or retrofitted unit shall not exceed the limit of 15 MW.

Justification of the choice of applicable baseline calculation for the project category:

In paragraph 9 of the above methodology, the baseline is defined as follows:

The base line is the KWh produced by renewable generating unit multiplied by an emission coefficient calculated in transparent and conservative manner as:

a) the average of approximate operating margin and build margin where

a1) the average emission is the weighted average of all generating sources serving the system; excluding hydro; geothermal; wind; low cost biomass; nuclear and solar generation

a2) the build margin is the weighted average emissions of recent capacity additions to the system, which capacity additions are defined as greater of most recent 20% of existing plants or 5 of the most recent plants

OR

b) The weighted average emissions in current generation mix.

c) Approximate operating margin emission factor and the weighted average emission factor can be calculated using either of the two following data vintages for years(s) y;

- **Option 1:**
  A-3 year average, based on the most recent statistics available at the time of PDD submission.
- **Option 2**
  The year in which project generation occurs, if emission factor is updated based on ex post monitoring.

d) Build margin emission factor can be calculated using either of the following data vintages for years(s) y:

- **Option 1**
  Most recent information available on plants already built at the time of PDD submission.
- **Option 2**
  For the first crediting period, emission factor is updated based on ex-post monitoring. For subsequent crediting periods, Emission factor should be calculated ex-ante, as described in option 1 above.

The baseline described above is applicable to the small- scale project activity, as it is electricity generation using bio-mass, which are carbon neutral as the emission would have occurred any way as the biomass will be dumped and/or allowed to decay and or burnt in un-controlled manner for purposes other than electricity generation. Hence the 14 MW power generated and connected to CSEB grid would be considered as carbon neutral and electricity delivered to grid by the project would otherwise

been generated by the operation of grid connected power plants and or by the addition of new generation sources which are fossil fuel fired thermal power plants.

Hence the project activity displaces the GHG's emissions of the CSEB grid electricity distribution system. This demonstrates that selection of the applicable baseline as above is justified for small scale project activity. The calculation of grid emissions is explained in section **B.5.**

Basic assumptions of baseline methodology and how the project activity meets the applicability conditions

We explain below the basic assumptions of the base line methodology.

1. Project activity generates electricity and connected to CSEB grid.
2. Project activity is based on biomass based boiler and STG to generate 14 MW electricity which will be sold to CSEB grid who will further supply electricity to their consumers.
3. The biomass used is mainly rice husk and wood chips. If required there is provision to use other agricultural residues like crop residues, non-edible oil cakes and bushes.
4. Rice Husk quality procured for generation of electricity may not be consistent and hence it is proposed to use small percentage of fossil fuel like coal to ensure consistent generation of electricity. We estimate that 5-10% fossil fuel is likely to be co-fired.
5. In the absence of project activity, the biomass will be dumped and /or allowed to decay and burnt in uncontrolled manner for non electricity generation.
6. In the absence of Project activity, the electricity requirement of CSEB consumers to the extent of 14 MW would be met by CSEB grid by drawing power from fossil fuel based power plants.
7. There is no legal binding that biomass shall be used for small power generation plants. The Project activity is being implemented as an economic activity.
8. The project activity will not generate more than 14 MW electricity during the entire crediting period of CDM project.
9. The project activity generates renewable electricity. This activity is not a co-generating type.

Hence it is established that the project activity meets the conditions set out in the approved methodology

How methodology is applied in the context of project activity.

The approved methodology is applied as follows

1. Small-scale project activity generates electricity based on renewable biomass
2. Project boundary considered will be the physical; geographical site of renewable electricity energy generation source
3. The base line is the weighted average emission in kg CO2 equ. / KWh of the current CSEB grid generation mix, in line with Option (b)

4. As no energy generating equipment is transferred from another activity or no existing equipment is transferred to another activity leakage considered as zero
5. Monitoring shall consist of the electricity generated by the renewable technology. The co-fired fossil fuel consumption as well as the renewable biomass consumption is monitored.

Key information and data used for biomass availability

[A] **As per official records of Chhattisgarh State and Orissa State:**

As per the official records available from the Agriculture department and other related departments of Chhattisgarh Govt. The following Data is available regarding the cultivated area of different crop and their potential yield during the year 2004-05 and for the future years.

These data reveal the following facts:

I. Cropping Pattern in the adjoining area of the Project in Chhattisgarh State

PADDY 2004-05

S.No.	District	Khariff Season		Productivity Kg/Hect.
		Total Yield		
		Cultivation Area In thousand Hect.	**Production** In thousand tonnes	
1)	Raigarh	370.70	212.00	1749.00
2)	Janjgir Champa	459.67	227.00	2025.00
3)	Jashpur	260.00	152.00	1711.00
4)	Korba	180.98	95.00	1905.00

The average yield recorded in Khariff season for Paddy was 1504.33 Kg/Hectare and in Rabi season it is more than 3000 Kg/Hectare. Accordingly the total Paddy production in the area is 1271350 tonnes/years in Kharif Season. There is about 13360 Hectare in Rabi crop also. Which yields @3250 Kgs/hectare yielding about 43420 tonnes of Paddy in this Rabi Season. Thus the total annual paddy production in this area is about 1314770 tonnes. Considering the Husk generation of 22% the total husk production in the region is 289249 tonnes. In addition to this it is reported that about 2% of the crop harvested by the farmers generates immature or seed less Pods, which is called "Badara" in local language. The farmers have not been collecting this material, as there is no economic value or return to them. Whereas these pod, have as good or the better heating value than the Rice Husk. On commissioning of this plant, the likely collection of this crop waste also will take place. The likely collection of this crop waste @ 2% of the total Paddy production, hence this area has the potential to generate 26295 tonnes of Badara (Immature Paddy) also.

Thus the total Rice Husk available in the above mentioned area of Chhattisgarh State within 100 KM of the project site can be considered as 315544 Tonnes/Years.

In addition to the above the availability of Paddy and Rice Husk from the adjoining districts (within 100 KM Radius) of Orissa State namely Bargarh, Sambalpur and Jharsuguda also is very large. Because in the district of Sambalpur, Jharsuguda and Bargarh the major crop is Paddy, which is grown twice in a years and some farmers also grow thrice in a year. This has been possible because of Mahanadi Reservoir and Irrigation facility created in that region. The reported Paddy Production in these three districts of Orissa are given below (during 2002-03) only.

Kharif Season:

S.No.	District	Total Yield in Tonnes	Area (Hectare)
1)	Bargarh	587693.90	297530.00
2)	Jharsuguda	55001.60	50839.00
3)	Sambalpur	220859.60	124292.00
		863555.10	472661.00

The Rice Husk generation from 863555.10 tonnes of Paddy @22% husk will be 189982.00 tonnes/year only in Kharif. The data for Paddy production in winter and summer crop is not available from official sources. However it is learnt from the field sources that the Paddy production in these two seasons also is equivalent or more than Kharif season. Thus the availability of Rice Husk from the adjoining districts of Orrisa (within 100 KM radius of the plant) can safely be assumed @380000 tonnes/year.

The actual sources of Rice husk are the Rice mills which procure the Paddy and hull it to Rice. There are 126 Rice Mills within 100 KM area of the plant only in the Chhattisgarh State from whom more than 1736 tonnes/day Rice Husk is available; which makes the availability of Rice Husk to more than **572880 tonnes/year**. The excess capacity of Rice Husk generation in the area is basically due to inflow of Paddy in the area from adjoining districts of Orissa, where Paddy production is in huge quantity and in excess than their actual milling capacity.

CHARACTERISTICS OF RICE HUSK

%	Rice Husk
Carbon	36.1
Hydrogen	4.0
Oxygen	31.82
Moisture	10.0
Sulphur	0.08
Ash*	18.0
Nitrogen	0.40
GCV (kcal/kg)	3150

* Ash has 92 – 95 % silica.

Calculation of Rice Husk requirement

Requirement of steam turbo generator to produce 14 MW Power	:	62000 Kgs/hr At 64.8 Kg/cm^{2}g and 490^{0}C.
Steam generated in Boiler	=	62000 Kgs/hr At 66.0 Kg/cm^{2}g and 495^{0}C
Enthalpy of Steam at 66 Kg/cm^{2}g and 495^{0}C temperature = enthalpy of steam at 66 KG/cm^2 & 495^{0}C – Enthalpy of boiler feed water as 66 KG/cm^2 & 150^{0}C	=	2770 KJ/Kg)
	=	661.60 K cal/Kg
Boiler efficiency	=	84%
Rice Husk required to be burnt per Kg of steam generation.	=	0.25 Kg/Kg
Steam generated	=	62000 Kgs/hr
Rice Husk required	=	15500 Kgs/Hr.= 15.5 Tonnes/hr.
Rice Husk required per Annum (to produce 14 MW power in 100% PLF)	=	15.5 Tonnes/hr. X 330 day X 24 hrs
	=	122779.14 Tonnes/Annum considered
Rice Husk required per Annum (at 80% PLF)	=	98223 Tonnes/Annum.
Available Rice Husk	=	**572880** Tonnes/Annum,

Hence it is established that the rice husk is abundantly available in the area.

Procurement of Rice Husk & Other Biomasses:

Rice husk will be procured from rice mills spread across the study area of 100 KM. The purchase contracts will be signed for major quantity with rice mills FOR ensuring the continuous supply of rice husk. Other biomasses if required have to be sourced from wide spread area as availability is un-organised and hence special efforts have to be made to procure the other biomasses as and when required.

The total number of rice mills in the area are 126 and the milling capacity is 248 tonnes/day. The rice husk produced is 1736 tonnes per day (573000 tonnes/annum). Project requirement is 98223 tonnes/annum. Hence the available rice husk with the rice mills are almost 5 times of the requirement of the project activity.

Storage

Since the Rice Husk is available from the Rice Mills throughout the year. Because most of the Mills operate throughout the year due to the Double cropping of Paddy in the Area. A huge quantity of Paddy is also available to these Rice Mills from the adjoining area of Orissa from Sambalpur, Jhasuguda, Sundargarh and Bargarh area, where the Paddy cultivation is even taken up in three crops. The area has intensive Paddy cultivation due to the irrigation facility from Mahanadi Reservoir at Sambalpur. Thus huge storage is not required.

It is proposed to store 10 day requirement of rice husk in sheds (approx. cap : 5000 MT). Open area also will be used during non-monsoon months as biomass storage.

B.2.3 Key Information and data used to determine the baseline scenario.

1. CSEB grid Electricity Distribution System, which is supplying the power requirement, has the electricity generation and imports capacities as follows.

SOURCE: CSEB Tariff Petition- 5/2005 FOR (IN TABLE F4)

					2004-05 (Million KWh)
(i)	**Size of Project activity**			:	14 MW (77.616 Million KWh net)
(ii)	**Total Generation from CSEB**			:	
	(a)	**Thermal (Coal based)**			
		Korba (E)-II		:	1254
		Korba (E) –III		:	761
		Korba (W)		:	4781
	(b)	**Hydel Power**			
		Hasdeo Bango		:	409
		Mini micro HPS Korba (W)		:	5
(iii)	**Drawn from Central Share**				
	(a)	**Thermal**			
		NTPC	Korba	**:**	2011
		NTPC	Vindhyachal-I	**:**	210
		NTPC	Vindhyacha-II	**:**	139
	(b)	**Gas**			
		NTPC	Kawas	**:**	-
		NTPC	Gandhar	**:**	-
	(c)	**Nuclear**			
		NPC	Kappa	**:**	71.7
(iv)	**Other Sources**				
	(a)	J.S.P.L 132		:	262
	(b)	J.S.P.L. 221		:	648
	(c)	BALCO		:	39
	(d)	Prakash Industries		:	4
	(e)	Jaiswal NECO		:	55
	(f)	Chhattisgarh Electric Co.		:	1
	(g)	NTPC Vidyut		:	35
(v)	**Others -1 (wind and CPP)**			:	-
(vi)	**Others -2 (Power Trading Corp. and Thermal Power Corp.)**			:	920
	TOTAL			**:**	**11605.7**

As is seen from the above, CSEB has to import the electricity to meet the shortfall in supply and demands.

2. **Section B.5** totally describes how the methodology tools are used to decide the baseline emissions.

3. The Project activity therefore successfully affects emission reductions through the displacement of grid based power generation source in the supply of electricity which would have otherwise been supplied by CSEB grid under baseline scenario in the absence of project activity.
4. Key information and data used are drawn from CSEB Tariff Petition 5/2005; CSEB other official sources, CSERC, CEA DOCUMENTS, & IPCC guidelines, to establish the reduction of CO_2 emissions.

B.3. 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:

>>

It is required to describe how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of registered small-scale CDM activity. The proposed small-scale CDM project activity is designed to generate power from the biomass only. The biomasses are considered as carbon neutral, as if not used in electricity generation would have been dumped and or allowed to decay and burnt in an uncontrolled manner for purposes other than electricity generation and this will have same carbon dioxide emissions as in electricity generation using biomass. The electricity generated by the project activity will be sold to CSEB grid electricity distribution system, who will supply this power to their consumers. Where as in the absence of the proposed small-scale project activity this electricity requirement would have been met by drawing the power from CSEB Grid power which is mainly generated from GHG gas emitting Fossil Fuel (Coal) based Thermal Power generation sources. Hence small-scale CDM project activity displaces the electricity from grid and thus reducing CO2 emissions from the fossil fuel based grid power.

It is required to show as per attachment A to Appendix B; the project activity would not have occurred anyway due to at-least one of the following barriers;

a. Investment barrier: a financially more viable alternative to the project activity would have led to higher emissions
b. Technological barrier: a less technologically advanced alternative involves lower risk due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions.
c. Barrier due to prevailing practice or existing regulatory policy requirement would have led to implementation of a technology with higher emissions
d. other barriers: without the project activity, for any specific reason identified by project participant, such as institutional barriers; or limited information, managerial resources, organizational capacity, financial resources or capacity to absorb new technologies, emission would have been higher

a. Investment Barrier.

1. The variable cost of transportation and collection of rice husk is estimated at Rupees 350 to 700 per tonne and procurement cost will be Rs.500 to 1000 per tonne and hence landed cost of rice husk will be average Rs. 1225 per tonne as compared to coal landed cost of Rs.600 per tonne (source: CSEB Tariff Petition 5/2005)

The rice husk prices are likely to increase due to the demand generated by this project activity as the market price always moves up once the requirement is firm, while the coal prices in comparison will remain firm as the prices are normally under control as the established companies are operating the coal mines and the Coal deposits are not as limited as Rice Husk.

2. The cost of fluid bed type boiler is 5 % more than conventional boiler.

3. Hence it can be seen that biomass based power plant has more capital investment and higher fuel procurement cost.

4. RREPL has to bear this additional costs compared to coal based plant. Hence the investment in biomass based power plant faces higher investment barrier.

5. The coal based electricity generation will be more attractive investment wise but coal based electricity generation will lead to additional GHG emissions

The Biomass based power plants do not have any additional major financial incentives other than the CDM benefits in comparison to Coal based Power Plants, whereas the Coal based power plants have the basic advantage of secured long term supply of coal from various Central Government owned Coal mines through linkage and from the private coal mines, as well as by procuring the surplus coal from various industries located in the area. In addition to these the coal based plants can also procure the industrial coal waste such as Char/ dolochar from nearby Sponge Iron plants and Coal middlings and washery rejects from nearby Coal Washeries, at much-much lower rates. Hence the natural profitability is in built with the coal based power plants due to the abundance of coal and reject coal at much cheaper rates than the Biomass. In view of this any Power plant promoting entrepreneur will have natural choice for the coal based power plants.

The other advantage available to a Biomass power plant is only by way of the priority to purchase the power by CSEB at the predetermined rates. The Board was offering Rs.2.25 per KWh to the Biomass Power which has now been revised to Rs.2.67 per KWh. The power purchase rates are fixed by the Regulatory Commission based on the Tariff Petition filed by the Board (CSEB). This also creates an uncertainty in the mind of the promoters about the possible variation in the Tariff. Whereas the coal based power plant can file the Tariff Petition before the regulatory commission and get their tariff fixed according to the fixed norms of the coal consumption, fixed by CEA and in accordance to the variation in coal prices, whereas there is no provision for accommodating the increase in Biomass purchase price while fixing the Tariff of Biomass Power Plant. Whereas a coal based power plant can fetch a better power tariff also than the Biomass based power plant, as it is evident from the CSEB approved Tariff.

b Technological Barrier

1. The renewable energy based power generation constitutes 4.97 % of total power generation in India and Actual biomass based power generation would be less than 1%.

2. Hence the experience on biomass based power plant is limited when compared to coal based power plants.

3. The lack of experience in biomass power plants result in unavailability of skilled personnel to run the plant efficiently.

4. The above acts as technological barrier for biomass project as the unavailability of skilled professional in running rice husk based fluid bed boiler may lead to lower steam generation and hence lower electricity generation in steam turbine generator.

5. Rice Husk Ash has higher Silica percentage than Coal and this is more abrasive than the Coal Ash. Thereby, causing higher abrasive impacts on Bed Tubes and other Boiler parts exposed to it. This requires special technology to manufacture Boiler to withstand to Rice Husk as Fuel.

6. Rice Husk has comparatively lower volatile matter than normal coal used in Power Plants. Thereby making it's full combustion a greater technology barrier and challenge. To over come this also it requires specially designed combustion system.

7. The less technological advanced alternative will be coal based power generation where this barrier will not exist as it is most widely used technology. The coal based electricity generation will be more attractive investment due to the familiarity with the technology, however coal based electricity generation will lead to additional GHG emissions.

c. ***Barrier due to Prevailing Practice***.

1. Historically the power generating plants are coal based as coal is easily available. The project site is in declared coal belt area and as per CSEB projection the coal available in the area is capable of generating 61000 MW electricity.

2. Historically biomass is burnt or allowed to decay as the biomass collection, and transportation is financially not attractive. The reason being the biomass is dispersed in large area and in much larger quantity, than the project requirement.

3. Biomass based power in CSEB grid electricity distribution system is only 2 million KWh while coal based power generation is more than 12000 million KWh

Electricity distribution by CSEB grid	=	12283 million KWh
Power generation from CSEB grid own coal base	=	7974 million KWh
Biomass based power plant owned by CSEB grid	=	Nil
Private owned power supply coal based	=	2467 million KWh
The biomass based generation	=	2 million KWh

Hence coal based power generation is the option selected overwhelmingly, the biomass based power generation is negligible.

OTHER BARRIERS

Operational Barriers.

As RREPL will generate 14 MW electricity and sell the generated power to CSEB grid, any grid failure may result in damages to project activity. CSEB owns no responsibility towards such a damage as per the normal agreement between CSEB and project participant. This involves an additional capital / repair /replacement / maintenance Expense on the project participant.

Any natural calamity like Draught or Flood or Windstorms may affect the Rice Husk availability. This may result into lower capacity operation of the plant.

Regulatory Barrier:

1) RREPL has to sell its generated 14 MW power to CSEB grid, who being government owned agency are the main distributing grid to distribute power in the state of Chhattisgarh.
2) Any agreement with state owned CSEB grid has inbuilt procedural and bureaucratic related barriers involving time and documentation.
3) The agreement is totally in favour of CSEB as grid owner takes no liability for any mishap/losses. Any future/present actions involving all risks /losses to be borne by project participant for any failure of the grid and related back lash on the plant machinery.
4) While CSEB will be making additional income by selling the power through grid, all investment regarding Connectivity has to be borne by project participant

National policies and circumstances of the project activity:

1. There is no law or stipulation either from state or central government that a green field power generation plant has to be based on biomass only.
2. In the absence of Project activity, the biomasses are dumped in open and or allowed to decay or burnt in uncontrolled manner for activities other than electricity generation.
3. The power generated will be sold to CSEB grid whose grid power is mainly fossil fuel based. hence this supply enables CSEB grid to meet its consumer demand with the biomass based power, to the extent of 14 MW supplied by RREPL; thereby the grid can proportionately reduce its fossil fuel based power generation or import.
4. The other alternative would be to install the HSD/GAS based power plant. The HSD based power plant has high capital cost and HSD prices are unsteady and always increasing which makes the project unviable. GAS is not available in this area and hence project has no option of gas to produce 14 MW power. Additionally these alternatives will result in additional GHG emissions.
5. RREPL has no other use of biomass as it is a power generating plant.

Barrier due to being the first project of the Company:

RREPL is a new company established to generate electricity, this is their first project, and hence the establishment of generating plant with biomass will be having many barriers as explained above. All these, would present a challenge to the management as it would have been much easier to establish a coal based power plant.

The above barriers would not have allowed the project activity to occur as the coal based electricity generation would face no such barriers. The Small-scale project activity is being carried out inspite of these barriers.

Hence the project activity is clearly a small –scale CDM project activity.

The project activity becomes financially profitable only after 3 years of operation at 80% PLF, so the RREPL board seriously considered the CDM benefits before selecting biomass based power generation technology and hope to generate profits earlier than 3 years. This can be sustained by extracts of board meeting.

Due to all these factors and uncertainties in rates and availability of Biomass the Bankers have their own reservation to extend the finance to the Biomass Power Project.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the small-scale project activity:

>>

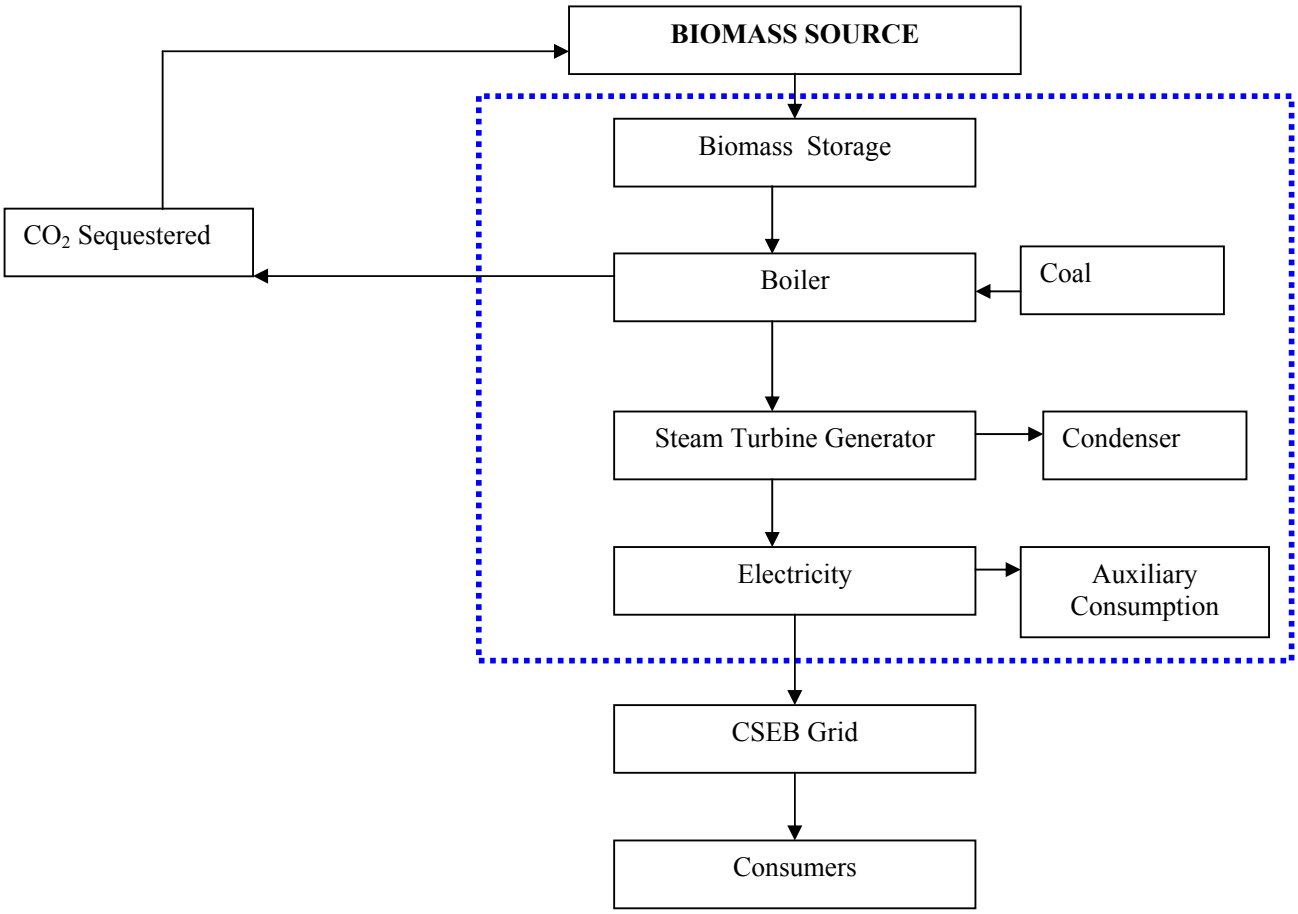
In line with methodology the project boundary encompasses the physical, geographical site of the renewable energy generation source; that is

1. Biomass based fluidised bed boiler to produce steam along with other boiler auxiliary equipment
2. Steam turbine generator and other auxiliary equipment.
3. Power synchronising equipment required for connecting to grid
4. Other equipment which are part of project activity within the physical boundary of site
5. Co-fired fossil fuel consumption of project activity.

Overview on emissions sources included in or excluded from the project boundary.

	Source	GHG Gases		Justification / Explanation
Baseline	Grid electricity generation	CO_2	Included	Main emission source
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Uncontrolled burning or decay of surplus biomass	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Excluded	In line with approved methodology
		N_2O	Excluded	Excluded for simplification. This is conservative. Note also that emissions from natural decay of biomass are not included in GHG inventories as anthropogenic sources.
Project Activity	On-site fossil fuel consumption due to the project activity (stationary or mobile)	CO_2	Included	co-fired fossil fuel consumption.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Off-site transportation of biomass	CO_2	Excluded	In line with the methodology
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Combustion of biomass for electricity and/ or heat generation	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Excluded	In line with approved methodology
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be small.
	Biomass storage	CO_2	Excluded	It is assumed that CO_2 emissions from surplus biomass residues do not lead to changes of carbon pools in the LULUCF sector.
		CH_4	Excluded	Excluded for simplification. Since biomass is stored for not longer than one year, this emission source is assumed to be small.
		N_2O	Excluded	Excluded for simplification. This emissions source is assumed to be very small.

PROJECT BOUNDARY



B.5 Details of baseline and its development

>>

Baseline as per approved methodology: **(Para 9)**

The base line is the KWh produced by renewable power generating unit multiplied by an emission coefficient calculated in transparent and conservative manner as:

a) the average the approximate operating margin and build margin where

a1) the average emission is the weighted average of all generating sources serving the system; excluding hydro; geothermal; wind; low cost biomass; nuclear and solar generation

. a2) the build margin is the weighted average emissions of recent capacity additions to the system, which capacity additions are defined as greater of most recent 20% of existing plants or 5 of the most recent plants

OR

b) The weighted average emissions in current generation mix

c) Approximate operating margin emission factor and the weighted average emission factor can be calculated using either of the two following data vintages for years(s) y;

- **Option 1**:
  A-3 year average, based on the most recent statistics available at the time of PDD submission.
- **Option 2**
  The year in which project generation occurs, if emission factor is updated based on ex post monitoring.

d) Build margin emission factor can be calculated using either of the following data vintages for years(s) y:

- **Option 1**
  Most recent information available on plants already built at the time of PDD submission.
- **Option 2**
  For the first crediting period, emission factor is updated based on ex-post monitoring. For subsequent crediting periods, Emission factor should be calculated ex-ante, as described in option 1 above.

Project activity emission reduction will be calculated by the above method "b" i.e. the weighted average emission in current generation mix based on ex post monitoring for the year in which project generation occurs as per the choice provided in **option-2 of para "c"** by the CDM-EB-23 vide I.D./Version 08, Scope-1, dtd. 03/March 2006.

In order to demonstrate the calculation of likely emission reduction from the project activity, estimation of emission reduction prior to validation, Operating Margin emission factor and the weighted average emission factor have been calculated based on **option 1 of "c"**. This is to indicate the method of calculation, however we opt for **option 2 of "c"** for calculating emission reduction i.e. approximate operating margin emission factor and the weighted average emission factor can be calculated in the years in which project generation occurs, if emission factor is updated based on ex post monitoring. we propose the weighed average emission factor and the calculation of emission reduction will be based on ex post monitoring.

Baseline Development:

Definition of Electric System:

As the electricity to be generated by the proposed project activity is less than 1% of the Chhattisgarh State Electricity Board (CSEB) grid electricity distribution system., hence we propose to take CSEB grid electricity distribution system as our baseline grid electric system. CSEB grid is the only state wide agency, distributing the electricity throughout the state to all types of consumers.

The above system draws power from the following sources:

1. Own generating plants
2. Allocation of power as State Share from Central Sector Power Plants.
3. Surplus power from captive power plants or stand alone power plants within the state.
4. Short term or mid term power purchase from the National Grid sources to meet the shortfall.

CSEB grid electricity distribution System:

(In Million KWh)

Grid Electricity	**2002-03**	**2003-04**	**2004-05**	**2005-06**
CSEB (Own)				
Coal	6858.22	6869.00	6796.00	7974.00
Hydel	276.48	298.00	414.00	432.00
Sub -Total ::	**7137.47**	**7167.00**	**7210.00**	**8406.00**
CENTRAL				
Coal	2855.93	2737.00	2360.00	1843.00
Gas	267.57	-	-	-
Nuclear	290.00	147.00	71.70	27.00
Sub Total ::	**3413.50**	**2884.00**	**2431.70**	**1870.00**
Renewable/ WHRB	255.36	-	-	-
Other Coal	410.89	610.00	1044.00	360.20
Others (1) (Wind/ CPP)	255.36	2.0	-	-
Other (2)	-	728.00	920.00	2106.80
Sub-Total ::	**921.61**	**1340.00**	**1964.00**	**2467.00**
Total ::	**11214.45**	**11393.00**	**11605.00**	**12743.00**

The above sources mainly comprise CSEB electric system.

The short fall in demand of the system is met through power purchase from various sources like:

1) Power Trading Corporation
2) Thermal Power Corporation
3) Other sources.

The quantum of shortfall in power to be purchased depends on the various factor i.e. availability, price and shortage. Therefore it is difficult to predict the quantity of power to be purchased from such sources.

The consumption pattern in the years of 2003-04, 2004-05 & 2005-06 have been taken as reported in Tariff Petition 5/2005-06 of CSEB, while 2003-04 and 2004-05 are actual electricity figures, whereas for 2005-06 are projected figures. For 2002-2003 the figures are sourced from CSEB official documents.

We are required to calculate the baseline emission co-efficient EFy in a transparent and conservative manner as

(a) The average of the approximate operating margin and the build margin where
   i. The "approximate operating margin" is the weighted average emissions (in $KgCO_2$equ./KWh) of all generating sources serving the system excluding hydro geothermal, wind, low cost biomass, nuclear and solar generation.
   ii. The "build margin" is weighted average emission (in $KgCO_2$equ./KWh) of recent capacity addition to the system which capacity additions are defined as the greater (in MWh) of most recent 20% of existing plants or the five most recent plants.

OR

(b) The weighted average emission (in $KgCO_2$equ./KWh) of the current generation mix.

(c) Approximate operating margin emission factor and the weighted average emission factor can be calculated using either of the two following data vintages for years(s) y;
   - Option 1:
     A-3 year average, based on the most recent statistics available at the time of PDD submission.
   - Option 2
     The year in which project generation occurs, if emission factor is updated based on ex post monitoring.

(d) Build margin emission factor can be calculated using either of the following data vintages for years(s) y:
   - Option 1
     Most recent information available on plants already built at the time of PDD submission.
   - Option 2
     For the first crediting period, emission factor is updated based on ex-post monitoring. For subsequent crediting periods, Emission factor should be calculated ex-ante, as described in option 1 above.

Baseline emission co-efficient will be calculated by the above method "b" i.e. the weighted average emission in current generation mix based on ex post monitoring for the year in which project generation occurs as per the choice provided in **Option-2 of para "c"** by the CDM-EB-23 vide I.D./Version 08, Scope-1, dtd. 03/March 2006.

In order to demonstrate the calculation of likely emission reduction from the project activity, estimation of emission reduction prior to validation, Operating Margin emission factor and the weighted average emission factor have been calculated based on **option 1 of "c"**. This is to indicate the method of calculation, however we opt for **option 2 of "c"** for calculating emission reduction i.e. approximate operating margin emission factor and the weighted average emission factor can be calculated in the years in which project generation occurs, if emission factor is updated based on ex post monitoring. we propose

the weighed average emission factor and the calculation of emission reduction will be based on ex post monitoring.

CURRENT GENERATION MIX OF CSEB GRID ELECTRICTY

The consumption pattern in the year of 2004-05 have been taken as reported in Tariff Petition 5/2005-06 of CSEB for calculating current weighted average emission co-efficient.

(i)	**Size of Project activity**			:	14 MW (69.854 Million KWh net)
					2004-05 (Million KWh)
(ii)	**Total Generation from CSEB**			:	
	(a)	**Thermal (Coal based)**			
		Korba (E)-II		:	1254
		Korba (E) –III		:	761
		Korba (W)			4781
	(b)	**Hydel Power**			
		Hasdeo Bango		:	409
		Mini micro HPS Korba (W)		:	5
(iii)	**Drawn from Central Share**				
	(a)	**Thermal**			
		NTPC	Korba	:	2011
		NTPC	Vindhyachal-I	:	210
		NTPC	Vindhyacha-II	:	139
	(b)	**Gas**			
		NTPC	Kawas	:	-
		NTPC	Gandhar	:	-
	(c)	**Nuclear**			
		NPC	Kappa	:	71.7
(iv)	**Other Sources**				
	(a)	J.S.P.L 132		:	262
	(b)	J.S.P.L. 221		:	648
	(c)	BALCO		:	39
	(d)	Prakash Industries		:	4
	(e)	Jaiswal NECO		:	55
	(f)	Chhattisgarh Electric Co.		:	1
	(g)	NTPC Vidyut		:	35
(v)	**Others -1 (wind and CPP)**			:	-
(vi)	**Others -2 (Power Trading Corp. and Thermal Trading Corp.)**			:	920
	TOTAL			::	**11605.7**

Explanation for the electricity imports classified as "Other-2"

The sources indicated in CSEB document Tariff Petition 5/2005 as others-2 mainly comprise of power trading corporation and thermal power corporation. We have used the Central Sector Power Generation Mix to assess the Carbon di-oxide emission factors for the quantum of power purchased shown as others. Because the Power Trading Corporation draws power from any of the nearest available surplus power sources available with it, for supplying the power to the demanding

grid. Hence is it difficult to assess which power generating sources has contributed to the power trading corporations supplied quantity of power to the CSEB Grid System. Therefore the Central Sector average has been considered.

Total Installed Power in Central Sector : 39908 MW

The composition of Central Sector Power generation source are as follows (2004-2005):

Hydel Power	:	6172.0 MW	15.46%
Coal Power	:	26007.5 MW	65.17%
Gas	:	4418.99 MW	11.07 %
Nuclear	:	3310.0 MW	8.3%
Grand Total	**:**	**3998.0 MW**	**100%**

* source – CEA document.

STEP -1 Calculation of simple OM emission factor EM_{OM}, simple y for Grid Electricity for coal fired power plants

Figures in Million KWh

	FY 03	**FY 04**	**FY 05**	**FY 06 (Projected)**
	Net	Net	Net	Net
CSEB	6858.22	6869.00	6796.00	7974.00
Central	2855.93	2737.00	2360.00	1843.00
Others	410.89	612.00	1044.00	360.20
Other 2	-	474.50	600.00	1373.00
Total	10125.04	10690.50	10800.00	11550.00

Step 1.1 Calculations for $EF_{OM,}$ Simple y for CSEB Grid Generated Electricity from coal fired plants Source : CSEB Tariff Petition 05/2005 for 2004-05 to2005- 2006 and CSEB Sources for 2002-03

		F.Y.03**	F.Y. 04	F.Y. 05	F.Y. 06
1.0	**Electricity Generated (Million KWh)**	6858.22	6869.00	6796.00	7974.00
2.0	**Net calorific value (NCVi)**				
2.1.1	For Coal- CSEB sources				
	K cal/Kg	3383.54	3407.63*	3383.54*	3398.72*
	TJ/t (10^{-3})	14.166	14.267*	14.166*	14.229*
2.2	**Net calorific value for Aux. Fuel From IPCC guidelines**				
	TJ/t (10^{-3})	0.04333	0.04333	0.04333	0.04333
3.0	**Fuel Consumption**				
3.1.1	Qty. of Coal (Million MT)				
	CSEB (CSEB Sources)	6.214	6.25	6.158	7.134
3.2	**Quantity of auxiliary Fuel in KL**				
3.2.1	CSEB	13179.569	12818.00	13060.00	12506.00
4.0	**Oxidation Factor $OXID_i$ - IPCC guidelines**				
	Coal	0.98	0.98	0.98	0.98
	Auxiliary Fuel	0.99	0.99	0.99	0.99
5.0	**CO_2 emission factor $EF_{CO2,i}$**				
5.1	**COAL**				
	$EF_{CO2,i}$ tCO_2/TJ IPCC guidelines	94.0	94.0	94.0	94.0
5.2	Auxiliary Fuel $EF_{CO2,i}$ tCO_2/TJ tCO2/TJ IPCC guidelines	73.5	73.5	73.5	73.5
6.0	**COEFi,j t CO_2/ t**				
	Coal	1.3050	1.3143	1.3050	1.3108
	Auxiliary Fuel	3.1529	3.1529	3.1529	3.1529
7.0	**EF_{OM}, simple, y** t CO_2eq **MWH**	**1.1879**	**1.2011**	**1.1879**	**1.1772**
	Coal	1.182	1.196	1.182	1.173
	Auxiliary fuel	0.00545	0.00530	0.00545	0.00445

* The weight averages from the figures available in CSEB Tariff Petition 5/2005-06.

** As the data on calorific value, quantity of fuel not available for 2002-03, we have considered lowest figures of the 2004-05 for this year to achieve lower emission factors.

Step-1.2 Calculations for $EF_{OM,}$ Simple y for imported Central Sector Electricity from coal fired power plants

Source : CEA General Review 2005

		F.Y.03**	F.Y. 04	F.Y. 05	F.Y. 06 (estimated)
1.0	**Electricity Imported (Million KWh)**	3266.82	3823.428	4003.551	3576.17
2.0	**Net calorific value (NCVi)**				
2.1	K cal/Kg	3820	3820	3820	3820
	TJ/t (10^{-3})	15.994	15.994	15.994	15.994
2.2	**Net calorific value for Aux. Fuel From IPCC guidelines**				
	TJ/t (10^{-3})	0.04333	0.04333	0.04333	0.04333
3.0	**Fuel Consumption**				
3.1.1	Qty. of Coal (Million MT)	2.166	2.535	2.654	2.371
3.2	**Quantity of auxiliary Fuel in KL**	639.791	748.800	784.076	700.376
4.0	**Oxidation Factor $OXID_i$ - IPCC guidelines**				
	Coal	0.98	0.98	0.98	0.98
	Auxiliary Fuel	0.99	0.99	0.99	0.99
5.0	**CO_2 emission factor $EF_{CO2,i}$**				
5.1	**COAL**				
	$EF_{CO2,i}$ tCO_2/TJ IPCC guidelines	94.0	94.0	94.0	94.0
5.2	Auxiliary Fuel				
	$EF_{CO2,i}$ tCO_2/TJ IPCC guidelines	73.5	73.5	73.5	73.5
6.0	**COEF i**				
	Coal	1.4733	1.4733	1.4733	1.4733
	Auxiliary fuel	3.1529	3.1529	3.1529	3.1529
7.0	**EF_{OM} simple, y** $t\ CO_2eq$ **MWH**	**0.9774**	**0.9774**	**0.9774**	**0.9774**
	Coal	0.977	0.977	0.977	0.977
	Auxiliary fuel	0.00056	0.00056	0.00056	0.00056

As the data available in CEA General Review is for 2003-04 where fuel consumption figure are provided. We have considered proportionate figure to arrive at fuel consumption for other years.

STEP-2 CALCULATION OF EF_{OM} Simple y for imported power from central sector electricity from Gas based power plants

GAS	FY 03	FY 04	FY 05	FY 06 (Projected)
	Net	Net	Net	Net
CSEB	Nil	Nil	Nil	Nil
Central	267.57	Nil	Nil	Nil
Other 2	-	80.6	102.00	233.00
Total	267.57	80.60	102.00	233.00

The CSEB Tariff Petition 5/2005 doesn't give the break up of sources of power imported from others-2 and hence the Central Sector generation break up is used to workout the above gas based electricity import.

The sources of gas based electricity generation are in central sector and CSEB grid has imported the gas based electricity only during 2002-03. The CEA General Review 2005 covers the fuel consumption data for 2003-2004 and hence the same have been considered for the calculation of emission factors, even though CSEB grid has not imported electricity for other years. As generation figures are not available separately for natural gas and naptha we have considered proportionate electricity generation using the fuel quantity in mass.

Parameters	**Unit**	**Gas**	**Naptha**	**Auxiliary Fuel (HSD)**
NCVi (Net calorific value) Source-IPCC guidelines	Tj/t of fuel	0.04333	0.04501	0.04333
OXIDi Source-IPCC guidelines		0.995	0.99	0.99
EF_{CO2} Source-IPCC guidelines	tCO_2/TJ	56.0	73.0	73.5
COEFi Source-IPCC guidelines	tCO_2/t	2.4143	3.2529	3.1529
Power generated	MWh/Year	4296838.89	2812071.101	7108910.00
Fuel Quantity	Tonnes	726822.00	475669.48	540.90
Emission Factor EF_{OM} simple y	tCO_2/MWh	0.4084	0.5502	0.0002
Average Emission Factor of Naptha & Gas and addition emission due to auxiliary figure	tCO_2/MWh	0.464740535		

STEP-3 Calculation for weighted average emission coeffient of current generation mix

Summary of above calculations EF_{OM} simple, y	= t CO_2eq/MWH
Emission factor for CSEB grid coal generated power	1.187933594
Emission factor for central sector and other sources coal generated power	0.977398334
Emission factor for Other sources gas generated power	0.464740535
Emission factor for CSEB grid hydel generated power	0
Emission factor for central sector hydel generated power	0
Emission factor for central sector nuclear generated power	0

Using above data we calculate the weighted average emission coefficient of current generation mix of CSEB grid electricity (2004-05) EF_y

(i)	**Size of Project activity**			:	14 MW (69.854 Million KWh net)	Emission co-efficient (in $KgCO_2$/KWh or t CO2/MWh)
					2004-05 (Million KWh)	
(ii)	**Total Generation from CSEB**			:		
	(a)	**Thermal (Coal based)**				
		Korba (E)-II		:	1254	
		Korba (E) –III		:	761	
		Korba (W)			4781	
		Sub-Total		::	**6796.00**	1.187933594
	(b)	**Hydel Power**				
		Hasdeo Bango		:	409	
		Mini micro HPS Korba (W)		:	5	
		Sub-Total		:	414	0.00
(iii)	**Drawn from Central Share**					
	(a)	**Thermal**				
		NTPC	Korba	**:**	2011	
		NTPC	Vindhyachal-I	**:**	210	
		NTPC	Vindhyacha-II	**:**	139	
		Sub-Total		**:**	2360	0.977398334
	(b)	**Gas**				
		NTPC	Kawas	**:**	0.0	
		NTPC	Gandhar	**:**	0.0	
		Sub-Total		**:**	0.0	0.00
	(c)	**Nuclear**				
		NPC	Kappa	**:**	71.7	
		Sub-Total		**:**	71.7	0.00
(iv)	**Other Sources (Thermal Coal)**					
	(a)	J.S.P.L 132		:	262	
	(b)	J.S.P.L. 220		:	648	
	(c)	BALCO		:	39	
	(d)	Prakash Industries		:	4	
	(e)	Jaiswal NECO		:	55	
	(f)	Chhattisgarh Electric Co.		:	1	
	(g)	NTPC Vidyut		:	35	
	Sub-Total			:	1044	0.977398334
(v)	**Others -1 (wind and CPP)**			:	0.00	0.00
	Sub-Total			:	0.00	0.00
(vi)	**Others -2 (Power Trading Corp. and Thermal Power Corp.)**			:		
	Thermal- Coal			:	599.4	0.977398334
	Gas			:	101.9	0.464740535
	Nuclear			:	76.3	0.00
	Hydel			:	142.4	0.00
	Sub-Total			:	**920.0**	
	Total Electricity in System			**::**	**11605.7**	
(vii)	**The weighted average emission** $EF_{electricity, y}$ **(in $KgCO_2$ equ./KWh or tCO2/MWh)**			**:**	**1.0369**	

STEP- 4: Determination of KWh produced by the project activity ;net electricity supplied to grid

Installed generation capacity	=	14 MW
ASSUMED PLF	=	0.7
Generated power/annum	=	14 x 330 x 24 x 0.7
	=	77616 MWH
auxiliary consumption	=	10%
net power made available to grid	=	77616 x 0.9 = 69854 MWH

STEP-5 Calculation Of CO_2 Baseline Emissions From Grid

$ER_{electricity, y} = EG_y . EF_y$

Where:

$ER_{electricity, y}$ are the emission reductions due to displacement of electricity during the year y in tons of CO_2

EG_y is the net electricity supplied to CSEB grid
= 69854MWH

$EF_{electricity, y}$ is the CO_2 emission factor for the electricity displaced due to the project activity during the year y in tons CO_2 / MW h. ,= 1.0369 t CO2/ MWH

Thus $ER_{electricity, y}$ = 69854 X 1.0369 = 72431 t C02/anum

LEAKAGE

If the energy generating equipment is transferred from another activity or if the existing equipment is transferred to another activity, leakage is to be considered . as the small-scale project activity is green field project, all the energy generating equipmensts are procured from original equipment manufacturers.

Hence leakage considered as zero (Ly = 0)

Date of Completion of this document 24/12/2005

Name of Entity for contact information

Preparation of this documents has been done by; Indus Technical and Financial Consultants Ltd., whose address is

Shri Lalit Kumar Singhania
Indus Technical and Financial Consultants Ltd
205, Samta Colony,
In front of Shikapuri Panchayat Bhawan
Raipur City, Chhattisgarh State 492001 INDIA
Tel : +91-771-2255186 Mobile : +91 93011 93400 / +91 94252 08189
Fax: +91-771-2254188
Email: indusryp@satyam.net.in

Indus Technical and Financial Consultants Ltd is not a project participant

Details of the Project Participant are as given below:

Organisation	R.R. Energy Pvt. Limited
Street/ P.O. Box	Transport Nagar
Building	65
City	KORBA
State/ Region	Chhattisgarh
Postcode/ Zip	495679
Country	INDIA
Telephone	07759-229374; 98932-88002
Fax	07759-222747
Email	spinltd@sancharnet.in / spinltd@rediffmail.com
URL	
Represented by:	Ramavatar Agrawal
Title	Managing Director
Salutation	Mr.
Last Name :	Agrawal
Middle Name:	
First Name:	Ramavatar
Department:	Management
Mobile:	98932-88002
Direct FAX:	
Direct Tel:	
Personal E-mail	None

SECTION C. Duration of the project activity / Crediting period:

C.1. Duration of the small-scale project activity:

>>

20 Years / 20 Years

C.1.1. Starting date of the small-scale project activity:

>>

April 2004

C.1.2. Expected operational lifetime of the small-scale project activity:

>>

20 Years and 0 months.

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

>>

Fixed crediting period

C.2.1. Renewable crediting period:

>>

Not applicable.

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

>>

Not applicable

C.2.1.2. Length of the first crediting period:

>>

Not applicable

C.2.2. Fixed crediting period:

>>

Fixed crediting period is 10 years.

C.2.2.1. Starting date:

>>

From the date of CDM registration of project activity.

C.2.2.2. Length:

>>

10 years 0 months

SECTION D. Application of a monitoring methodology and plan:

>>

D.1. Name and reference of approved monitoring methodology applied to the small-scale project activity:

>>

Applicable baseline methodology

In line with paragraph 6(c) of decision 17/CP.7 on the modalities and procedures for the CDM, and 'Appendix B' of the simplified modalities and procedures for small-scale CDM project activities; "Indicative simplified base line and monitoring methodologies for small-scale CDM project activity categories" of Annexure II to decision 21/ CP.8 . The applicable type and category is :

Type-I RENEWABLE ENERGY PROJECTS

Category I.D. Grid connected renewable electricity generation

I.D./ Version 08 Scope ## 03 March 2006

1. This category comprises renewable energy generation units, such as photovoltics, hydro, tidal/wave, wind, geothermal and renewable biomass ,that supply electricity to and /or displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generation unit.
2. If the unit added has both renewable and non renewable components; the eligibility limit of 15 MW for a small-scale CDM project activity only applies to the renewable component. If the unit added co fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW
3. Biomass combined heat and power (co-generation) system that supply electricity to and/or displace electricity from a grid are included in this category. To qualify under this category, the sum of all forms of energy output shall not exceed 45 $MW_{thermal}$. e.g. for a biomass based co-generating system the rating for all the boilers combined shall not exceed 45 $MW_{thermal}$.
4. Project activities adding renewable energy capacity should consider the following cases:
   a. Adding new units;
   b. Replacing old units for more efficient units.

   To qualify as a small scale CDM project activity, the aggregate installed capacity after adding the new units (case 1) or of the more efficient units (case 2) should be lower than 15 MW.
5. Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category. To qualify as a small scale project, the total output of the modified or retrofitted unit shall not exceed the limit of 15 MW.

D.2. Justification of the choice of the methodology and why it is applicable to the small-scale project activity:

>>

The approved methodology

	Methodology Steps		Project Activity
1)	Limits to electricity generation from biomass to 15 MW	:	Project activity generates 14 MW from biomass mainly Rice Husk with some amount of co-firing of fossil fuel i.e. coal for consistency in electricity generation.
2)	Covers grid connected electricity generation		Project activity will sell the generated electricity to CSEB grid
3)	the base line is the KWh Power produced by renewable generating unit multiplied by an emission coefficient calculated in transparent and conservative manner as 3.a. the average the approximate operating margin and build margin where a1. the average emission is the weighted average of all generating sources serving the system; excluding hydro; geothermal; wind; low cost biomass; nuclear and solar generation a2 the build margin is the weighed average emissions of recent capacity additions to the system, which capacity additions are defined as greater of most recent 20% of existing plants or 5 of the most recent plants OR 3.b the weighted average emissions in current generation mix 3c) Approximate operating margin emission factor and the weighted average emission factor can be calculated using either of the two following data vintages for years(s) y; • Option 1: A-3 year average, based on the most recent statistics available at the time of PDD submission. • Option 2 The year in which project generation occurs, if emission factor is updated based on ex post monitoring. 3d) Build margin emission factor can be calculated using either of the following data vintages for years(s) y: • Option 1		Baseline emission reduction will be calculated by the above method "b" i.e. the weighted average emission in current generation mix based on ex post monitoring for the year in which project generation occurs as per the choice provided in **option-2 of para "c"** by the CDM-EB-23 vide I.D./Version 08, Scope-1, dtd. 03/March 2006. In order to demonstrate the calculation of likely emission reduction from the project activity, estimation of emission reduction prior to validation, Operating Margin emission factor and the weighted average emission factor have been calculated based on **option 1 of "c"**. This is to indicate the method of calculation, however we opt for **option 2 of "c"** for calculating emission reduction i.e. approximate operating margin emission factor and the weighted average emission factor can be calculated in the years in which project generation occurs, if emission factor is updated based on ex post monitoring. we propose the weighed average emission factor and the calculation of emission reduction will be based on ex post monitoring.

	Most recent information available on plants already built at the time of PDD submission. • Option 2 For the first crediting period, emission factor is updated based on ex-post monitoring. For subsequent crediting periods, Emission factor should be calculated ex-ante, as described in option 1 above.		
4)	**leakage** is to be considered only if the energy generating equipment is transferred from another activity or if the existing equipment is transferred to another activity.		The project activity is green field project with new energy generating equipment bought from equipment suppliers specifically as per requirement of the project activity. Hence leakage considered as Nil.
5)	**monitoring** shall consist of the electricity generated by renewable technology. In the case of co fired plants; the amount of biomass and fossil fuel input shall be monitored,.		The monitoring will be inline with this concept by monitoring the electricity generated by renewable technology. This is biomass based project activity with co-firing of fossil fuel to the extent of 5 to 10%, fossil fuel will be monitored for the quantity & quality.

D.3 Data to be monitored:

ID No.	Data Type	Data Variable	Data unit	Measured, (m) calculated (c) estimated (c)	Recording Frequency	Proportion of data to be monitored	How the data will be achieved electronic / data	For how long is achieved to be kept (Year)	Comment
1. E_{GEN}	Quantitative	Total electricity generated **Location** i) At generating plant	MWH /year	Online measurement (m)	Continuously/ annum	100%	Electronic	12	Monitoring location: meter at plant and DCS will measure the data. Manager In-charge would be responsible for regular calibration of the meter.
2. E_{AUX}	Quantitative	Auxiliary electricity Consumption Location i) At generating plant	MWH /year	Online measurement (m)	Continuously/ annum	100%	Electronic	12	Monitoring location: meter at plant and DCS will measure the data. Manager In-charge would be responsible for regular calibration of the meter.
3. E_{NET}	Quantitative	Net electricity generated from small-scale project activity	MWH /year	Calculated	Continuously /annum	100%	Electronic /Paper	12	Calculated from the above measured parameters. Algorithm for project emission calculation given in baseline methodology. E_{GEN} - $E_{AUX,}$ emission calculations as per baseline methodology.
4. E_{NET}	Quantitative	Net electricity generated from small-scale project activity	MWH /year	Online measurement (m)	Continuously /annum	100%	Electronic	12	The CSEB will install an export meter at the export terminal of the plant which will online record the power exported to the Grid. This will be recorded after deducting all the power consumed in Auxiliary. The CSEB will be regularly checking the calibration of the meter.

Contd.. D.2.3

ID No.	Data Type	Data Variable	Data unit	Measured, (m) calculated (c) estimated (e)	For which baseline method(s) must this element be included.	Recording Frequency	Proportion of data to be monitored	How the data will be archived electronic / paper	For how long is archived to be kept (Years)	Comment
5 EF_y	Emission factor	CO_2 emission factor of the grid	tCO_2eq/ MWH	Calculated (c)	Weighted average of current generation mix.	Yearly	100%	Electronic /Paper	12	calculated weighted average of current generation mix.
6 $EF_{OM,y}$ simple	Emission factor	CO_2 operating margin emission factor of the grid	tCO_2eq / MWH	Calculated (c)	Simple OM	Yearly	100%	Electronic / Paper	12	Calculated as indicated in the relevant OM baseline method above for each fuel used in the grid
7. F i,j,y	Fuel Qty.	Amount of each fossile fuel Consumed by grid and by importing plants/ sources	Tonnes	Measured (m)	Simple OM, BM	Yearly	100%	Electronic / Paper	12	Obtained from CSEB / CEA documents.
8. COEF i,k	Emission factor Coefficient	CO2 emission Coefficient for each by grid and by importing plants/ sources	tCO_2eq / t of fuel	calculated	Simple OM, BM	Yearly	100%	Electronic / Paper	12	Obtained from CSEB / CEA / IPCC.
9. GEN j,y	Electricity Qty.	Electricity generation / import of CSEB grid	MWH /yr	Measured (m)	Simple OM	Yearly	100%	Electronic / Paper	12	Obtained from CSEB documents.

Contd.. D.2.3

ID No.	Data Type	Data Variable	Data unit	Measured, (m) calculated (c) estimated (e)	For which baseline method(s) must this element be included.	Recording Frequency	Proportion of data to be monitored	How the data will be archived electronic / paper	For how long is archived to be kept (Years)	Comment
10. Qi	Fuel Quantity for project activity (1) Biomass (2) fossil fuel i.e. Coal	weight	Tonnes/r	Measures (m)	For calculating project emission	daily	100%	Electronic / Paper	12	To be recorded in the stock books & consumption register of the Company.
11. NCV	Fuel quality (1) Biomass (2) fossil fuel i.e. Coal	Calorific value	K Cal/kg	Measured (m)	For calculating project emission	One sample per batch.	100%	Electronic/ Paper	12	By Govt. recognised laboratory.

D.4. Qualitative explanation of how quality control (QC) and quality assurance (QA) procedures are undertaken:

>>

Data	Uncertainty level of data High/medium / low	Are QA/QC procedures planned	Outline explanation why QA/QC are or are not being planned.
D..3 (1to3)	Low	Yes	This data will be used for calculation of electricity generated by project activity.
D..3 (4 to 8)	Low	No	This data is collected hence no need QA procedures.
D..3 (9) to (11)	Low	No	This data will be required for calculation of project emission.

D.5. Please describe briefly the operational and management structure that the project participant(s) will implement in order to monitor emission reductions and any leakage effects generated by the project activity:

>>

Operation and Management Structure for Monitoring

(A) Purpose

To define the procedures and responsibilities for GHG Performance monitoring, measurement and reporting of data and dealing with uncertainties.

(B) Scope

This procedure is applicable to 14 MW biomass based power project of RREPL, India.

(C) Responsibilities

Shift Engineer (Operations): Responsible for reporting hourly and eight hourly data of the biomass and coal consumption, steam generation. The report is then sent to Manager (O&M)

Manager (O&M) : Responsible for reviewing the monitored parameters on hourly and eight hourly based and presenting through a daily executive summary report, duly signed by himself, to the General Manager (Plant).

Shift Engineer (Electrical)*:* Responsible for taking shift wise meter reading for electricity generation, Auxiliary consumption Export to the Grid and pre-operation of the Shift Report. The report is then sent to the Manager (E&I) for his review on daily basis.

Manager (E&I)*:* Responsible for reviewing the monitored parameters shift-wise and presenting through a daily executive summary report, duly signed by himself, to the General Manager (Plant).

General Manager (Plant): Responsible for summarizing data of Electrical, Mechanical, Process (/operation) Departments and report the same to the Vice President (Power) and CMD (RREPL) on daily basis.

CSEB Personnel: Responsible for monitoring the total power generated by RREPL and certifying the same jointly with RREPL on a monthly basis, for making the payment electricity received by the CSEB grid.

Serial No.	Activity
1.0	**GHG Performance Parameter**
1.1	The monitoring protocol requires RREPL to monitor the following GHG Performance parameters for estimating the emissions reductions from Biomass based power plant: • Gross generation of electricity • Auxiliary consumption of electricity. • Net electricity generation • Fuel consumption (1) for biomass (2) for Fossil Fuel (Coal)
2.0	**Metering System**
2.1	The metering system for the Power plant consist of • External Metering System of CSEB for metering the net export of power (Main meter). • External metering system of CSEB for metering total generation. • In house metering system of RREPL (for metering the generation of power, auxiliary consumption, export to CSEB grid) • Flow meter for steam inlet to turbine. • Temperature gauge for fluidised bed boiler steam. • Pressure gauge for Fluidised bed boiler steam. • Biomass consumption in the boiler to be tallied with the store issuance of the biomass and purchase invoices. • Fossil fuel consumption in the boiler to be tallied with the store issuance of the fossil fule and purchase invoices.
2.2	**In house Metering System of RREPL** RREPL will have an in-house metering system, to monitor the overall performance of the plant. The metering system mainly comprises of three meters. • One in-house generation meters • In-house Auxiliary consumption meter. • In-house export meter (Check meter) The in-house generation meters (or the Energy Meter) will be micro-processor based metering device monitor, the total power generation as well as the net unit of auxiliary electricity consumed by RREPL. The reading of this meter will be used to cross-check the reading of the External Metering System of CSEB. The Shift Engineer (Electrical) shall monitor hourly and eight hourly data on total generation, auxiliary consumption, net electricity available for export. The hourly data will be recorded in the generation log book and the eight hourly data will be

	recorded in the plant log book. The complete and accurate records in the plant log book will be signed by the Shift Engineer (Electrical). Both of these reports will be sent to the Manager (Electrical & Instrumentation) for his review on a daily basis. On the basis of the reported parameters, a complete and accurate executive daily summary report will be prepared and signed by the Manager (Electrical & Instrumentation) and sent to the General Manager (Plant) for proper administration and accounting.
3.0	**Calibration of the Metering System**
3.1	All the metering devices will be calibrated at regular intervals so that the accuracy of measurement is ensured all the time. The meters recording total generation will be calibrated by CSEB with a pre-calibrated meter. The other meters will be calibrated internally as per suppliers calibration schedule following the standard procedures for calibration.
4.0	**Reporting of the Monitored Parameters/ Authority and Responsibility of monitoring and reporting**
4.1	**Metering System of CSEB** The CSEB personnel and RREPL personnel will jointly read the CSEB export meter and generation metering system, for recording the net electricity exported to CSEB Grid and the total generation from the Power Plant on the last day of every month and keep the complete and accurate records for proper administration and accounting. The accuracy of the main meter reading will be substantiated by the check meter reading. In the event that the main metering is not in service, then the check meter shall be used. A monthly report will be prepared based on these joint meter reading, which will be sent to the Vice President (Power) of RREPL. The monthly invoice against the electricity exports to CSEB grid will be based on the monthly reports raised by RREPL/ CSEB jointly. The Shift Engineer (Electrical) shall take daily reading (at 6.00 AM) of the Main and Check meters of the external metering system and shall keep the complete and accurate records in the CSEB reading book (maintained at the plant) for proper administration. The reading will be verified by the Manager (Electrical and Instrumentation) on daily basis and sent to the General Manager (Plant) at the Administrative Building in the plant for his review and for preparing the daily report.
4.2	**In-house Metering System of RREPL** The Shift Engineer (Electrical) shall monitor hourly and eight hourly data on total generation, auxiliary consumption, net electricity available for export. The hourly data will be recorded in the generation log book and the eight hourly data will be recorded in the plant log book. The complete and accurate records in the plant log book will be signed by the Shift Engineer (Electrical). Both of these reports are sent to the Manager (Electrical & Instrumentation) for his review on a daily basis. On the basis of the reported parameters, a complete and accurate executive daily

	summary report will be prepared and signed by the Manager (Electrical & Instrumentation) and sent to the General Manager (Plant) for proper administration and accounting.
5	**Fuel quantity monitoring**
5.1	**Biomass :** The quantity of Biomass will be monitored by (1) Issue records from stores (2) Consumption record of Shift Engineer. (3) Stock records from stores. (4) Purchase records (5) Entry records
5.2	**Coal:** The quantity of coal will be monitored by (1) Issue records from stores (2) Consumption record of Shift Engineer. (3) Stock records from stores. (4) Purchase records (5) Entry records
5.3	The quantities of biomass and fossil fuel will be monitored before blending, and feeding into the boiler.
5.4	**Lab Analysis:** (1) Sample will be drawn from each new batch on regular basis of Biomass or Fossil fuel received and sent to laboratory for analysis of the following: (a) Chemical composition (b) Calorific value. (2) The records of all analysis reports will be maintained in paper. (3) The testing will be normally carried out in-house laboratory. However for cross checking purposes, analysis is carried out of the sample by Govt. approved laboratory, once in three months.
6.	**Uncertainties and Adjustments:**
6.1	The hourly, eight hourly, daily and monthly data will be recorded at various points as stated above. Any observations (like inconsistencies of report parameters) and/or discrepancies in the operation of the power plant will be documented as "History" in the daily report prepared by the General Manager (Plant) along with its time of occurrence, duration and possible reasons behind such operational disruptions. Necessary corrective actions will be undertaken at the earliest. Any discrepancies in the Main reading (for example, difference between main meter and check meter reading or extreme deviation in the net generation figure from that reported by the In-house Meter of RREPL), if identified, will immediately be brought to the notice of CSEB. Corrective actions will be undertaken at the earliest after identification of reason of such discrepancy. Furthermore, as a safety measure, the total power generating system will be equipped with an Automatic Alarming System which shall give a prior indication of

	any fluctuations in the operating parameters of the power plant thereby enabling the operators to take necessary preventive measures. These measures will be undertaken in order to detect and minimize the uncertainty levels in data monitoring.
7.0	**Experience and Training**
7.1	All the Shift Engineers (Electrical and Instrumentation, Operations) are qualified engineers/ technologists. All the operators of the power plant will be IBR certified and NPTI certified engineers, and they also undergo an exhaustive on-the-job training program including plant operations, data monitoring and report preparation.
7.2	**Emergency Preparedness Plan** The total power generating system of power plant will be equipped with an "Automatic Alarming System" which helps the operators to take necessary preventive actions before any kind of non-functioning of the power plant results. RREPL will be having fire fighting system in place. In addition RREPL shall have standard procedures for tackling emergencies arising from • Blackout • Low boiler drum level/ low feed water level • Load throw off • Boiler Tube leakage. • Boiler tripping at alarm systems.
	Records 1. Generation Log Book, maintained by Electrical & Instrumentation Department at site, containing hourly data from all the In-house Metering System. 2. Plant Log Book, maintained by Electrical & Instrumentation Department at site, containing eight hourly data from all the In-house Metering System. 3. Daily Executive Summary (submitted to the General Manger (Plant), prepared by Electrical & Instrumentation Department at site containing daily data for all the in-house metering system and record of any History with details. 4. CSEB Reading Book, maintained by Electrical & Instrumentations Department at site, consisting of daily export of power to CSEB grid. 5. Daily report containing the performance parameters of the power plant and record of any history with details, maintained at site with a copy being sent to the Head Office. 6. Monthly Report on net quantity of electricity generated at RREPL's Plant and invoice raised by RREPL on CSEB as maintained at the plant with a copy being sent to the Head Office of RREPL.

	7.	Biomass consumption in the boiler to be tallied with the store issuance of the biomass and purchase invoices.
	8.	Co-fired fossil fuel consumption in the boiler to be tallied with the store issuance of the fossil fuel and purchase invoices.

D.6. Name of person/entity determining the monitoring methodology:

>>

Preparation of this documents has been done by Indus Technical and Financial Consultants Ltd., whose address is

Shri Lalit Kumar Singhania
Indus Technical and Financial Consultants Ltd.
205, Samta Colony,
In front of Shikapuri Panchayat Bhawan.
Raipur city , Chhattisgarh State 492001 INDIA
Telephone : +91-771-2255186
Mobile : +91-93011 93400/ +91 94252 08189
Fax : +91-771-2254188
Email : indusryp@satyam.net.in
Website: www.itfcenv.com

SECTION E.: Estimation of GHG emissions by sources:

E.1. Formulae used:

>>

E.1.1 Selected formulae as provided in appendix B:

>>

Not provided in Appendix B

E.1.2 Description of formulae when not provided in appendix B:

>>

E.1.2.1 Describe the formulae used to estimate anthropogenic emissions by sources of GHGs due to the project activity within the project boundary:

>>

Carbon dioxide emissions from on-site consumption of fossil fuels ($PEFF_y$) due to fossil fuel (coal) being used for co-firing.

Rice Husk quality procured for generation of electricity may not be consistent and hence it is proposed to use small percentage of fossil fuel like coal to ensure consistent generation of electricity. We estimate that 5-10% fossil fuel is likely to be co-fired. We have taken 10% of the fuel quantity requirement to calculate the project emission due to co-firing. Estimated consumption of Rice Husk is 98223 Tonnes per annum for 80% PLF. Hence for calculating the project emission due to co-firing we have considered 9800 tonnes of coal per annum.

$$PEFF_y = Q_i \, NCV_i \, EF_{CO2} \, OXIDi$$

Where,

$PEFF_y$ = Emission arising out of combustion of fossil fuel (Coal) due to co-firing.

Q_i = 9800 Tonne/Year

NCV_i = 14.166×10^{-3} Tj/t (refer **Section B-5, Step 1.1 for F.Y.05**)

OXIDi = 0.98 } (Source: IPCC guidelines)

EF_{co2} = 94.0 tCO_2/Tj }

$PEFF_y$ = $9800 \times (14.166 \times 10^{-3}) \times 94.0 \times 0.98$

= $12788.72 = 12789 \, tCO_2eq.$

E.1.2.2 Describe the formulae used to estimate leakage due to the project activity, where required, for the applicable project category in appendix B of the simplified modalities and procedures for small-scale CDM project activities

>>

As per methodology project leakage as nil. Ly = 0

E.1.2.3 The sum of E.1.2.1 and E.1.2.2 represents the small-scale project activity emissions:

>>

Sum of E.1.2.1 and E.1.2.2 = 12789 t CO2/annum = $PEEF_y$

E.1.2.4 Describe the formulae used to estimate the anthropogenic emissions by sources of GHGs in the baseline using the baseline methodology for the applicable project category in appendix B of the simplified modalities and procedures for small-scale CDM project activities:

>>

A base line emission factor EF_Y is calculated as simple OM described for each fuel I in case of CSEB generation and import using the formulae provided in ACM 0002. The sources for data are as given below;

1) CSEB Tariff petition 5/ 2005.
2) CEA data
3) IPCC guide lines.

$$EF_{OM,y} = \frac{\sum F_{i,j,y} \cdot COEF_{i,j}}{\sum_j GEN_{j,y}}$$

Where,

$F_{i,j,y}$ is the amount of fuel $_i$ (in tonnes) consumed by relevant power sources $_j$ in years$_y$.
Source : CSEB document/ CEA document/ CSEB Tariff Petition 5/2005.

$_j$ refers to the power sources delivering electricity to the grid, not including low-operating Cost and must-rum power plants and including imports to the grid.

$COEF_{i\,j\,y}$ Is the CO_2 emission coefficient of fuel $_i$ (t CO_2/t of fuel), taking into account the carbon content of fuel used by relevant power source $_j$ and the percent oxidation of the fuel in year(s) and

$GEN_{j,y}$ Is the electricity (MWh) delivered to the grid by sources $_j$.
sources : CSEB document/ CSEB Tariff Petition 5/2005.

The CO_2 emission Coefficient $COEF_i$ is obtained as

$$COEF_i = NCV_i \cdot EF_{CO2,i}, OXID_i$$

Where,

NCV_i is the net calorific value TJ /tonnes of fuel i,
Source : CSEB Tariff Petition 5/2005 /CEA documents/ IPCC guidelines.

$OXID_i$ oxidation factor
Source : IPCC guidelines.

$EF_{CO2,i}$ is the CO_2 emission factor per unit of energy of the fuel i
t CO_2 eq / tonnes of fuel
(source – IPCC Guidelines)

Step 2: Determination of EG_y

EG_y corresponds to the net quantity of electricity generation in the project plant ($EG_y = EG_{project\ plant,\ y}$).

Leakage

There is no leakage in the project activity. Ly=0

Emission Reductions

$ER_y = ER_{electricity,\ y} - PEFF_y - L_y$

Where:

ER_y	are the emissions reductions of the project activity during the year y in tonnes of CO_2,
$ER_{electricity,y}$	are the emission reductions due to displacement of electricity during the year y in tonnes of CO_2, = 72431 t CO2 /annum
$PEFF_y$	Emission arising out of combustion of fossil fuel (Coal) due to co-firing =12879 tCO_2e / annum.
L_y	Leakage.

E.1.2.5 Difference between E.1.2.4 and E.1.2.3 represents the emission reductions due to the project activity during a given period:

>>

emission reductions as difference between E.1.2.4 and E.1.2.3 = 72431-12789 = 59642 t CO2/annum

E.2 Table providing values obtained when applying formulae above:

>>

Year	Estimation of Project activity emission reduction tonnes of CO_2e	Estimation of baseline emission reduction tonnes of CO_2e	Estimation of leakage tonnes of CO_2e	Estimation of emission reduction tonnes of CO_2e
2006	12789	72431	0	59642
2007	12789	72431	0	59642
2008	12789	72431	0	59642
2009	12789	72431	0	59642
2010	12789	72431	0	59642
2011	12789	72431	0	59642
2012	12789	72431	0	59642
2013	12789	72431	0	59642
2014	12789	72431	0	59642
2015	12789	72431	0	59642
				596420 for the entire crediting period

SECTION F.: Environmental impacts:

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

>>

RREPL conducted the EIA study for the project . we list below salient points.

Air quality due to project activity

The project uses rice husk biomass as fuel in the boiler. Biomass is considered as carbon neutral as the carbon emissions would have occurred anyway in the absence of project activity. Hence there is no addition in GHG gases emission. Biomass are low in sulphur content and hence SO2 emissions will be negligible.

Biomass has 18% average ash content. Hence ash generation would be to the extent of 60 tpd in boiler. out of this 10% is considered as bed ash which can not be used in cement/ brick making purposes. However balance 90% will be fly ash which will be collected from boiler ESP/Economiser/Air Pre-heater. This fly ash will be conveyed to fly ash silo. The ash handling system of boiler is designed to remove bed ash from the furnace of boiler.

The SPM levels from ESP will be maintained below 100 mg/m^3. Accordingly the Ambient Air Quality surrounding the plant will remain well within the prescribed limits of the State Pollution Control Board and Central Pollution Control Board.

This will totally eliminate any concern regarding the Air born pollution of Ash due to wind.

Water quality

Air cooled Heat Exchanger for water used in turbine exhaust steam condensing will be installed to reduce water consumption. The steam condensate will be reused as boiler feed water. There will be no waste water discharged into surrounding bodies in study area. Waste water generated in DM plant will be neutralised and used for green belt creation/maintenance purposes and for Dust depression.

Noise pollution

Noise arises from boiler and turbo generator. Equipment selection and design has been done in such a way that noise levels of 90dbA at plant level and 55-65dbA will be maintained at the Boundary limits of the Plant Leqs for area will be below set standards.

The Project activity will produce 14 MW power based on BIOMASS steam generation (FBB) and steam turbines.

The installation of FBB and POWER PLANT requires approvals of IBR (Indian Boiler Regulation) and CECB (Chhattisgarh Environment Conservation Board) and both the approvals will be received before the Commissioning of project activity.

A. A well equipped laboratory to monitor the ambient air quality; stack emissions and noise levels within the plant and boundary limits will be set up.
B. Full fledged horticulture department to use waste waters to create and maintain green belt will be established.

C. Fire protection system shall consist of fire hydrants and portable fire extinguishers.

The Fire hydrant system will comprise of electric driven pumps and stand by pumps will be diesel fired. water pumping points with the required length of hose will be provided.

Portable fire extinguishers will be combination of different types like foam; and Sand Buckets will be provided at switchyard.

D. ESP shall be provided to maintain SPM levels below 100 mg/m^3, and bag filters will be provided for other fugitive dust emission control.

E . Conveying systems will be provided with proper coverings and bag filters to prevent Fugitive emissions

F. Fly ash silos will be covered type.

G. All roads within the plant will be paved and made Pucca as far as possible.

H. Green Belt will be provided on the Boundary of the Plant and along the Roads and in the open space available.

I. Sufficient Height Chimney will be provided for the Good spatial distribution of SPM emitted through chimney.

J. On the basis of EIA studies; mathematical predictions; evaluation of impacts with recommended environment management plan the power plant is safe from environmental angle.

Project activity meets existing, national and regional regulations in force.

SECTION G. Stakeholders' comments:

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

>>

RREPL identifies the following as stake holders to keep the transparency in the operational activity of the project promoted and thereby meeting local/ environmental regulations.

1) Local Authority (Member of Legislative Assembly of Chhattisgarh)
2) Local authority of Village –Garh Umuria and Darra Muda
3) Chhattisgarh State Electricity Board (CSEB)
4) Chhattisgarh Environment Conservation Board (CECB)
5) Chhattisgarh State Electricity Regulatory Commission (CSERC)
6) Chhattisgarh Renewable Energy Development Agency (CREDA)
7) Chhattisgarh State Industrial Development Corporation (CSIDC)
8) Non- Governmental Organisations.
9) Consultants
10) Equipment suppliers.
11) Transporters of the Biomass.
12) Rice Mill Owners supplying the Biomass Fuel.

G.2. Summary of the comments received:

>>

RREPL management appraised the representatives of village Panchayat of village about the project activity. The members of Panchayat appreciated and expressed their no objection for project activity.

Similarly RREPL management appraised MLA regarding the project activity who also appreciated and expressed no objection for the project activity.

Permission have been sought from the State agencies like CECB, CREDA, CSIDC etc. wherever required legally and have been received and other State agencies have been appraised of the project activity.

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

>>

The relevant comments and important clauses mentioned in the project documents/ Detailed project report, Environment clearances were considered while preparation of CDM Project Design Document. RREPL management representatives met various stake holders for apprisal regarding project activity and sought the support.

All the stake holders appreciated the energy efficient environment friendly project activity which has sustainable contribution to the development.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organisation	**R.R. Energy Pvt. Limited**
Street/ P.O. Box	**Transport Nagar**
Building	**65**
City	**KORBA**
State/ Region	**Chhattisgarh**
Postcode/ Zip	**495679**
Country	**INDIA**
Telephone	**07759-229374; 98932-88002**
Fax	**07759 22747**
Email	spinltd@sancharnet.in / spinltd@rediffmail.com
URL	495679
Represented by:	**Ramavatar Agrawal**
Title	**Managing Director**
Salutation	**Mr**
Last Name :	**Agrawal**
Middle Name:	
First Name:	**Ramavatar**
Department:	**Management**
Mobile:	**98932-88002**
Direct FAX:	
Direct Tel:	
Personal E-mail	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

NO ANNEXURE 1 PARTY FUNDING IS RECEIVED

- - - - -

Appendix I : Abbreviation

ABC	After Burning Chamber
Annex	Annexure
BAU	Business As Usual
CPP	Captive Power Plant
CER	Carbon Emission Reduction
CEA	Central Electricity Authority
CSEB	Chhattisgarh State Electricity Board
CSERC	Chhattisgarh State Electricity Regulatory Commission
CDM	Clean Development Mechanism
DM	De-Mineralized
ESP	Electro Static Precipitator
EIA	Environmental Impact Assessment
FBB	Fluidized Bed Boiler
GHG	Green House Gas
HSD	High Speed Diesel
HT	High Tension
IBR	Indian Boiler Regulation
KWh	Kilo Watt hour
LSHS	Low Sulphur Heavy Stock
MWh	Mega Watt hour
MW	MW
NM^3/Hr	Normal Meter Cub per Hour
PLF	Plant Load Factor
PDD	Project Design Document
Qty	Quantity
RREPL	R.R. Energy Pvt. Ltd.
SEB	State Electricity Board
STG	Steam Turbine Generator
SPM	Suspended Particulate Matter
tCO_2	Tonnes Carbon-dioxide
tCO_2eq	Tonnes Carbon-dioxide equivalent
TPD	Tonnes Per Day
T/hr	Tonnes per hour
T&D	Transmission and Distribution
TG	Turbine Generator
WHR	Waste Heat Recovery