CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

A. General description of project activity

B. Application of a baseline and monitoring methodology

C. Duration of the project activity / crediting period

D. Environmental impacts

E. Stakeholders' comments

Annexes

Annex 1: Contact information on participants in the project activity

Annex 2: Information regarding public funding

Annex 3: Baseline information

Annex 4: Monitoring plan

SECTION A. General description of project activity

A.1 Title of the project activity:

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Power generation from waste heat of new DRI kilns at JSPL

Version: 05

Date: 26/06/2007

A.2. Description of the project activity:

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Purpose

Jindal Steel & Power Limited (JSPL) has implemented Waste Heat Recovery (WHR) based Power Project (power plant) on the new Direct Reduction Iron (DRI) kilns (4 x 0.18 million tonnes per annum (MTPA) capacity each) that have been installed in the phase-1 expansion of the steel plant. In coal based DRI processes, sized and measured quantities of lump iron ore and coarse fraction of non-coking coal are fed in to a rotary kiln. The coal not only acts as a reducing agent but it also supplies the heat required for maintaining the temperature profile of the charge within the kiln. The temperature of the charge bed inside the kiln helps to complete the reduction .The temperature of the charge bed inside the kiln is confined to a maximum of around 950-1050 ^{0}C depending up the ash fusion temperature of the coal used so that the entire reduction occurs in the solid state. Thus the DRI process results in generation of waste gas stream which is at high temperatures. The pollution control method of dealing with this waste gas stream with high temperature and particulates is by first cooling it (by air or water) then reducing the particulate load and then releasing it to atmosphere without utilization of the sensible heat. The project activity results in gainful utilization of the waste heat from the kilns.

The purpose of the project activity is to recover the sensible heat available from waste hot gases emanating from the kiln and to generate power out of it. The project activity results in achieving energy efficiency through waste heat recovery and significantly reducing the effect of thermal pollution to atmosphere. The project activity consists of 4 numbers of waste heat recovery boilers connected to 4 DRI kilns. The boilers would be receiving approximately 440,000 Nm^3/h waste gas. The waste gas does not contain any significant volatile gases and the only green house gas (GHG) present in it is CO_2. The composition of the waste gases remains unaltered due to the project activity. The temperature of these waste gases emanating from the kilns is around 900 – 950^{0}C. The sensible heat from the gas would be extracted in the boilers and the exhaust gas would thereafter be let out to the atmosphere through tall stacks at around 160^{0}C. The steam produced in the boilers would be used to run the steam turbine generator to generate 2x25 MW electricity. In the absence of the project, JSPL would have produced the equivalent quantum of electricity by putting up a coal based power plant or generation of equivalent electricity would have occurred at power plants connected to the grid.

Project Activity's contribution to Sustainable Development

The sustainable development indicators stipulated by the Government of India (host country) in the interim approval guidelines for CDM projects are as follows[1,2]:

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[1] http://envfor.nic.in:80/divisions/ccd/cdm_iac.html

- Social well being
- Economic well being
- Environmental well being
- Technological well being

The JSPL project activity assists in achieving the above components of sustainable development as follows:

Social well being

The project activity results in generation of direct and indirect employment[3]. This employment generation was during the stage of construction of the waste heat recovery based power generation units at the project site and at the equipment supplier's end. Also human resource would be required continuously to operate the power plant. In the absence of the project activity, no such employment generation would have occurred either during the construction phase or during the operational phase.

Economic well being

The project activity would help in reducing the energy requirements by effectively utilizing the waste gases. Indirectly this would result in displacement of coal for energy purpose (as coal is the predominant fuel used for power generation in the region). Massive power generation capacity has been built in the country during the tenth and eleventh plan predominantly based on coal as a fuel. The domestic coal production has not been able to keep pace with the growing demand of coal for power production leading to poor plant load factor and/or import of coal, thereby reduced grid reliability. The export of surplus power to the grid would help in strengthening the grid reliability and stability thus attracting further investments in the region, consequently enhancing trade and reducing the dependency on imported coal.

Environmental well being

The project activity helps positively in direction of global climate change by avoiding the generation of greenhouse gases which would have been generated if equivalent amount of power would have been generated by the grid. It would also result in avoidance of thermal pollution in the vicinity that would have occurred due to waste gas emissions at high temperature. Further, it results in reduced resource water usage which would have been required for cooling the hot gases emanating from the kilns.

Technological well being

The project activity configuration has been optimized by making use of the thermodynamic cycle. To achieve higher overall efficiency and energy conservation, regenerative feed heating using extraction steam from turbine has been opted for the project activity. Various alternative pressure and temperature levels of steam generation were considered based on recommended steam turbine inlet pressure and temperature as per IEC-45. Thus it is ensured that the most efficient technology is used for the project activity.

Thus it is ensured that the project activity is in-line with the sustainable development criteria given by the Indian Government. It has positive contribution towards the stipulated indicators.

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[2] http://envfor.nic.in/cdm/host_approval_criteria.htm

[3] http://jpcindiansteel.org/execsum.pdf

A.3. Project participants:

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Name of Party involved* ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	The Party involved wishes to be considered as project participant (Yes/No)
India (host)	Jindal Steel & Power Limited (JSPL)	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

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The project activity is in the existing premises of the JSPL manufacturing facility in Raigarh.

A.4.1.1. Host Party(ies):

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India

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

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Chhattisgarh

A.4.1.3. City/Town/Community etc:

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Patrapali Village, Raigarh District

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

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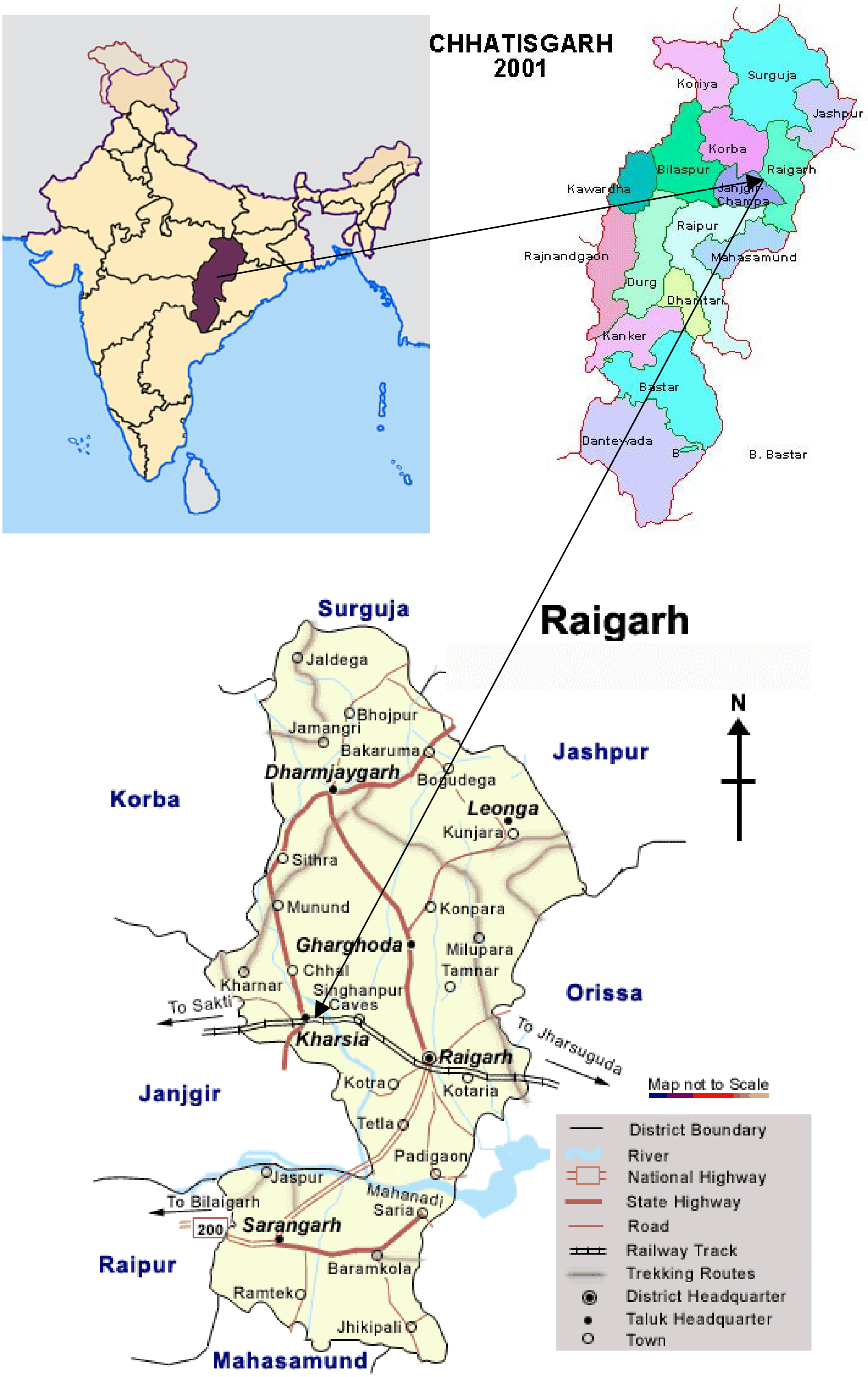
The project is located in Village Patrapali, District Raigarh, Chhattisgarh State in Central India. Raigarh town is located approximately 6 km from the site in the south east direction. The coordinates of the project site are:

Longitude: 82^{0}20’32” E
Latitude: 21^{0}55’36” N

The project site is approachable from Kharsia Road passing along the east and north boundary of the JSPL plant. The Mumbai – Howrah railway line passes from the south side of the plant and the nearest railway station is Kirorimal Nagar.



Location of Project Activity (map not to scale)

A.4.2. Category(ies) of project activity:

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The project activity is a large scale potential CDM project related to energy generation from waste gases thus fits under the Category 1: Energy Industries (renewable / non-renewable sources) as per "List of Sectoral Scopes", Version 04.

A.4.3. Technology to be employed by the project activity:

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The project activity consists of the following main units:

- 4 numbers of waste heat recovery boilers
- 2 numbers number of steam turbines
- Electrical generator
- Appropriate power evacuation system

and the related instrumentation and controls.

The technical specifications of the key units are as follows:

Waste heat recovery boiler

Type	:	Semi-outdoor, Natural circulation, single drum, water tube
Steam output	:	57 tonnes per hour
Steam pressure	:	67 kg/cm^2
Steam temperature	:	485^{0}C

Steam turbine

Type	:	Single cylinder with 3 uncontrolled extractions for regenerative feed heating, tandem compound, multistage, non-reheat
Capacity	:	25 MW
Steam pressure	:	64 kg/cm^2
Steam temperature	:	480^{0}C
Rated speed	:	3000 RPM

Electrical generator

Type	:	Two pole, 3 phase Air cooled, Brushless excitation with digital automatic voltage regulation system
Speed	:	3000 RPM
Frequency	:	50 Hz
Power factor	:	0.8 (lagging)
Voltage	:	11 kV

The high pressure boiler and the fully condensing turbine would ensure that maximum power output is obtained from the waste gas. The power getting generated in the power plant at 11 kV is stepped up to 220 kV and connected to the existing 220 kV switchyard of JSPL. The high voltage transmission and the proximity of the switchyard would ensure that the transmission and distribution losses are minimal.

The technology for the boilers and turbines is well established and available in India and the project activity does not involve any transfer of technology.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

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Years	**Annual estimation of emission reductions in tonnes of CO_2e**
2007-08	287,968
2008-09	287,968
2009-10	287,968
2010-11	287,968
2011-12	287,968
2012-13	287,968
2013-14	287,968
2014-15	287,968
2015-16	287,968
2016-17	287,968
Total estimated reductions (tonnes of CO_2e)	**2,879,680**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	**287,968**

A.4.5. Public funding of the project activity:

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No public funding from parties included in Annex – I is involved in the project activity

SECTION B. Application of a baseline and monitoring methodology

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

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Title: "Consolidated baseline methodology for waste gas and/or heat and/or pressure for power generation"

Reference**:** UNFCCC Approved consolidated baseline methodology **ACM0004 / Version 02**, Sectoral Scope: 01, 3rd March 2006.

The approved methodology also draws upon and "Version 03 of the tool for demonstration and assessment of additionality" and the following methodology for grid emission factor calculation:

Title: "Consolidated baseline methodology for grid-connected electricity generation from renewable sources"

Reference: UNFCCC Approved baseline methodology ACM0002 / Version 06, Sectoral Scope: 01, 19th May 2006.

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

>>
The methodology ACM0004 is applicable to project activities that generate electricity from waste heat or the combustion of waste gas in industrial facilities.

The methodology applies to electricity generation project activities:

- that displace electricity generation with fossil fuels in the electricity grid or displace captive electricity generation from fossil fuels;
- where no fuel switch is done in the process where the waste heat or pressure or the waste gas is produced after the implementation of the project activity

The methodology covers both new and existing facilities. For existing facilities, the methodology applies to existing capacity, as well as to planned increases in capacity during the crediting period.

JSPL has set up new DRI kilns to manufacture sponge iron. The project activity utilizes the waste gas emanating from these DRI kilns to produce electricity. The generated electricity fulfils the increased demand from the projects and the excess is exported to the grid thereby displacing the grid power; which will be generated based on fossil fuels. Prior to implementation of the project activity, JSPL was exporting power to the grid but with the expansion activity, the electricity demand has increased. This increase in power demand would have resulted in stoppage of any export to grid rather import from grid would have been required to meet the power demand. Thus effectively the project activity displaces the electricity generation with fossil fuels in the electricity grid, thereby satisfying the first applicability criteria of the methodology.
Moreover, in the project activity, no fuel switch has been done in the process where the waste heat is produced. The waste gases remain the same before and after the project activity (the composition remains unaltered) except that the temperature of the exit gases would be lowered.

Thus the project activity satisfies all the applicability conditions as specified in the methodology ACM0004, thence the said methodology is applicable for the project activity.

B.3. Description of the sources and gases included in the project boundary

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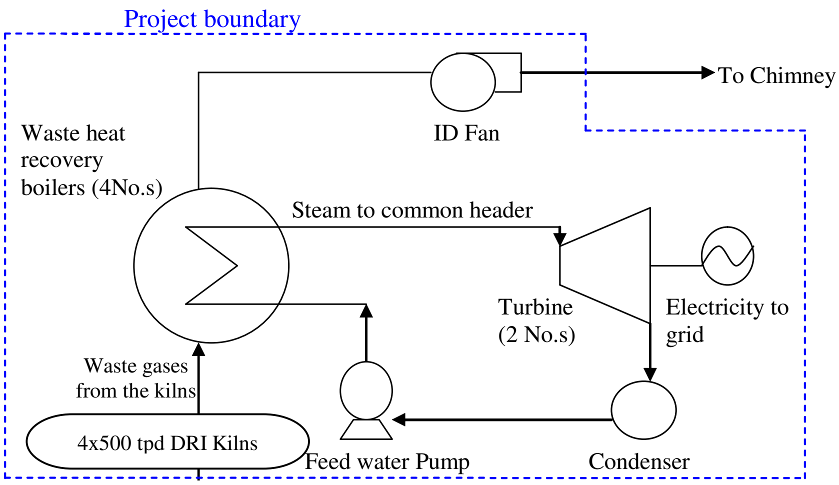
The definition of project boundary states that the project boundary shall encompass all anthropogenic emissions by sources of greenhouse gases (GHG) under the control of the project participants that are significant and reasonably attributable to the CDM project activity.

As per ACM0004, for the purpose of determining GHG emissions of the project activity, project participants need to include:

- CO_2 emissions from combustion from auxiliary fossil fuel: As discussed earlier that there is no provision of auxiliary fossil fuel firing in the project activity so there are no project activity related emissions. The project boundary related to ACM0004 as applied to the project activity comprises of the DRI kilns supplying the waste gases, WHRBs, turbines and the auxiliaries as shown in the following figure:

The project boundary starts from supply of waste gases from the kilns at the boiler inlet to the point of electricity generated by the project activity.



The sources and gases included in the project boundary is summarised in the following table:

	Source	Gas	Included?	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.
	Captive 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.
Project Activity	On-site fossil fuel consumption due to the project activity	CO_2	Included	May be an important emission source
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.

	Combustion of Waste gas for electricity generation	CO_2	Excluded	It is assumed that this gas would have been burned in the baseline scenario
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

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Identification of alternative baseline scenarios consistent with current laws and regulations:

The methodology as applied to the project activity involves the identification of alternative baseline scenarios that provide or produce electricity for in-house consumption excluding options that:

- do not comply with legal and regulatory requirements; or
- depend on key resources such as fuels, materials or technology that are not available at the project site.

The possible alternative scenarios in absence of the CDM project activity would be as follows:

(a) The proposed project activity not undertaken as a CDM project activity;

(b) Import of electricity from the grid;

(c) Existing or new captive power generation on-site, using other energy sources than waste heat and/or gas, such as coal, diesel, natural gas, hydro, wind, etc;

(d) A mix of options (b) and (c), in which case the mix of grid and captive power should be specified

(e) Other uses of the waste heat and waste gas

(f) The continuation of the current situation, whether this is captive or grid-based power supply (if not already included in the options above).

Among the alternatives that do not face any prohibitive barriers, the most economically attractive alternative should be considered as the baseline scenario.

Alternative a: The proposed project activity not undertaken as a CDM project activity

JSPL may set up a waste heat recovery based electricity generation at its facility for meeting in-house requirements. This alternative is in compliance with all applicable legal and regulatory requirements. However, this alternative faces a number of barriers (as detailed in subsequent Section B.5) making it predictably prohibitive. Hence this option is not a part of baseline scenario.

Alternative b: Import of electricity from the grid

In this alternative net electricity being produced by the project activity gets generated by the regional grid. Thus an equivalent amount of CO_2 emissions would take place at the thermal power plants supplying power to the Western region electricity grid. This alternative is in compliance with all applicable legal and regulatory requirements and can be a credible baseline scenario.

Alternative c: Existing or new captive power generation on-site, using other energy sources than waste heat and/or gas, such as coal, diesel, natural gas, hydro, wind, etc

A coal based captive power plant put up at JSPL. This alternative is in compliance with all applicable legal and regulatory requirements. This alternative is in compliance with all applicable legal and regulatory requirements and can be a credible baseline scenario.

Alternative d: A mix of options (b) and (c), in which case the mix of grid and captive power should be specified

This could be the baseline scenario but it may be noted that the baseline emission factor of the grid is more conservative than that of the coal based captive power generation[4], as the grid mix consists of coal, gas, hydro, nuclear and other renewable energy sources.

Alternative e: Other uses of the waste heat and waste gas

Although this alternative is in compliance with all the applicable legal and regulatory requirements, it faces the barriers as depicted in subsequent section B.5. Hence it cannot be a part of the baseline scenario.

Alternative f: The continuation of the current situation, whether this is captive or grid-based power supply (if not already included in the options above).

This has already been included in the above alternatives.

Among all these alternatives, the alternative that does not face any prohibitive barriers and is the most economically attractive should be considered as the baseline scenario. Taking a conservative approach, "**Alternative b: Import of electricity from the grid"** would be the most likely **baseline scenario,** as it faces no prohibitive barrier and is also economically attractive. It may be noted that the baseline emission factor of the grid is more conservative than that of the coal based captive power generation, as the grid mix consists of coal, gas, hydro, nuclear and other renewable energy sources.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

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The step-wise approach to establish additionality of the project activity is as follows:

JSPL intends to have the crediting period starting after the project activity gets registered; JSPL has considered the incentive from the CDM before the start of the project activity and the evidence for the same can be verified by the validators (Resolution passed by the Board of Directors of JSPL on 8th May 2003). The crediting period would be starting after the date of registration.

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a. Define alternatives to the project activity;

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

Referring to section B.2. the alternatives available to JSPL are:

- Equivalent electricity generation from the grid
- Coal based captive power generation on site

[4] The emission factor of coal based power generation is around 1.1 kg of CO_2/kWh, whereas the grid emission factor is 0.81 kg of CO_2/kWh

Both these alternatives are in line with the applicable laws and regulations and thus can be part of the baseline scenario. To be on the conservative side, equivalent electricity generation from the grid has been taken as the baseline scenario, as this has a lower emission factor.

Step 2: Investment analysis
Or
Step 3: Barrier analysis
JSPL proceeds to establish project additionality by conducting the Step 3: Barrier Analysis.

The project proponent is required to determine whether the proposed project activity faces barriers that:
(a) Prevent the implementation of this type of proposed project activity; and (b) Do not prevent the implementation of at least one of the alternatives through the following sub-steps:

Sub-step 3a. Identify barriers that would prevent the implementation of type of the proposed project activity
The project activity had its associated barriers to successful implementation. These barriers are detailed below:

Technological barriers:
Various technologies have been developed on coal based reduction of iron oxides for the manufacturing of sponge iron. Out of these several technologies only a few were proved to be commercially successful. Of the coal based technologies SL/RN technology of Lurgi GmbH, has been the most successful one[5]. Direct reduction processes are very sensitive to chemical and physical characteristics of raw materials used in the process. For the successful operations the process licensors of direct reduction technology have specified the characteristics of the raw materials to be used in the process. The characteristic desired for the non-coking coal to be used as the reductant is that it should have high fixed carbon content and high volatiles content. Ash, sulphur and moisture in coal should be low. The ash fusion point of coal is required to be high. The coal should be highly reactive and should have low coking and swelling indices. Since such kind of raw material (coal) is not available in plenty in India, so JSPL has invested in the process improvement progressively and have indigenously developed and improved the coal based technology suiting to the Indian raw materials. As per available statistics only two plants have been based on this technology namely at JSPL and Monnet Ispat & Energy Limited (MIEL). The kilns operating at these locations are having maximum capacity of 300-350 tpd. MIEL has implemented waste heat recovery based power generation on these kilns despite the barriers associated with it after taking CDM revenues into consideration. JSPL has put further research in designing the capacity of individual kilns to 500 tpd.

There were problems associated with the older 300 tpd kilns and associated waste heat recovery based power generation system such as economizer tube leakages, radiation tube leakages, convection tube leakages, boiler inlet duct choking (from after burning chamber to WHRB) and associated production loss. Still JSPL has gone ahead with implementation of waste heat recovery based power generation system on these new kilns taking CDM revenues into consideration to overcome these risks associated with the project.

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[5] http://www.dsir.gov.in/reports/techreps/tsr062.pdf

The waste heat recovery based power generation system is solely dependant on the quantity and quality of waste gases emanating from the DRI kilns. The gases leaving the kiln have very high particulate load (iron particles being carried away along with the flue gases) that create erosion and fouling problems on the gas side of the boiler tubes. The waste gases emanating from the kilns can severely damage downstream equipment such as the electrostatic precipitator, fans, dampers and the exhaust stack. Due to the poor quality of raw material (low Tumbler index of the iron-ore) and the technical constraints to remove the particulate load from the high temperature waste gases these problems remain inherent to the process. Also there is nitrate stress corrosion cracking likely in waste heat recovery boilers[6]. It has been observed that corrosion is the major reason leading to tube leakage thereby the boilers are to be shutdown for maintenance. Failure of the boiler also leads to forced shutdown of the kilns, since the kilns are attached to the boilers without any isolation mechanism. Thus for the running of the kilns the boiler availability is a must. Regular failures of boiler, due to the high corrosive nature of gases leads to not only high DRI production loss but also the impact spills over to the downstream processes where power is getting consumed.

Barriers due to prevailing practice

The high capacity DRI kilns[7] (500 tpd or more) with WHRB for sponge iron production and power generation respectively is not a prevalent practice being followed in the region. The usual configuration of DRI kilns being installed in the region are of the capacity of 100 tpd or 300 tpd. These smaller kilns give much more flexibility of operation but also consume more resources and thereby lead to higher emissions. There are not many high capacity kilns operating in the region. The few units such units operating in the region inclusive of JSPL are as follows:

Name of Unit	Location	Capacity (MTPA)	Number of Modules
Nova Iron & Steel	Bilaspur	0.15	1
Prakash Industries	Champa	0.40	2
Jindal Steel & Power Limited (JSPL)	Raigarh	0.72	4
Raipur Alloys & Steel Limited (RASL)	Raipur	0.36	2
Godavari Ispat & Power Limited (GPIL)	Raipur	0.18	1

Out of the above units Nova Iron & Steel does not have any WHRB installed. Apart from JSPL, Prakash Industries, RASL and GPIL have WHRB installed, but they are having common steam header wherein steam from coal fired boilers (FBC) is also being fed into the system. Thereby it is ensured that even in the case of failure or lower plant load factor of kilns the power plant operates. Moreover, in comparison to Prakash Industries (32 kg/cm^2 boiler), JSPL has put up higher efficient high pressure boilers (67 kg/cm^2) and turbines to maximize the power generation from the waste gases emanating from the kiln. Also Prakash Industries has setup the DRI Kilns based on SL/RN technology of Lurgi, Germany and the waste heat recovery based power generation in collaboration with Lurgi ,Germany. JSPL is exporting the excess power that it is able to generate to the grid, whereas power generated by waste heat recovery system at Prakash Industries is used for captive purposes only. RASL and GPIL have installed the WHRB after taking CDM into consideration[8,9].

[6] Nitrate Stress Corrosion Cracking in Waste Heat Recovery Boilers, R.G.I. Leferink, W.M.M. Huijbregts. C , Anti-Corrosion Methods and Materials, Vol 49 (2002), No 2, p 118-126

[7] DRI kilns with capacity of 500 tonnes per day (tpd)

[8] http://cdm.unfccc.int/Projects/Validation/DB/R9ZPB6H2Q9HX1UJ9H54WZQ66MVF3QY/view.html

Thus the JSPL project activity is the first of its kind, solely dependant on the waste gases emanating from the kilns with no other source of steam generation to run the turbines.

Also in order to utilize the waste gases effectively, JSPL has made the provision of interconnection arrangement between the waste gases emanating from the kilns. This arrangement has been made for the first time in sponge iron plants. The interconnection damper is to take care of the emissions happening during start-up and shut-down of the kilns. Although damper provided between these connections could fail due to the high dust concentration/accumulation. Thus any such failure in the interconnection damper would result in stoppage of kilns thereby leading to heavy production losses.

The key points of the prevailing practice barriers are as follows:

- There are only five units with high capacity 500 tpd kilns operating in the region. Of these units one unit is having no waste heat recovery system and the other four including JSPL have opted for waste heat recovery based power generation after taking CDM into consideration.
- The JSPL project activity is solely dependant on the waste heat emanating from the kilns and is not supported by any coal/DRI char fired boiler.

Other barrier(s)

The other risks and barriers associated with the project activity are as follows:

- As compared to the coal fired boilers, the waste heat recovery boilers have higher failure rates. Since these WHRBs are directly linked to the DRI kilns so any failure in the boiler would also require stopping of the DRI kilns, thereby leading to production loss apart from the loss in power generation.
- The poor or non-availability of waste gases due to any technical fault in the kiln will hamper the power generation from the project activity. If the heat content of the waste gas is not sufficient, the project activity will directly be affected since there are no inbuilt provisions to increase waste gas temperatures through auxiliary fuel firing. Also the turbines cannot be supplied by steam from any other fossil based source as no such provision is present in the project activity.
- Non-availability of waste gas at the required temperature can also result in a complete closure of the project activity. Also resumption of production process takes a long time. Hence the power interruption even for a short spell can destabilize the manufacturing process, besides causing production loss and damage to the sophisticated equipments due to thermal shock.

Sub-step 3b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity)

The barriers to the project activity are not applicable to the other identified alternatives as they are the prevailing practices and business as usual scenario. The power that would be generated from the project activity could have been generated without the above mentioned barriers through the grid or by a captive coal based power plant. The revenues obtained through CDM would help JSPL in alleviating the above stated barriers related to boiler failure and other associated losses.

Step 4: Common Practice analysis:

Based on the information about activities similar to the project activity, the project proponent is supposed to carry out common practice analysis to complement and reinforce the barrier analysis.

[9] http://cdm.unfccc.int/Projects/Validation/DB/W79H0S1HL1Z1OO1LYJO3HIIYNRNX83/view.html

The project proponent is required to identify and discuss the existing common practice through the following sub-steps:

Step 4a: Analyze other activities similar to the proposed project activity
As per the available statistics discussed in above sections, there is only one waste heat recovery system at Prakash Industries operating in the region which is similar to the project activity. Essential distinctions between the project implemented at JSPL and Prakash Industries are as follows:

- In comparison to equipments used by Prakash Industries, the equipments used by project activity at JSPL are highly efficient high pressure boilers and turbines to maximize the power generation from the waste gases emanating from the kiln
- JSPL is exporting the excess power that it is able to generate, to the grid, whereas power generated by waste heat recovery system at Prakash Industries is used for captive purposes only.
- Furthermore, Prakash Industries have implemented the waste heat recovery based power generation system in collaboration with Lurgi, Germany. Whereas JSPL has implemented the project activity indigenously.

Step 4b: Discuss any similar options that are occurring
As per the available data on waste heat recovery projects implemented, it is well evident that similar projects are not commonly carried in the sponge iron industry (kiln capacity of 500 tpd or more) in the region.

The other industries which have implemented or are implementing such kind of project activity are RASL and GPIL after taking CDM into consideration. Moreover in these projects the waste heat recovery based power plants are also supported by coal fired boilers (FBC) thereby ensuring that in case of failure of the WHRB the well established coal fired boilers ensure power generation.

The registration of the project activity as a CDM project and financial benefits accrued thereby would encourage other entities in similar nature of work to pursue such kind of initiatives. Based on the above steps, it may be satisfactorily concluded that JSPL project activity is not a baseline scenario and hence is clearly additional. The likely non-project options are coal based power generation and/or equivalent electricity generation from the grid. Taking a conservative approach, electricity generation from the grid has been taken as the baseline scenario

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

>>
Baseline emissions
As the baseline scenario is determined to be grid power imports, the Emissions Factor for displaced electricity is calculated as per option 2 given in the methodology as follows:

Option 2. If baseline scenario is grid power imports
As the baseline scenario is determined to be grid power import, the Emissions Factor for displaced electricity is calculated as per ACM0002:

Emission Factor of the Grid (EF_{Grid})
Electricity baseline emission factor of Western Regional Grid (EF_y) is calculated as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM)

factors according to the following three steps. Calculations for this combined margin is based on data from official sources (where available) which is publicly available.

STEP 1. Calculation of the Operating Margin emission factor

The Simple OM emission factor ($EF_{OM,simple,y}$) is calculated as the weighted average emissions (in t CO_2equ/GWh) of all generating sources serving the system, excluding hydro, geothermal, wind, low-cost biomass, nuclear and solar generation.

$$EF_{OM,simple,y} = \frac{\sum_{i,j} F_{i,j,y} \otimes COEF_{i,j}}{\sum_{j} GEN_{j,y}}$$

where

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

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

$F_{i,j,y}$ is the amount of fuel i (in a mass or volume unit) consumed by relevant power sources j in year(s) y , taken as actual value or calculated as given below

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

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

$$\sum_{i} F_{i,j,y} = \left(\sum_{j} GEN_{j,y} \otimes 860 \Big/ NCV_i \otimes E_{i,j} \right)$$

where

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

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

$E_{i,j}$ is the efficiency (%) of the power plants by source j

The CO_2 emission coefficient $COEF_i$ is obtained as

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

where

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

$EF_{CO2,i}$ is the CO_2 emission factor per unit of energy of the fuel i

$OXID_i$ is the oxidation factor of the fuel

The Simple OM emission factor ($EF_{OM,simple,y}$) is calculated ex-ante separately for the most recent three years and an average value has been considered as the OM emission factor for the baseline ($EF_{OM,y}$).

$$EF_{OM,y} = \sum_{y} EF_{OM,simple,y} / 3$$

where y represents the years.

STEP 2. Calculation of the Build Margin emission factor

The Build Margin emission factor ($EF_{BM,y}$) has been calculated as the generation-weighted average emission factor (t CO_2/GWh) of a sample of power plants m of WREB. The sample group *m* consists of either

• the five power plants that have been built most recently, or

• the power plants capacity additions in the electricity system that comprise 20% of the system generation (in GWh) and that have been built most recently.

Project proponent should use from these two options that sample group that comprises the larger annual generation. The calculation for Build Margin emission factor is furnished below:

$$EF_{BM,y} = \frac{\sum_{i,m} F_{i,m,y} \otimes COEF_{i,m}}{\sum_{m} GEN_{m,y}}$$

where

$F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ - Are analogous to the variables described for the simple OM method above for plants m.

Calculations for the Build Margin emission factor $EF_{BM,\ y}$ has been done as ex ante based on the most recent information available on plants already built for sample group m of Western region grid at the time of PDD submission. The sample group m consists of the 20 % of power plants supplying electricity to grid that have been built most recently, since it comprises of larger annual power generation. (Refer Annex 3)

Further, none of the power plant capacity additions in the sample group have been registered as CDM project activities.

STEP 3. Calculation of the Emission Factor of the Grid (EF_{Grid})

The electricity baseline emission factor of Western Regonal Grid, EF_y is calculated as the weighted average of the Operating Margin emission factor ($EF_{OM,y}$) and the Build Margin emission factor ($EF_{BM,y}$):

$$EF_y = W_{OM} \otimes EF_{OM,y} \oplus W_{BM} \otimes EF_{BM,y}$$

where the weights w_{OM} and w_{BM}, by default, are 50% (i.e., $w_{OM} = w_{BM} = 0.5$), and $EF_{OM,y}$ and $EF_{BM,y}$ are calculated as described in Steps 1 and 2 above and are expressed in t CO_2/GWh.

Baseline Emission Calculations

Net units of electricity substituted due to waste heat recovery based power in the grid (EG_y)

= (Electricity generated -Auxiliary Consumption)

$$= (EG_{GEN} - EG_{AUX})$$

Therefore the Baseline Emission is calculated as,

$$BE_y = EG_y \otimes EF_y$$

where,

BE_y = Baseline Emissions due to displacement of electricity during the year y (in tons of CO_2)

EG_y = Net units of electricity due to WHR substituted in the grid during the year y (in GWh)

EF_y = Emission Factor of the grid (in tCO_2/ GWh) and
y is any year within the crediting period of the project activity

Project emissions
There is no emissions form the project activity.

Emission reduction
The emission reduction ER_y by the project activity during a given year y is the difference between the baseline emissions through substitution of electricity generation with fossil fuels (BE_y) and project emissions (PE_y), as follows:

$ER_y = BE_y – PE_y$

Where:
ER_y is the emission reductions of the project activity during the year y in tonnes of CO_2
BE_y is the baseline emissions due to displacement of electricity during the year y in tonnes of CO_2
PE_y are the project emissions during the year y in tonnes of CO_2

Now, since the project emissions are non-existent in the project activity so the emission reductions (ER_y) equal the substitution of electricity generation with fossil fuels (BE_y)
$ER_y = BE_y$

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

Data / Parameter:	**EF_y**
Data unit:	(kg CO_2 / kWh)
Description:	CO_2 emission factor of Western grid
Source of data used:	Baseline CO_2 emission database, version 2.0- www.cea.nic.in
Value applied:	0.81
Justification of the choice of data or description of measurement methods and procedures actually applied :	The CO_2 emission factor for Western grid calculated as per the approved methodology ACM0002 by the Central Electricity Authority (CEA) which is the nodal agency is being used. This being the country specific data.
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

>>

Project Emissions
Project Emissions are applicable only if auxiliary fuels are fired for generation startup, in emergencies, or to provide additional heat gain before entering the Waste Heat Recovery Boiler.
Project Emissions are given as:

$$PE_y = \sum_i Q_i \times NCV_i \times EF_i \times \frac{44}{12} \times OXID_i$$

Since no auxiliary fuels will be fired in the proposed project activity, project activity emissions are not applicable.

Baseline Emissions
Baseline emissions are given as:

$$BE_{electricity,y} = EG_y \cdot EF_{electricity,y}$$

As the baseline scenario is determined to be grid power supply, the emission factor for displaced electricity is calculated as per ACM0002. The emission factor EF_y as per the CEA report is **0.81 kgCO_2/kWh.**

EG_y i.e. Net units of electricity due to the project activity during the year y are calculated as follows:

S. No.	Year	Power generation capacity (MW)	Plant load factor (%)	Auxiliary Power consumption (%)	Working days per year	Hours of operation per day	Electricity generation (GWh)
1	2007-08	50	90	10	365	24	354.78
2	2008-09	50	90	10	365	24	354.78
3	2009-10	50	90	10	365	24	354.78
4	2010-11	50	90	10	365	24	354.78
5	2011-12	50	90	10	365	24	354.78
6	2012-13	50	90	10	365	24	354.78
7	2013-14	50	90	10	365	24	354.78
8	2014-15	50	90	10	365	24	354.78
9	2015-16	50	90	10	365	24	354.78
10	2016-17	50	90	10	365	24	354.78
	Total						**3,547.80**

The baseline emissions are calculated as the product of EG_y and EF_y estimated to be 287,968 tCO_2 annually over the crediting period. The emission reduction ER_y by the project activity during a given year y is the difference between the baseline emissions (BE_y) and project emissions (PE_y), as follows:

$$ER_y = BE_y - PE_y$$

As the project activity emissions PE_y are nil, the emission reductions are equal to the baseline emissions i.e. 287,968 tCO_2 annually over the crediting period.

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

>>

Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of emission reductions (tonnes of CO_2e)
2007-08	0	287,968	0	287,968
2008-09	0	287,968	0	287,968
2009-10	0	287,968	0	287,968
2010-11	0	287,968	0	287,968
2011-12	0	287,968	0	287,968
2012-13	0	287,968	0	287,968

2013-14	0	287,968	0	287,968
2014-15	0	287,968	0	287,968
2015-16	0	287,968	0	287,968
2016-17	0	287,968	0	287,968
Total (tonnes of CO_2e)	**0**	**2,879,680**	**0**	**2,879,680**

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

>>

B.7.1 Data and parameters monitored:

Data / Parameter:	**EG_{GEN}**
Data unit:	GWh/yr
Description:	Total electricity generated
Source of data to be used:	Onsite instrumentation
Value of data applied for the purpose of calculating expected emission reductions in section B.5	394.20
Description of measurement methods and procedures to be applied:	Monitoring location: Energy meters in the main electrical panels located in the power plant control room will measure the data. Manager In-charge would be responsible for regular calibration (internal as well as external) of the meter. External calibration would be carried out annually or as per manufacturer's guidelines. This would ensure the accuracy of the energy meters. Generation would be logged hourly by the electrical operator in the log books. Shift-in-charge would monitor the log books and would forward the cumulated report of the day to the power plant in-charge.
QA/QC procedures to be applied:	This can be cross-checked with the individual consumption of the different load centres. The calibrated equipments can be checked by the verifier. The calibration of the equipments for measurement of power will be done once a year. As an emergency preparedness measure, for the power generation one back-up meter would be provided apart from the main meter. Regular internal audits of the power plant would be carried out to ensure that the systems are being followed.
Any comment:	-

Data / Parameter:	**EG_{AUX}**
Data unit:	GWh/yr
Description:	Auxiliary Electricity
Source of data to be used:	Onsite instrumentation
Value of data applied for the purpose of calculating expected emission reductions in section B.5	10% of generation.
Description of measurement methods and procedures to	Essentially the auxiliary consumption of electricity for the WHR based power plant will be in the fans for maintaining the draught,

be applied:	boiler feed-water pumps, the condenser pumps and other smaller equipments in the power plant. Monitoring location: Energy meters in the main electrical panels located in the power plant control room will measure the data. Manager In-charge would be responsible for regular calibration (internal as well as external) of the meter. External calibration would be carried out annually or as per manufacturer's guidelines. This would ensure the accuracy of the energy meters. Auxiliary consumption would be logged hourly by the electrical operator in the log books. Shift-in-charge would monitor the log books and would forward the cumulated report of the day to the power plant in-charge.
QA/QC procedures to be applied:	This can be cross-checked with the individual consumption of the different load centres. The calibrated equipments can be checked by the verifier. The calibration of the equipments for measurement of power will be done once a year. During the time of failure of the auxiliary meter, the auxiliary power consumption would be based conservatively on the auxiliary load connected to the power plant. Regular internal audits of the power plant would be carried out to ensure that the systems are being followed.
Any comment:	-

B.7.2 Description of the monitoring plan:

>>

The methodology requires the project participant to monitor the following:

- Net electricity generation from the proposed project activity;
- Data needed to calculate carbon dioxide emissions from fossil fuel consumption due to the project activity;
- Data needed to recalculate the operating margin emission factor, if needed, based on the choice of the method to determine the operating margin (OM), consistent with "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002);
- Data needed to recalculate the build margin emission factor, if needed, consistent with "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002);
- Data needed to calculate the emissions factor of captive power generation.

The project activity will have the monitoring of the generation of the total electricity generated and the auxiliary electricity thereby enabling the calculation of the net electricity supplied to the facility. As there will be no fossil fuel consumption in the project activity so monitoring of the same would not be required.

Further, for ex-ante estimation of the emission factor the reports made publicly available by the Central Electricity Authority (CEA) has been taken into consideration.

The Plant Manager is responsible for monitoring and archiving of data required for estimating emission reductions. He would be supported by the shift in-charge who would continuously monitor the data logging and would generate daily, monthly and annual reports.

The detailed description of the monitoring plan is provided in Annex 4.

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

>>

Date of completing the final draft of this baseline section *(DD/MM/YYYY)*:
26/06/2007

Name of person/entity determining the baseline:
Jindal Steel & Power Limited

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>>
29/05/2003

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

>>
15 years

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

>>
The project activity will be using a fixed crediting period.

C.2.1. Renewable crediting period

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

>>
Not selected

C.2.1.2. Length of the first crediting period:

>>
Not selected

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>>
01/09/2007
The project participants hereby confirm that the crediting period would start after the registration of the project activity.

C.2.2.2. Length:

>>
10 years 0 months

SECTION D. Environmental impacts

>>

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

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As the project investment is more than INR 500 million so carrying out an Environmental Impact Assessment (EIA) is mandatory for the project activity[10]as per Indian legislation. JSPL has carried out an environmental impact assessment (EIA) study for the expansion project covering the DRI kilns and the power plant. No significant adverse impacts and trans-boundary impacts are arising due to the project activity. JSPL has submitted the EIA and other related documents to the Ministry of Environment and Forests (MoEF), Government of India, and subsequently MoEF has accorded environmental clearance to the project. The EIA report and the environmental clearance can be checked by the designated operational entity during validation.

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

>>

No significant environmental impacts are arising due to the project activity (In fact the consideration of usage of waste gases from the kilns for production of power has been taken due to its positive environmental contribution).

The impacts on the environment associated with the coming up of the project activity during construction phase and operation phase are as follows:

Construction Phase Impacts

The impacts arising due to the construction phase were short term, marginal and reversible in nature. The identified key issues related to physical and social environment during this phase and the associated management plan to mitigate the negative impacts are as follows:

Employment Generation: The project activity provided employment to the local work force and also resulted in indirect employment generation during this period.

Sanitation: The workers were encouraged to carry lunch from home and were provided with proper drinking water facility and toilet conveniences. This ensured non-contamination of surrounding areas.

Dust Generation: Due to movement of construction machinery and vehicles, dust is generated. This dust generation was minimised by supplying regular water sprinkling and providing suitable road surface treatment to ease traffic flow.

Topography: The project activity is located on a flat land that involved little site preparation and levelling. This did not alter the drainage pattern of the site and surroundings. It was ensured that

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

adequate drains and garland drains are constructed keeping proper alignment in conformity to the existing drainage pattern so that the alteration is kept to the minimum and flooding, etc., does not occur.

Land Use: All resettlement issues have been addressed through the Government authorities while acquiring land for the project activity. The land is not forest land. Therefore, the impact on land use pattern is marginal.

Greenery Development: Extensive greenery development has been undertaken by JSPL over the years and is a continuing practice.

Operation Phase Impacts

During operation phase of the project activity the identified key issues related to physical and socio-cultural environment and the associated management plan to mitigate the negative impacts are as follows:

Air Pollution: The waste gas emanating from the kilns after passing through the waste heat recovery boilers are let into the atmosphere through the stacks. The temperature of these gases at the stack exit is around 160 ^{0}C. In fact the project activity is not leading to any (further) contribution to the atmospheric emissions, because these emissions would have occurred in the absence of the power plant also. Had the project activity not been in place, or the waste heat recovery boilers are bypassed, then the atmospheric emissions would have been much more significant as the temperature of the gases coming out of the kilns is around 900 – 950 ^{0}C. The project activity helps in reducing this thermal load by bringing the gas temperature down to 160 ^{0}C and also effectively utilizing it for power generation purpose, thus resulting in reduced greenhouse gas emissions.

Noise Pollution: During the operation stage, noise is generated from turbines and other moving machines, of the order of 95 dB(A) maximum at 1 meter from source. To keep the noise levels at minimum and reduce its adverse impact on the surrounding areas following measures have been taken:

- Housing of the turbines and compressors inside building
- Regular preventive maintenance of pumps and other rotating equipment
- Provision of appropriate sound absorbing material in a room where both the source and the receiver are present so that the reflecting sound will be absorbed
- Strengthening of the developed greenbelt
- People working in noisy areas are given proper protective gears (ear plugs etc.)

Water Pollution: Since the project is designed for water re-circulation system hence there is no wastewater discharge associated with the project activity. The wastewater from the project activity would mainly comprise of blow-downs of cooling water circuit. All the wastewater generated is reused leaving no scope for any wastewater discharge outside the plant premises. Thus the project activity does not result in any kind of water pollution.

Solid Waste: No solid waste is generated due to the project activity and thus there is no adverse impact on the soil quality.

Land Use Pattern: The land acquired for the project site has not resulted in any displacement or resettlement of people. The land is not forest land. Hence there is no significant impact on the land

use pattern of the area. Also, the land allocated for the project activity is within the existing premises of JSPL.

Ecology: No wild life sanctuary or national park or biosphere reserve is located within 25 km of the project site.

Socio-economics: Establishment of any project leads to socio-economic changes. Influx of population leads to change in economic status of the community. People from the surrounding villages have been recruited in the project activity. In order to prevent the degradation of physical and aesthetic environment, proper sanitation facility and other basic facilities like drinking water supply and sewerage has been provided. Thus there has been positive impact on the socio-economic conditions due to generation of direct and indirect employment during construction and operation phase.

The EIA study for the project has been carried out by a Government approved laboratory & Consulting firm. The EIA study has revealed that there are no serious environmental risks or liabilities arising due to the project activity.

SECTION E. Stakeholders' comments

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

>>
The local stakeholders identified for the project activity are as follows:

- The nearby villagers represented by the village panchayat committee
- The people of Raigarh represented by the elected members of legislative assembly (MLAs)
- Officials of the general administration, grievances addressal and public relations department

Notification through regional and national newspapers for public hearing was brought out requesting the stakeholders to participate and communicate any suggestions/objections regarding the project activity in writing. For widespread publication, on 18th October 2003, an advertisement in the daily newspapers was given for the public hearing. On 18th November 2003, public hearing was conducted as per provision of Environmental Impact Assessment Notification, 1994 (as amended) for the project activity. In an official notice in accordance with the regulations public hearing was scheduled in presence of a formed panel. The meeting was done on the said date in the office of the Sub-Divisional Officer (Revenue), Raigarh. The proceeding of the public hearing along with objections/suggestion etc., were received in writing.

E.2. Summary of the comments received:

>>
No adverse comments were raised during the public hearing. Moreover, the people have appreciated the efforts being taken by JSPL towards community development and agree that the project activity will lead to development of the region.
The objections/suggestion made by the panel members and local people were related to the infrastructure development (road), employment generation, providing training, education, health, social development and water table conservation.
JSPL as a socially responsible organization is committed toward sustainable development and has been addressing these issues positively.

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

>>
No adverse comments have been received for the project activity as it is a measure towards environmental conservation and pollution control.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Jindal Steel & Power Limited
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding from Parties included in Annex I is availed for this project activity.

Annex 3

BASELINE INFORMATION

For the project activity the baseline scenario was determined as equivalent electricity generation from the grid as shown in Section B2 earlier. As per ACM0004 methodology, if the baseline scenario is grid power supply then the Emission Factor for the displaced electricity is calculated according to ACM0002 baseline methodology.

A) Choice of the grid that will be affected by the project activity

Western Region grid which comprises of Madhya Pradesh, Chhattisgarh, Maharashtra, Gujarat, Goa, Daman & Diu and Dadar & Nagar Haveli, is chosen as the grid system for the project activity, since the project activity is in Chhattisgarh.

B) Determination of the carbon intensity of the chosen grid

The emission factor for Western grid as given by the Central Electricity Authority (CEA) as per combined margin **(OM + BM)/2 = 0.81 kgCO_2/kWh**

Annex 4

MONITORING INFORMATION

The monitoring plan has been prepared in accordance with in ACM0004. The project activity being a waste heat recovery based power generation one, there are no/negligible project emissions generated during operation of the project activity.
The monitoring methodology will essentially aim at measuring and recording through devices, which will enable verification of the emission reductions achieved by the project activity that qualifies as Certified Emission Reductions (CERs). The methods of monitoring adopted should also qualify as economical, transparent, accurate and reliable.
The project activity will employ state of the art monitoring and control equipments that will measure, record, report and control various key parameters like total power generated, power used for auxiliary consumption, flow rate, temperature and pressure parameters of the steam generated and steam sent to turbine for generation of power. The monitoring and controls will be part of the Distributed Control System (DCS) of the entire plant. All instruments will be calibrated and marked at regular interval to ensure accuracy.

Project factors affecting emission reduction claims

The potential factors that may affect the emission reduction claims are: -

Frequency of monitoring: -

The emission reduction generated by the project is calculated by multiplying the total unit electricity generated by the appropriate Emission Factor calculated on the basis of current baseline scenario. Therefore it important to meter the net generation of power produced on real time basis. Thus such parameters that directly influence the total revenue generated from the emission reduction calculation by the project will be monitored on continuous basis through online monitoring system in place.

Reliability: -

The amount of emission reductions achieved by the project is dependent on the net energy generated from the project as well as baseline emission factor. Therefore meter readings calculating the final value of total electricity produced from the project side will be monitored with calibrated instruments. Calibration as per instrument specifications shall ensure reliability of measures. All power-measuring instruments will be calibrated once a year for ensuring reliability of the system.
For baseline emission factor calculation, data has been collected from the reliable sources such as WREB annual reports, CEA reports etc.

Registration and Reporting: -

Registration of data will be online in the control cabin through a microprocessor. Hourly data logging in log sheets in hard copies will be there in addition to software memory. Daily, weekly and monthly reports will be prepared stating the generation.