CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

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Power generation from waste heat at NSIL

Version: 01

Date: 09/05/2006

A.2. Description of the project activity:

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Purpose

Nalwa Sponge Iron Limited (NSIL) has implemented Waste Heat Recovery (WHR) based Power Project at their sponge iron plant. The NSIL sponge iron plant has 6 rotary kilns of 100 tonnes per day (tpd) capacity each for sponge iron production at Raigarh in Chhattisgarh state. Operation of these rotary kiln releases around 20,000 – 22,000 Nm^3/hr of gases per kiln at high temperature of around 900-1000 °C. The waste gas does not contain any 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. As per normal practice, these waste gases are released in the atmosphere after air scrubbing. In this way, the sensible heat of the waste gases goes unutilised. This is a loss in terms of energy as the escaping gases have the potential of producing large amount of steam through a heat exchanger, which can either be used for power generation or for some process. 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 for captive purposes. 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 6 numbers of waste heat recovery boilers connected to the 6 rotary kilns. The sensible heat from the gas is extracted in the boilers and the exhaust gas is thereafter let out to the atmosphere through tall stacks at around 160^0C. The steam produced in the boilers is used to run the steam turbine generator to generate 2x8 MW electricity. In the absence of the project, NSIL would have purchased similar quantum of electricity from Jindal Steel & Power Limited or 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]:

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

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

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

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

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 is expected in the country during the tenth and eleventh five year 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 displacement of grid through waste heat based power generation would partially reduce the dependency on coal and improve the grid reliability and stability thus attracting further investments in the region, consequently enhancing trade.

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 imported from 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.

Technological well being

High pressure boilers and turbines have been used for the power generation purpose from the waste gases thereby maximizing the power output. The best available technology has been used in 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.

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)	Nalwa Sponge Iron Limited (NSIL)	No

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

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

>>
The project activity is located adjacent to existing rotary kiln module. The P.H. No. of the project activity is 36, *Khasra* No. 141.

A.4.1.1. Host Party(ies):

>>
India

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

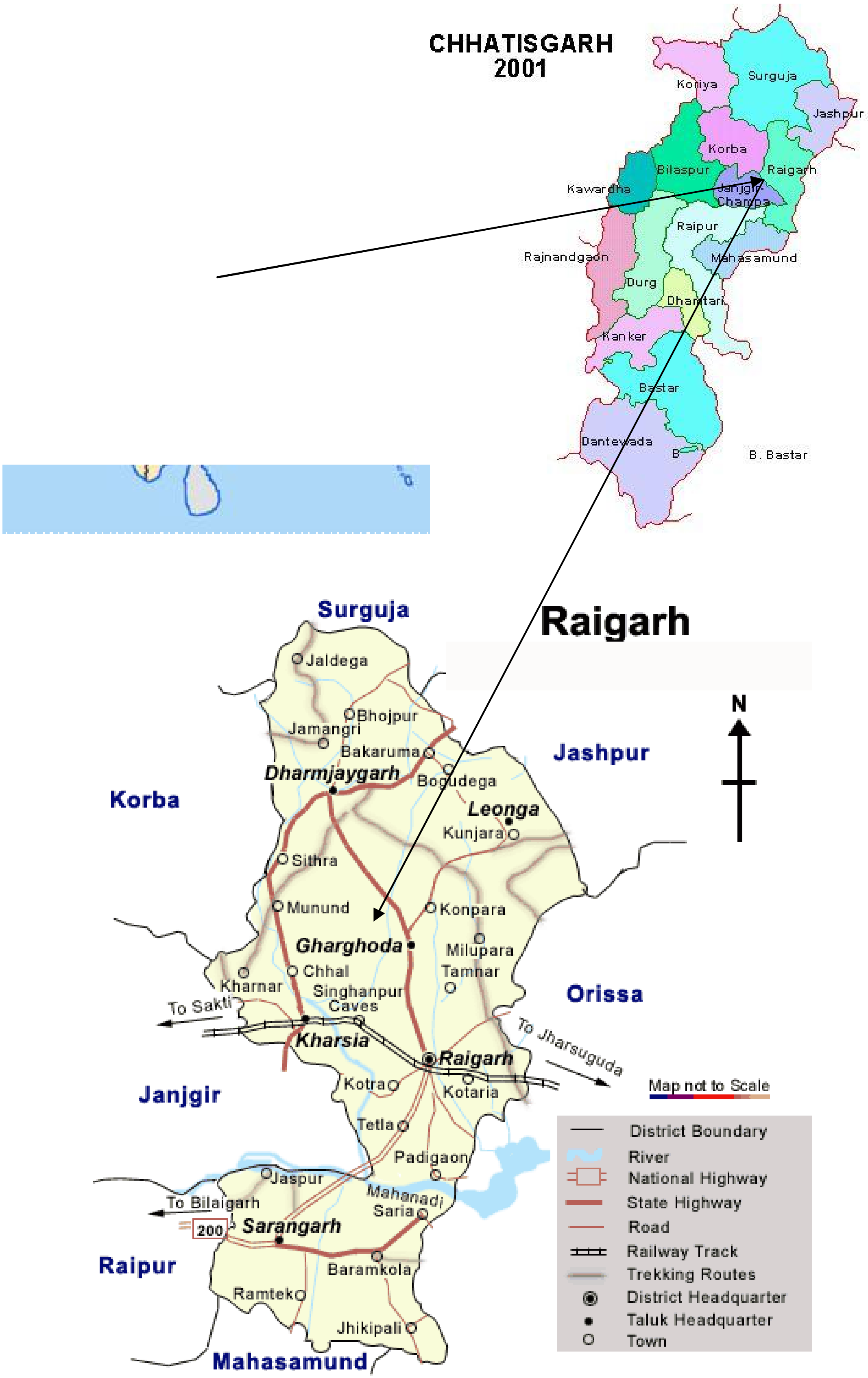
>>
Chhattisgarh

A.4.1.3. City/Town/Community etc:

>>
Village Taraimal, *Tehsil* Gharghoda, District Raigarh

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

>>
The project activity is about 12-13 km North of Raigarh town in the state of Chhattisgarh, by the side of Raigarh – Charchoda highway. The plant facilities are located more than 500 meter away from the road. Kelo river flows about 1-2 km east side of the plant. The site is surrounded by Taraimal village (0.5 – 1 km in NE direction) and Gerwani village (1-2 km SSE direction). The Mumbai – Howrah railway line is located about 16 km south of the plant. The nearest railway station is Raigarh.



Location of Project Activity (map not to scale)

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

>>

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”..

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

>>

The project activity consists of the following main units:

- 6 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

The WHRB are semi outdoor type, waste gases based, natural circulation, radiant, non-reheat, wet bottom type. The steam generating unit comprises of boiler drum, water cooled furnace wall system, economiser, super heaters, air heater, ID fans etc.

Steam output	:	12 tonnes per hour
Steam pressure	:	66 kg/cm^2
Steam temperature	:	485^{0}C

Steam turbine

The turbine are single cylinder, multistage, tandem compound, non-reheat, condensing regenerative feed heating type unit.

Capacity	:	8 MW
Steam pressure	:	64 kg/cm^2
Steam temperature	:	480^{0}C
Rated speed	:	7000 RPM

Electrical generator

Type	:	Two pole,3 phase Air cooled, Brushless excitation with digital automatic voltage regulation system
Speed	:	1500 RPM
Frequency	:	50 Hz
Power factor	:	0.8 (lagging)
Voltage	:	11 kV

The high pressure boiler and 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 132 kV and connected to the existing 132 kV switchyard of NSIL. The high voltage transmission and the proximity of the switchyard would ensure that the transmission and distribution losses are a 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. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

>>

The project activity would be generating electricity through the recovery of sensible heat from the waste gas emanating from the smaller sized kilns. In the absence of the project activity, the gas would have been released through the stack without heat recovery. Thus, due to the project activity, electricity will be generated without any GHG emissions. This electricity will be displacing/avoiding the fossil fuel based power generation (primarily coal based) in the Western Grid (generation mix: thermal (coal and gas) 90.86%, nuclear and other renewable sources 9.14%: refer to Table B3).

The project activity would be generating around **493.4** million units of electricity over a period of 10 years and hence would result in CO_2 emission reduction of **374,270** tonnes.

Currently no national or sectoral policy is existent in India that promotes waste heat recovery in the sponge iron industry[4] or stated in the draft national steel policy[5]. Although Chhattisgarh government has a policy of allowing industries (with investments on fixed assets in excess of INR 1000 millions) to have captive power plant, to generate power from waste heat recovery[6] and exemption from electricity duty for a period of 15 years; these policies do not essentially mandate the industry to set up a waste heat recovery unit. Still, as a sustainable development measure, NSIL has gone forward for waste heat recovery power generation.

[4] http://www.envfor.nic.in/cc/inisector.htm

[5] http://steel.nic.in/spolicy.pdf

[6] http://chhattisgarh.nic.in/industries/industrial_policy2.htm

A.4.4.1. 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**
2006 – 07	37,427
2007 – 08	37,427
2008 – 09	37,427
2009 – 10	37,427
2010 – 11	37,427
2011 – 12	37,427
2012 – 13	37,427
2013 – 14	37,427
2014 – 15	37,427
2015 – 16	37,427
Total estimated reductions (tonnes of CO_2e)	**374,270**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	**37,427**

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 methodology

B.1. Title and reference of the approved baseline 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, 03 March 2006.

B.1.1. 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.

The project activity utilizes the waste gas emanating from the kilns at NSIL to produce electricity. NSIL imports electricity from JSPL which also supplies electricity to the regional grid. So due to the project activity JSPL would be exporting similar quantum of electricity (as supplied to NSIL) to the regional grid. Thus due to the cascading effect the NSIL project activity would essentially displace the regional grid. The generated electricity will partially fulfil the electricity demand at the NSIL plant and thereby helps in displacing the grid power. Effectively the project activity would be displacing 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 is being 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 gets 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.2. Description of how the methodology is applied in the context of the project activity:

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The methodology as applied to the project activity has the following steps:

1. Identification of alternative baseline scenarios consistent with current laws and regulations;
2. Additionality assessment of the project;
3. Determination of project emissions;
4. Determination of baseline emission;
5. Estimation of emission reduction.

Step 1: 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 baseline scenarios** are as follows:

Alternative 1: The project activity not undertaken as a CDM project activity

NSIL may set up the 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 Section B3 below) making it predictably prohibitive. Hence this option is not a part of baseline scenario.

Alternative 2: 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 Western region electricity grid. This alternative is in compliance with all applicable legal and regulatory requirements and can be a baseline scenario.

Alternative 3: Coal based captive power generation

A coal based captive power plant put up at NSIL. This alternative is in compliance with all applicable legal and regulatory requirements. But this alternative would require additional investments for putting up the coal based power plant.

Alternative 4: Diesel based captive power generation

A diesel based captive power plant put up at NSIL. Although, this alternative is in compliance with all applicable legal and regulatory requirements, it is economically prohibitive given the rising crude prices and thereby higher cost of generation. Thus it can be excluded from the baseline scenario.

Alternative 5: Gas based captive power generation

NSIL may generate its own power using natural gas based captive power plant. Although this alternative is in compliance with all regulatory and legal requirements, it is not a realistic alternative due to non-availability of natural gas distribution network in Chattisgarh[7]. Therefore, alternative 5 may be excluded from baseline scenario.

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. Thus from the above identified alternatives, it can be found that alternatives 2 and 3 are the most likely alternatives for the baseline scenario. Taking a conservative approach, "**Alternative 2: 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.

[7] State wise/Sector wise Allocation of Natural Gas - http://petroleum.nic.in/ngbody.htm

Step 2: Additionality assessment of the project:

Please refer to section B.3. for the additionality of the project activity.

Step 3: Determination of project emissions:

The waste gas emanating from the kilns is not having any calorific value and hence cannot be fired in a furnace. Also there is no provision of auxiliary fuel firing in the project activity, thus there would not be any emissions in the project activity.

Step 4: Determination of baseline emission:

Taking a conservative approach the baseline scenario applicable to the project activity is 'import of electricity from the grid', accordingly the baseline emission factor for displaced electricity has been calculated in accordance with ACM0002/Version 05 (3rd March 2006). The combined margin has been calculated as described in the methodology taking the relevant grid definitions and emission factors. Please refer annex 3 for the details in determining the baseline emissions.

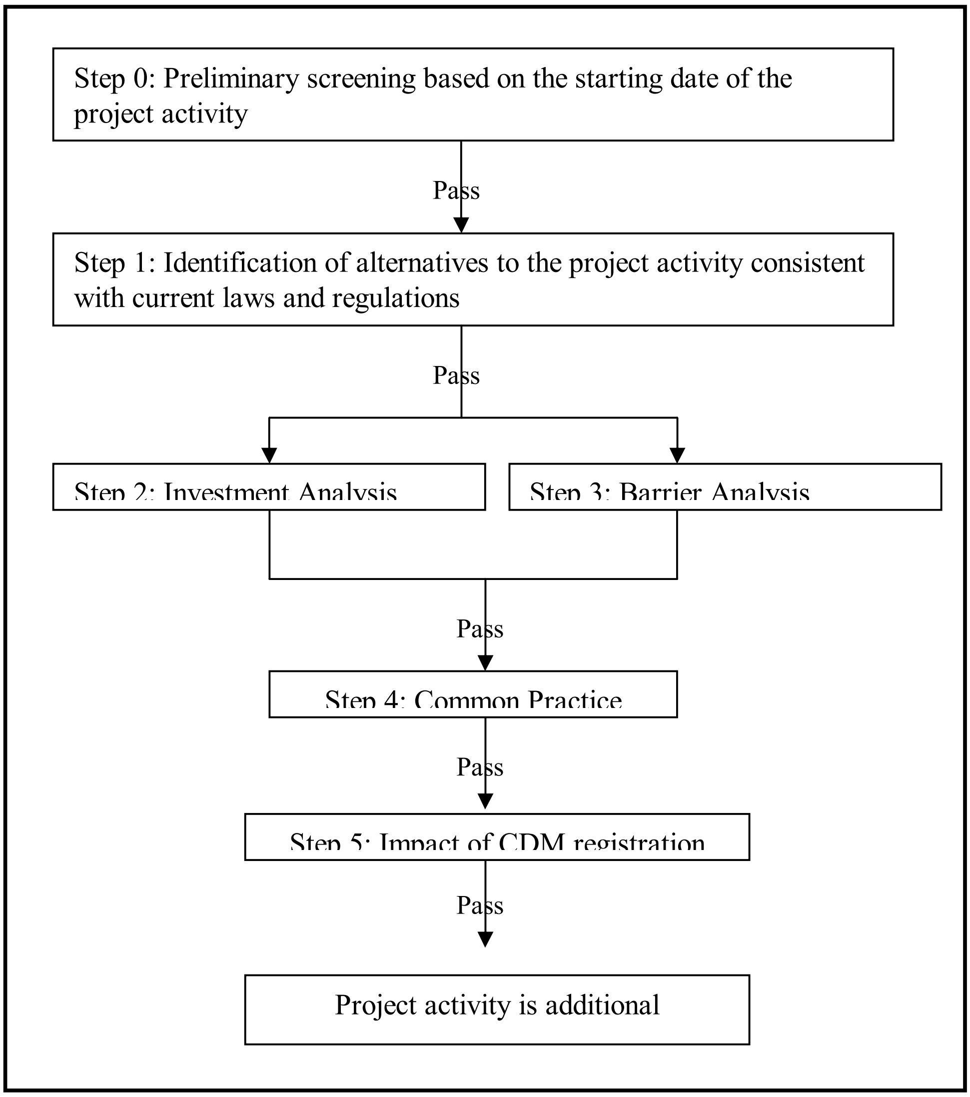
Step 5: Estimation of emission reduction:

As per the methodology the emission reductions by the project activity are calculated as the difference between baseline emissions and project emissions. Since there are no project emissions in the project activity so the emission reductions are equivalent to the baseline 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 CDM project activity:

>>

As per the decision 17/cp.7, paragraph 43, a CDM project activity is additional if anthropogenic emissions of green house gases by sources are reduced below those that would have occurred in absence of registered CDM project activity. The methodology requires the project proponent to determine the additionality based on 'Tool for the demonstration and assessment of additionality', Version 02, dated 28 November 2005. The flowchart in the figure below provides a step-wise approach to establish additionality of the project activity.



Flowchart for demonstrating additionality of the project

Step 0: Preliminary screening based on the starting date of the project activity
If project participants wish to have the crediting period starting prior to the registration of their project activity, they shall:

(a) Provide evidence that the starting date of the CDM project activity falls between 1 January 2000 and the date of the registration of a first CDM project activity, bearing in mind that only CDM project activities submitted for registration before 31 December 2005 may claim for a crediting period starting before the date of registration;

(b) *Provide evidence that the incentive from the CDM was seriously considered in the decision to proceed with the project activity. This evidence shall be based on (preferably official, legal and/or other corporate) documentation that was available to third parties at, or prior to, the start of the project activity.*

NSIL intends to have the crediting period starting after the project activity gets registered; hence this step is not applicable.

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 NSIL are:

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

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, import of elctricity 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
NSIL 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:

- ***Dirty waste gas***: the gas leaving the kiln has a very high particulate load that can create erosion and fouling problems on the gas side of the boiler tubes. The waste gases emanating from the kilns have high levels of SO_2 and SO_3 in them. The waste gas must therefore be kept at a temperature greater than 150°C to prevent the condensation of these gases as sulphuric acid. Sulphuric acid is highly corrosive and would severely damage downstream equipment such as the electrostatic precipitator, fans, dampers and the exhaust stack. Also there is nitrate stress corrosion cracking likely in waste heat recovery boilers[8].
- ***Input heat variations***: The gas generated by the DRI kiln varies widely in both flow and heat over short periods of time. Thereby the power output may vary. Thus incorporation of an attemperator (an over-sized steam drum) was required so that the effects of such wide variations are effectively balanced out.
- ***Maximising electricity production***: To maximise the electricity production from the waste gases high pressure and high temperature configuration is being utilised in the project activity. A fully

[8] 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

condensing turbine which gives the maximum power output is being used in the project activity. Also the flue gas exit in the project activity is being kept to the lowest possible maximising the heat recovery from the waste gases. An economiser design was adopted to prevent corrosion while maximising electrical output. The economiser ensures that the gas temperature remains above the acid dew point before the exhaust stack. The heat extracted from the gas in the condensate heater is used to preheat the condensate entering the deaerator of the boiler, eliminating the use of steam for preheating and thus providing the capacity to generate additional power.
Another aspect of the design that promotes maximum electricity output is the boiler cleaning system. Soot blowers are installed to clean the boiler and economiser tubes. The soot blowers will shake the dust from the tubes thereby maintaining the heat transfer area for heat recovery.

- ***Priority of kiln output***: As the core business of NSIL is to produce steel, it is important that the Waste Heat Recovery Plant not dictate kiln operations. A waste gas bypass system was installed to allow kiln operation during maintenance shutdowns of the boiler. During bypass operation, water sprays are used to cool the waste gas from 900°C (exit temperature form the kiln) to about 160°C in order to protect the electrostatic precipitator, ducts and fans. Such cooling and the resulting thermal shock, if performed in a traditional ducting lined refractory, would result in cracking and dislodging of the lining. The alternative adopted for the quench tower was an internally insulated structure consisting of an internal single plate construction made from high temperature steel plates.
- ***Safe and reliable connection to the electricity grid***: Digital High Voltage protection relays are required for the connection of the system to the grid. This includes distance protection, generator protection, transformer protection and protection against pole slipping on the generator. The relays are linked back to the main DCS for the plant, providing extensive monitoring and status information, and allowing disconnection and reconnection with grid as required.

Other Operational barrier(s)
The project activity faces operational risks related to the waste gas generation and its heat content, which effect the successful implementation of the project activity.

- The non-availability of waste gases due to any technical fault in the kiln will prevent power generation in 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.
- Cumulative effect of sustained variable frequency operation due to fluctuations in waste gas supply (flow rate & temperature) may have substantial bearing in safe and sustained operation of assets like the power plant equipments.
- 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.

Barriers due to prevailing practice
The low capacity DRI kilns[9] with WHRB for sponge iron production and power generation respectively is not a prevalent practice being followed in the region. 20 sponge iron units with DRI kilns with capacity of 100 tonnes per day (tpd) and lower exist in the region. Out of these 20 units only one unit has waste heat

[9] DRI kilns with capacity of 100 tonnes per day (tpd) and lower

recovery system. However this unit has only two kilns in comparison to 6 kiln operated by NSIL. Hence, the NSIL project activity is the first of its kind in the region.

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.

Step 4: Common Practice analysis:
Based on the information about activities similar to the proposed project activity, the project proponent is supposed to carry out common practice analysis to complement and reinforce the barrier analysis. 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 available statistics, there are around 20 sponge iron units with kiln capacity of 100 tonnes per day (tpd) and lower operating in the region. Waste heat based power generation activity is being carried out at only 1 unit.
Step 4b: Discuss any similar options that are occurring
Still, the sponge iron units with (only) lower kiln capacity (100 tpd or less only) in the region have not opted for implementation of WHRB for power generation from the waste gases emanating from the kiln. Only one activity of similar type to the NSIL project activity is existent in the region. Essential distinctions between the project implemented at NSIL and other unit are as follows:

- In comparison to two kilns operated by other unit, NSIL is operating 6 units, which makes it difficult to operate the waste heat recovery project because of its scale of operation.
- Plant load factor (PLF) for the waste heat recovery project implemented by NSIL is very low compared to any other project, which makes it economically unattractive to implement the project.

Step 5: Impact of CDM registration
The registration of the project activity as a CDM project and financial benefits accrued thereby would encourage other sponge iron units with lower capacity kiln size to pursue such kind of initiatives. Also it might trigger industries in other sectors to look into their processes and identify opportunities wherein waste heat recovery would be materialised. Thus CDM registration would result in reducing GHG emissions and promoting new and cleaner technology.

Based on the above steps, it may be satisfactorily concluded that the NSIL project activity is not a baseline scenario and hence is clearly additional. The likely non-project options are coal based power generation and/or import of electricity from the grid. Taking a conservative approach, import of electricity from the grid has been taken as the baseline scenario[10].

[10] The emission factor of coal based power generation is around 1.1 kg of CO_2/kWh, whereas the grid emission factor is 0.759 kg of CO_2/kWh

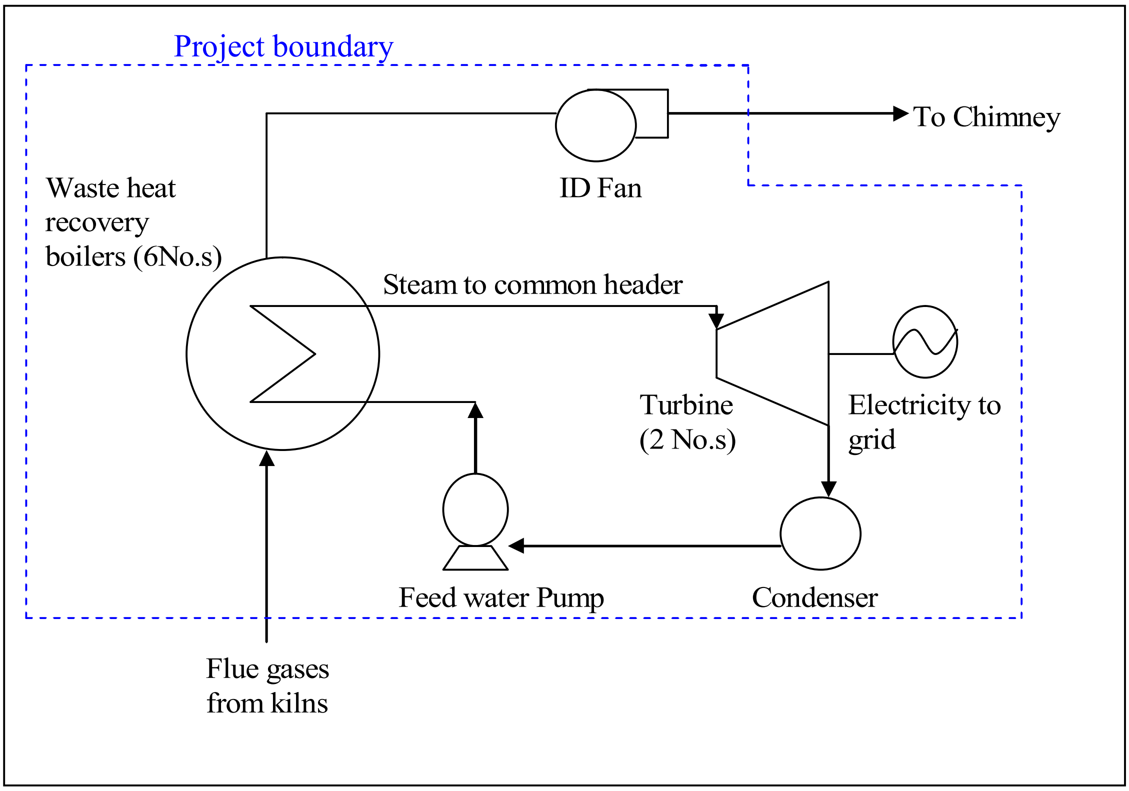
B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

>>

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 fuels

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 WHRBs, turbines and the auxiliaries as shown in the following figure:



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

Further, for the purpose of calculation of baseline emissions Western Regional Electricity Grid (WREB) has been considered within the system boundary. Estimation of baseline emissions has been done based on data and information available from WREB sources and Central Electricity Authority (CEA) sources as applicable.

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

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As required by ACM0004 methodology, baseline is calculated as per ACM0002 and the net baseline emission factor was found to be 0.759 kg CO_2/ kWh. Please refer to details in Annex 3 of the PDD.

Date of completing the final draft of this baseline section *(DD/MM/YYYY)*:
09/05/2006

Name of person/entity determining the baseline:
Nalwa Sponge Iron Limited and its associated consultants

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:

>>
June 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:

>>
01/09/2006

C.2.2.2. Length:

>>
10 years

SECTION D. Application of a monitoring methodology and plan

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

>>

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

Reference: UNFCCC Approved consolidated monitoring methodology **ACM0004 / Version 02**, Sectoral Scope: 01, 03 March 2006.

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

>>

The monitoring methodology is used in conjunction with the approved baseline methodology ACM0004 – "Consolidated baseline methodology for waste gas and/or heat and/or pressure for power generation". The applicability criteria for the approved baseline methodology ACM0004 and approved monitoring methodology ACM0004 are identical and have been justified in section B.1.1. Thus the said methodology is applicable to the project activity.

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.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Not applicable. As per the methodology ACM0004 project emissions are applicable only if auxiliary fuels are fired for generation start-up, in emergencies, or to provide additional heat gain before entering the waste heat recovery boiler. Since in the project activity there will be no auxiliary fossil fuel firing / consumption involved, thence no project emissions.

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>>

Not applicable

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1. EG_{GEN}	Total Electricity Generated	On-site instrumentation	MWh/yr	m	Continuously	100%	Electronic/paper	Monitoring location: meters at plant and DCS will measure the data. Manager In-charge would be responsible for regular calibration of the meter, which would be carried out annually.
2. EG_{AUX}	Auxiliary Electricity	On-site instrumentation	MWh/yr	m	Continuously	100%	Electronic/paper	Monitoring location: meters at plant and DCS will measure the data. Manager In-charge would be responsible for regular calibration of the meter, which would be carried out annually.
3. EG_y	Net Electricity supplied	On-site instrumentation	MWh/yr	c (EG_{GEN} - EG_{AUX})	Continuously	100%	Electronic/paper	Calculated from the above measured parameters.
4. EF_y	CO_2 Emission factor of the grid	Grid reports and CEA reports	tCO_2/MWh	c	Once at the start of the crediting period	100%	Electronic/paper	Calculated as a weighted sum of the OM and BM emission factors
5. $EF_{OM,y}$	CO_2 Operating Margin emission factor of the grid	Grid reports and CEA reports	tCO_2/MWh	c	Once at the start of the crediting period	100%	Electronic/paper	Calculated as per Step 1 of ACM0002

6. $EF_{BM,y}$	CO_2 Build Margin emission factor of the grid	Grid reports and CEA reports	tCO_2/MWh	c	Once at the start of the crediting period	100%	Electronic/paper	Calculated as per Step 2 of ACM0002
7. $F_{i,j,y}$	Amount of each fossil fuel consumed by each power source / plant	Grid reports and CEA reports	t or m^3/yr	c	Once at the start of the crediting period	100%	Electronic/paper	Since data of fossil fuel consumption for all the power plants is not available so conservative estimation of the same has been carried out based on the highest efficiency achieved by the power plant operating in the region.
8. $COEF_{i,j}$	CO_2 emission coefficient of each fuel type and each power source / plant	Grid reports and CEA reports, IPCC guidelines	tCO_2/ t or m^3	m	Once at the start of the crediting period	100%	Electronic/paper	Plant or country specific values to calculate COEF are preferred to IPCC default values
9. $GEN_{j,y}$	Electricity generation of each power source / plant	Grid reports	MWh/yr	m	Once at the start of the crediting period	100%	Electronic/paper	Obtained from the power producers, dispatch centers or latest local statistics.

All the data mentioned above would be archived for two years after the crediting period.

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>>

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 combined margin are 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/MWh) 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 (MWh) delivered to the grid by source j

$F_{i,j,y}$ is the amount of fuel i (in a mass or volume unit) consumed by relevant power sources j in year(s) y , 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 (MWh) 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 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.

<u>STEP 2. Calculation of the Build Margin emission factor</u>

The Build Margin emission factor ($EF_{BM,y}$) has been calculated as the generation-weighted average emission factor (t CO_2/MWh) 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 MWh) 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 Northern 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/MWh.
(Please refer to "Annex 3: Baseline Information" for further details on grid analysis)

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

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

Not applicable

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Not applicable

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

>>

Not applicable

D.2.3. Treatment of leakage in the monitoring plan D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Not applicable

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>>
Not applicable

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>>
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 are the emission reductions of the project activity during the year y in tonnes of CO_2
BE_y are the baseline emissions due to the 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)
$ER_y = BE_y$

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
D.2.1.3 – 1	Low	This will be cross-checked with the amount of steam generated in the WHRBs. The calibrated equipments can be checked by the verifier. The calibration of the equipments for measurement of power and steam will be done once a year.
D.2.1.3 – 2	Low	The auxiliary consumptions are usually fixed but still the calibrated meters can be checked by the verifier
D.2.1.3 – 3	Low	This is a calculated value
D.2.1.3 – 4 - 9	Low	Latest data from local statistics, Grid reports, CEA reports. IPCC data will be checked against recent IPCC publications.

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

>>
The head (Power Plant) 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 reports

D.5 Name of person/entity determining the monitoring methodology:

>>
Nalwa Sponge Iron Limited and its associated consultants

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

>>
Not applicable. The waste heat recovery boilers of the project activity are unfired type, thus there will be no auxiliary fossil fuel consumption. Thence there will be no greenhouse gas emissions occurring due to the project activity.

E.2. Estimated leakage:

>>
Not applicable as per the methodology ACM0004.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

>>
There are no project activity emissions.

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

>>
Baseline emissions (BE_y) are calculated using the formula:
$BE_y = EF_y \times EG_y$
Where,
EG_y Net electricity generated
EF_y Baseline emission factor

Year	**Estimation of Net Electricity generated, EG_y (million kWh/annum)**	**Estimation of Emission factor, (tonnes of CO_2 per million kWh)**	**Estimation of baseline emissions (tonnes of CO_2e)**
2006-07	49.34	758.61	37,427
2007-08	49.34	758.61	37,427
2008-09	49.34	758.61	37,427
2009-10	49.34	758.61	37,427
2010-11	49.34	758.61	37,427
2011-12	49.34	758.61	37,427
2012-13	49.34	758.61	37,427
2013-14	49.34	758.61	37,427
2014-15	49.34	758.61	37,427
2015-16	49.34	758.61	37,427
Total (tonnes of CO_2e)	**493.4**	**758.61**	**374,270**

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

>>

Emissions reductions (ER_y) are calculated using formula:

$ER_y = BE_y - PE_y$

Since project emissions (PE_y) are zero, the emission reductions are equal to baseline emissions as given in table below.

E.6. Table providing values obtained when applying formulae above:

>>

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)
2006-07	0	37,427	0	37,427
2007-08	0	37,427	0	37,427
2008-09	0	37,427	0	37,427
2009-10	0	37,427	0	37,427
2010-11	0	37,427	0	37,427
2011-12	0	37,427	0	37,427
2012-13	0	37,427	0	37,427
2013-14	0	37,427	0	37,427
2014-15	0	37,427	0	37,427
2015-16	0	37,427	0	37,427
Total (tonnes of CO_2e)	**0**	**374,270**	**0**	**374,270**

SECTION F. Environmental impacts

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

>>

As the project investment was less than INR 500 million so carrying out an Environmental Impact Assessment (EIA) is not mandatory for the project activity[11]as per Indian legislation. Still as a responsible organization NSIL has carried out an EIA study for the project activity and an Environmental Management Plan (EMP) has been made accordingly. The project activity complies with all environmental legislations and meets all the consent requirements given by the State Pollution Control Board. The impacts that are evident due to the project activity 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 are:

- Generation of dust due to movement of vehicles and construction activity
- Generation of solid waste due to debris and discarded materials

Operation Phase Impacts

During operation phase of the project activity the identified environmental impacts are:

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 ^oC.

Noise Pollution: During the operation stage, noise is generated from turbines and other moving machines.

Water Pollution: About 30 m^3/hr of de-mineralized water (DM water) and clarified water is required for steam generation in WHRB, condenser cooling and cooling of mechanical equipment. The condenser cooling water is re-circulated through cooling towers. Make-up clarified water is added to the cooling tower. Chlorine/bleaching powder is added as biocide in the cooling tower water. Trisodium phosphate/hexamine is added as anti-scaling chemical in boiler, 6 m^3/hr of wastewater in the form of boiler blow-down and cooling tower blow-down is generated. The boiler blow-down is at 100 ^oC and contains phosphate (<1 ppm). The cooling tower blow-down is 5-6 ^oC higher than ambient temperature and contains free chlorine (< 0.1 ppm). There are no other pollutants in the blow-down.

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 NSIL.

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

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.

F.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). Still an Environmental Management Plan (EMP) has been made to mitigate the possible adverse impact of the project activity. Thereby it is ensured that the existing environmental quality of the area is maintained/improved. The impacts on the environment associated with the coming up of the project activity during construction phase and operation phase and the associated mitigation plans are as follows:

Construction Phase

The following measures were considered during the construction stage to minimize the impact on environment:

- Appropriate disposal of discarded materials generated during construction
- All discarded or surplus materials, litter and other debris were removed from the construction site and other working areas in a proper manner.
- The roads used during construction stage were sprinkled with water on a regular basis to minimize the fugitive dust emission.
- The workers were given drinking water and sanitation facility at the construction site. Adequate drainage facilities including catchment pits and sedimentation basin were made to drain the construction water in a proper manner.

Operation Phase

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 ^{o}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 – 1000°C. The project activity helps in reducing this thermal load by bringing the gas temperature down to 160°C and also effectively utilizing it for power generation purpose, thus resulting in reduced greenhouse gas emissions. Also an electrostatic precipitator (ESP) has been provided at the exit of the WHRB to control the particulate matter before discharge through the 58m tall stack.

Noise Pollution: During the operation stage, noise is generated from turbines and other moving machines. To keep the noise levels at minimum and reduce its adverse impact on the surrounding areas following measures have been taken:

- Low noise prone equipments were selected
- The vibrations were dampened by proper mounting and alignment
- Noise prone unit were isolated from the working personnel's continuous exposure by making glass cabins
- Providing administrative control (through ear plugs/muffs and ensuring that no plant personnel is over exposed to noise)
- Adequate plantations were done in and around the plant premises to reduce the noise level.

Water Pollution: The blow-downs are taken to settling pond and then reused for dust suppression in the raw material handling plant, road washing and other minor construction purpose.

SECTION G. Stakeholders' comments

G.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 local people (villagers represented by the village *panchayat* committee of Taraimal)
- Chhattisgarh Environment Conservation Board (CECB)

NSIL had informed the *sarpanch* of VillageTaraimal (village head) about their intention of expansion of their sponge iron plant and putting up the project activity. It was requested from the village people to raise their concern and if there were no comments then to kindly issue the No Objection Certificate (NOC) to the project activity.

Also, NSIL had written an application to the CECB for obtaining the consent to operate the project activity under the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981.

G.2. Summary of the comments received:

>>
No adverse comments were raised during the meeting held by the *panchayat* committee during their discussions held for the project activity. They have unanimously given the NOC to the project activity.

CECB has also given the consent to operate the plant under Section 25/26 of the Water (Prevention and Control of Pollution) Act, 1974, and under section 21 of the Air (Prevention and Control of Pollution) Act, 1981, subject to certain conditions.

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

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

NSIL is meeting the conditions stipulated in the consent letter given by CECB.

Further, the CDM-PDD would be posted on the validator's web site for public viewing and global comments.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Nalwa Sponge Iron Limited
Street/P.O.Box:	Taraimal, Gharghoda Road
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Represented by:	
Title:	Wholetime Director - Finance
Salutation:	Mr.
Last Name:	Maroo
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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

Complete analysis of the system boundary's electricity generation mix has been carried out for calculating the emission factor of Western Region electricity grid is as follows:

Combined Margin
The approved consolidated baseline methodology ACM0002 suggests that the project activity would have an effect on both the operating margin (*i.e.* the present power generation sources of the grid, weighted according to the actual participation in the state grid mix) and the build margin (*i.e.* weighted average emissions of recent capacity additions) of the selected grid and the net baseline emission factor would therefore incorporate an average of both these elements.

Step 1: Calculation of Operating Margin
As mentioned above the project activity would have some effect on the Operating Margin (OM) of the Regional Grid. The Operating Margin emission factor(s) ($EF_{OM,y}$) is calculated based on one of the four following methods:

(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch Data Analysis OM, or
(d) Average OM.

As per the methodology 'Dispatch Data Analysis' (1c) should be the first methodological choice. However, this method is not selected for OM emission factor calculations due to non-availability of activity data.

'Simple OM' (1a) method is applicable to project activity connected to the project electricity system (grid) where the low-cost/must run[12] resources constitute less than 50% of the total grid generation in
1) average of the five most recent years, or
2) based on long-term normal for hydroelectricity production.

[12] The low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation.

The Simple adjusted OM (1b) and Average OM (1d) methods are applicable to project activity connected to the project electricity system (grid) where the low-cost/must run resources constitute more than 50% of the total grid generation.

To select the appropriate methodology for determining the Operating Margin emission factor ($EF_{OM,y}$) for the project activity, NSIL conducted a baseline study wherein the power generation data for all power sources in the project electricity system were collected from government/non-government organisations and authentic sources. The power generation mix of Western Regional electricity grid comprises of coal, gas, nuclear and hydro power generation as well as some imports from other regional grids as shown in Table B3 below.

Table B3 - Power generation Mix of Western Regional Grid for last five years

Energy Source	2000-01[13]	2001-02[14]	2002-03[15]	2003-04[16]	2004-05[17]
Total Power Generation (MU)	164428.5	164310.5	164710.1	169119.2	171732.6
Total Thermal Power Generation	151373.8	---	147642.0	149868.5	155734.2
Total Low Cost Power Generation	13054.7	---	17068.15	19250.73	15998.41
Thermal % of Total grid generation	92.06	---	89.64	88.62	90.68
Low Cost % of Total grid generation	7.94	---	10.36	11.38	9.32
% of Low Cost generation out of Total grid generation – (Average of the four most recent years)					**9.75**

NSIL has therefore adopted the 'Simple OM' (1a) method, amongst the 'Simple OM' (1a), 'Simple adjusted OM' (1b) and 'Average OM' (1d) methods to calculate the Baseline Emission Factor of the chosen grid.

The Simple OM emission factor ($EF_{OM,simple,y}$) is calculated as the generation-weighted average emissions per electricity unit (tCO_2/MU) taking into consideration the present power generation mix excluding low cost must run hydro-power projects of the selected grid, the design efficiency of the thermal power plants in the grid mix and the IPCC emission factors.

The Simple OM emission factor can be calculated using either of the two following data vintages for years(s) *y*:

- A 3-year average, based on the most recent statistics available at the time of PDD submission, or
- The year in which project generation occurs, if $EF_{OM,y}$ is updated based on ex post monitoring.

[13] CEA Report 2000-01

[14] Data not available

[15] CEA Report 2002-03

[16] CEA Report 2004-05

[17] WREB Report 2004-05

NSIL has calculated the OM emission factor as per the 3-year average of Simple OM calculated based on the most recent statistics available at the time of PDD submission.
Table B4 shows the power generation mix of Western Regional electricity grid under different jurisdiction such as State, Central and Private power plants respectively. The identified plants have been categorically differentiated on the basis of their fuel source used for generation.

Table B4: Power Generation Mix of Western Regional electricity grid

Year of offer	**2002-03**		**2003-04**		**2004-05**	
Generation Mix					**Base Year**	
Sector	**MU**	**%**	**MU**	**%**	**MU**	**%**
Thermal Coal Based-Western Region	129253	78.47	128817	76.17	130462	75.97
Thermal Gas Based-Western Region	18389	11.16	21051	12.45	25272	14.72
Hydro-Western Region	8122	4.93	9226	5.46	10524	6.13
Wind-Western Region	879	0.53	1522	0.90	0	0.00
Nuclear-Western Region	5600	3.40	5306	3.14	4497	2.62
Import from Self Generating Industries	2468	1.50	3197	1.89	978	0.57
Total	**164710**	**100.0**	**169119**	**100.0**	**171733**	**100.0**
Total generation excluding Low-cost power generation	147642		149869		155734	
Generation by Coal out of Total Generation excluding Low-cost power generation	129253	87.54	128817	85.95	130462	83.77
Generation by Gas out of Total Generation excluding Low-cost power generation	18389	12.46	21051	14.05	25272	16.23
Imports from others						
Imports from NREB	1124		1137		1093	
Imports from SREB	467		0		1767	
Imports from EREB	257		1450		9095	
Total including imports	166559		171707		183687	

Calculation of Operating Margin Emission Factor
The following table gives a step by step approach for calculating the Simple Operating Margin emission factor for Western Regional electricity grid for the most recent 3 years at the time of PDD submission i.e.2002-2003, 2003-2004 & 2004-2005.

Table B5: Calculation of Simple Operating Margin

Estimation of Baseline Emission Factor (tCO_2/MU)	**2002-03**	**2003-04**	**2004-05**
Simple Operating Margin	-	-	-
Fuel 1 : Coal			
Avg. Efficiency of power generation with coal as a fuel, %	36.732	36.576	36.487
Avg. Calorific Value of Coal used (kcal/kg)	4171	3820	3820
Estimated Coal consumption (tons/yr)	72552891	79288901	80497035
Emission Factor for Coal-IPCC standard value (tonne CO2/TJ)	96.1	96.1	96.1
Oxidation Factor of Coal-IPCC standard value	0.98	0.98	0.98
COEF of Coal (tonneCO2/ton of coal)	1.645	1.506	1.506
Fuel 2 : Gas			

Avg. Efficiency of power generation with gas as a fuel, %	45	45	45
Avg. Calorific Value of Gas used (kcal/kg)	11942	11942	11942
Estimated Gas consumption (tons/yr)	2942817	3368913	4044423
Emission Factor for Gas- IPCC standard value(tonne CO2/TJ)	56.1	56.1	56.1
Oxidation Factor of Gas-IPCC standard value	0.995	0.995	0.995
COEF of Gas(tonneCO2/ton of gas)	2.791	2.791	2.791
EF (OM Simple, excluding imports from other grids), tCO2/MU	863.87	859.67	851.08
EF (NREB), tCO2/MU	790.00	740.00	730.00
EF (SREB), tCO2/MU	770	760	740
EF (EREB), tCO2/MU	1190.00	1190.00	1180.00
EF (OM Simple), tCO2/MU	**863.58**	**861.92**	**866.96**
Average EF (OM Simple), tCO2/MU	**864.15**		

Step 2: Calculation of Build Margin

The project activity would have some effect on the Build Margin (BM) of the Western Regional Electricity Board. The Build Margin emission factor ($EF_{BM,y}$) is calculated as the generation-weighted average emission factor (tCO_2/MU) of a sample of power plants. The methodology suggests the project proponent to choose one of the two options available to calculate the Build Margin emission factor $EF_{BM,y}$

Option 1:

Calculate the Build Margin emission factor $EF_{BM,y}$ *ex ante* based on the most recent information available on plants already built for sample group *m* at the time of PDD submission. The sample group *m* consists of either:

(a) The five power plants that have been built most recently, or
(b) The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MU) and that have been built most recently.

Project participants should use from these two options that sample group that comprises the larger annual generation.

Option 2:

For the first crediting period, the Build Margin emission factor $EF_{BM,y}$ must be updated annually ex post for the year in which actual project generation and associated emission reductions occur. For subsequent crediting periods, $EF_{BM,y}$ should be calculated ex-ante, as described in Option 1 above. The sample group m consists of either

(a) the five power plants that have been built most recently, or
(b) the power plants capacity additions in the electricity system that comprise 20% of the system generation (in MU) and that have been built most recently.

Project participants should use from these two options that sample group that comprises the larger annual generation.

NSIL has adopted Option 1, which requires the project participant to calculate the Build Margin emission factor $EF_{BM,y}$ ex ante based on the most recent information available on plants already built for sample group m at the time of PDD submission. The sample group m should consist of either (a) the five power plants that have been built most recently, or (b) the power plants capacity additions in the electricity system that comprise 20% of the system generation (in MU) and that have been built most recently. Project participants are required to use from these two options that sample group that comprises the larger annual generation. As per the baseline information data the option (b) comprises the larger annual generation. Therefore for the project activity the sample group m consists of (b) the power plants capacity additions in the electricity system for 2004-05 that comprise 20% of the system generation (in MU) and that have been built most recently.

The following Table presents the key information and data used to determine the BM emission factor for the most recent year 2004-05.

Table B6: Most recent capacity additions in Western Regional Electricity Grid for 2004-05 that comprise 20% of gross generation

Sample of Power Plants for BM Calculation								
Sr.No.	Power plant name / location	State	Year of commissioning	Fuel Type	Capacity of the new addition	Total Capacity	Generation of the Unit in 2004-2005	Comments
					(MW)	(MW)	(MU)	
1	R.P.Sagar	Madhya Pradesh		Hydro	172 (50%)		188.64	Year of commissioning for these power plants are not available. But being low-cost power generation sources, all of them are considered for BM calculation to arrive at a conservative value of BM.
2	Jawahar Sagar	Madhya Pradesh		Hydro	99 (50%)		140.52	
3	Yeoteshwar	Maharashtra		Hydro	0.08		0.00	
4	Aravelam	Goa		Hydro	0.05		0.00	
5	Akrimota Lignite	Gujarat	31/3/2005	Lignite	125		0.00	
6	Indira Sagar Unit-8	Madhya Pradesh	23/3/2005	Hydro	125	1000	0.80	
7	Sardar Sarovar RBPH Unit-1	Gujarat	1/2/2005	Hydro	200		42.13	Generation from Sardar Sarovar RBPH Unit-1 & Sardar Sarovar CHPH Unit-1 to 5
8	Sardar Sarovar RBPH Unit-1	Madhya Pradesh	1/2/2005	Hydro	200		149.65	
9	Sardar Sarovar RBPH Unit-1	Maharashtra	1/2/2005	Hydro	200		71.09	
10	Indira Sagar Unit-6	Madhya Pradesh	29/12/2004	Hydro	125	1000	41.74	

11	Gangrel Unit-4	Chattisgarh	5/11/2004	Hydro	2.5		7.52	Generation from Gangrel Unit-1 to 4
12	Indira Sagar Unit-7	Madhya Pradesh	27/10/2004	Hydro	125	1000	25.16	
13	Gangrel Unit-3	Chattisgarh	17/10/2004	Hydro	2.5		0.00	Generation already considered in Gangrel Unit-4
14	Sardar Sarovar CHPH Unit-1	Gujarat	4/10/2004	Hydro	50		0.00	Generation already considered in Sardar Sarovar RBPH Unit-1
15	Sardar Sarovar CHPH Unit-1	Madhya Pradesh	4/10/2004	Hydro	50		0.00	
16	Sardar Sarovar CHPH Unit-1	Maharashtra	4/10/2004	Hydro	50		0.00	
17	Sardar Sarovar CHPH Unit-3	Gujarat	31/8/2004	Hydro	50		0.00	
18	Sardar Sarovar CHPH Unit-3	Madhya Pradesh	31/8/2004	Hydro	50		0.00	
19	Sardar Sarovar CHPH Unit-3	Maharashtra	31/8/2004	Hydro	50		0.00	
20	Sardar Sarovar CHPH Unit-2	Gujarat	16/8/2004	Hydro	50		0.00	
21	Sardar Sarovar CHPH Unit-2	Madhya Pradesh	16/8/2004	Hydro	50		0.00	
22	Sardar Sarovar CHPH Unit-2	Maharashtra	16/8/2004	Hydro	50		0.00	
23	Indira Sagar Unit-5	Madhya Pradesh	23/7/2004	Hydro	125	1000	120.09	
24	Gangrel Unit-2	Chattisgarh	29/6/2004	Hydro	2.5		0.00	Generation already considered in Gangrel Unit-4
25	Sardar Sarovar CHPH Unit-4	Gujarat	3/5/2004	Hydro	50		0.00	Generation already considered in Sardar Sarovar RBPH Unit-1
26	Sardar Sarovar CHPH Unit-4	Madhya Pradesh	3/5/2004	Hydro	50		0.00	

27	Sardar Sarovar CHPH Unit-4	Maharashtra	3/5/2004	Hydro	50		0.00	
28	Gangrel Unit-1	Chattisgarh	2/4/2004	Hydro	2.5		0.00	Generation already considered in Gangrel Unit-4
29	Indira Sagar Unit-4	Madhya Pradesh	28/3/2004	Hydro	125	1000	138.18	
30	Indira Sagar Unit-3	Madhya Pradesh	27/2/2004	Hydro	125	1000	314.87	
31	Sardar Sarovar CHPH Unit-5	Gujarat	15/2/2004	Hydro	50		0.00	Generation already considered in Sardar Sarovar RBPH Unit-1
32	Sardar Sarovar CHPH Unit-5	Madhya Pradesh	15/2/2004	Hydro	50		0.00	
33	Sardar Sarovar CHPH Unit-5	Maharashtra	15/2/2004	Hydro	50		0.00	
34	Indira Sagar Unit-2	Madhya Pradesh	18/1/2004	Hydro	125	1000	390.83	
35	Indira Sagar Unit-1	Madhya Pradesh	1/1/2004	Hydro	125	1000	300.20	
36	Dhuvaran CCCP ST	Gujarat	22/9/2003	Gas	38.77	133.6	194.42	
37	Dhuvaran CCCP GT	Gujarat	4/6/2003	Gas	67.85	133.6	340.25	
38	Bansagar (Stage-III) Unit-3	Madhya Pradesh	2/9/2002	Hydro	20	60	26.47	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
39	Bansagar (Stage-II) Unit-2	Madhya Pradesh	1/9/2002	Hydro	15	30	34.77	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
40	Bansagar (Stage-II) Unit-1	Madhya Pradesh	28/8/2002	Hydro	15	30	33.33	
41	Hazira CCGP-GSEL Surat	Gujarat	31/3/2002	Gas	52.1	156.1	386.23	
42	Majalgaon Unit-1	Maharashtra	1/1/2002	Hydro	0.75	2.25	0.00	Assumed as no generation data is
43	Majalgaon	Maharashtr	1/1/2002	Hydro	0.75	2.25	0.00	

	Unit-2	a						provided in WREB Annual Report (2004-2005): Annex-X
44	Majalgaon Unit-3	Maharashtra	1/1/2002	Hydro	0.75	2.25	0.00	
45	Karanjavan	Maharashtra	26/10/2001	Hydro	3	3	0.00	
46	Hazira CCGP-GSEL Surat	Gujarat	16/10/2001	Gas	52	156.1	377.78	
47	Hazira CCGP-GSEL Surat	Gujarat	30/9/2001	Gas	52	156.1	387.36	
48	Bansagar (Stage-III) Unit-2	Madhya Pradesh	25/8/2001	Hydro	20	60	24.68	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
49	Bansagar (Stage-III) Unit-1	Madhya Pradesh	18/7/2001	Hydro	20	60	24.51	
50	Dudhganga Unit-1	Maharashtra	27/2/2001	Hydro	12	24	62.03	Includes generation from both Dudhganga Unit-1 & 2
51	Khaparkheda Unit-4	Maharashtra	7/1/2001	Coal	210	840	1354.05	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
52	Khaparkheda Unit-3	Maharashtra	31/5/2000	Coal	210	840	1463.92	
53	Koyna (Stage-IV) Unit-4	Maharashtra	3/5/2000	Hydro	250	1000	223.01	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
54	Dudhganga Unit-2	Maharashtra	31/3/2001	Hydro	12	24	0.00	Generation already considered in Dudhganga Unit-1
55	Koyna (Stage-IV) Unit-3	Maharashtra	3/3/2000	Hydro	250	1000	718.46	Station auxiliary consumption is distributed in the ratio of installed capacity of the

								Units
56	Vindhyachal STPS Unit-VIII	Central Share	February'2000	Coal	500	2260	3586.90	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
57	Koyna (Stage-IV) Unit-2	Maharashtra	25/11/1999	Hydro	250	1000	265.68	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
58	Sanjay Gandhi Unit-IV	Madhya Pradesh	23/11/1999	Coal	210	840	1332.96	Station auxiliary consumption from all the four Units is distributed in the ratio of installed capacity of the Units
59	Rajghat Unit-3	Madhya Pradesh	3/11/1999	Hydro	7.5	22.5	13.71	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
60	GIPCL-Surat Lignite	Gujarat	November'1999	Lignite	250	250	1627.53	
61	Rajghat Unit-1	Madhya Pradesh	15/10/1999	Hydro	7.5	22.5	18.75	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
62	Rajghat Unit-2	Madhya Pradesh	29/9/1999	Hydro	7.5	22.5	10.89	
63	Warna Unit-2	Maharashtra	1/9/1999	Hydro	8	16	28.34	Net generation is distributed as per the installed capacity of the

								Units.
64	Reliance Salgaonkar	Goa	14/8/1999	Gas	48	48	138.36	
65	Koyna (Stage-IV) Unit-1	Maharashtra	20/6/1999	Hydro	250	1000	526.76	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
66	Surya CDPH	Maharashtra	4/6/1999	Hydro	0.75	0.75	0.00	
67	Bhandardara Stage-II	Maharashtra	19/5/1999	Hydro	34	44	36.71	
68	Dhabol	Maharashtra	13/5/1999	Gas	740	740	0.00	
69	Terwanmedhe	Maharashtra	31/3/1999	Hydro	0.2	0.2	0.09	
70	Vindhyachal STPS Unit-VII	Central Share	March'1999	Coal	500	2260	3560.31	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
71	Sanjay Gandhi Unit-III	Madhya Pradesh	28/2/1999	Coal	210	840	1412.06	Station auxiliary consumption from all the four Units is distributed in the ratio of installed capacity of the Units
72	Surya	Maharashtra	1/1/1999	Hydro	6	6	13.88	
73	Dimbhe	Maharashtra	17/10/1998	Hydro	5	5	9.02	
74	Warna Unit-1	Maharashtra	16/9/1998	Hydro	8	16	28.34	Net generation is distributed as per the installed capacity of the Units.
75	Kadana Unit-IV	Gujarat	27/5/1998	Hydro	60	240	96.71	Station auxiliary consumption

								is distributed in the ratio of installed capacity of the Units
76	Gandhinagar Unit-5	Gujarat	17/3/1998	Coal	210	210	1423.01	
77	Bhimgarh Unit-2	Madhya Pradesh	10/3/1998	Hydro	1.2		0.00	Included in Mini-Micro Hydro Power Plants wherefrom the generation is zero in 2004-2005
78	Bhimgarh Unit-1	Madhya Pradesh	17/2/1998	Hydro	1.2		0.00	
79	Manikodh	Maharashtra	9/2/1998	Hydro	6	6	4.08	
80	Kadana Unit-III	Gujarat	1/2/1998	Hydro	60	240	94.74	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
81	GPEC	Gujarat	1998	Gas	655		3565.16	
82	GIPCL	Gujarat	Nov-97	Gas	160		1098.91	
83	Chandrapur Unit-7	Maharashtra	1/10/1997	Coal	500	2340	3113.62	Station auxiliary consumption is distributed in the ratio of installed capacity of the Units
84	Kutch Lignite Unit-3	Gujarat	31/3/1997	Lignite	75	215	423.25	
85	Satpura Unit-2	Madhya Pradesh	9/2/1997	Hydro	0.5		0.00	Included in Mini-Micro Hydro Power Plants wherefrom the generation is zero in 2004-2005
86	Chargaon	Madhya Pradesh	7/2/1997	Hydro	0.8		0.00	
87	Tilwara	Madhya Pradesh	2/1/1997	Hydro	0.25		0.00	
88	Tata (H) Bhira PSU	Maharashtra	1997	Hydro	150		577.93	
89	Essar Gas	Gujarat	1997	Gas	515 (300MW to GEB)		3327.73	

90	Satpura Unit-1	Madhya Pradesh	9/2/1996	Hydro	0.5		0.00	Included in Mini-Micro Hydro Power Plants wherefrom the generation is zero in 2004-2005
91	Kakrapar Unit-2	Central Share	1995	Nuclear	220	440	1106.27	
92	Dahanu (BSES) Unit-2	Maharashtra	29/3/1995	Coal	250		2001.27	
Total							37025.64	
20% of Gross generation in the most recent year i.e. 2004-2005							36655.77	
Coal							21298.88	
Gas							9816.20	
Hydro							4804.29	
Nuclear							1106.27	

Build Margin Emission Factor is calculated as shown in Table B7.

Table B7: Build Margin Emission Factor Calculation

Build Margin	**2004-05**
Fuel 1 : Coal	
Avg. efficiency of power generation with coal as a fuel, %	36.487
Avg. calorific value of coal used in Western Grid, kcal/kg	3820
Estimated coal consumption, tons/yr	13141763
Emission factor for Coal (IPCC),tonne CO2/TJ	96.1
Oxidation factor of coal (IPCC standard value)	0.98
COEF of coal (tonneCO2/ton of coal)	1.506
Fuel 2 : Gas	
Avg. efficiency of power generation with gas as a fuel, %	45
Avg. calorific value of gas used, kcal/kg	11942
Estimated gas consumption, tons/yr	1570914
Emission factor for Gas (as per standard IPCC value)	56.1
Oxidation factor of gas (IPCC standard value)	0.995
COEF of gas(tonneCO2/ton of gas)	2.791
EF (BM), tCO2/MU	**653.06**

Step 3: Combined Margin

Therefore the net baseline emission factor as per combined margin **(OM + BM)/2 = 758.61 tCO_2/MU**

Annex 4

MONITORING PLAN

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.

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