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

CONTENTS

Annexes

Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

SECTION A. General description of small-scale project activity

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

>> Electricity generation from BF gas at Hiriyur, Karnataka.
Version: 01
Date -04/06/2008

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

>>
The project activity utilizes the waste gas emanating from the Blast Furnace installed at the existing industrial facility of VSL steels Limited for generation of 4 MW electricity. The electricity thus generated is used to meet the in-house electricity requirement at the industrial facility of VSL Steels Limited.

VSL Steels Limited[1] the project proponent is a manufacturer of high quality Pig Iron and is a flag ship company of the "VSL GROUP".
For the manufacturing of Pig Iron the Project Proponent has installed a mini Blast Furnace with MECON technology in the industrial facility with a production capacity of 450 TPD of hot metal. The Blast Furnace on an average generates 52,000 NM3 of BF gas per hour. The average calorific value of BF gas produced is 720 Kcal/NM3.
Part of the BF gas thus generated is used for heating the induced air in stoves of the MBF and remaining quantity is used for electricity generation in the project activity. In the absence of the project activity the BF gas which is used for electricity generation would have been flared into the atmosphere.

In the Project activity the BF gas (i.e. the BF gas left after the use of stove heating) is fired in a boiler which is of the make Thermax and having an installed capacity of 22 TPH. The steam generated from the boiler at MCR has outlet temperature of 440+/- 5 ^{0}C and has an outlet pressure of 43 kg/cm2. The burner in the boiler is designed for firing 22000 NM3/hr of BF gas.
The steam generating from the boiler is then passed to the steam turbine with an installed capacity of 4.5 MW to generate electricity. The turbine is a multi stage impulse bleed cum condensing steam turbine with the alternator having an output of 4000 kW and is of BHEL make.
In the absence of the project activity the Project Proponent would have gone for a coal based power plant for generating the equivalent amount of electricity.

The PP has also installed a DG set which is operated on F.O. to provide the auxiliary power requirement to operate the BF gas based power plant during the start-up. This DG set is also used to meet the electricity requirement of the manufacturing process when the BF gas based power plant is not in operation.
Initially during the start-up of the boiler the boiler needs to be heated slowly and a gradual increase in the temperature and pressure gradient should be maintained. For this purpose the PP also uses FO during the start-up in the boiler so that the temperature and pressure gradient of the boiler is increased gradually.

The electricity generated by this project activity will replace/ substitute the equivalent amount of electricity that could have been generated by using more carbon emissive fuels i.e coal. Since the waste gas would have been flared anyway in absence of project activity, the additional emissions from

[1] The name was changed from SLR Steels Limited to VSL Steels Limited on 11th March 2008.

generation of electricity by combusting waste gases, in the project activity is zero. Hence, the project activity is reducing the anthropogenic GHG emission into the atmosphere by displacing electricity generation with GHG intensive fossil fuel with that of “zero GHG emission fuel”.

Contribution of the project activity to sustainable development

Ministry of Environment and Forests, Govt. of India has stipulated the social well being, economic well being, environmental well being and technological well being as the four indicators for sustainable development in the host country approval eligibility criteria for Clean Development Mechanism (CDM) projects[2].

Social well-being

- The project activity improved public utility services in surrounding villages such as improvement in power supply, road network, water supply, sanitation, medical care facilities and communication in surrounding villages.

Environmental well-being

- The project activity reduces the GHG emissions associated with the combustion of fossil fuels into the atmosphere.
- The project activity reduces the air pollutants and the particulate matter associated with the flaring of the BF gas into the atmosphere.

Economic well-being

- The project activity has provided employment opportunity for 20 persons.

Technological well-being

- The project activity demonstrates the use of BF gas for electricity generation, which would help other steel industries to replicate the same.
- The project activity demonstrates the use of zero fuel oil fired BFG boiler which would help other steel industries to replicate the same.

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)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Government of India (Host)	VSL Steels Limited (VSLSL)	No

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

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

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

A.4.1.1. Host Party (ies):

>>India

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

>> Karnataka State

A.4.1.3. City/Town/Community etc:

>>
Paramenahalli Village, Hiriyur, Chitradurga District.

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

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VSLSL Plant is strategically located at Paramenahally village in Hiriyur taluk, Chitradurga district, KARNATAKA STATE. The nearest major town is Chitradurga, about 50 km from the site. The plant site is located at 1.5km from the state highway SH-19. The nearest railway station is Davangere about 100 Kms. The nearest airport is Bangalore about 170 Kms. The nearest seaport is New Mangalore about 325 Kms.

The co-ordinates are:
Latitude – 13^0 51' 35" N
Longitude – 76^0 34' E

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

Project has applied approved methodologies available for small-scale CDM project at UNFCCC website under Appendix B of the simplified modalities and procedures for small-scale CDM project activities.

Project type & category:

Project Category
Type III: Renewable Energy Projects **Category III Q: Waste Gas Based Energy Systems.**

The methodology used for this project is the approved small-scale CDM baseline methodology AMS-I.D (Version 01, EB 35) "Waste gas based energy systems".
The project activity may principally be categorized in Scope Number 4, Sectoral Scope – Manufacturing industries.

Technical Details:

Boiler

Boiler Capacity	22 TPH (MCR)
Make	Thermax
Maximum Allowable working Pressure & Design Pressure	53 kg/cm^2 (g)
Hydrostatic Test Pressure	79.5 kg/cm^2 (g)
Steam Outlet Pressure	43.0 kg/cm^2 (g)

Steam Outlet Temperature	440+/- 5^{0} C
Heating Surface Boiler bank	 680 m^2
Super heater	176 m^2
Economizer	216 m^2
Boiler registration number	KTK - 3078

Turbine

Turbine Sl.No	FR13 - 89		
Year of manufacturing	2006		
	Min	Normal	Max
Power (KW)		4500	
Inlet Steam Temp. (Deg.c)		435	
Inlet Steam Pr. (KSCA)		42	
Exhaust Steam Pr. (KSCA)		0.18	
Bleed Steam Pr.(KSCA)		4.75	
Extraction Steam Pr. (KSCA)		----	
Turbine Rotor Speed (RPM)		8278	
Gear Box Output Speed (RPM)		1500	
Turbine Trip Speed Range (RPM)	9106	TO	9520
1st Critical Speed Range (RPM)	3200	TO	3600

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

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Total Chosen Crediting period is from 01/10/2008 to 30/09/2018	
Years	Estimation of Annual Emission reductions in tonnes of CO_2 e
Year A	24681
Year B	24681
Year C	24681
Year D	24681
Year E	24681
Year F	24681
Year G	24681

Year H	24681
Year I	24681
Year J	24681
Total estimated reductions (tonnes of CO_2 e)	246810
Total number of crediting years	10
Annual average of estimated reductions over the crediting period (tCO_2 e)	24681

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

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Public funding such as grants from official development funds is not involved in this project activity.

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

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As mentioned under *Appendix C of the Simplified Modalities and Procedures for Small-Scale CDM project Activities,* the following results into debundling of large CDM project:

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

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

With reference to points of de-bundling, none of the aforementioned conditions are applicable to the project activity and therefore, the project activity is considered as small scale CDM 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 small-scale project activity:

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Project has applied approved methodology available for small-scale CDM project at UNFCCC website under Appendix B of the simplified modalities and procedures for small-scale CDM project activities

Type III: Other Project Activities.
Category III Q: Waste gas based energy systems.

Reference:
III.Q./Version 1
Scope: 4
EB 35.
Valid from 19th October 2007

"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" version 01, EB 32

"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" version 01, EB 39

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

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The project activity involves utilization of the waste gas for the generation of electricity.
The project activity falls under the small scale projects. The methodology chosen for the project activity and its applicability to the project activity is discussed below.

Type III: Other Project Activities.
Category III Q: Waste gas based energy systems.

Technology/measure

Applicability Condition	***Justification***
The category is for project activities that utilize waste gas and/or waste heat at existing facilities as an energy source for: • Cogeneration; or • Generation of electricity; or • Direct use as process heat; or • For generation of heat in elemental process1 (e.g. steam, hot water, hot oil, hot air).	The project activity utilizes the waste gases from the Blast Furnace (BF Gas) for the generation of electricity.
The category is also applicable to project activities that use waste pressure to generate electricity at existing facilities.	This is not applicable to the project activity as this is a waste gas based power project..
The recovery of waste gas/heat may be a new initiative or an incremental gain in an existing practice.	The recovery of waste gas for electricity generation is a new initiative and is not an incremental gain in an existing practise.

In case the project activity is an incremental gain, the difference between the technology used before project activity implementation and the project technology should be clearly shown. It should be demonstrated why there are barriers for the project activity that did not prevent the implementation of the technology used before the project activity implementation.	This condition is not applicable as the project activity is a new initiative and not an incremental gain in the existing practice.
Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO2 equivalent annually. Wherever the measures lead to waste heat recovery which is incremental to an existing practice of waste heat recovery, only the incremental gains in GHG mitigation should be taken into account and such incremental gains shall result in emission reductions of less than or equal to 60 kt CO2 equivalent annually.	The emissions reduction from the project activity is equal to 24681tCO2e per annum which is less than 60 kt CO2 equivalent annually
The waste gas/pressure utilized in the project activity was flared or released into the atmosphere in the absence of the project activity at existing facility. This shall be proven by either one of the following: • By **direct measurements** of energy content and amount of the waste gas for at least *three years* prior to the start of the project activity. • **Energy balance** of relevant sections of	The waste gas utilized for electricity generation in the project activity was being flared in the absence of the project activity at existing facility. This can be proved from the process plants manufacturer's specification. As per the specification by Mecon Limited, the engineering and consultancy firm that designed the mini blast furnace complex at VSL Steels Limited, Hiruyur, the quantity of the BF gas generated per hour is 52,000NM3/hour. The BF gas has no useful application apart from the heating of the stoves. The quantity of the BF gas required for the heating the 3 stoves is 19310 NM3/hour (Max) as per the specification given by Mecon Limited. The BF gas remaining after the stove heating is 32,690 NM3/hour. In the project activity the BF gas remaining after the stove heating is used for electricity generation. In the project activity the boiler has the capability to fire 22,000 NM3/hour of BF gas as per the specification given by

the plant to prove that the waste gas/heat was not a source of energy before the implementation of the project activity. For the energy balance the representative process parameters are required. The energy balance must demonstrate that the waste gas/heat was not used and also provide conservative estimations of the energy content and amount of waste gas/heat released. • **Energy bills** (electricity, fossil fuel) to demonstrate that all the energy required for the process (e.g. based on specific energy consumption specified by the manufacturer) has been procured commercially. Project participants are required to demonstrate through the financial documents (e.g. balance sheets, profit and loss statement) that no energy was generated by waste gas and sold to other facilities and/or the grid. The bills and financial statements should be audited by competent authorities. • **Process plant** manufacturer's	Thermax, the manufacturer of the boiler. Hence it can be seen that the BF gas remaining after the stove heating was flared into the atmosphere in the absence of the project activity.

original specification/information, schemes and diagrams from the construction of the facility could be used as an estimate of quantity and energy content of waste gas/heat produced for rated plant capacity/per unit of product produced.	
For the purpose of this category waste gas/heat/pressure is defined as: by-product gas/heat or pressure of machines and technical processes for which no useful application is found in the absence of the project activity and for which it can be demonstrated that it has not been used prior to, and would not be used in absence of the CDM project activity (e.g. because of low pressure, heating value or quantity available). In the project scenario, this waste gas/heat/pressure is recovered and conditioned for use.	The waste gas utilized in the project activity for electricity generation is a by-product of the Blast Furnace and is termed as BF gas. The BF gas has no useful application apart from the use for stove heating. A part of the BF gas generated was used for the stove heating and the remaining quantity was flared in the absence of the project activity. The project activity utilizes the BF gas for generation of electricity. In the absence of the project activity the PP would have gone for a coal based electricity generation due to lower levelized cost of electricity generation in comparison to the electricity generation using BF gas. Hence the BF gas wouldn't have been used for electricity generation in the absence of project activity due to high levelized cost of electricity generation, the fluctuations in the quantity of BF gas available for electricity generation and the lack of skilled labor to operate the BF gas based power plant.

B.3. Description of the project boundary:

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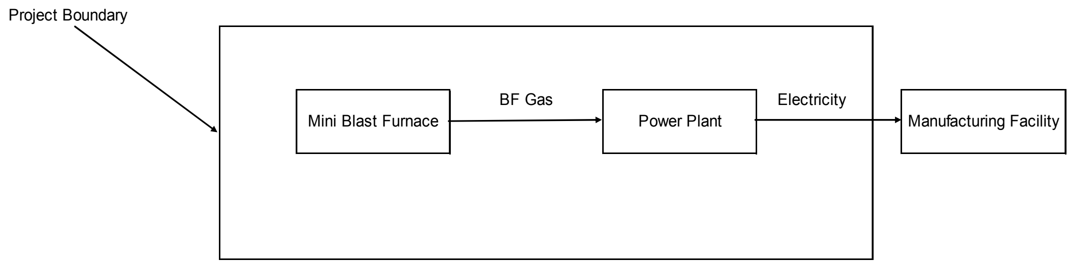
As per the methodology - AMS III.Q, the project boundary is defined as:

"the physical, geographical site of the facility where the waste gas/heat/ pressure is produced and transformed into useful energy delineates the project boundary"

In the project activity, the project boundary includes the Mini Blast Furnace where the waste gas is produced, the captive power plant (CPP unit) in the industrial facility of VSL steels Limited where the BF gas is utilized for electricity generation.



The sources and gases included in the project boundary are tabulated below:

	Source	Gas	Included/ Excluded	Justification
Baseline	Electricity Generation, Grid or power source	CO_2	Included	Main Emission Source
		CH_4	Excluded	Excluded for Simplification.
		N_2O	Excluded	Excluded for Simplification
	Fossil fuel consumption in boiler for steam generation.	CO_2	Excluded	Excluded as the plant is not a cogeneration unit.
		CH_4	Excluded	Excluded as the plant is not a cogeneration unit.
		N_2O	Excluded	Excluded as the plant is not a cogeneration unit.
	Fossil Fuel consumption in cogeneration plant	CO_2	Excluded	Excluded as the plant is not a cogeneration unit.
		CH_4	Excluded	Excluded as the plant is not a cogeneration unit.
		N_2O	Excluded	Excluded as the plant is not a cogeneration unit.
Project	Supplemental fossil fuel consumption at the project plant	CO_2	Included	Main emission Source
		CH_4	Excluded	Excluded for Simplification
		N_2O	Excluded	Excluded for Simplification
	Supplemental electricity consumption.	CO_2	Included	Main Emission Source
		CH_4	Excluded	Excluded for Simplification
		N_2O	Excluded	Excluded for Simplification
	Project emissions from cleaning of gas	CO_2	Excluded	The gas cleaning system is through the process of wet scrubbing where there is no use of electricity/heat.

		CH_4	Excluded	The gas cleaning system is through the process of wet scrubbing where there is no use of electricity/heat
		N_2O	Excluded	The gas cleaning system is through the process of wet scrubbing where there is no use of electricity/heat

B.4. Description of baseline and its development:

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As per the methodology AMS IIIQ Version 1, the baseline is defined as:
"For computing the emissions in the baseline the procedure provided in paragraphs 6 to 13 of AMS I.C shall be used."

The possible baseline scenarios for the PP include:

- Electricity generation using coal fired power plant.
  This is a plausible baseline scenario due to abundance supply of coal. It is also the low cost energy sources for most of the power plant in the region.
- Electricity and steam generation using other liquid petroleum fuels.
  In the recent years global price of petroleum has gone up which prohibits the Project proponent (PP) to opt for liquid petroleum fuel based power generation.
- Electricity generation using Natural Gas fired power plant.
  This is not a feasible option due to the unavailability of Natural Gas in the region.
- Electricity import from the grid
  The energy shortage in the state of Karnataka is 251 MU against the demand of 34,578 MU in the year 2005-2006 and the peak power shortage is 602 MW against a demand of 6160 MW in year 2005-2006. As it can be seen from the above figures it is quite evident that the power deficit in the state of Karnataka is at an alarming magnitude. As the project activity's purpose is to meet the continuous power requirement at the manufacturing facility, import of the power from the grid is not a realistic scenario for the PP due to the high magnitude of the power deficit. Moreover the cost of power for electricity import from the grid is at 4.30 INR/kWh which is higher than the levelized cost of electricity generation using coal as the fuel which is 2.39 INR/kWh as calculated in the section B.5.

Hence the baseline scenario is electricity generation from the coal based power plant.

As per the para 6 of the approved methodology AMS IC Version 13 the baseline is defined as:

"For renewable energy technologies that displace technologies using fossil fuels, the simplified baseline is the fuel consumption of the technologies that would have been used in the absence of the project activity times an emission coefficient for the fossil fuel displaced. IPCC default values for emission coefficients may be used."

Hence the simplified baseline is the anthropogenic GHG emissions from the consumption of coal in the coal based power plant that would have been used by the PP in the absence of the project activity.

As per the para 8 of the approved methodology AMS IC Version 13,

Baseline emissions for electricity produced in captive plants shall be calculated as the amount of electricity produced with the renewable energy technology (GWh) multiplied by the CO2 emission factor per unit of energy of the fuel that would have been used in the baseline plant in (tCO2 / TJ) divided by the efficiency of the captive plant.

Hence the Baseline Emissions are calculated as:

$BEy = fcap \times (EGy \times 3.6 \times EF_{Coal}) / \eta$

BEy - the baseline emissions from electricity and steam displaced by the project activity during the year y in tCO2e.
EGy - the net electricity generation during the year y in GWh
3.6 is the conversion factor, expressed as TJ/GWh.
EF_{Coal} - the CO2 emission factor per unit of energy of the coal in (tCO2 / TJ) obtained from reliable local or national data if available, otherwise IPCC default emission factors are used.
η - the efficiency of captive power plant.
fcap – Capping of the basline emissions.
As per the para 13 of the approved methodology AMS IC Version 13,

Efficiency of the baseline units shall be determined by adopting one of the following criteria:
(a) Highest measured efficiency of a unit with similar specifications,
(b) Highest of the efficiency values provided by two or more manufacturers for units with similar specifications,
(c) Maximum efficiency of 100%.

Capping of baseline emissions

As an introduction of element of conservativeness, this category requires that baseline emissions should be capped irrespective of planned/ unplanned or actual increase in output of plant, change in operational parameters and practices, change in fuel types and quantity resulting in increase in waste gas generation. In case of planned expansion a separate CDM project should be registered for additional capacity. The cap can be estimated using the two methods described below. In order to apply the cap the energy produced should be multiplied by a capping factor fcap. In case electric energy and thermal energy are produced simultaneously appropriate conversion factors should be used to obtain total energy produced. Project proponents shall use method 1 to estimate the cap if data is available.

In the current project activity as the data is not available the PP has chosen method 2.

Method 2: The manufacturer's data for the facility shall be used to estimate the amount of waste gas/heat/pressure that the industrial facility generates per unit of product generated by the process that generates waste gas/heat/pressure (either the product of a section of the plant or product of entire plant, whichever is more representative). In case any modification is carried out by project proponent or in case the manufacturer's data is not available, an assessment should be carried out by independent qualified / certified external process experts such as a chartered engineer to estimate a conservative quantity of waste gas generated by plant per unit of product manufactured by the process generating waste gas/heat/pressure. The value arrived at based on above sources of data shall be used to estimate the baseline cap (fcap). The documentation of such assessment shall be verified by the validating DOE.

Under this method, following equations should be used to estimate fcap.

As per the equation 2 of the methodology AMS IIIQ fcap is calculated as follows:

$$f_{cap} = \frac{Q_{WG,BL}}{Q_{WG,y}}$$

As per the equation 3 of the methodology AMS IIIQ, $Q_{WG,BL}$ is calculated as follows:

$$Q_{WG,BL} = Q_{BL,product} \times q_{wg,product}$$

$q_{wg, product} = (q_{wg, per hour} * 24 * 350) / Q_{BL, product}$
In case the calculated value of fcap is higher than 1, fcap is set to 1.
Where:
$Q_{WG, BL}$ Quantity of waste gas generated prior to the start of the project activity estimated using equation 3 of AMS IIIQ. (Nm3)
$Q_{BL, product}$ Production by process that most logically relates to waste gas generation in baseline. This is estimated based on 3 years average prior to start of project activity.
$q_{wg, product}$ Amount of waste gas the industrial facility generates per unit of product generated by the process that generates waste gas.
$q_{wg, per hour}$ Quantity of waste gas produced per hour
24 = Number of Hours.
350 = Operational days in year.

Variable	Data Source
EG_y – Electricity generated	Records maintained by project proponent
$Q_{WG,y}$ Quantity of Waste Gas used for electricity generation during the year y	Records maintained by the project proponent.
Parameter	**Data Source**
EF_{Coal} – Emission Factor of Coal (tCO2/TJ)	Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories
η - the efficiency of captive power plant	Specification of sub critical coal-fired power plant according to the heat rate (10.255 MJ/kWh) applied by Central Electricity Regulatory Commission (Terms & conditions of Tariff) Regulations, 2004 (www.cercind.org)
$Q_{BL,\ product}$ Production by process that most logically relates to waste gas generation in baseline	Specification as per Mecon Ltd. Table 3.2, technological parameters, page 14 in the Report on the Plant Facilities, Technological parameters and operating procedures for blast furnace complex at VSL steels Limited, Hiriyur, Chitradurga, Karnataka prepared by Mecon Ltd.
$q_{wg,\ per\ hour}$ Amount of waste gas the industrial facility generates per hour	Specification given by Mecon Ltd.

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

As explained above, the project initiative qualifies under Type IIIQ- Waste systems for energy. The following paragraph has been detailed on project additionality.

In accordance with simplified modalities and procedures for small-scale Clean Development Mechanism (CDM) project activities, a simplified baseline and monitoring methodology listed in Appendix B may be used if project participants can demonstrate that the project activity would otherwise not be implemented due to the existence of one or more barrier(s) listed in attachment A of Appendix B. Attachment A to Appendix B has listed the following barriers:

(a) Investment barrier
(b) Technological barrier
(c) Barrier due to prevailing practice
(d) Other barriers

The barriers that have been overcome by the project developer are listed below:

a) Investment barrier.
b) Technological Barrier

A) Investment barrier:

According to the "Non-binding best practice examples to demonstrate additionality for SSC project activities" a project activity is deemed to be additional if there is a financially more attractive alternative, which would have led to higher emissions.

The purpose of the project activity is to utilize the waste gases generated from the mini Blast Furnace for generation of electricity and utilization of same generated electricity for in-house consumption. The alternative scenario would be installation of a coal based captive power plant for equivalent amount of electricity generation. This alternative scenario would have led to higher GHGs emissions into the atmosphere in comparison to the project activity.

The project proponent (PP) has adopted investment comparison analysis to analyse the financial viability of the project activity (waste gas based electricity generation) vis-à-vis to the available alternative scenario (coal based electricity generation).

The financial indicator, levelized cost of electricity generation has been calculated for the project activity and is compared with the levelized cost of electricity generation with coal based electricity generation alternative scenario.

The project proponent has invoked certain assumption for the levelised cost of electricity generation calculation. . The below table illustrates the assumptions that are considered while calculating the levelized cost of electricity generation for the project activity.
All the initial investment costs associated with the generation of electricity such as the cost to be paid for the turbine manufacturer, boiler manufacturer, transportation charges, land and infrastructure charges, building charges are considered to calculate the total project cost. The depreciation was made available on the equipment costs and civil and building works costs on the basis of the Straight Line method according to the company act. The costs and the electricity generation have been discounted in calculating the levelized cost of electricity generation.
It is important to understand that the financial analysis of the project activity was conducted on the basis of the scope of supply given by the manufacturer. According to the manufacturer (Thermax) specification of the boiler, the boiler is designed to fire only 90% of the BF gas. The rest 10% of the fuel used in the boiler is F.O. and hence the project activity requires an average of 1382 KL of Furnace Oil per year.

Description	Quantity	Source
Project Cost (Lakhs)	1935	Capex Document certified by the Chartered Accountant
Equity	360	
Term Loan	1575	Term Loan Paper
Gross Power Generation (kW)	4500	Installed Capacity
Auxiliaries	225	Assumed figure
Plant Capacity Utilization (%)	70%	Assumed figure
Repairs and Maintenance (2.5% of capital Cost)	48.375	
Administrative Expenses (Lakhs)	27	
Salaries and wages (Lakhs)	45	
Escalation on salaries and wages (%)	5%	
Annual Escalation on Adm Expenses (%)	5%	

Loan Repayment (yrs)	4	Term Loan Paper
Moratorium	6	Term Loan Paper
Number of monthly Installments	42	Term Loan Paper
Interest Rate	15%	
Fuel Requirement (KL)	1382	Manufacturer specification
Cost of Fuel (Rs/KL)	22000	Supplier Invoice.
Escalation on Repair and Maintenance	5%	
Escalation on cost of alternate fuel	5%	
Insurance (0.2% of project cost)	2.57	
Rate of Depreciation as per company's law		
Building & Civil Works (%)	10.00%	Company's Act
Plant and Machinery	15.33%	Company's Act

The levelized electricity cost of generation calculated using the above parameters comes out to be 2.93 INR/kWh

Similar assumptions were made for calculating the levelized cost of electricity generation using coal as the fuel input.The assumptions for calculating the levelized electricity generation cost using coal as the fuel are detailed below: (All the assumptions are taken from the CERC (Terms & Conditions of tariff) Regulations, 2004).
The assumption for the cost of coal is taken from the "Report of the expert committee of fuels on power generation" Executive Summary published by Planning Wing of Central Electricity Authority, Government of India, New Delhi in February 2004.

Description		Quantity
Installed Capacity	MW	4.5
Estimated Project Cost / MW	Mn. Rs.	40.00
Total Project Cost	Mn. Rs.	180.00
Debt	70%	126.00
Equity	30%	54.00
Rupee Debt	100%	126.00
Rupee Equity	100%	54.00
Depreciation %		7.84%
Depreciation for Civil Works		3.34%
Maximum Depreciation	90.00%	162.00
Life Time of the Project Activity	Years	25

Stabilization period of the each unit	Months	6
Station Heat Rate - Stabilization	Kcal/kWh	2600
Station Heat Rate - Normal Operations	Kcal/kWh	2400
Auxiliary Consumption - Stabilization	%	9.00%
Auxiliary Consumption - Normal Operation	%	9.00%
Oil Consumption - Stabilization	ml/kWh	4.50
Oil Consumption - Normal Operation	ml/kWh	2
Calorific Value of Coal per kg	Kcal	3500
Calorific Value of oil per kg	Kcal	10200
Plant Load Factor - Stabilization -First year	%	80.00%
Plant Load Factor - for the balance period of First Year	%	80%
Plant Load Factor - Normal Operation	%	90%
Deemed Generation obligation - Normal	%	80%
O & M Expenses % of Capital Cost	%	2.50%
O & M Expenses for installed capacity	Rs. Mn	4.50
Escalation		6.00%
Working Capital Norms		
Primary Fuel Cost	Months	1
Primary Fuel Stock	Months	0.5
Secondary Fuel Furnace Oil	Months	2
O&M and Insurance Expenses	Month	1
Spares	%	1
Working Capital Interest	%	10.50%
Term Loan Repayment Schedule		
Rupee loan Repayment	Quarters	36
Moratorium	Quarters	4
Repayment Period	years	10
Rupee loan interest		10.25%
Cost of Primary Fuel INR per tonne		
Coal Cost		392.00

Royalty		65.00
Excise Duty		30.00
Handling Charges		30.00
Transportation charges (Railway freight for 2000 KM)		1,375.90
Landed Cost of Coal		1,892.90
Cost of Secondary Fuel (HFO) INR per litre		
Landed Cost		22,000.00

The levelized electricity cost of generation using coal as the input fuel calculated using the above parameters comes out to be 2.49 INR/kWh

The levelized electricity cost of generation using BF gas and coal is given below:

Alternative	Levelized Electricity generation costs (Rs/ kWh)
Domestic Coal based captive power generation (based on price of domestic coal at delivery point)	2.49
Project activity without consideration of CDM	2.93

As it can be seen from the above analysis of the levelized cost of electricity generation, there is another financially more viable alternative (coal based electricity generation) available to the project proponent that would have led to higher GHGs emissions into the atmosphere.

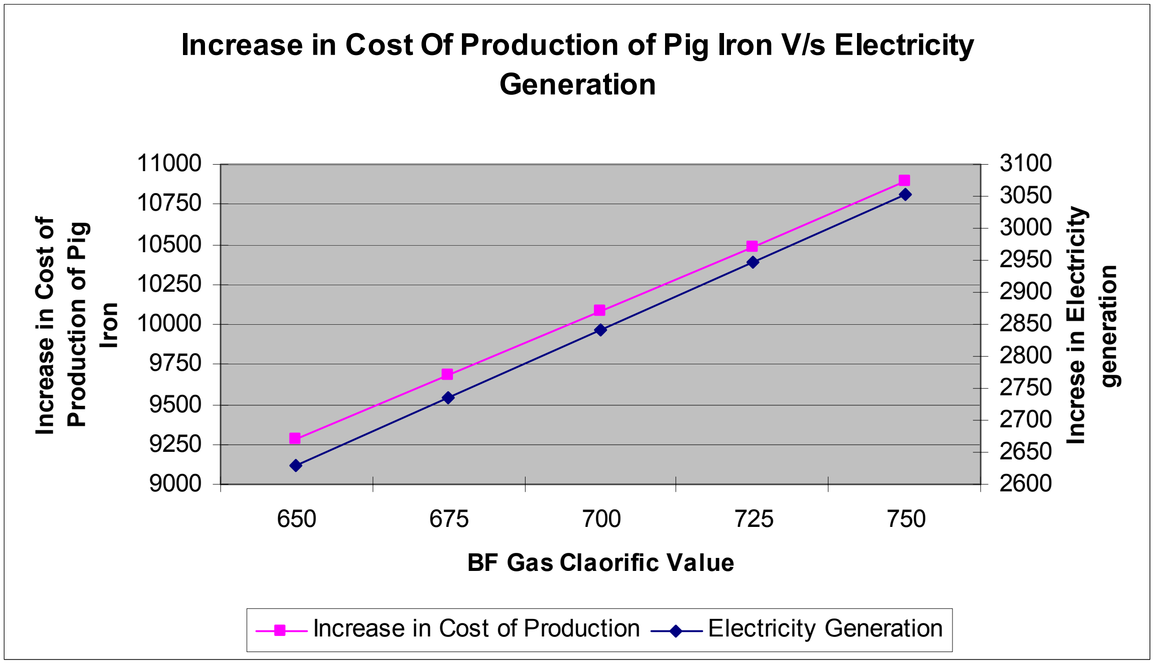
Hence the project activity crosses the investment barrier according to the attachment A to the appendix B of the small-scale project activities.

The project taken as CDM project activity would provide significant amount of returns from the sale of the Emission Reductions accrued from the project activity. These returns would increase the cash flow of the project activity and make the project financially more feasible for the project proponent.

B) Technological barrier:

BF gas is a lean fuel and it requires a supporting fuel or a heating medium to burn completely. The Plant was operated in the same mode in the initial two months of the operations. The expectation of more carbon credit from the project activity has twisted their thinking towards more cleaner approach and they thought of achieving zero supporting fuel in the BF gas based power generation. To achieve zero supporting fuel VSLSL constituted an in house R&D team comprising of various technical experts. This was done through numerous trial testing and experiment to ascertain the impacts of various size and type of heating zone. This has resulted in development of a heating zone around the burner of the boiler to facilitate in complete burning of the Waste gas. As this is not a proven technology the R&D team faced an uphill task in convincing the management to go for the technology. The operators' skill set had to be enhanced to operate such kind of new initiative and they had to be given continuous training to get well versed with the operating parameters of this initiative. Such kind of initiative might even decrease the combustion efficiency of the fuel and also might result in wide fluctuations in BF gas input into the burner. Such kind of wide fluctuations might even cause the flame to drip, which would result in the total block out of the Power Plant. This block out will seriously affect the manufacturing process and might result in heavy production losses.

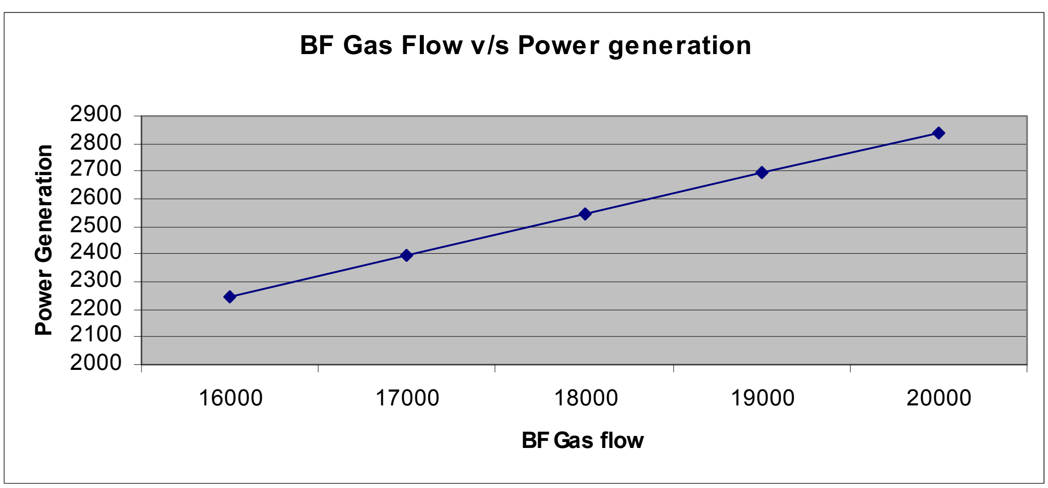
The electricity generation from the BF gas is dependent on the calorific value of the BF gas. The calorific value is further dependent on the percentage of the CO (carbon monoxide) present in the BF gas. The higher percentage of CO present in the BF gas the higher is the calorific value of the BF gas and higher would be the electricity generation. It needs to be understood that CO in the Blast Furnace is used as the reducing agent for the production of pig iron from the iron ore. Hence the higher percentage of CO in the BF gas means that less amount of CO is used for reducing the iron ore in the Blast Furnace, which signifies that the Blast Furnace is not operating efficiently. The CO in the blast furnace is formed due to the combustion of coke, which is the input to the blast furnace. Hence lower the amount of CO used for reducing the iron ore in the Blast Furnace the higher would be the quantity of coke to be burnt per unit of the product. With the unit price of the coke as high as INR 22/ Tonne the higher amount of coke burning would lead to high production cost and hence would decrease the profitability of the manufacturing process. Hence the electricity generation and the profitability forms a viscous circle with the higher electricity generation from BF gas would mean that the PP has incurred a high production cost i.e. lower profitability and lower electricity generation would mean lower production cost i.e. higher profitability.
Hence the PP had to cross the technical barrier of finding the optimum balance between the electricity generation and the profitability of the manufacturing process and stabilizing it over a period of time.



The BF gas is a by-product of the Blast Furnace operations. This is a lean fuel and carries a lot of dust. During the operation of the boiler dust will deposit on the heating surface of the boilers which hampers the heat transfer and can lead to complete shut down of the power plant.

There is a wide variation in the pressure across the BF gas line. These wide fluctuations affect the Furnace Draft Conditions and also the quantity of the fuel that is supplied to the boiler. The fluctuations in the quantity of the BF gas supplied to the boiler causes fluctuations in the electricity produced from the power plant which will hamper the manufacturing process and would result in heavy production losses.

The flowing graph reflects the variation in the power generation with respect to the variation in the quantity of BF gas supplied to the boiler.



The above technological barriers illustrates that the implementation of the project activity involves high risks due to the uncertainty of the performance parameters. Such kind of uncertainties in operational parameters doesn't exist for the operation of coal-based power plant, which would have led to higher emissions.
Thus from the above discussion it can be concluded that the project activity faces the barriers and is not a business as usual scenario.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

>>
Baseline Emissions:

$BEy = fcap \times (EGy \times 3.6 \times EF_{Coal}) / \eta$

BEy - the baseline emissions from electricity and steam displaced by the project activity during the year y in tCO2e.
EGy - the net electricity generation during the year y in GWh
3.6 is the conversion factor, expressed as TJ/GWh.
EF_{Coal} - the CO2 emission factor per unit of energy of the coal in (tCO2 / TJ) obtained from reliable local or national data if available, otherwise IPCC default emission factors are used.
η - the efficiency of captive power plant.
fcap – Capping of the baseline emissions.
As per the para 13 of the approved methodology AMS IC Version 13,

Efficiency of the baseline units shall be determined by adopting one of the following criteria:
(a) Highest measured efficiency of a unit with similar specifications,
(b) Highest of the efficiency values provided by two or more manufacturers for units with similar specifications,
(c) Maximum efficiency of 100%

As per the equation 2 of the methodology AMS IIIQ fcap is calculated as follows:

$$f_{cap} = \frac{Q_{WG,BL}}{Q_{WG,y}}$$

As per the equation 3 of the methodology AMS IIIQ, $Q_{WG,BL}$ is calculated as follows:

$$Q_{WG,BL} = Q_{BL,product} \times q_{wg,product}$$

In case the calculated value of fcap is higher than 1, fcap is set to 1.
$q_{wg, product} = (q_{wg, per hour} * 24 * 350) / Q_{BL, product}$
In case the calculated value of fcap is higher than 1, fcap is set to 1.
Where:
$Q_{WG, BL}$ Quantity of waste gas generated prior to the start of the project activity estimated using equation 3 of AMS IIIQ. (Nm3)

$Q_{BL,\ product}$ Production by process that most logically relates to waste gas generation in baseline. This is estimated based on 3 years average prior to start of project activity.
$q_{wg,\ product}$ Amount of waste gas the industrial facility generates per unit of product generated by the process that generates waste gas.
$q_{wg,\ per\ hour}$ Quantity of waste gas produced per hour
24 = Number of Hours.
350 = Operational days in an year
As the facility has not been operational for a period of 3 years prior to the start of the project activity, hence as a conservative estimate the $Q_{BL,\ product}$ is taken as the production capacity as specified in the technological parameters in the manufacturer's specifications.
$q_{wg,\ product}$ is taken as the amount of waste gas produced per ton of hot metal calculated on the data of quantity of waste gas generation per hour as per the manufacturer's specification.
$Q_{WG,y}$ is taken as 22,000 NM3/hr which is the mentioned in the manufacturer's specification as the maximum amount of BF gas that the burner is designed for firing for the ex-ante calculation. For the ex-post emission reduction calculation the actual amount of waste gas used for electricity generation that is measured will be used.

Project Emissions:

As per the methodology AMS III Q Version01

Project Emissions include emissions due to combustion of auxiliary fuel to supplement waste gas and emissions due to consumption of electricity by the project activity.

As per the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" version 01, the Project Emissions are calculated as follows:

$$PE_{FC,j,y} = \sum_{i} FC_{i,j,y} \times COEF_{i,y}$$

Where:
$PE_{FC,j,y}$ are the CO2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO2 / yr);
$FC_{i,j,y}$ is the quantity of fuel type i combusted in process j during the year y (mass or volume unit / yr);
$COEF_{i,y}$ is the CO2 emission coefficient of fuel type i in year y (tCO2 / mass or volume unit);
i are the fuel types combusted in process j during the year y.

The CO2 emission coefficient $COEF_{i,y}$ can be calculated following two procedures, depending on the available data on the fossil fuel type i, as follows:

Option A: The CO2 emission coefficient $COEF_{i,y}$ is calculated based on the chemical composition of the fossil fuel type i, using the following approach:

If $FC_{i,j,y}$ is measured in a mass unit: $COEF_{i,y} = w_{C,i,y} \times 44/12$

If $FC_{i,j,y}$ is measured in a volume unit: $COEF_{i,y} = w_{C,i,y} \times \rho_{i,y} \times 44/12$

Where:
$COEF_{i,y}$ is the CO2 emission coefficient of fuel type i (tCO2 / mass or volume unit);

$w_{C,i,y}$ is the weighted average mass fraction of carbon in fuel type i in year y (tC / mass unit of the fuel);
pi,y is the weighted average density of fuel type i in year y (mass unit / volume unit of the fuel);
i are the fuel types combusted in process j during the year y.

Option B: The CO2 emission coefficient COEFi,y is calculated based on net calorific value and CO2 emission factor of the fuel type i, as follows:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$

Where:
COEFi,y is the CO2 emission coefficient of fuel type i in year y (tCO2 / mass or volume unit);
NCVi,y is the weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit);
EFCO2,i,y is the weighted average CO2 emission factor of fuel type i in year y (tCO2/GJ);
i are the fuel types combusted in process j during the year y.

Option B has been chosen for the Emission Reduction Calculation.

$PE_{FC,y} = FC_{FO,y} \times COEF_{FO,y}$

$COEF_{FO,y} = NCV_{FO,y} \times (4.186/10\text{^}9) \times EF_{CO2,FO,y}/1000$
$FC_{FO,y}$ = Quantity of Furnace Oil Consumed during the year y (kg)
$NCV_{FO,y}$ = Net Calorific Value of Furnace Oil (Kcal/Kg)
4.186/10^9 = Conversion from Kcal to TJ
$EF_{CO2,FO,y}$ = Emission factor of Furnace Oil (kg CO2/GJ)

As per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" version 01, the Project Emissions from the electricity consumption from an of-grid power plant are calculated as follows:

$$PE_{EC,y} = \sum_{j} EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$

$PE_{EC,y}$ are the project emissions from electricity consumption by the project activity during the year y (tCO2 / yr);
$EC_{PJ,y}$ is the quantity of electricity consumed by the project activity during the year y (MWh);
$EF_{EL,j,y}$ = Emission factor for electricity generation for source *j* in year *y* (tCO2/MWh)
$TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source *j* in year *y*

The electricity consumed in the project activity is from the captive power plant. Hence the scenario applicable to the project activity as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" version 01 is Scenario B: Electricity Consumption from an off-grid captive power plant.

Option B2 (A conservative default value of 1.3 tCO2/MWh) is being used for $EF_{EL,j,y}$.

$PE_y = PE_{FC,y} + PE_{EC,y}$
Emission Reductions:

ER = BEy - PEy

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

(Copy this table for each data and parameter)

Data / Parameter:	η
Data unit:	Percentage points
Description:	The energy efficiency of technology in the most likely baseline scenario.
Source of data used:	Specification of sub critical coal-fired power plant according to the heat rate (10.255 MJ/kWh) applied by Central Electricity Regulatory Commission (Terms & conditions of Tariff) Regulations, 2004 (www.cercind.org)
Value applied:	35.1%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Data has been collected from official source.
Any comment:	

Data / Parameter:	$EF_{FO,}$
Data unit:	Kg CO_2e/TJ
Description:	Emission Factor of Furnace Oil
Source of data used:	IPCC Default Value, Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	77400
Justification of the choice of data or description of measurement methods and procedures actually applied :	Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Any comment:	IPCC Default Value

Data / Parameter:	EF_{Coal}
Data unit:	Kg CO_2e/TJ or tCO_2e/TJ
Description:	Emission Factor of Furnace Oil
Source of data used:	IPCC Default Value, Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	96100
Justification of the choice of data or description of measurement methods	Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories

and procedures actually applied :	
Any comment:	IPCC Default Value

Data / Parameter:	$Q_{BL, product}$
Data unit:	Tonnes per Day
Description:	Production capacity of the installed Blast Furnace in tonnes per day
Source of data used:	Table 3.2, technological parameters, page 14 in the Report on the Plant Facilities, Technological parameters and operating procedures for blast furnace complex at VSL steels Limited, Hiriyur, Chitradurga, Karnataka prepared by Mecon Ltd.
Value applied:	450
Justification of the choice of data or description of measurement methods and procedures actually applied :	The data is taken from the Report on the Plant Facilities, Technological parameters and operating procedures for blast furnace complex at VSL steels Limited, Hiriyur, Chitradurga, Karnataka prepared by Mecon Ltd. As the data referred is from the specification given by Mecon Ltd that designed the BF Complex at VSL Steels Ltd, the data is considered to be authentic.
Any comment:	Specification given by Mecon Ltd that designed the Blast Furnace Complex at VSL Steels Ltd.

Data / Parameter:	$q_{wg, per hour}$
Data unit:	NM3/hr
Description:	Quantity of waste gas in NM3 per hour
Source of data used:	The quantity is as per the report given by Mecon Ltd that designed the Blast Furnace Complex at VSL Steels Limited.
Value applied:	52000
Justification of the choice of data or description of measurement methods and procedures actually applied :	As the value used is from the specification provided by Mecon Ltd that designed the BF Complex at VSL Steels Ltd, the data is considered to be authentic.
Any comment:	Designer's Specification

Data / Parameter:	$q_{wg, product}$
Data unit:	NM3/thm
Description:	Quantity of waste gas in NM3 per tonne of hot metal produced
Source of data used:	Calculated by the formula: $q_{wg, product} = (q_{wg, per hour} * 24 * 350) / Q_{BL, product}$
Value applied:	2733.33
Justification of the choice of data or description of measurement methods and procedures actually	As the value used is on the basis of the value provided by Mecon Ltd which designed the Blast Furnace Complex at VSL Steels Limited, the data is considered to be authentic.

applied :	
Any comment:	

Data / Parameter:	$NCV_{FOB,y}$
Data unit:	kcal/kg
Description:	Net Calorific Value of Furnace Oil
Source of data used:	FO invoice/ IS:1448-1960
Value applied:	9500
Justification of the choice of data or description of measurement methods and procedures actually applied :	This is calculated by using IS:1448-1960. Density of FO given in the FO supplier invoice is matched with the calorific value chart of the IS 1448-1960 chart.
Any comment:	Applicable where option B is used.

Data / Parameter:	$\mathbf{EF_{EL,j,y}}$
Data unit:	tCO2e/MWh
Description:	Emission factor for electricity generation for source *j* in year *y* (tCO2/MWh)
Source of data used:	In case of scenario B and option B.2 use a conservative default value of 1.3
Value applied:	1.3
Justification of the choice of data or description of measurement methods and procedures actually applied :	This value is applied as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" version 01
Any comment:	Applicable where Scenario B and option B.2 is used.

Data / Parameter:	**TDLj,y**
Data unit:	-
Description:	Average technical transmission and distribution losses for providing electricity to source *j*
Source of data used:	In case of scenario B, assume TDLj,y = 0 as a simplification
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	This value is applied as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" version 01
Any comment:	Applicable where Scenario B is used.

B.6.3 Ex-ante calculation of emission reductions:

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Baseline Emissions:

BEy = fcap × (EGy × 3.6 × EF_{Coal}) / η

BEy - the baseline emissions from electricity and steam displaced by the project activity during the year y in tCO2e.
EGy - the net electricity generation during the year y in GWh
3.6 is the conversion factor, expressed as TJ/GWh.
EF_{Coal} - the CO2 emission factor per unit of energy of the coal in (tCO2 / TJ) obtained from reliable local or national data if available, otherwise IPCC default emission factors are used.
η - the efficiency of captive power plant.
fcap – Capping of the baseline emissions.
As per the para 13 of the approved methodology AMS IC Version 13,

EGy = $EG_{GROSS,y} – EG_{AUX,y}$

Efficiency of the baseline units shall be determined by adopting one of the following criteria:
(a) Highest measured efficiency of a unit with similar specifications,
(b) Highest of the efficiency values provided by two or more manufacturers for units with similar specifications,
(c) Maximum efficiency of 100%

As per the equation 2 of the methodology AMS IIIQ fcap is calculated as follows:

$$f_{cap} = \frac{Q_{WG,BL}}{Q_{WG,y}}$$

As per the equation 3 of the methodology AMS IIIQ, $Q_{WG,BL}$ is calculated as follows:

$$Q_{WG,BL} = Q_{BL,product} \times q_{wg,product}$$

In case the calculated value of fcap is higher than 1, fcap is set to 1.

$q_{wg, product}$ = ($q_{wg, per hour}$ * 24 * 350) / $Q_{BL, product}$
In case the calculated value of fcap is higher than 1, fcap is set to 1.
Where:
$Q_{WG, BL}$ Quantity of waste gas generated prior to the start of the project activity estimated using equation 3 of AMS IIIQ. (Nm3)
$Q_{BL, product}$ Production by process that most logically relates to waste gas generation in baseline. This is estimated based on 3 years average prior to start of project activity.
$q_{wg, product}$ Amount of waste gas the industrial facility generates per unit of product generated by the process that generates waste gas.
$q_{wg, per hour}$ Quantity of waste gas produced per hour
24 = Number of Hours in a day.
350 = Operational Hours in a year.

As the facility has not been operational for a period of 3 years prior to the start of the project activity, hence as a conservative estimate the $Q_{BL, product}$ is taken as the production capacity as specified in the technological parameters in the manufacturer's specifications.
$q_{wg, product}$ is taken as the amount of waste gas produced per ton of hot metal calculated on the data of quantity of waste gas generation per hour as per the manufacturer's specification.

$Q_{WG,y}$ is taken as 22,000 NM3/hr which is the mentioned in the manufacturer's specification as the maximum amount of BF gas that the burner is designed for firing.

fcap =((52000 × 24 × 350) / 450) × 450)/(22000 × 24 × 350) = 2.36
As fcap is greater than 1, as per the approved methodology AMS IIIQ fcap is set to 1.

BEy = 1 × (25.13× 3.6 × 96.1) / (0.351) = 24766 tCO2e

Year	BEy (tCO2e)
1	24766
2	24766
3	24766
4	24766
5	24766
6	24766
7	24766
8	24766
9	24766
10	24766

Project Emissions:

As per the methodology AMS III Q Version01

Project Emissions include emissions due to combustion of auxiliary fuel to supplement waste gas and emissions due to consumption of electricity by the project activity.

As per the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" version 01, the Project Emissions are calculated as follows:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y}$$

Where:
$PE_{FC,j,y}$ are the CO2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO2 / yr);
$FC_{i,j,y}$ is the quantity of fuel type i combusted in process j during the year y (mass or volume unit / yr);
$COEF_{i,y}$ is the CO2 emission coefficient of fuel type i in year y (tCO2 / mass or volume unit);
i are the fuel types combusted in process j during the year y.

The CO2 emission coefficient $COEF_{i,y}$ can be calculated following two procedures, depending on the available data on the fossil fuel type i, as follows:

Option B: The CO2 emission coefficient COEFi,y is calculated based on net calorific value and CO2 emission factor of the fuel type i, as follows:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y}$$

Where:
COEFi,y is the CO2 emission coefficient of fuel type i in year y (tCO2 / mass or volume unit);
NCVi,y is the weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit);
EFCO2,i,y is the weighted average CO2 emission factor of fuel type i in year y (tCO2/GJ);
i are the fuel types combusted in process j during the year y.

$PE_{FC,y} = FC_{FO,y} \times COEF_{FO,y}$

$COEF_{FO,y} = NCV_{FO,y} \times (4.186/10^9) \times EF_{CO2,FO,y}/1000$
$FC_{FO,y}$ = Quantity of Furnace Oil Consumed during the year y (kg)
$NCV_{FO,y}$ = Net Calorific Value of Furnace Oil (Kcal/Kg)
4.186/10^9 = Conversion from Kcal to TJ
$EF_{CO2,FO,y}$ = Emission factor of Furnace Oil (kg CO2/GJ)

$PE_{FC,y} = 21600 \times 0.003077 = 67$ tCO2e

$COEF_{FO,y} = 9500 \times (4.186/10^9) \times 77400/1000 = 0.003077$

As per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" version 01, the Project Emissions from the electricity consumption from an of-grid power plant are calculated as follows:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y})$$

$PE_{EC,y}$ are the project emissions from electricity consumption by the project activity during the year y (tCO2 / yr);
$EC_{PJ,y}$ is the quantity of electricity consumed by the project activity during the year y (MWh);
$EF_{EL,j,y}$ = Emission factor for electricity generation for source *j* in year *y* (tCO2/MWh)
$TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source *j* in year *y*

The electricity consumed in the project activity is from the captive power plant. Hence the scenario applicable to the project activity as per the Tool to calculate baseline, project and/or leakage emissions from electricity consumption" version 01 is Scenario B: Electricity Consumption from an off-grid captive power plant.

The PP is using the Option B2 (Use the following conservative default values: A value of 1.3 tCO2/MWh) for $EF_{EL,j,y}$.

$PE_{EC,y} = 21.6 * 1.3 *(1+0) = 28$ tCO2e

$PEy = PE_{FC,y} + PE_{EC,y}$

PEy = 67 + 28 = 95 tCO2e

Year	PEy (tCO2e)
1	95
2	95
3	95
4	95
5	95
6	95
7	95
8	95
9	95
10	95

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

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Emissions Reductions = Baseline Emissions (BE) – Project Emissions (PE) – Leakage (L)

Year	Estimation of Project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
	t CO2	t CO2		t CO2
1	95	24766	0	24681
2	95	24766	0	24681
3	95	24766	0	24681
4	95	24766	0	24681
5	95	24766	0	24681
6	95	24766	0	24681
7	95	24766	0	24681
8	95	24766	0	24681
9	95	24766	0	24681
10	95	24766	0	24681
Total (tonnes of CO2e)	950	247660	0	246810

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

B.7.1 Data and parameters monitored:	
(Copy this table for each data and parameter)	
Data / Parameter:	$EG_{GROSS,y}$
Data unit:	kWh
Description:	Gross Electricity generation
Source of data to be used:	Power Plant Log Book
Value of data	26460000
Description of measurement methods and procedures to be applied:	The gross electricity generation is measured using the 3 phase 4 wire energy meter which is located in the CPP Control Room. The make of the meter is L&T and the serial No. of the meter is 06609650 and is of 0.5 class accuracy. The readings are taken every shift by the shift engineer and are recorded in the power plant log book every hour. The Power plant manager cross checks the data every day in the morning at 6:00 hrs.
QA/QC procedures to be applied:	Internal Quality Control and Quality Assurance procedures will be followed where the Power Plant Manager will check the data that the Senior Engineer enters in the log book on a daily basis.
Any comment:	

Data / Parameter:	$Q_{WG,y}$
Data unit:	Kg
Description:	Quantity of BF gas utilized for electricity generation
Source of data to be used:	Boiler Log Book
Value of data	184800000
Description of measurement methods and procedures to be applied:	The quantity of waste gas is measured using the ventury type gas flow meter. The pressure of the waste gas varies across the ventury. The differential pressure is measured across the transmitter and it's converted to mA and the signal is given to the DCS. The DCS converts the mA signal into Kg/hr. the totalizer present in the DCS gives the figure in Kg for the day. The shift in-charge takes the reading and resets the totalizer everyday in the morning at 6:00 hrs and records in the log book. The power plant manager cross checks the data. The flow transmitter is of the make Rosemount with the serial no. 00137623-06/05. The DCS is Industrial^{IT} 800XA system version 4.0. The DCS is supplied by ABB.
QA/QC procedures to be applied:	Internal Quality Control and Quality Assurance procedures will be followed where the Power Plant Manager will check the data that the Shift In charge enters in the log book on a daily basis.
Any comment:	

Data / Parameter:	$FC_{FO,y}$
Data unit:	Kg
Description:	Quantity of FO used in the boiler
Source of data to be used:	Boiler Log Book
Value of data	21600

Description of measurement methods and procedures to be applied:	The quantity of F.O. is measured using a mass flow meter. The meter is of the make Micro Motion INC. and the model number is R100S129NVBMEZZZ. The Serial No. of the meter is 14001143. The shift in-charge takes the reading and resets the totalizer everyday in the morning at 6:00 hrs and records in the log book. The power plant manager cross checks the data
QA/QC procedures to be applied:	Internal Quality Control and Quality Assurance procedures will be followed where the Power Plant Manager will check the data that the Shift In charge enters in the log book on a daily basis.
Any comment:	

Data / Parameter:	$NCV_{WG,y}$
Data unit:	Kcal/NM3
Description:	Net Calorific Value of the waste gas
Source of data to be used:	Power Plant Log Book
Value of data	720
Description of measurement methods and procedures to be applied:	Every day 2 samples of the BF gas is taken at 10:30 hrs and 16:30 hrs and is tested in the own laboratory using the Orast Apparatus for the composition of CO, CO2, based on the % composition of CO the NCV is calculated using the formula % of CO *30 + 75.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$NCV_{FOB,y}$
Data unit:	kcal/kg
Description:	Net Calorific Value of Furnace Oil
Source of data to be used:	FO invoice/ IS:1448-1960
Value of data	9500
Description of measurement methods and procedures to be applied:	This is calculated by using IS:1448-1960. Density of FO given in the FO supplier invoice is matched with the calorific value chart of the IS 1448-1960 chart.
QA/QC procedures to be applied:	
Any comment:	Applicable where option B is used.

B.7.2 Description of the monitoring plan:

>>

The project activity is operated and managed by the project proponent. The individual plant record data related to their respective project activity. In order to monitor and control the project performance, VSLSL has placed a project management team. They are coordinated by Project Executor (VP: M& U) and AGM (CPP) who is responsible for checking the information consistency. VSLSL has well diversified procedure for collection of data and analysis of data at different levels and for subsequent corrective actions as when required in line with these policies.

The project team has entrusted with the responsibility of storing, recording the data related to the project activity. The project team is also responsible for calculation of actual creditable emission reduction in the most transparent and relevant manner.

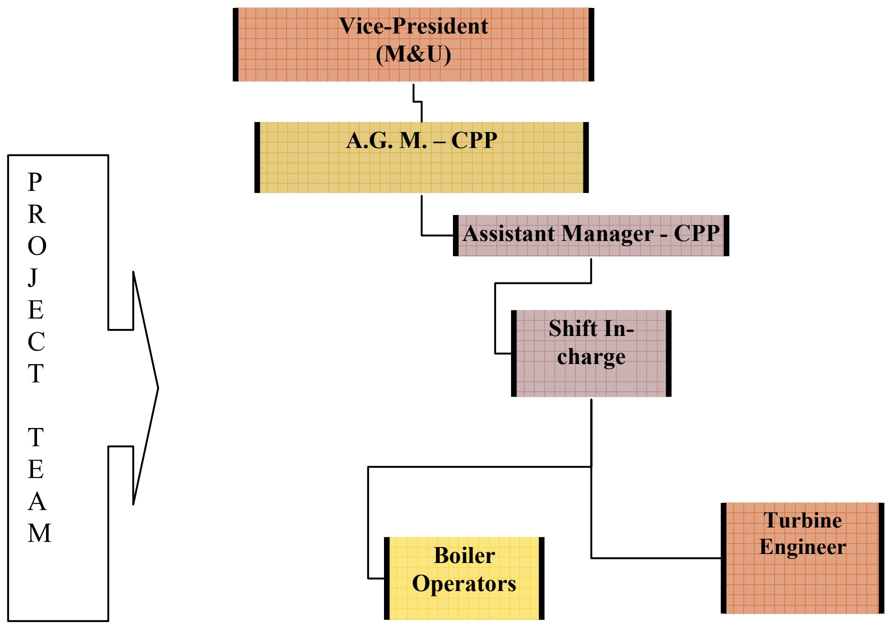
Inspection and record daily check list of critical parameters of project activity is maintained. The maintenance staff accesses the condition of all the power plant equipment and measuring equipment and take appropriate action in case it is required.

Installed meters are calibrated according to the maintenance schedule programmed at the start of the operation and recalibrated according the plants performance requirement.
All the monitoring data is stored /will be recorded and kept under safe custody of the Project Executor (VP: M & U) for a period of crediting period (10 years fixed crediting period) + 2 years.

The Instrumentation and the control system for the project activity are designed with adequate instruments to control and monitoring the various operating parameters for safe and efficient operations. All the instruments are of reputed make and are calibrated at regular intervals.

The BF gas based power project abides and will abide by all regulatory and statutory requirements as prescribed under the state and central laws and regulations.
Also any change within the project boundary, such as change in spare and or equipments will be recorded and any change in the emission reduction due to such alteration will also be studied and recorded.

Operational and Management Structure
All relevant functions and tasks are sufficiently described in the manual and the standard operating procedures of the quality management system.



Designation	Responsibilities
Vice-President (M&U)	Registration Project Execution
A.G. M. – CPP	Operation Verification of data Inspection of data whenever necessary to independently check the authenticity of data and take corrective actions wherever required. Storage of data
Assistant Manager - CPP	Operation, Monitoring and Verification of Data Data Recording Storage of data
Shift Engineers And Operators (Operation and Maintenance)	Operation and Maintenance Storage of data Data Recording Data Collection Archiving of data Observation ,Monitoring

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

>>

Core CarbonX Solutions Pvt Ltd. (www.corecarbonx.com)
101,6-3-1102
Near HSBC bank
Somajiguda, Rajbhavan Road,
Hyderabad –500482, Andhra Pradesh, India,
Mobile-+91-9963047666, +91-9908387772
Core CarbonX Solutions Private Limited is not a project participant.

Date of completing the final draft of this baseline section *(DD/MM/YYYY)*: 04/06/2008

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:

>>

18/04/2006.

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

>>

20Years 0 Months

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

>>

Fixed crediting period

C.2.1. Renewable crediting period

>>

NA

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

>>

NA

C.2.1.2. Length of the first crediting period:

>>

NA

C.2.2. Fixed crediting period:

10 years

C.2.2.1. Starting date:

Date of registration or 01/11/2008

C.2.2.2. Length:

>>

10 Years 0 months

SECTION D. Environmental impacts

>>

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

>>

As stated in the environmental impact assessment (EIA) notification vide S.O. 60(E)[3] dated 27/01/1994, India's Environmental Protection Act of 1986 project such as this with the investment of less than Rs. 500 million does not have to produce an EIA .The investment in this project is less than 500 million i.e. it involves investment of 193.5 millions only. Thus, the PP did not require an EIA study.

However a Environmental Management Plan (EMP) is prepared and it was submitted. This EMP would form a guiding factor for achievening the desired goal of sustainable Eco-friendly development in the region.

The major objectives of this EMP are:

- To establish the existing environmental scenario
- To predict the impacts of the plant operations on the environment
- To suggest preventive and mitigation measure to minimise adverse impacts and to maximise beneficial impacts
- To suggest monitoring programme, to evaluate the effectiveness of mitigation measures.

The Impact associated with the project activity was studied and found that overall environmental impacts are not significant. A summary of impacts is presented below:

Climate

Temperature

The temperature variation is a regional phenomenon and the proposed plant activity over a meager area is not anticipated to affect the temperature adversely.

Rainfall

Regional forces control the rainfall pattern and the proposed plant operation over a relatively small area is not anticipated to affect the same.

Wind Speed

The wind speed in any area is dependent on the generation of elevation and depressions and pressure in the region. Thus the plant activities are not likely to contribute to any variation in wind sped in the area, green belt developed around the plant.

Air quality

The ambient air quality results show that SPM, RPM, SO_2, NO_X and CO levels are well within limits prescribed by CPCB for areas meant for Residential, Rural and Other Uses. To minimize the adverse impact of release of pollutants and enhance beneficial impacts, the following measures shall be undertaken:

- Development of green belt along the plant boundary
- Proper flow of traffic and speed control
- Proper maintenance of roads

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

- Regular watering of plant haul roads

Noise levels

The exposure to excessive noise levels can lead to the following:

- Prevention of sleep, insomnia and fatigue.
- Decrease in speech reception, and distraction and distraction and diminished concentration thus adversely affecting job performance efficiency.
- Chronic psychological disturbance including impaired hearing.
- In certain extreme cases, there are irreparable cardiovascular, respiratory and neurological damages.

The noise survey conducted at various locations in and around the proposed plant area shows that the noise levels are generally around 29.4 to 49.5 db (A) away from the working areas. The deployment of machinery is expected to raise the noise levels in the proposed plant. The workers near high noise equipment shall be provided with earplugs.

As the nearest village is 2.5 km from the proposed plant area, no impact of noise on the village is likely due to plant operations. However, adequate control measures have to be taken to mitigate the adverse impact on the plant workers.

Surface water

As the area lies on ground level, no adverse impact of soil erosion due to rainfall is anticipated.

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:

>>

This project activity will result in positive impacts like better local air quality and GHG emission reductions into the atmosphere. The project participants consider the environmental impacts not significant.

SECTION E. Stakeholders' comments

>>

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

>>

A local stakeholder's consultation meeting was organized on 29th January 2008 at VSL Steels Limited, Hiryur. The stakeholders for the CDM project activity as identified by VSL steels Ltd comprised of the local villagers, the employees of VSL Steels Ltd; contract labour; and government officials. The stakeholders were informed about the meeting 15 days in advance through the letter of invitation from the management of VSL Steels Limited.

The queries and the comments of stakeholders that were raised during the meeting were recorded during the stakeholder meeting.

The agenda that was followed for the stake holder meeting process is described as below

1 Welcome Address
2 Election of the Chair of the meeting and approval of the proposed Agenda
3 Presentation of the CDM-Kyoto Protocol and role of local stake holder
4 Presentation of the Projects undertaken by VSL Steels Ltd.
5 Discussion and Articulation of concerns
6 Chair summarizing the local stake holder concerns
7 Vote of Thanks followed by Tea

Mr. H.N. Somashekarappa (AVP, Operations) had welcomed the audience and proposed the name Mr. Rajesh, Env.Offr. KSPCB, Chitradurga as the chairman of the meeting. The audience was unanimous in the decision of electing Mr. Rajesh as the chairman.

The minutes of the meeting were recorded by the PP and will be shown to the DOE during the site visit. The list of attendees along with their signatures is also kept for record and the photographs of the event were also taken.
Mr. Rajesh made the participants aware about the Green House Effect and its impact on Global Warming. He also explained the impacts of the greenhouse gasses like Carbon Dioxide, Methane, Nitrous Oxide on the environment. This was followed by a brief introduction on climate change, global warming, Kyoto protocol and the CDM process. The precautionary measures that VSL Steels Ltd is taking to prevent the hazards related to dust, CO gases, Water Scarcity etc was also highlighted in the discussion. Mr. Jaffer Kutty (V.P.-Operations) explained how VSL steels Ltd is using the BF Gases to run Turbine and generate Electricity. It was also explained that the proposed CDM Project Activity is an initiative towards climate change mitigation measures. This will reduce the consumption of fossil fuels for generating equivalent amount of electricity thereby reducing the direct emissions of GHG green house gases into the atmosphere. After the presentation was completed, the Mr. Somashekarappa from VSL Steels Ltd opened the session for stakeholders to articulate their queries, comments and suggestions.
The participants sought clarifications on Kyoto Protocol and Clean Development Mechanisms process.
Mr. K T Thippeswamy, Taluk panchayat member appreciated the company's contributions towards the local employment and company's effort towards the growth of Social and Economical Status Quo and its development projects initiated in the local villages of Hiriyur Taluq.
Mr. Rajesh, the Chairman, in summarizing the discussion lauded the management of VSL Steels Ltd for their efforts in generating electricity using the BF Gases. He emphasized that such efforts would collectively help to improve the overall local as well global environment.

E.2. Summary of the comments received:

>>

The specific concerns expressed by the participants are summarized below along with clarifications provided on such concerns

1. Question: Effect of ground water due to the power plant at the site?
Answer: Water is being used for cooling purpose only for Power Plant. This water is recycled. Only make up water is added to take care of the evaporation loss. It is a zero discharge plant. There is no adverse effect on ground water

2. Question: Is there any emissions of Harmful Gases from the Power Plant or from other sources to the environment?

Answer: The CO gas which is hazardous to the atmosphere is being used for the power generation instead of leaving to the atmosphere. So the operation of the Power Plant is environment friendly and not hazardous. So this Power Plant project helps in reducing the emission of hazardous gases into the atmosphere and makes the environment and it's surrounding clean.

3. Question : How many peoples are employed in the Power Plant
   Answer: Due to operation of the Power Plant about 50 people are employed directly & indirectly.

4. Question: What is the Calorific Value of BF Gases?
   Answer: the calorific value of BF gases ranges between 700-800 kCal/NM3.

5. Question: What is VSLSL's contributions towards the Society and Government?
   Answer: VSL steels is located in a underdeveloped area employing around 1000 people directly and indirectly. Management has spent an about Rs. 1 Cr. (Rupees One Crore) in last 2 years towards the welfare of the society and villagers. Due to operation of this Steel Factory, migration of the people from the villages to the neighbouring cities and other states in search of livelihood is reduced to a great extent. This has helped the local standard of living improved.

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

>>

The stakeholders were provided clarifications on the issues raised as above to their satisfaction. None of the concerns expressed by the stakeholders required an action to be taken by the Project Proponent during the project operation and at any other stage.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	S L R Steels Ltd.
Street/P.O.Box:	Paramenahally Village, Hiryur Taluk
Building:	
City:	Chittadurga District
State/Region:	Karnataka
Postfix/ZIP:	572143
Country:	India
Telephone:	08193-276082
FAX:	08193-276093
E-Mail:	Jafar.kutty@slrsteels.com
URL:	www.slrsteels.com
Represented by:	
Title:	Vice President
Salutation:	Mr.
Last Name:	Kutty
Middle Name:	Jaffer
First Name:	O
Department:	
Mobile:	+91-9343866203
Direct FAX:	08193-276093
Direct tel:	08193-276082
Personal E-Mail:	Jafar.kutty@slrsteels.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Public funding from Annex I and diversion of ODA is not involved in this project.

Annex 3

BASELINE INFORMATION

Variable	Data Source
EG_y – Electricity generated	Records maintained by project proponent
$Q_{WG,y}$ Quantity of Waste Gas used for electricity generation during the year y	Records maintained by the project proponent.
Parameter	**Data Source**
EF_{Coal} – Emission Factor of Coal (tCO2/TJ)	Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories
η - the efficiency of captive power plant	Specification of sub critical coal-fired power plant according to the heat rate (10.255 MJ/kWh) applied by Central Electricity Regulatory Commission (Terms & conditions of Tariff) Regulations, 2004 (www.cercind.org)
$Q_{BL,\ product}$ Production by process that most logically relates to waste gas generation in baseline	Specification as per Mecon Ltd. Table 3.2, technological parameters, page 14 in the Report on the Plant Facilities, Technological parameters and operating procedures for blast furnace complex at VSL steels Limited, Hiriyur, Chitradurga, Karnataka prepared by Mecon Ltd.
$q_{wg,\ per\ hour}$ Amount of waste gas the industrial facility generates per hour	Specification given by Mecon Ltd.

Annex 4

MONITORING INFORMATION

As Discussed in Section B 6.2 and B.7.

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Appendix – A

Levelized Cost of electricity generation using BF Gas.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Units Generated (Lakhs kWh)	251.37	251.37	251.37	251.37	251.37	251.37	251.37	251.37	251.37	251.37
Cost of Auxiliary Fuel (Lakhs)	304.04	319.242	335.2041	351.96431	369.56252	388.04065	407.44268	427.81481	449.20555	471.66583
Cost of Labour	45	47.25	49.6125	52.093125	54.697781	57.43267	60.304304	63.319519	66.485495	69.80977
Repair & Maintainance	48.375	50.79375	53.333438	56.000109	58.800115	61.740121	64.827127	68.068483	71.471907	75.045502
Insurance o Factory Assest	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57
Administrative Expenses	27	28.35	29.7675	31.255875	32.818669	34.459602	36.182582	37.991711	39.891297	41.885862
Interest on Term Loan	219.375	168.75	101.25	33.75	0	0	0	0	0	0
Depreciation	114.49948	114.49948	114.49948	114.49948	114.49948	114.49948	114.49948	114.49948	114.49948	114.49948
Interest on Working Capital	0	0	0	0	0	0	0	0	0	0
Total Cost of Generation	760.85948	731.45523	686.23702	642.1329	632.94857	658.74252	685.82617	714.26401	744.12373	775.47645
Cost per Kwh	**3.03**	**2.91**	**2.73**	**2.55**	**2.52**	**2.62**	**2.73**	**2.84**	**2.96**	**3.08**
PV Factors	1	0.8695652	0.7561437	0.6575162	0.5717532	0.4971767	0.4323276	0.375937	0.3269018	0.2842624
	3.03	2.53	2.06	1.68	1.44	1.30	1.18	1.07	0.97	0.88
Levelized Cost of Generation	2.93									

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Units Generated (Lakhs kWh)	251.37	251.37	251.37	251.37	251.37	251.37	251.37	251.37	251.37	251.37
Cost of Auxiliary Fuel (Lakhs)	495.24912	520.01158	546.01216	573.31277	601.9784	632.07732	663.68119	696.86525	731.70851	768.29394
Cost of Labour	73.300258	76.965271	80.813535	84.854211	89.096922	93.551768	98.229356	103.14082	108.29787	113.71276
Repair & Maintainance	78.797778	82.737666	86.87455	91.218277	95.779191	100.56815	105.59656	110.87639	116.42021	122.24122
Insurance o Factory Assest	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.57
Administrative Expenses	43.980155	46.179163	48.488121	50.912527	53.458153	56.131061	58.937614	61.884495	64.978719	68.227655
Interest on Term Loan	0	0	0	0	0	0	0	0	0	0
Depreciation	114.49948	114.49948	15.654712	15.654712	15.654712	15.654712	15.654712	15.654712	15.654712	15.654712
Interest on Working Capital	0	0	0	0	0	0	0	0	0	0
Total Cost of Generation	808.3968	842.96316	780.41307	818.52249	858.53738	900.55302	944.66943	990.99167	1039.63	1090.7003
Cost per Kwh	**3.22**	**3.35**	**3.10**	**3.26**	**3.42**	**3.58**	**3.76**	**3.94**	**4.14**	**4.34**
PV Factors	0.2471847	0.2149432	0.1869072	0.162528	0.1413287	0.1228945	0.1068648	0.0929259	0.0808051	0.0702653
	0.79	0.72	0.58	0.53	0.48	0.44	0.40	0.37	0.33	0.30
Levelized Cost of Generation										

Appendix –B

Levelized Cost of electricity generation using coal.

Total Fuel Cost		21.89	19.58	41.23	43.29	45.46	47.73	50.12	52.62	55.25	58.02	60.92	60.92	60.92	60.92	60.92	60.92	60.92	60.92	60.92	60.92	60.92	60.92	60.92	60.92	60.92	60.92
O&M Expesnses		2.250	2.250	4.770	5.056	5.360	5.681	6.022	6.383	6.766	7.172	7.603	8.059	8.542	9.055	9.598	10.174	10.785	11.432	12.117	12.845	13.615	14.432	15.298	16.216	17.189	18.220
Depreciation			13.30	13.30	13.30	13.30	13.30	13.30	13.30	13.30	13.30	13.30	13.30	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
Interest on Debt			18.90	18.11	16.01	13.91	11.81	9.71	7.61	5.51	3.41	1.31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest on Working Capital		0.208425	0.19372413	0.423654	0.445108	0.467654	0.491347	0.516245	0.542412	0.56991	0.598808	0.629177	0.632171	0.635344	0.638708	0.642273	0.6460523	0.6500584	0.6543048	0.658806	0.6635772	0.6686348	0.6739957	0.6796784	0.685702	0.692087	0.6988551
Cost of Generation			78.57	77.84	78.11	78.50	79.02	79.67	80.46	81.40	82.50	83.76	82.91	71.13	71.65	72.19	72.77	73.39	74.04	74.73	75.46	76.24	77.06	77.93	78.85	79.83	80.87
Electriicty Generation			31.49	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54	31.54
Cost per kWh			2.49	2.47	2.48	2.49	2.51	2.53	2.55	2.58	2.62	2.66	2.63	2.26	2.27	2.29	2.31	2.33	2.35	2.37	2.39	2.42	2.44	2.47	2.50	2.53	2.56
PV Factors	15%		1	0.869565	0.756144	0.657516	0.571753	0.497177	0.432328	0.375937	0.326902	0.284262	0.24718471	0.214943	0.186907	0.162528	0.1413287	0.1228945	0.1068648	0.0929259	0.0808051	0.0702653	0.0611003	0.0531307	0.0462006	0.0401744	0.0349343
			2.49	2.15	1.87	1.64	1.43	1.26	1.10	0.97	0.86	0.76	0.65	0.48	0.42	0.37	0.33	0.29	0.25	0.22	0.19	0.17	0.15	0.13	0.12	0.10	0.09
Levelized cost of electricity generation		2.49																									