Summary report of " Investigation for CDM project of waste heat recovery based captive power plant in sponge iron plants of Orissa, India."

1. Bases of project implementation

1.1 Outline of proposed project and its background.

A lot of rotary kiln sponge iron manufacturers are operating in India This project is to generate through utilization of waste heat of flue gases at rotary kiln plant, and to reduce the purchasing power from grid (power plant), and further to sell the purplus to grid. By this project, burning amount of coal in grid is reduced and hence leads to the reduction of CO2 emission. The background of this project is as follows:

(1) Iron and steel making industry in India

India has unique characteristic in the iron and steel making industry. In general, most of the iron and steel making process are integrated steel making process with blast furnace, and electric arc furnace using scrap. Their share is about 96% in the world. Other than these, there is Electric arc furnace using direct reduced sponge iron process. The reducing agent is natural gas in case of oil countries, and coal in non-oil countries. In India, steel-making production by coal base-direct sponge iron making process occupies about 8%. This is a unique process that is seldom operating in other countries. The reason is that India produces coal as well as iron ore, but the coal quality is not coking coal, hence not for applicable in the blast furnace. At present, waste gas from the rotary kiln is not heat recovered and emitted in the air.

(2) Energy condition of India

India has been developing with average 5.5% GDP growth. in last 20 years. In this time range, its population also increased by 2 % annually. On the other hand, due to the rapid industrialization, urbanization and motorization, the energy demand also increased which surpassed the GDP growth in this period. The power generation also increased 6.1% annually, which shows the elasticity to GDP growth was 1.5 times, which was supported by the enormous amount of the domestic coal. The ratio of thermal generation in total generation amount increased from 55%(in 1978) to 78%(in 2001), showing about 10% increase per year. The increasing coal consumption caused the serious environmental problem such as air pollution.

Because of the rapid increase of automobile gasoline demand, energy consumption in terms of primary energy raised by 5.5% annually in last 20 years. Indian industry is expected to have the high growth rate. Energy demand depends on the GDP growth rate and population growth. The Indian energy consumption per capita was 0.31 toe in 2001, rather lower level compared to other developing countries in Asia. In considering the future development in India, energy consumption per capita will go up to 2 times of present level, and to keep the energy sources needed to the country growth is indispensable.

Table 1 Primary energy consumption per capita

(Unit: toe/capita)

Country	Energy consumption per capita			Annual increase of energy consumption (%) (1995–2001)
	1995	2000	2001	
India	0.270	0.317	0.316	2.7
China	0.714	0.735	0.726	0.3
Thailand	0.839	0.953	1.020	3.3
Malaysia	1.740	2.020	2.070	2.9
Philippines	0.368	0.429	0.414	2.0
Indonesia	0.410	0.478	0.499	3.3
Vietnam	0.122	0.183	0.207	9.2
Japan	3.950	4.130	4.100	0.6

(Source: The Energy Conservation Center, Japan)

(3) Electricity power condition of India

The electric power generation amount in India has been increasing with 5.5% in last several years. But demand increase due to rapid growth industry, the supply of power has been less than the demand and been insufficient chronically. Therefore, installation and modernization of generation facilities, transmission and distribution equipment, etc, are big issues. Indian government expresses the test calculation result that India must construct about 100 new facilities in 10 years, which have the capacity of 1,000MW generation capacity, to meet the future demand by replacing the old equipment. But the depreciation of the existing power stations has not yet completed and the financial support is not sufficient for new construct and replacement of old facilities. They therefore are obliged to operate with overload condition, which lead the big transmission and distribution loss. This kind loss amounts to more than 50% of total generation in an unfavorable state, and total loss is expected to be about Rs 260 billion in 2001.It is said that in India about 40% of generated power is properly utilized, the balance 60% is loss and steal. Indian government had laid the emphasis on generation, but they changed their opinion to emphasize the investment to transportation and distribution field. Generation amount by energy sources shows that 78% is by thermal and 13% is by hydraulic. Thus, Indian electric power industry has big issues, but due to the financial problems, it is far difficult to be solved.

(4) Summary of background

1) India is facing to the lack of energy. For the development, they need to solve such problems, but due to budget problems, it is not easy to improve them.
2) Electric power has also the similar problems, and not easy to overcome.
3) A lot of sponge iron manufacturers with rotary kiln are operating in India, and waste heat gas is disposed to the air. Electric generation utilizing this gas is very beneficial to improve Indian

energy situation.

1.2 General information of host country

India is the second biggest country with its population about 1.1billion. After depending from UK in 1947, although it had a lot of difficulties, it has developed internationally and became to play important role in the world. Since 1980s, it showed the actual GDP rate in average 5.5% annually. The IT industry has rapidly developed, and due to that, the position of India in terms of economic scale is at present 12th in the world and 4th in Asia. Together with this development, India received a rapid growth of automobile industry and also the tremendous demand increase of electric power. As a result, its CO2 emission level was pushed up to be 5th in the world following after Japan (USA 24%, China 13%, Russia 6%, Japan 5%, India 4%).

Recently, "BRICs "countries consisting of Brazil, Russia, India, and China are considered to be new group with their enormous future development. At present, their GDP per capita are not high, namely Russia $4,093, Brazil $3,417, China $1,269, and India $618. BRICs are, however, considered to establish the big economic growth in future and in 2050 their economic scale will show the following order in the world: China–USA–India–Japan–Brazil– Russia.

In economical relation between India and Japan, India shows the about 10th position in the trade amount for both import from India(main products are iron ore, sea foods etc) and export to India(machinery, electric devices, etc) . Recently IT industry of India developed rapidly and soft ware became one of the main export items to Japan (it is not listed in the statistic table). In future this IT technology will be applied to industrial items and be exported to Japan. Thus, India has potential power and energy, therefore we need to pay special attention to it as to be the next important country after China.

1.3 Policy for CDM/JI in host country, such as CDM/JI entity and DNA organization

(1) Indian government is very positive for CDM project. In December 2003, India set up the DNA(Designated national Authority) in the government. The member consists of Ministry of finance, Ministry of Foreign affairs and Ministry of Industry, etc. Since then, it issued 181 pieces of written approval as of 15 November 2005. The approved CDM consist of various field items. Main items is biomass such as sugar cane, husk etc,. Other than biomass, there are some industrial items such as steelmaking industry, cement industry and so on. Three CDM project similar to this Orissa project (waste heat recovery for generation in the sponge iron manufacturers) are also approved already.

(2) Point Carbon, Oslo, which provides several CDM information, is giving a CDM host country rating. In this rating, India is ranked as 1st position. Following India, such countries like Chile, Brazil and China come. The reason and back ground of this rating is as follows:

India is currently CDM world market leader when it comes to projects with host country approval

and numbers of projects with PDDs. It has the widest range of project types of any host country and high number of knowledgeable players regarding CDM consultancy. However, investment climate remains relatively poor and at the state level, barriers for project implementation may arise. Also, many project have additionally problems.

(3) Thus India has been positively tackling the PDD together with governmental and private organizations from the early stage, and given the approval for several CDM projects. We therefore consider that this project will be approved.

1.4 The areas where proposed project assists the sustainable development/technology transfer for host country.

As already described in 1.1, India suffers the lack of energy and electricity. This project proposes to generate electricity by utilizing waste heat gas from rotary kiln, which is presently disposed in the air. A lot of rotary kiln are operating in India, therefore this project may contribute towards the solution of energy problem Indian energy problem with a sustainable and immediate result.

1.5 Supporting system for Survey

SPCO summarizes the Final Report. The organizations below are the support member for that.

(1) Japan side

1) Supporting organization: Japan Consulting Institute

＊ role: pre-validation of PDD

(2) India side

1) Supporting organization 1:OSIMA(Orissa Sponge Iron Manufacturers Association)

*place: Bhubaneswar, Orissa

*role: Organize the 17 participants companies in Orissa

2) Supporting organization 2: BPNSI(Biju Patnaik Nation Steel Institute)

*place: New Delhi

*role: Information collection and assistance for PDD making

3) Supporting organization 3: MECON Limited

*place: Ranchi, Jharkhand

*role: Providing information on rotary kiln (detail specification, cost etc,)

2. Project planning

2.1 Contents of the project

There is a lot of small and medium size manufacturers who produce sponge iron by rotary kiln process. Sponge iron is used as the raw material at electric arc furnace. A lot of such manufacturers is located in Orissa. At present, hot waste gas from rotary kiln (about 950 ℃) is

not utilized and disposed into the air. As it is difficult to remove dust from the hot gas by dust separator, dust is also disposed into air. Thus rotary kiln process has the problems from both viewpoints of energy saving and environment. However, as most manufactures are small and medium size, they can not afford to invest the effective measures. Under such situation, BPNSI together with OSIMA has decided to modernize such plants. They consist of the installing generator at the exit of the kiln to utilize hot waste gas for generation, and to collect the dust from waste gas. The generated electric power contributes to reduce the purchasing power from the power plant (grid) and the excess amount is sold togrid. As a result, coal consumption for generation in grid may reduce and hence CO2 emission in grid will be reduced.

2.2 Project size

(1) Number of manufactures: 17

(2) Sponge iron production: about 750, 000 tons/year

(3) Construction cost: million US$ 48

(4) Capacity of generation: 50MW

(5) Generated electric power: about 360,000MW

(6) Emission factor: 0.843t-CO2/MWh

(7) CO2 reduction: about 300,000ton/year

(8) Expected CER amount: million US$ 3.0/ year　(in case of 1 ton CO2 = US$ 10)

2.3 Project boundary/Baseline/Additionality

(1) Project boundary

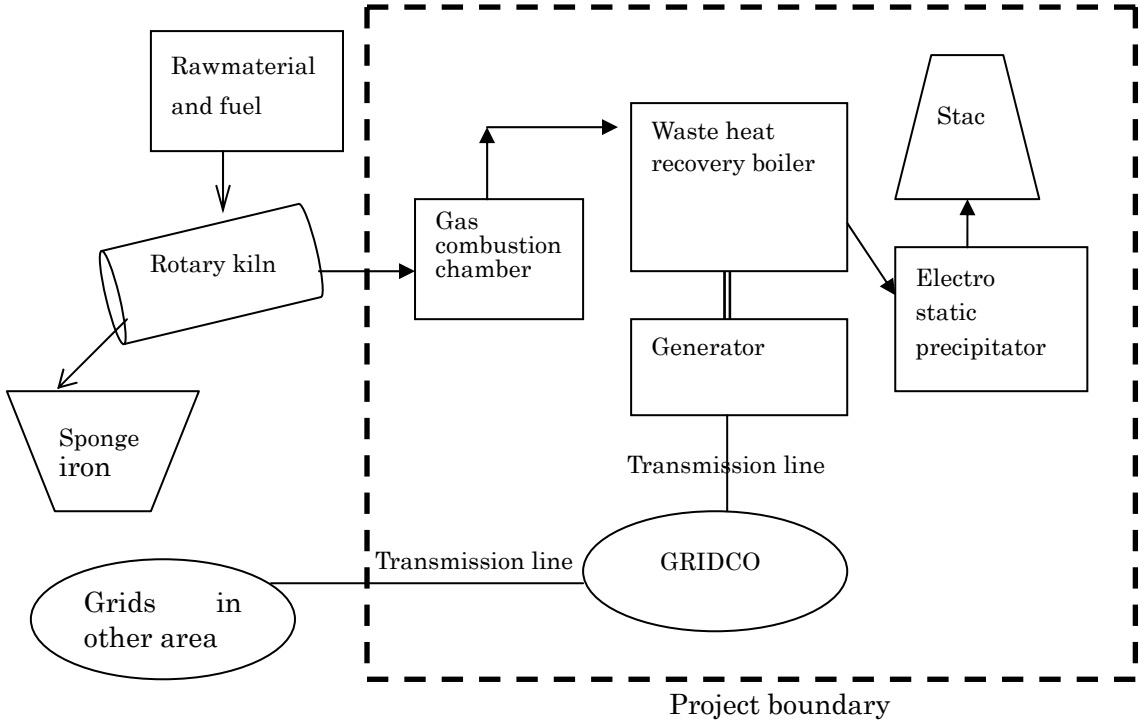

Figure 1　Project boundry

(2) Baseline

At present the participants (17 sponge iron manufacturers) don't have their own captive power plant, and they are purchasing 100% of electric power from grid. The reason of this condition may be the evidence of the Baseline. Generally, the fuels of captive plant are natural gas, coal, diesel, hydro, wind etc. Out of these, natural gas has the difficulty for obtaining, and is not practical. Diesel power plant is for the emergency use. Coal based plant is the most practical one, but the captive power plant size in the manufacturers are small compared to the grid, hence they are not competitive and are unfavorable. In considering this background, the present situation, that is , purchasing of electricity from grid is the Baseline.

(3) Emission factor

In ACM0002, a combined margin is specified in such formula:

Combined Margin (CM) = (Operation Margin (OM) + Build Margin (BM))/2

1) OM

As the net import to grid exceeds 20% of the total generation in the project electric system, we need to go Step1, Step 2 and Step 3. In Step 1, we applied Simple OM, because Dispatch Data Analysis OM is not available. In this calculation, hydropower ratio was 41.8%<50%, therefore we considered 100% thermal power in the following calculation. According to IEA, IPCC data, the emission factor of coal is 95.52t-CO2/MWh. Energy efficiency in Grid was obtained as 34.78%. By these factors, OM for the last 3 years was calculated as 1.00125t-CO2/MWh.

2) BM

In this project, 20% of the most recent plants sum up to 10 power plants. Therefore we take into consideration the 10 most recent plants built in Orissa. BM is calculated to be 0.68659t-CO2/MWh.

3) CM

As a result of OM and BM, CM was calculated to be 0.843923t-CO2/MWh.

(4) Additionality

We proved additionality by analyzing from step 0 through 5 specified in PDD.

1) There is evidence that a Japan/India meeting was held on March 23, 2005 about this project. Prior to this time, Indian manufacturers had no ideas to generate utilizing waste heat from rotary kiln because of high construction cost. In this meeting Indian side recognized that this project would be viable only with the aide of CDM credit.

2) It was found that there were no any applicable laws and regulation that enforced this project.

3) Investment analysis was carried out. It was found that Net gain would be minus for all 7 years. With the CDM credit (assumed t-CO2 = US$15), Net gain will be plus for all 7 years. This shows that this project is financially not visible without considering the benefit of CDM.

4) We identified the barriers that prevent the implementation of proposed project activity: There

are technological barriers that skilled and/or properly trained labor is not available, and it takes some time to provide the qualified persons. This is a barrier, which the project proponents have accepted considering the benefits afforded by CDM.

By above-mentioned steps, this project proved the additionality of this project.

2.4 GHG reduction and Leakage in project

(1) CO2 reduction: about 300,000ton/year

(2) Leakage: No leakage

2.5 Monitoring methodology

Table 2 Monitoring methodology

No.	Subject	Unit	Frequency	Remarks
1	Fuel and products amount	ton or m3	Continuously	(*)
2	Fuel calorie	TJ/t or m3	Monthly	As the need arises
3	Carbon coefficient	C/TJ	Monthly	
4	Total generated power	MWh/y	Continuously	
5	Power consumed at the auxiliary facilities	MWh/y	Continuously	
6	Generation in grids	MWh/y	Continuously	

(*)This is not required in Monitoring Method, and this is just for information.

(Source: PDD)

2.6 Environmental aspect

The rotary kiln process will not be influenced by this project, therefore Sox, Nox , waste material amount are unchanged. Dust collector system of rotary kiln is wet type EP or ventury scrubber using water spray. Usually these dust collectors have bigger fluctuation, hence less dust collecting ability than boiler type dust collector. As a conclusion, this project may eliminate more dust than the present condition.

2.7 Stakeholders comments

Comments of such stakeholders as village residents, officials of block, district, state and central government, central government Ministry of Environment & Forest (MoEF) etc. Summary of comments are as follows.

(1) Peripheral village constituent

They were happy that their villages would develop because of the project activity, by way of employment opportunities, better delivery of electricity in their homes and farm machinery, less pollution, establishment of nearby schools and better roads.

(2) Officials of Block, District,and state & Central Government

They note that the project activity would bring all round improvement in the quality of life and was a mechanism whereby sustainable development could be brought about.

(3) GRIDCO officials

GRIDCO will be relieved that a number of captive power plants were coming up in the States of Orissa, which would go a long way in alleviating the problem of voltage drops in the system due to excessive drawals.

3. Project implementation

3.1 Business formation

Business formation is shown in Figure. 2.

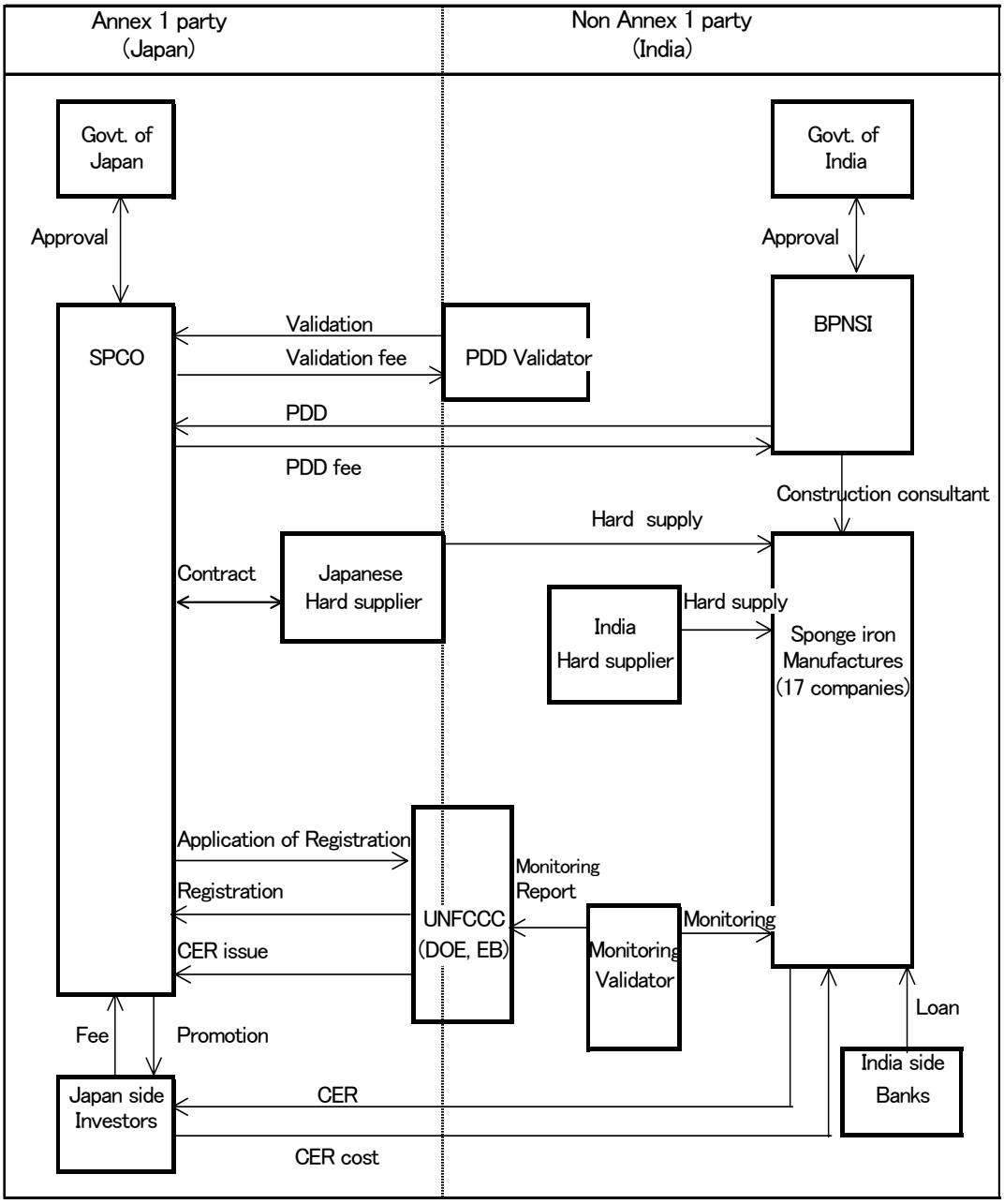

Figure 2 Business formation

3.2 Financial plan for the business

At this time, detail of financial plan is not yet confirmed. Indian partners expect both Japanese and Indian side will invest 12.5% each, and covers 75% by loan. The possibility of loan source would be JBIC, Japanese trading companies, banks etc, but that will be considered depending on the future trend of CER and at present nothing is decided. We will consider this after total plan is settled.

3.3 Financial analysis

In order to know the feasibility of this project, a financial analysis (IRR on project) was carried out. To compare the effect of CER, we put 4 CER levels (US$ 0/ t-CO2, US$ 5, US$ 10 and US$ 15).

Table 3 IRR on project

CER(US$ / t-CO2)	IRR after tax(%)
0	9.6
5	12.6
10	15.4
15	18.1

This results tells that even in case of CER is US$ 15 / t-CO2, IRR result does not reach to the 20-25% range, which is considered to be the lowest level for investment decision. This shows that under these conditions it is difficult to commence this project. Another financial analysis, "Return of years for investment" is shown in Table 4.

Table 4 Return of years of investment

CER(US$ / t-CO2)	Years of return for investment (years)
0	5.1
5	4.4
10	3.8
15	3.4

*Year of return = Initial investment / (annual sales amount - operation cost)

This figure also shows that even in case of US$ 15 / t-CO2, the figure is almost equal to the "decision making level"(3.5 years) for investment.

3.4 Prospect and issue of the project

At present the project detail is not yet settled. After this survey, practical investigation will be necessary to find out the effective business condition. They are;

* Reduction of Initial cost
* Price up of power selling to grid
* Future tendency of CER in the world market, etc.

4. Validation/Determination

4.1 Validation

In this survey, Validation is out of scope. In the due time the Validation will be carried out borne by SPCO.