FY2008　CDM/JI FEASIBILITY STUDY
Report – Summary

Title of Feasibility Study (FS)

CDM feasibility study on direct reduction iron production by utilizing coke oven gas in Hebei Province, China

Name of Main Implementing Entity

Mizuho Information & Research Institute, Inc.

1. Description of Project Activity

(1) Host Country and Area

China; Hebei Province

(2) Outline of Project Activity

Hebei Province is the center of China's iron & steel industry, blessed with abundant natural resources. At the same time, however, the province faces environment deterioration from serious air pollution, including greenhouse gas emissions, due to its inefficiencies in production systems and facilities.

Under such circumstances, with governmental policies to promote energy efficiency and environment protection in China, Beris Engineering & Research Corporation has conducted technological development to utilize unused coke oven gas (COG): specifically, COG is used as reducing agent instead of coke for integrated blast furnace-converter (BF-C) steelmaking, the most common production approach in China's iron & steel industry. Direct reduction iron (DRI), the iron produced with COG as reducing agent, and also called as sponge iron, is used as raw material for crude steel production in electric furnace. This project is conducted in a new DRI plant with 170,000 tons of annual production capacity, in cooperation with a local company in Tangshan City, Hebei Province, whose coke production is 120 Mt/yr. Sponge iron produced in the plant is transported to an electric furnace to be used as raw material for crude steel production.

This technology, in addition to replacing reducing agent from coke to COG, transforms steelmaking approach itself from the conventional integrated BF-C method to a more energy efficient one using direct reduction furnace and electric furnace (DRF-EF). CO2 emissions from BF-C and DRF-EF are 1,818 kgCO2/t-crude steel and 1,099 kgCO2/t-crude steel, respectively, which reduces emissions by 719 kgCO2/t-crude steel, cutting more than 50%. The DRI plant in this project is capable to produce approx. 150,000 t-crude steel, therefore, annual emission reduction is estimated at approx. 110,000t-CO2/yr.

This project is planned to start for January 2010, taking into account construction phase of the DRF. During the first commitment period of the Kyoto Protocol, CER is expected to be issued for three years.

2. Contents of this study

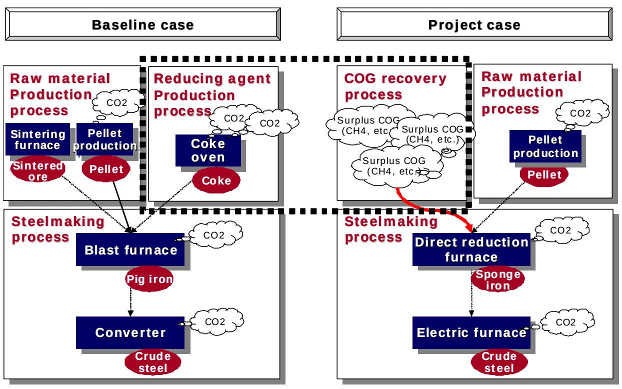
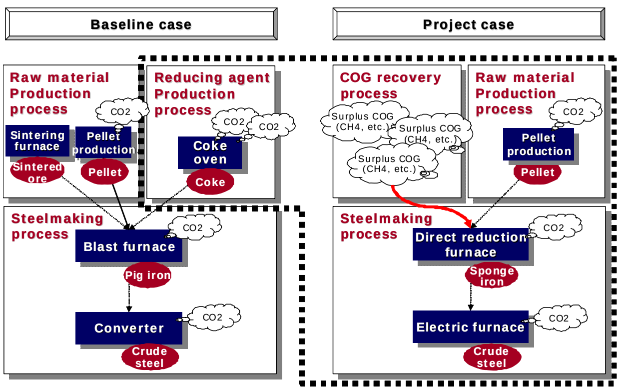
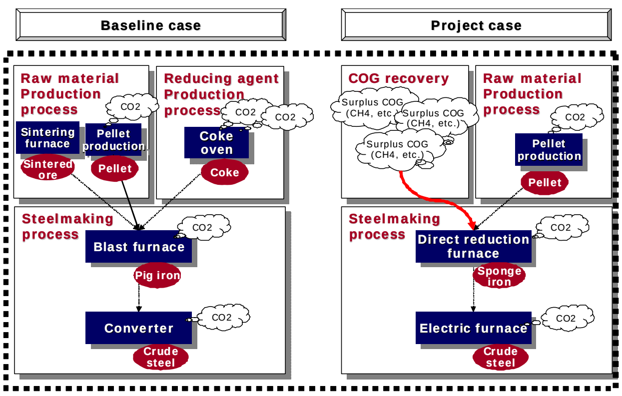
(1) Issues in this study

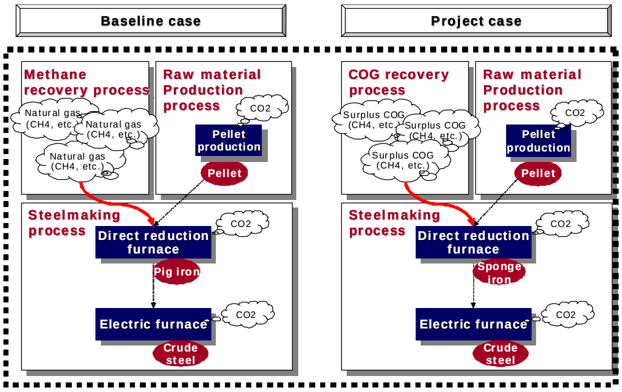
Identification of project boundary and baseline

- In this project, surplus COG is utilized as reducing agent. No applicable methodology to this project has been approved: as a matter of course, no registered project exists in this field.

- Therefore, it needs to formulate notions of setting applicability, project boundary and baseline for developing a new methodology.
- For identifying project boundary and baseline, several scenarios are assumed, as shown in the table below. Among those, select or modify one scenario which is practical for China's actual situations as well as applicable to a new CDM methodology.

Table 1 Possible scenarios for project boundary and baseline

Project boundary	Baseline case and project case
Scenario 1:  	• Baseline case: COG emission due to flaring from coke oven. Baseline emission is monitored CO2. • Project case: Recovery of the COG flared. No CO2 emission. • Associating baseline and project cases (reference value for calculation): COG volume recovered. • [Problem] Not enough strong to demonstrate that recovered COG is certainly utilized.
Scenario 2:  	• Baseline case: COG emission due to flaring from coke oven. Baseline emission is monitored CO2. (as with Scenario 1) • Project case: Production of sponge iron or crude steel, by using recovered COG. • Associating baseline and project cases (reference value for calculation): COG volume recovered. • [Problem] Is project case emission not larger than the baseline? This boundary is used in DME-related NMs and AM0037.
Scenario 3:  	• Baseline case: Crude steel production with integrated BF-C steelmaking. • Project case: Crude steel production with electric furnace using recovered COG • Associating baseline and project cases (reference value for calculation): crude steel production volume. *comparison of emissions per ton of crude steel production • [Problem] Monitoring is complicated. • [Problem] The unit in this scenario is per ton of crude steel: another unit could be required to express crude steel production with electric furnace as baseline (as with Scenario 4).
Scenario 4:	• Baseline case: Crude steel production with

Project boundary	Baseline case and project case
	electric furnace using natural gas. • Project case: Crude steel production with electric furnace using recovered COG. • Associating baseline and project cases (reference value for calculation): crude steel production volume. *comparison of emission per ton of crude steel production • [Problem] Does this scenario make a reduction? • [Problem] Is this baseline adoptable in China?

Estimation of GHG emission reductions

- In this FS, it is necessary to estimate GHG emission reduction for crediting period, based on the scenario selected in the previous section (Identification of project boundary and baseline).
- Regarding data provided from the counterpart (for assuming parameter), the data should be verified, or other data should be obtained from official sources, because it is more desirable to use such data that reflects China's situation as well as is authorized by public authorities.

Evaluation of environmental impacts and other indirect impacts

- There are pollutant emissions such as NOx and SOx from sintering process in BF-C steelmaking. Another concern is air pollutant emission from coke production which is subject to regulation under emission standards for pollutants such as NOx.
- In this FS, taking into account conditions such as data availability, effects to control emissions from coke production are considered as environmental impacts for an assessment.

Stakeholders' comments

- For launching this project, it is necessary to provide explanations on the project outline and registration as a CDM project to the related entities, calling for their comments.

Investment plan

- It is necessary to re-estimate project costs including DRF construction based on the assumed coke plant capacity in this project, and set out how to cover such costs in an investment plan.

Investment analysis

- Investment analysis has already been conducted assuming a certain size project, which indicates that benefit from being registered as CDM is essential for implementing this project.
- In this FS, investment analysis should be re-conducted taking into consideration the above-mentioned estimates and benefits.

Demonstration of additionality

- This project uses an unprecedented new technology in the world, including Japan.

- Therefore, as a matter of course, there are some technological barriers in this project. Besides, prior estimations indicate that this project has additionality in economic sense, too.
- For this project, it is necessary to formulate notion of how to demonstrate additionality based on information provided from the counterparts.

(2) FS implementation system

The system to implement this FS and the roles of each party are as show below:

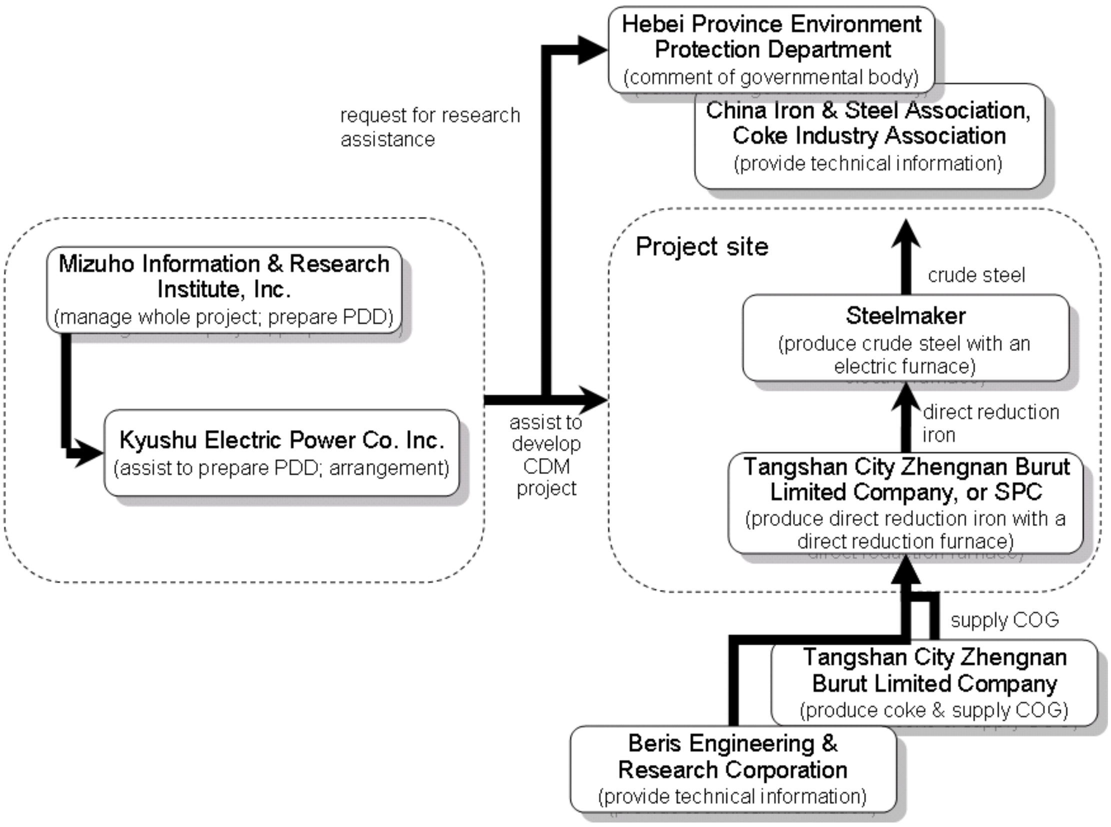


Figure 1 FS implementation system

(3) Contents of FS

Site visits have been conducted three times. See the attached "Site visit reports" for details.

Month/year	Company to visit	Outline of interview
September 2008	Beris Engineering & Research Corporation	• Gave an explanation on CDM to the Chinese counterpart to deepen their understanding of this project. They assured to provide necessary information for CDM registration. • Japanese side deepened understanding of the technology developed by the counterpart; then both parties had discussions toward CDM registration of this project. • Collected basic information on steelmaking in the host country to determine a project boundary (up to crude steel production) and a baseline (BF-C). Obtained energy consumption units for each process in baseline case and

		project case to estimate CO2 emission reduction.
November 2008	Tangshan City Zhengnan Burut Limited Company * accompanied by Beris Engineering & Research Co.	• Tangshan City Zhengnan Burut Limited Company plans to expand its coke production capacity from the current level of 0.5Mt/yr to 1.2Mt/yr in March 2009, which will also increase COG emission (from current 90-100Mm3/yr). • Although COG is processed by flaring in general, not used for energy, the company provides COG for an alternative of city gas at a reasonable price.
January 2009	Hebei Province Environment Protection Department, Hebei Coke Industry Association	• Gave an explanation on outline of this project to the participants: questions were raised afterwards, asking on condition of COG after reduction process and on roles of project participants. After the Q&As, they commented that this project was reasonable in terms of secondary use of COG as reducing agent, in addition to conventional use as energy, and that they would provide supports to it. • Shortage in coke in the Province is likely to continue. It is also learned that there is no barrier in regulations for construction of a direct reduction furnace.

Identification of project boundary and baseline

- Among the possible scenarios for project boundary and baseline, as described in Table 1, Scenario 3 is employed to develop a new methodology.
  - Project boundary: Processes up to crude steel production through DRF-EF approach
  - Baseline scenario: Integrated steelmaking with blast furnace and converter

Estimation of GHG emission reductions

- Reduction of GHG emissions in this project is estimated at 111,114 t-CO_2/yr, based on information mainly given in the interviews. This estimation reflects the production capacity of 1.2 Mt/yr that the COG supplier Tangshan City Zhengnan Burut Limited Company plans to expand for March 2009.

Evaluation of environmental impacts and other indirect impacts

- External environmental cost can be reduced in the project activity from eliminating coke production process. An estimation result based on emission reference values shows that the cost is expected to be cut by approx. 350,000 yen/yr.

Stakeholders' comments

- China Iron & Steel Association gave their comment in a meeting that they would positively promote this project.
- Meeting with the Environment Protection Department of Hebei Province was held on January 15th, 2009. They gave a comment that this project was reasonable in terms of secondary use of COG as reducing agent, in addition to conventional use as energy, and that they would positively promote this project.

- Another meeting was with Hebei Province Coke Industry Association, considering that the key factor of this project would be how well to utilize COG. During the meeting they raised a question, asking if any changes in calorific values of COG would occur after reduction process, to which Japanese parties answered that the values would remain the same. Subsequently, they assured to provide their positive supports to promote this project.

Investment plan

- Investment plan for this project has not been determined.
- However, it is highly possible that the project operator would manage with its own fund, because total cost of this project is relatively small.

Investment analysis

- Investment recovery period is estimated at approx. 8.6 years and IPP is 10.2% if there is no profit generated from selling CER, which is less attractive to operators. However, if the project is registered as a CDM, the period can be shortened to less than three years and IRR increase up to 33.5%.

	Without profit from credit	With profit from credit
Investment recovery period	8.6 years	2.9 years
IRR	10.2%	33.5%

Demonstration of additionality

- This project employs an unprecedented new technology in the world, including Japan.
- Therefore, there are (1) technological barriers due to not having an example of commercial operation and (2) cost barriers for initial investment and operation.
- As mentioned above, the investment analysis indicates another barrier.

3. Project implementation plan

(1) Identification of project boundary and baseline

Table 2 shows emission sources for baseline case and project case.

Table 2 Emission sources in this project

Source		Gas	Included ?	Justification / Explanation
Baseline	Coke oven	CO_2	Yes	Main emission source.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Sintering	CO_2	Yes	Main emission source.

	furnace	CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Pellet furnace	CO_2	Yes	Main emission source.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Blast furnace	CO_2	Yes	Main emission source.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Converter	CO_2	Yes	Main emission source.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project activity	Pellet furnace	CO_2	Yes	May be an important emission source.
		CH_4	No	Excluded for simplification. This emission source will be negligible.
		N_2O	No	Excluded for simplification. This emission source will be negligible.
	Direct reduction furnace	CO_2	Yes	May be an important emission source.
		CH_4	No	Excluded for simplification. This emission source will be negligible.
		N_2O	No	Excluded for simplification. This emission source will be negligible.
	Electric furnace	CO_2	Yes	May be an important emission source.
		CH_4	No	Excluded for simplification. This emission source will be negligible.
		N_2O	No	Excluded for simplification. This emission source will be negligible.

Figure 2 shows the outline of boundary for baseline and project cases.

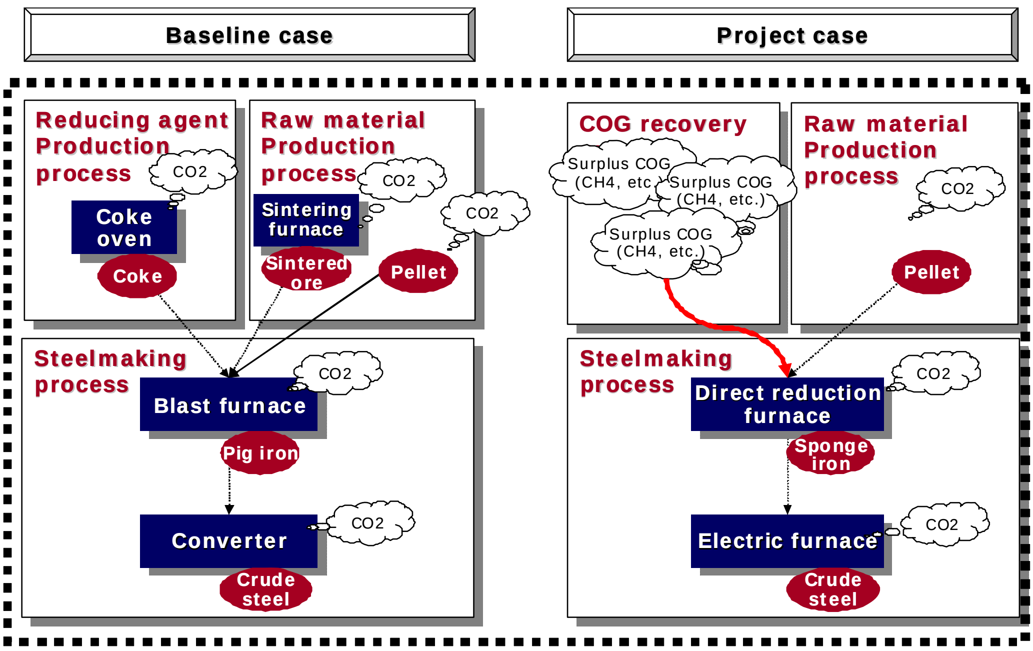


Figure 2　Project boundary

Baseline case and emission intensity

Baseline is crude steel production by blast furnace-converter (BF-C) steelmaking approach under which CO2 emissions occur from each of the following processes:

- Coke oven process

For producing 1 ton of coke, it consumes 1.32 ton of coal and generates 420m3 of COG, with CO2 emission from both. COG includes CO: 6 - 7%, CO2: 1 - 3%, H2: 55 - 60%, CH4: 24 - 26%, N2: 5 - 6%, H2O: 3 - 4% and CmHn: 1 - 2%. Carbon content of COG is approx. 35%. It is assumed that blast furnace gas is consumed in this process that does not consumed in sintering furnace process, pellet production process or blasé furnace process. Besides, as indirect emission, 36.79 [kWh/t-coke] of electricity is consumed.

- Sintering furnace process

For producing 1 ton of sintered ore, it consumes 70 kg of coal and 60m3 of blast furnace gas, with CO2 emissions from both. Besides, as indirect emission, 37.89 [kWh/t-sintered ore] of electricity is consumed.

- Pellet production process

For producing 1 ton of pellet, it consumes 250 m3 of blast furnace gas, generating CO2. Meanwhile, as indirect emission, 34.85 [kWh/t-pellet] of electricity is consumed.

- Blast furnace process

For producing 1 ton of pig iron, it consumes 400 kg of coke and 150 kg of coal, with CO2 emission from both. CO2 contents of coke and coal are 85% and 65%. But emissions from these combustions are seemed as BFG and this is utilized in each process such as pellet production process. Then 810 [m3-BFG/t-pig iron] consumed in this process of total generated BFG are considered to CO2 emission in this process. Besides, as indirect emission, 167.69 [kWh/t-pig iron] of electricity is consumed for blasting.

- Converter process

For producing 1 ton of crude steel, it consumes 10m3 of COG for heating fuel. 100 m3/t-crude steel of converter gas generates in this process, but this is utilized in other process out of project boundary. So this emission is not considered in this process. Meanwhile, as indirect emission, 43.46 [kWh/t-crude steel] of electricity is consumed for blasting and oxygen injection.

Project case and emission intensity

For project case, CO_2 emissions occur from the following processes.

- Direct reduction furnace process

For producing 1 ton of sponge iron, 364m3 of COG is consumed for heating COG, generating CO_2. Carbon content of COG increase up to 41.5% because this COG is utilized in direct reduction process before this process. Meanwhile, as indirect emission, 30 [kWh/t-crude steel] of electricity is consumed for blasting and oxygen injection.

- Pellet furnace process

For producing 1 ton of pig iron, it consumes 1.4 ton of pellet. Calculation for emission from pellet furnace is as described in the baseline case.

- Electric furnace process

As indirect emission, it consumes 380 kWh of electricity/t-crude steel.

(2) Monitoring plan

In line with the newly-developed baseline methodology as above, a new monitoring methodology is also formulated.

Monitoring in the baseline case

For calculation of the baseline emission, all value is determined before the project starts (ex-ante). Therefore, there is no monitoring item and variable for the baseline case.

Monitoring in the project case

For the project case, each of emission intensity of the processes given above is to be monitored.

(3) GHG emission reductions

GHG emission reductions are as shown in Table 3.

Table 3 GHG emission reductions

Item	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Baseline Emissions	t-CO2e	280,938	280,938	280,938	280,938	280,938	280,938	280,938	280,938	280,938	280,938	2,809,379
Project Activity Emissions	t-CO2e	169,824	169,824	169,824	169,824	169,824	169,824	169,824	169,824	169,824	169,824	1,698,243
Leakage	t-CO2e	0	0	0	0	0	0	0	0	0	0	0
Total Reductions	t-CO2e	111,114	111,114	111,114	111,114	111,114	111,114	111,114	111,114	111,114	111,114	1,111,136

(4) Duration of project activity/crediting period

This project assumes the following periods for project implementation and credit acquisition.

Duration of project activity: 2010 – 2030 (for 21 years)
Crediting period: 2010 – 2019 (for 10 years)

This project is planned to be conducted in a newly-constructed direct reduction furnace. Thus, the commencement date of project period is scheduled for January 1st, 2010, when the new furnace starts its operation.

(5) Environmental impacts and other indirect impacts

For preparing a PDD, environmental impact analysis needs to be conducted, following a prescribed flow, to satisfy various environmental standards. The standards for air environment are as shown below.

Regarding emission standards, outlet concentration is subject to assessment: the second class standard of China's national standard,"GB9078-1996" (Emission Standard of Air Pollutants for Industrial Kiln and Furnace), is applied.

Table 4 Emission Standard of Air Pollutants for Industrial Kiln and Furnace (unit: mg/m3)

Pollutant	2nd class standard	Emission source
SO2	850	Flue
Fume and dust (mg/m3)	200	

Regarding assessment coverage for environmental impacts as result of emissions, "the area within 3 km from flue to predominant wind direction and 1.5km to other directions" is applied. For air concentration (SO2, NO2, TSP) within the coverage, the "second class" level of China's national standard "GB3095-1996" (National Ambient Air Quality Standard) is applied.

Table 5 National Ambient Air Quality Standard

No.	Pollutant	Concentration limit (mg/m3)			Basis
		Hourly average	Daily average	Yearly average	

1	SO_2	0.50	0.15	0.06	GB3095-1996 (2nd class)
2	NO_2	0.24	0.12	0.08	
3	TSP	/	0.30	0.20	

(6) Stakeholders' comments

China Iron & Steel Association gave a stakeholder's comment.

The comment from China Iron & Steel Association was provided in the meeting held in their office in Beijing on December 1st, 2008. Kyushu Electric Power Co. explained an outline of this project to the four participants from the Association, and comments were subsequently provided.

In the meantime, as for Hebei Coke Industry Association and Hebei Environment Protection Department, comments were given on January 15th, 2009, during a visit to the Department's office in Shijiazhuang City. In the meeting, outline of the project was explained to the staffs from the Environment Protection Department and Hebei Coke Industry Association, and comments were subsequently provided.

China Iron & Steel Association

In recognition that this project will promote energy efficiency and CO_2 emission reduction in Hebei Province, China Iron & Steel Association gave a comment that they would positively promote implementation of this Project.

For reference, there are roughly 30 CDM projects for iron & steel sector in China, some of which have already registered by the CDM Executive Board.

Hebei Province Environment Protection Department, Hebei Coke Industry Association

COG can be used for energy purpose such as methyl alcohol (for gasoline additives, coatings, etc.), city gas, power generation and heating, as actually used. In this project, before used for such energy purposes, COG is utilized as reducing agent for direct reduction steelmaking approach. This can be done because calorific value of COG remains intact before/after the process, which means this project allows operators to utilize surplus COG two times in different ways. In this regard, Hebei Province Environmental Protection Department and Hebei Coke Industry Association gave a positive comment that this project was reasonable in terms of utilizing surplus COG two times, as reducing agent and energy source, so that they would give supports for implementation.

(7) Project implementation system

The system to implement this project is as shown below.

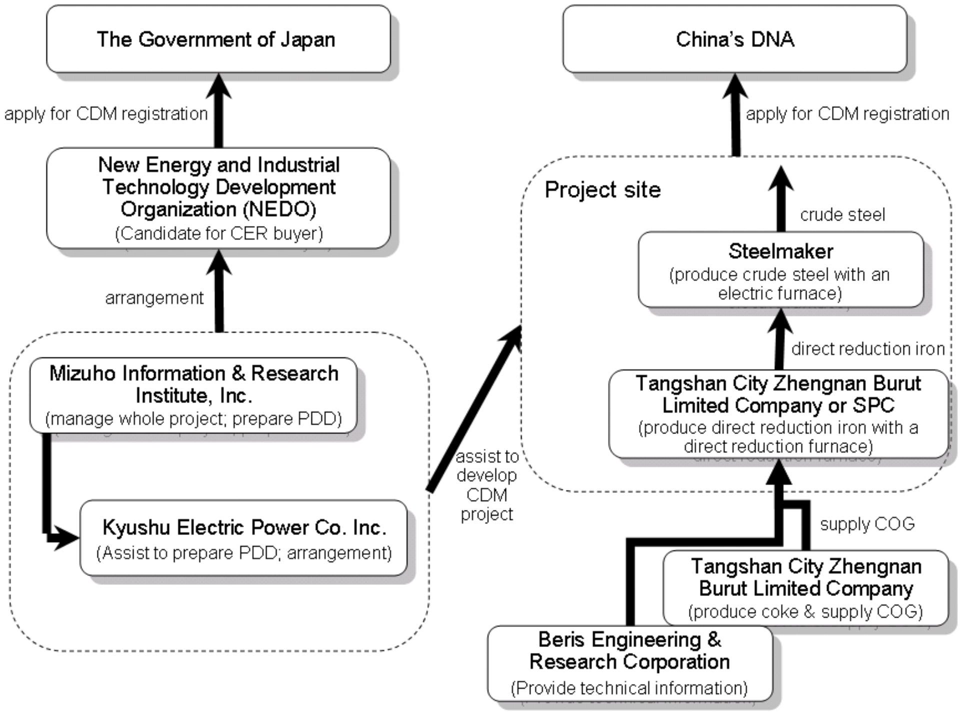


Figure 3　Project implementation system

(8) Investment plan

This FS identifies that investment of this project has not been determined in details. It should be noted that details of investment plan often remain undetermined in China's business practice until just before a project starts or a feasibility study report is completed at the earliest.

Besides, Beris Engineering & Research Corporation, the project operator, estimates the cost of this project at approx. 36 million Yuan in total based on an assumption under the current situation, which is likely to be covered with their own funds.

(9) Investment analysis

Financial analysis shows that it will take more than 8 years for recovery of initial investment, despite showing a slight surplus as a project. In general, the local iron & steel company has their threshold for investment decision-making as "investment recovery within 6 years" or "IRR = 20%," which means that this project would be determined as "low profitability" under the current situation. When taking into consideration benefit from credit, profitability of this project improves, making conditions more preferable for investment decision-making. It is not likely that credit price would give effects on investment decision-making, even in the case of plunging credit prices.

Table 6　Project profitability (with no benefit of credit)

Initial investment	35.84 mil. yuan
Production	654 mil. yuan/year
Sales	659 mil. yuan /year
Profit (before tax)	4.52 mil. yuan /year

Profit (after tax)	4.16 mil. yuan /year
Investment recovery period	8.6 years
IRR	10.2 %

Table 7 Comparison of project profitability (with/without credit)

	Without profit from credit	With profit from credit
Investment recovery period	8.6 years	2.9 years
IRR	10.2%	33.5%

Table 8 Comparison of IRR (with credit)

Credit price	5	7	9	11	13
IRR	22.8%	28.2%	33.5%	38.8%	44.1%

(10) Demonstration of additionality

This section describes reasoning and basis to demonstrate additionality by using an additionality tool. The additionality tool used is the "Tool for the demonstration and assessment of additionality (version 05.2)", developed by CDM Executive Board (EB).

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

The most realistic and plausible alternative option for the project activity was identified in accordance with the following "sub-steps".

Sub-step 1a: Define alternatives to the project activity:

Define the most realistic and plausible alternative which is acceptable to project participants that provide goods and services or project developers, as an option comparable to the proposed CDM project activity. As already mentioned, acceptable alternatives are the following options:

- Project activity proposed in a situation not being registered as a CDM project activity; or
- BF-C steelmaking with using coke (CSTL-A), while using COG as energy (COG-C).

As already mentioned, COG use as energy (COG-C) is not included in the project boundary so that project activity and its alternative give no effect on the ways of COG utilization/treatment, which is therefore not included in investment analysis. Investment analysis here is conducted concerning sponge iron production which is the core of this project activity (Step 2).

Sub-step 1b: Consistency with mandatory laws and regulations:

In Hebei Province, general coke production and steelmaking processes are required to satisfy all relevant laws and regulations. These alternatives are in full compliance with such laws and regulations and therefore cannot be an exemption as the baseline scenario.

Step 2: Investment analysis

Sub-step 2a: Determine appropriate analysis method

The CDM project activity and the alternative identified in "Step 1" generate economic benefit other than the CDM-related revenue. Therefore, "the simple cost analysis (Option I)" cannot be applied to it.

Instead, the benchmark analysis (Option III) is applied to this case.

Sub-step 2b: Option III. Apply benchmark analysis

Upon application of the benchmark analysis (Option III), IRR regarding construction and operation of a direct reduction furnace is selected as the financial/economic indicator, with which project operators make investment decision-making. For IRR benchmark, an industrial indicator for construction decision-making ("Methods and Data about Economic Assessment of Construction Projects") is used.

For this case, the following benchmarks are referred.

Table 9 Benchmark for investment decision-making in China's iron & steel industry

Investment recovery period	within 6 years
IRR	20% and above

Sub-step 2c: Calculation and comparison of financial indicators (only applicable to Options II and III):

As already mentioned, project profitability exceeds the two benchmarks (investment recovery period and IRR) when the project has profit from selling credit, allowing initial investment.

Table 10 Comparison of project profitability (with/without credit)

	Without profit from credit	With profit from credit
Investment recovery period	8.6 years	2.9 years
IRR	10.2%	33.5%

Sub-step 2d: Sensitivity analysis (only applicable to Options II and III):

Considering that pellet purchase cost accounts for a large proportion of production cost, sensitivity analysis was conducted on current pellet price (1,720 Yuan/t) and its variations.

As result, when price increases merely 1%, profitability is decreased to as low as benchmark level, indicating that profitability of this project largely depends on pellet price. However, such price-change risk can be alleviated considerably by making a long-term purchase contract for pellet before the project starts.

Table 11 Comparison of IRR (with credit)

Pellet price (Yuan/t)	1,703 (-1% from present)	1,720	1,737 (+1% from present)
IRR	44.8%	33.5%	20.8%

Step 4: Common practice analysis

Sub-step 4a: Analyze other activities similar to the proposed project activity:

In the past or on-going cases, no activity similar to the proposing project activity has been conducted. As described in Sub-step 1a, baseline scenario is consisted with BF-C steelmaking using coke with COG utilization for energy purpose, which is the common practice in China.

In addition, regarding sponge iron production technology employed in this project, the following barriers exist:

(1) technological barrier due to not having an example of commercial operation

(2) cost barrier for initial investment and operation

In this regard, this project is enough worth to be implemented as CDM.

Sub-step 4b: Discuss any similar Options that are occurring:

No similar project has been implemented.

(11) Prospects and issues for project implementation

This project is less attractive for investors if not registered as a CDM project, as described in "Investment assessment" section. On the other hand, this project can be quite attractive if taking into account the potential benefit from selling CER, since a sizeable GHG reduction is expected in this project. Therefore, whether to be registered as a CDM project is the key factor of this project.

Issues for implementation of this project can be categorized based on the two perspectives: CDM registration and project implementation. The issues are development of a new methodology and demonstration of the technology employed for this project for the former while impacts of economic crisis, construction of a new facility (DRF) and difficulties in coordination among project participants for the latter. The following paragraphs provide descriptions focusing on these five issues.

Development of a new methodology

For implementation of this project, a new methodology needs to be developed, since there is no approved methodology applicable to this project. Thus, discussions were conducted to develop a new methodology, including about notion of project boundary and baseline.

However, it is unpredictable if this new methodology would be approved by the CDM Executive Board (EB) as it is: it is possible that EB would request applicants to modify the methodology to a more precise and conservative direction over the notion of baseline and methods of parameter setting. Major concerns are as follows:

- Project boundary and baseline scenario: there are some other choices in setting baseline instead of integrated BF-C steelmaking, such as direct reduction method using natural gas (Scenario 4 in Table

1).

- Parameters and monitoring items: as a premise, general values are used for each parameter in baseline, because monitoring is implemented at facilities which are not directly related with project operators. If seeking precision, an ex-post assessment may be requested.
- Investment assessment: Prices of raw materials and energies show rapid changes reflecting recent economic conditions: China is no exception. Therefore, at validation or registration stages, it may be requested to re-calculate the values by using the latest data.

Another issue is how long it would take for registration procedures in the EB, which often delays. It is necessary to set a timeframe for this project, including project commencement date, based on a rather conservative assumption taking the delay into consideration.

Demonstration of the technology employed for this project

Direct reduction steelmaking using natural gas is in commercial operation in several countries in the world. However, there is no such commercial example for steelmaking using COG.

According to Beris Engineering & Research Corporation, a counterpart in this project as well as the developer of this technology, there will be no issues in terms of validity of the technology, since the company has filed a patent application for this technology. However, a question remains that whether the patent filing would be enough to demonstrate validity of this technology as evidence if required at validation and registration stages.

Impacts of economic crisis

Impacts of the recent economic crisis come to the surface in China's iron & steel industry. Possibility is raised that changes in supply/demand of iron & steel may affect materials for this project such as coke in its supply-demand balance and price in coming months.

Prices of pellet and coke would be affected by the crisis for the time being. As described above, changes in pellet price have a significant impact on investment assessment of this project.

In addition, the fact identified in the interviews with local companies for this FS was that not a few coke operators in the area went out of business or suspended operation due to the recent plunge of coke price. The coke producer which will provide COG to this project keeps operation and plans to expand production volume owing to its clients that include a major steel producer. However, it is still possible that the operator might be forced to suspend its operation if coke price drops further in future, which means the project will be in need of an alternative coke producer. In this regard, attention must be paid to monitor the development of iron & steel market both in China and worldwide, along with the pellet price trend.

Construction of a new facility (direct reduction furnace)

This project includes construction of a new direct reduction furnace. Therefore, delays from the original schedule may occur for site acquisition and construction: attention should be paid for scheduling, such as project commencement date and crediting period.

Coordination among project participants

Various business operators are directly/indirectly involved with this project. Discussions are underway between the Chinese stakeholders regarding what type of business entity would be suitable for sponge iron production in this project, which may change the project implementation system as the result.

- Technology provider: Beris Engineering & Research Corporation
- COG supplier: Tangshan City Zhengnan Burut Limited Company
- Sponge iron producer (with direct reduction furnace): under discussion between Tangshan City Zhengnan Burut Limited Company and Beris Engineering & Research Corporation, regarding how both parties would be involved in the production.
- Crude steel producer (with electric furnace): electric furnace operator(s)

4. (Pre-)Validation (only if implemented)

(1) Outline of (pre-)validation

Not implemented.

(2) Communications with DOE

Not implemented.

5. Realization of co-benefit in host country

(1) Assessment of pollution prevention effect in host country

Positive effect of pollution prevention by implementing this project is to reduce COG emission that should have been generated from coke production (which is not related to the COG used in the project scenario). This will lead to an elimination of air pollutant released through COG emission. With such effects, this program is characterized as a pollution prevention measure.

Table 12 Pollution prevention effect from this project

Scenario	Reduction process	(not included in project boundary) COG
Baseline case	● Coke is produced for and used as reducing agent. ● COG generation from coke production.	● Used for energy purpose
Project case	● COG generated from coke production process is utilized for reducing agent ● No additional COG generation	● Used for reducing agent first and then for energy purpose.
Pollution prevention effect	● Effects can be expected from eliminating COG emission which should have been generated from coke production, in relevant volume to the production size of this project.	● NA

For this assessment, outlet concentration standard can be considered the upper limit of environmental impact. In addition to air pollutants, the same assessment is conducted to CO2.

Table 13 Pollution prevention effect from this project

	Concentration limit (mg/m^3)	Annual gas emission (m^3/year)	Maximum annual emission of environmental burden (t/yr)
SO_2	850	860 m^3/t-sponge iron x 170,000 t-sponge iron/year = 1.46 x 10^8 m^3/year	124
NO2	0.08/0.06 x 850 = 1,130, assuming the same attenuation with SO2		165
Fume, dust	200		29.2
CO2	—		111,114

(2) Suggestion for co-benefit index (if any results are available)

Mitigation of environmental burden is a pollution prevention effect by itself. In addition, by doing so, external environmental cost can be reduced, which can be a co-benefit index.

In this section, mitigation of damage is estimated in monetary value to express willingness-to-pay (WTP) for avoiding environmental burden, by using the Life-cycle Impact assessment Method based on Endpoint modeling (LIME: publicized in cooperation of Japan’s Advanced Industrial Science and Technology (AIST) and the national LCA project).

As a co-benefit index of this project, external environmental costs from reducing air pollutants (SO2, NO2) are evaluated at 133,000 yen/yr for SO2, 30,000 yen/yr for NO2, and 180,000 yen/yr for CO2 . Although the estimate results are somewhat small in absolute amounts, it should keep in mind that the values reflect WTP in Japan. Positive effects of this project to mitigate air pollution in China should be more highly evaluated.

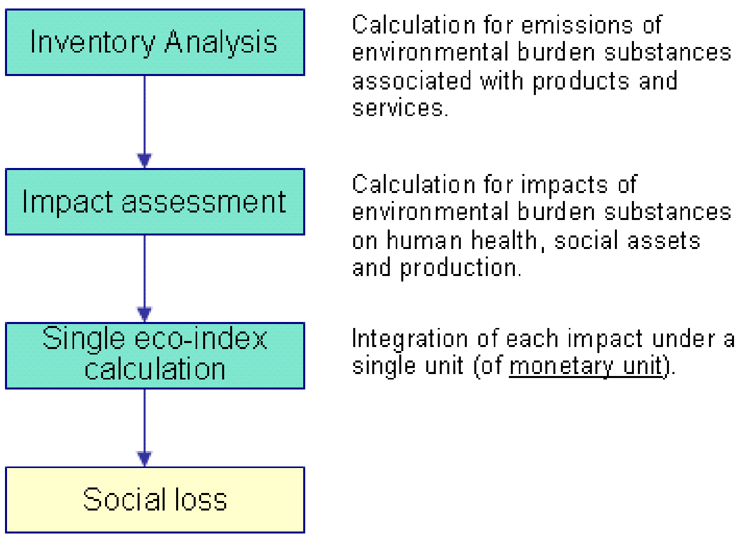


Figure 4 Assessment flow in LIME

Table 14 Mitigation of environmental external cost by this project

	Maximum emission of environmental burden (t/yr)	Conversion factor (Yen/t)	External environmental cost (10,000 yen/yr)
SO2	124	1,070	13.3
NO2	165	181	3.0
CO2	111,114	1.62	18.0

Source:

- Site-visit reports