Ministry of Economy, Trade and Industry, Japan

Feasibility study of JCM project for energy saving technologies for iron and steel industry in India

Abstract

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Deloitte Tohmatsu Consulting LLC

JP Steel Plantech Co.
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1 Overview of F/S
1.1 Objective of the study

Under the recent situation where actions to mitigate global warming are globally being conducted, the government of Japan has been working toward establishment and implementation of a scheme of Joint Crediting Mechanism (JCM), in order not only to quantitatively evaluate Japan’s contribution to reductions and absorptions of Greenhouse Gas (GHG) emission but also to utilize JCM for achievement of Japan’s reduction goal through spread and implementation of technologies, products, systems, services, and infrastructures for GHG emission reductions to developing countries. In COP21, which was held in 2015, all the participants built consensus on the adoption of the Paris agreement, which is accelerating worldwide actions for climate change.

On the other hand, the government of India, which is a targeted country of this feasibility study (F/S), has actively taken actions to mitigate global warming, and has set a challenging goal that the CO2 emissions intensity of its GDP by 33 to 35 % by 2030 from 2005 level in Intended Nationally Determined Contribution (INDC), which was announced in October 2015. It is assumed that more active political actions for CO2 emission reductions will need to be implemented.

The government of India has not yet signed a bilateral agreement for JCM with the government of Japan, but considering the momentum described above, further progress of negotiation is expected in the future. Moreover, it is also possible that energy consumption of iron and steel industry would be increasing in the long term in India, and promotion of actions for energy saving to the industry is an urgent issue. In these situation, actions for CO2 emission reductions in iron and steel industry would play a major role for India to achieve their overall target.

Goals of this F/S are clarifying values of JCM and remarkable low-carbon technologies and products, trying to promote spread of low-carbon technologies and products in India, and contributing to increasing the number of signatory countries to bilateral agreements for JCM, by making new policy recommendations to India, and by proposing business schemes which work closely with the policy recommendations for spread of low-carbon technologies and products.
1.2 Overview of the study

The focus has been given to iron and steel industry in this F/S, where it is said that energy saving potential is particularly high. Detailed contents of this F/S are shown below:

Table 1: Overview of this F/S

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Feasibility study of JCM project for energy saving technologies for iron and steel industry in India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>India</td>
</tr>
<tr>
<td>Field</td>
<td>Energy Saving Technology for Iron and Steel Industry</td>
</tr>
<tr>
<td>Project member</td>
<td>· Deloitte Tohmatsu Consulting LLC (DTC)</td>
</tr>
<tr>
<td></td>
<td>· JP Steel Plantech Co. (SPCO)</td>
</tr>
<tr>
<td>Project period</td>
<td>This F/S was conducted from October 2015 to March 2016.</td>
</tr>
<tr>
<td>Contents of the F/S</td>
<td></td>
</tr>
<tr>
<td>a. Recommendation of policy related to JCM to partner country</td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Collection of information about policy, trend, institutions, regulation scheme and business environment, and clarifying issues based on the collected information</td>
</tr>
<tr>
<td></td>
<td>· Generation of hypothesis about schemes and recommendation contents which promote introduction of technologies to be targeted in this F/S</td>
</tr>
<tr>
<td></td>
<td>· Explanation about this project to public sector and related organizations in India, implementation of hearing survey and dialogue about the hypothesis with them, and putting policy recommendation contents together based on the hearing survey and the dialogue</td>
</tr>
<tr>
<td>b. Consideration of practical business plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Selection of targeted steel plants</td>
</tr>
<tr>
<td></td>
<td>· Preliminary collection of information and data</td>
</tr>
<tr>
<td></td>
<td>· Implementation of field study and diagnosis of respective facilities in the targeted steel plants</td>
</tr>
<tr>
<td></td>
<td>· Selection of targeted technologies</td>
</tr>
<tr>
<td></td>
<td>· Calculation of effects with an introduction of the technologies, and development of introduction plan of the technologies</td>
</tr>
</tbody>
</table>
### c. Consideration of CO2 emission reductions methodologies, and calculation of estimated CO2 emission reductions

- Investigation of document for methodologies, and definition of methodology development policy
- Compilation of the methodologies
- Calculation of estimated CO2 emission reductions with the introduction of the targeted technologies

### d. Analysis of economic effect and impacts to the partner country

- Calculation of economic effect, based on calculation result of energy saving effect
- Organization of costs with the introduction of the technologies and competent authorities
- Implementation of sensitivity analysis
- Discussion with the targeted steel plants, based on the evaluation result of payback

### e. Organization of issues and success factors for JCM project

- Organization of issues and success factors for JCM which were recognized in the past projects, and discussion on site
- Evaluation of ripple effects with introduction of the technologies

### f. Implementation of actions for promoting understanding about JCM and strengthening relationships

- Taking actions necessary to promote understanding about JCM and to strengthen relationships

<table>
<thead>
<tr>
<th>Technology</th>
<th>F/S was conducted for two candidate technologies as below:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>· Coke Dry Quenching (CDQ)</td>
</tr>
<tr>
<td></td>
<td>· Top Pressure Recovery Turbine (TRT)</td>
</tr>
</tbody>
</table>
2 Overview results of the study

2.1 Selection of targeted steel plants

The following two steel plants were selected as the targeted steel plants in this F/S, based on three selection requirements below.

<Selection requirements>

- Steel plant which is managed by the government of India
- Steel plant which has Blast Furnace (BF) and Oxygen Converter
- Steel plant whose issues for introduction of energy saving technologies are clarified

<Targeted steel plants>

- Steel Authority of India Limited (SAIL), Bhilai Steel Plant
- Rashtriya Ispat Nigam Limited (RINL), Visakhapatnam Steel Plant

Figure 1: Steel plant’s location in India
2.2 Selection of candidate technologies

2.2.1 Before 1st F/S on site

On starting the F/S, the following four technologies were selected as candidate technologies which are appropriate to be introduced to the targeted BF integrated steel plants in India, based on three selection requirements below.

<Selection requirements>

- Technologies for facilities whose energy saving effects are high within iron-making process
  - As a result, energy saving technologies for Sintering, Coking, BF, and Converter were selected.

- Technologies whose introduction effects are higher than those written in authorized reference materials, such as Technology Customized List (TCL) ver. 2.0 for India

- Technologies which the targeted steel plants possibly have great need to introduce

<Candidate technologies before 1st F/S on site>

- Sinter Plant Heat Recovery
- Coke Dry Quenching (CDQ)
- Top Pressure Recovery Turbine (TRT)
- Converter Gas Recovery Device

2.2.2 After discussion on 1st F/S on site

Based on discussion of possible energy saving technologies to be introduced with the targeted steel plants, the following two technologies were selected as candidate technologies.

- Coke Dry Quenching (CDQ)
- Top Pressure Recovery Turbine (TRT)
2.3 Coke Dry Quenching (CDQ)

2.3.1 Overview of technology

CDQ is a system which cools red-hot cokes (approximately 1000°C) discharged from the coke oven with gas circulating in an enclosed system to less than 200°C. Thermal energy which is absorbed by the circulating gas at the moment is recovered as steam in boiler. Electricity could be generated by utilizing the steam. In addition, the amount of thermal energy recovered in boiler is increased more, by burning combustible gases (such as methane and hydrogen) which red-hot cokes take into the enclosed system. Furthermore, reducing the amount of dust which flies into boiler prevents facilities in the subsequent process such as brick structure, boiler, duct, Multi-cyclone, and circulation fan from attrition, which makes it possible to utilize these facilities much longer, because cokes dust particles accompanied with gas which flows from CDQ are partly burned in dust catcher.

CDQ made in former Soviet Union has serious issues. First, risks from a viewpoint of safety have to be reduced. It adopted γ ray type coke level meter, which could considered as a safety issue. Second, the amount of combustible gas and dust relieved into the air have to be reduced from environment point of view. Combustible gas element and dust are included in surplus gas, and the gas is relieved into the air after combustion instead of being recovered. The large amount of dust, almost equal to that of coke wet quenching, is relieved into the air. Third, regular maintenance costs have to be reduced by controlling facilities’ abrasion, which is caused by dust flying from CDQ main unit to downstream. Features of main functions of CDQ which is proposed to be retrofit are as follows. That is, after CDQ is retrofit, air injection is introduced instead of air suction, which would lead to complete burning of combustible gas. In addition, pressure balance of blower is changed, which would accomplish steady operation. Because of CDQ’s retrofit, energy saving effect is assumed 42,660 MWh/y electricity generation for Visakhapatnam Steel Plant. Other measures and effects with retrofit of CDQ are as follows. Measures for first issue are replacing γ ray type coke level meter with μ type coke level meter, and installing online gas analyzer which makes it possible to continuously analyze and monitor gas element in circulating gas. Effects with the measures are that a device which might cause safety hazard could be replaced, that continuous monitoring of cokes charging level would make charging time on operation predictable, and that explosion in oven could be avoided and the amount of recovered heat could be dramatically increased by constantly controlling the amount of combustible gas and the air in coke oven. Measures for second issue are
domestic reduction of the amount of dust relieved into the air by removing flare stack which combusts and relieves surplus gas and instead installing bag filter. An effect with the measures is that the amount of dust which is relieved into the air is reduced, which could relieve environmental liability. The comparison results of the amount of relieved dust in Visakhapatnam Steel Plant are that 18.2 kg/h reduced to 0.03 kg/h after retrofit, that 0.1625 kg/t-coke reduced to 0.3 g/t-coke after retrofit, and that 162 t/y reduced to 3.2 t/y after retrofit. Measures for third issue are that the amount of coke dust which is accompanied with gas flowing out is reduced by reducing the amount of gas flowing out from oven and that intermittent and vast amount of air suction are avoided by appropriately setting a pressure of an oven gate. Effect with the measures is that the abrasions of boiler, cyclone, and gas duct are relieved by reducing the amount of dust which is accompanied with gas flowing out, and it is estimated that maintenance costs would decrease to one eighth for Visakhapatnam Steel Plant.

Figure 2: Retrofit items for existing CDQ
2.3.2 RINL, Visakhapatnam Steel Plant

(1) Effects of technology introduction

Annual energy saving effect, annual economic effect, and annual CO2 emission reductions effect were also calculated as follows.

Annual energy saving effect = (Electricity generation with CDQ retrofit - Electricity generation with the existing CDQ) * Annual operation (hours * days * operating rate) * the number of CDQ to be introduced

⇒ (8,467 kWh - 6,032 kWh) * (24 hours * 365 days * 100 %) * 2 = 42,660 MWh/y

Annual economic effect = Annual energy saving effect * Electricity price on site * Exchange rate

⇒ 42,660,000 kWh * 5 Rs/kWh * 1.8 JPY/Rs = 383,940,000 JPY/y

Annual CO2 emission reductions effect = Annual energy saving effect * CO2 emission factor

⇒ 42,660 MWh * 0.9 t·CO2/MWh = 38,394 t·CO2/y

(2) Proposed introduction plan and profitability

Project’s duration to retrofit CDQ would be 18 months. Total initial cost to retrofit CDQ is assumed 650,000,000 JPY, based on estimation by the manufacturer.

Simple payback period of the initial cost was calculated as follows.

Simple payback period = Total initial cost / Annual economic effect

⇒ 650,000,000 JPY / 383,940,000 JPY/y = 1.7 years (approx.)
2.3.3 SAIL, Bhilai Steel Plant

(1) Effects of technology introduction

Annual energy saving effect, annual economic effect, and annual CO2 emission reductions effect were also calculated as follows.

Annual energy saving effect = (Electricity generation with CDQ retrofit - Electricity generation with the existing CDQ) * Annual operation (hours * days * operating rate) * the number of CDQ to be introduced

⇒ (9,266 kWh - 6,610 kWh) * (24 hours * 365 days * 100 %) * 2 = 46,530 MWh/y

Annual economic effect = Annual energy saving effect * Electricity price on site * Exchange rate

⇒ 46,530,000 kWh * 6.592 Rs/kWh * 1.8 JPY/Rs = 552,100,000 JPY/y (approx.)

Annual CO2 emission reductions effect = Annual energy saving effect * CO2 emission factor

⇒ 46,530 MWh * 0.9 t-CO2/MWh = 41,877 t-CO2/y

(2) Proposed introduction plan and profitability

Project’s duration to retrofit CDQ would be 18 months. Total initial cost to retrofit CDQ is assumed 650,000,000 JPY, based on estimation by the manufacturer.

Simple payback period of the initial cost was calculated as follows.

Simple payback period = Total initial cost / Annual economic effect

⇒ 650,000,000 JPY / 552,100,000 JPY/y = 1.2 years (approx.)
2.4 Top Pressure Recovery Turbine (TRT)

2.4.1 Overview of the technology

TRT is a facility which generates electricity by driving turbine with BF gas. After getting through TRT, BF gas is utilized as fuel in steel plant. In fact, installation of TRT to steel plant in India has been recognized difficult in terms of payback so far.

In this F/S, Package Type TRT, which is a Japanese technology, was recommended. Features of Package Type TRT are as follows. First, it is TRT which Japanese company has uniquely developed for small and medium BF. Second, it contains equipment in container. Costs of foundation work are greatly reduced by containing turbine and power generator in container. Third, Removal and diversion become easy when BF is stopped.

![Package Type TRT](image)

Figure 3: Package Type TRT
2.4.2 RINL, Visakhapatnam Steel Plant

(1) Effects of technology introduction

Annual energy saving effect, annual economic effect, and annual CO2 emission reductions effect were also calculated as follows.

Annual energy saving effect = Electricity generation with new TRT installation * Annual operation (hours * days * operating rate) * the number of TRT to be introduced

⇒ 12.4MWh * (24 hours * 365 days * 95%) * 3 = 309,600 MWh/y

Annual economic effect = Annual energy saving effect * Electricity price on site * Exchange rate

⇒ 309,600,000 kWh * 5 Rs/kWh * 1.8 JPY/Rs = 2,786,400,000 JPY/y

Annual CO2 emission reductions effect = Annual energy saving effect * CO2 emission factor

⇒ 309,600 MWh * 0.9 t-CO2/MWh = 278,640 t-CO2/y

(2) Proposed introduction plan and profitability

Project’s duration to newly install TRT would be 24 months. Total initial cost to newly install TRT is assumed 1,229,500,000 JPY, based on estimation by the manufacturer.

Simple payback period of the initial cost was calculated as follows.

Simple payback period = Total initial cost / Annual economic effect

⇒ 1,229,500,000 JPY / 928,800,000 JPY/y (for 1 TRT) = 1.3 years (approx.)
2.4.3 SAIL, Bhilai Steel Plant

(1) Effects of technology introduction

Annual energy saving effect, annual economic effect, and annual CO2 emission reductions effect were also calculated as follows.

Annual energy saving effect = Electricity generation with new TRT installation * Annual operation (hours * days * operating rate) * the number of TRT to be introduced

⇒ 2.7MWh * (24 hours * 365 days * 95%) * 1 = 22,470 MWh/y

Annual economic effect = Annual energy saving effect * Electricity price on site * Exchange rate

⇒ 22,470,000 kWh * 6.592 Rs/kWh * 1.8 JPY/Rs = 266,000,000 JPY/y (approx.)

Annual CO2 emission reductions effect = Annual energy saving effect * CO2 emission factor

⇒ 22,470 MWh * 0.9 t-CO2/MWh = 20,223 t-CO2/y

(2) Proposed introduction plan and profitability

Project’s duration to newly install TRT would be 24 months. Total initial cost to newly install TRT is assumed 1,229,500,000 JPY, based on estimation by the manufacturer.

Simple payback period of the initial cost was calculated as follows.

Simple payback period = Total initial cost / Annual economic effect

⇒ 1,229,500,000 JPY / 266,600,000 JPY/y (for 1 TRT) = 4.6 years (approx.)
2.5 MRV methodology for TRT

As for CDQ, MRV (Measurement, Reporting, and Verification) methodology of it is not developed, because the proposal is retrofitting CDQ and it is difficult to figure out current status and obtain accurate information in a short time.

2.5.1 Top Pressure Recovery Turbine (TRT)

(1) Title of the methodology

「Installation of Top Pressure Recovery Turbine (TRT) on Blast Furnace (BF)」

(2) Terms and definitions

<table>
<thead>
<tr>
<th>Terms</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Pressure Recovery Turbine: TRT</td>
<td>TRT is a facility which recovers gas emission from BF and generates electricity by utilizing the gas pressure. Expansion turbine is installed on the way where BF gas emission in the process of manufacturing pig iron in BF is guided to gas holder. The expansion turbine reduces the gas pressure and electricity is generated by turning turbine generator with the gas pressure energy.</td>
</tr>
<tr>
<td>Top pressure</td>
<td>Pressure of gas emission from the top of BF where steel is produced by reducing iron ore is from 3 to 4. Generally, the pressure is relieved into the air.</td>
</tr>
</tbody>
</table>

(3) Summary of the methodology

<table>
<thead>
<tr>
<th>Items</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure of GHG emission reduction</td>
<td>By improving BF's capacity to recover waste energy, the amount of reused energy is increased, which leads to GHG emissions reductions.</td>
</tr>
<tr>
<td>Calculation of reference emissions</td>
<td>Reference emissions are calculated based on the estimated electricity consumption of current BF without proposed project.</td>
</tr>
<tr>
<td>Calculation of project emissions</td>
<td>Project emissions are calculated based on the electricity consumption of improved BF with the proposed project.</td>
</tr>
<tr>
<td>Monitoring parameters</td>
<td>• Electricity consumption which is accompanied with smelting scrap (Project) [MWh]</td>
</tr>
<tr>
<td></td>
<td>• Crude steel production [t]</td>
</tr>
</tbody>
</table>
(4) **Eligibility Criteria**

This methodology is applicable to projects which satisfy all of the following criteria.

On developing this MRV methodology, the case where TRT is newly installed on BF is assumed.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criterion 1</td>
<td>TRT serves not only spread of low carbon technologies which contribute to net emission reduction, but also promotion of appropriate mitigation of host country.</td>
</tr>
<tr>
<td>Criterion 2</td>
<td>Especially for iron and steel industry in host country, TRT is recognized as highly prioritized technology to be introduced and spread because of great need for TRT.</td>
</tr>
<tr>
<td>Criterion 3</td>
<td>Improvement with the proposed project can be quantified.</td>
</tr>
<tr>
<td>Criterion 4</td>
<td>Facility which is targeted in this project is BF.</td>
</tr>
<tr>
<td>Criterion 5</td>
<td>Either retrofitting of the existing TRT or new installation of TRT is conducted.</td>
</tr>
</tbody>
</table>

(5) **Emission Source and GHG types**

<table>
<thead>
<tr>
<th>Items</th>
<th>Emission sources</th>
<th>GHG types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference emissions</td>
<td>Consumption of grid electricity which is accompanied with iron-making in BF</td>
<td>CO2</td>
</tr>
<tr>
<td>Project emissions</td>
<td>Consumption of grid electricity which is accompanied with iron-making in BF</td>
<td>CO2</td>
</tr>
</tbody>
</table>

(6) **Reference emissions**

a. **Establishment of reference scenario**

Establish reference scenario when the existing BF is not improved and continuously operated.

b. **Calculation of reference emissions**

\[ RE_y = \frac{E_{GRIDy}}{CS_y} \times CS_y \times EF_y \ldots \ (1) \]
Where,

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description of data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>REy</td>
<td>Reference CO2 emissions in the y th year [tCO2]</td>
<td></td>
</tr>
<tr>
<td>EGRIDy</td>
<td>Electricity purchase (consumption) in the y th year [MWh / t]</td>
<td></td>
</tr>
<tr>
<td>CSy</td>
<td>Steel plant’s operation index (basic unit per ton)</td>
<td></td>
</tr>
<tr>
<td>EFy</td>
<td>CO2 emission factor of grid electricity [tCO2 / MWh]</td>
<td></td>
</tr>
</tbody>
</table>

(7) Calculation of project emissions

\[ PE_y = \left( \frac{EGRID_y}{CS_y} \times CS_y - EreTRT_y \right) \times EF_y \]  

Where,

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description of data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEy</td>
<td>Project CO2 emissions in the y th year [tCO2]</td>
<td></td>
</tr>
<tr>
<td>EreTRT_y</td>
<td>Electricity generation from TRT operation in the y th year [MWh]</td>
<td></td>
</tr>
</tbody>
</table>

(If needed, necessary electricity of TRT is subtracted.)

(8) Calculation of emission reductions

Emission reductions are calculated as the difference between the reference emissions and project emissions, as follows:

\[ ER_y = RE_y - PE_y \]  

Where,

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description of data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERy</td>
<td>CO2 emission reductions in the y th year [tCO2]</td>
<td></td>
</tr>
</tbody>
</table>

(9) Data and parameters which reference fixed value

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description of data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGRIDy</td>
<td>Grid electricity consumption in the y th year [kWh / t]</td>
<td>Actual value</td>
</tr>
<tr>
<td>EreTRT_y</td>
<td>Electricity generation from TRT in the y th year [kWh/t]</td>
<td>Actual value</td>
</tr>
<tr>
<td>EFy</td>
<td>CO2 emission factor of grid electricity in the y th year [tCO2 / kWh]</td>
<td>Either actual value, or published value from electricity generation institution or the government of the country</td>
</tr>
</tbody>
</table>
2.6 Estimation of CO2 emission reductions using MRV methodology

Using MRV methodology described above, CO2 emission reductions were calculated at time of onsite F/S in November 2015 for TRT installation to Visakhapatnam Steel Plant, where the introduction of TRT is effective and feasible at this time.

<Reference emissions>

- Annual electricity purchase
  \[ \text{EGRID}_y = 50 \, \text{MW (annual electricity purchase (ave.))} \times 365 \, \text{days} \times 24 \, \text{h} \]
  \[ = 438,000 \, \text{MWh/t} \]

- CO2 emission factor of grid electricity
  \[ \text{EF}_y = 0.9 \, \text{tCO2/MWh} \]

Thus, reference emissions are as follows.

- Reference emissions
  \[ \text{RE}_y = \frac{\text{EGRID}_y}{\text{CS}_y} \times \text{CS}_y \times 0.9 \, \text{tCO2/MWh} \]
  \[ = 394,200 \, \text{t/y} \]

<Project emissions>

- Electricity generation from TRT operation
  \[ \text{EreTRT}_y = 12.4 \, \text{MW} \times 3 \, \text{(for 3 TRT)} \times 365 \, \text{days} \times 24 \, \text{h} \times 0.95 \, \text{(facility operating rate)} \]
  \[ = 309,600 \, \text{MWh} \]

- CO2 emission factor of grid electricity
  \[ \text{EF}_y = 0.9 \, \text{tCO2/MWh} \]

Thus, project emissions are as follows.

- Project emissions
  \[ \text{PE}_y = \left( \frac{\text{EGRID}_y}{\text{CS}_y} \times \text{CS}_y \times \text{EreTRT}_y \right) \times \text{EF}_y \]
  \[ = \left( 438,000 \, \text{MWh/t} / \text{CS}_y \times \text{CS}_y - 309,600 \, \text{MWh} \right) \times 0.9 \, \text{tCO2/MWh} \]
\[=115,500 \text{ t/y}\]

<Estimation of CO2 emission reductions>

Based on the calculation above, estimation of CO2 emission reductions are as follows.

\[ER_y = RE_y - PE_y\]

\[=394,200 \text{ t/y} - 115,500 \text{ t/y}\]

\[=278,700 \text{ t/y}\]

2.7 Feasibility of technologies introduction

As follows are evaluation results of feasibility of two technologies (CDQ/TRT) which were selected as targeted technologies to be introduced in this F/S. Total grades for feasibility are described, based on evaluation results of energy saving, CO2 emission reductions, and difficulty for introduction (investment, installation environment, and needs).

![Figure 4: Results of F/S for technology introduction to 2 target plants](image-url)
2.7.1 RINL, Visakhapatnam Steel Plant

As for both CDQ and TRT, energy saving and CO2 emission reductions are expected to be high. In terms of payback, simple payback period of CDQ is 1.7 years, and that of TRT is 1.3 years, which means there is no particular problem because the simple payback periods are within the acceptable period. In addition, there is no problem about space for installation environment. However, when the result of this F/S was reported and opinions were exchanged with the participants in the plant, it was figured out that CDQ needed to be introduced but TRT was unfeasible to be introduced at that time.

Utilizing the accomplishment of this project as much as possible, the following actions are supposed to be conducted in the near future.

- Making sure of feedback for the results of CDQ introduction
  - Further discussion of the report result with the person in charge of CDQ is needed.
  - Once confirmation of the person in charge of CDQ is obtained, follow-up would be made as needed.

2.7.2 SAIL, Bhilai Steel Plant

As for CDQ, feasibility is high, because energy saving and CO2 emission reductions are expected to be high, simple payback period is short (1.2 years), and there is no particular problem about installation environment. At this time, the assumed issues do not become obvious yet, because the existing CDQ is relatively new. Therefore, situations would need to be continuously checked.

As for TRT, it is figured out that feasibility is low, because capacity for electricity generation is not high due to the existing facility, which means that high energy saving and CO2 emission reductions are not expected and simple payback period is not short (4.6 years).

Utilizing the accomplishment of this project as much as possible, the following actions are supposed to be conducted in the near future.

- Recalculation of energy saving effect and simple payback period for CDQ introduction
  - As for onsite F/S result, about energy saving and simple payback period for CDQ introduction calculated by utilizing information which was obtained in November 2015, it was requested that parts of foundation data needed to be replaced with more elaborate data. Under the request, utilized data has been sent and confirmation has been requested during this project. The data is now being checking by the plant.
Once reconfirmed data is obtained, each effect (energy saving effect, economic effect, and CO2 emission reductions effect) and simple payback period would be recalculated, and the information would be communicated to the plant.

- Confirmation of place where TRT is installed
  - On onsite F/S result, when analysis result of TRT introduction was reported, there was issue of space for installation in BF
  - At that time, TRT introduction effect was not high. Therefore, this action would be conducted when there is an opportunity

### 2.8 Issues for establishment of JCM

#### 2.8.1 Ripple effects of introducing the targeted technologies

Given the plan to increase iron and steel production in India for 2025 is realized, and if the targeted technologies are introduced across India, calculation results shows that CO2 emission reductions could be 1415.5 million ton.

1. **CDQ**

Given CDQ made in Japan is newly introduced to all the coke ovens which are newly constructed from now to 2025, estimation of CO2 emission reductions across India is calculated, comparing to the case that CDQ is not introduced. Given crude steel production increases to 300 million ton by 2025 and around 60% of the production are produced by BF, CO2 emission could be reduced by around 7.72 million ton, comparing to the case that CDQ is not introduced.

![Figure 5: Estimation of annual CO2 emission reductions with CDQ introduction (across India, 2025)](image-url)
(2) TRT

Given TRT made in Japan is newly introduced to all BF which are newly constructed from now to 2025, estimation of CO2 emission reductions across India is calculated, comparing to the case that TRT is not introduced. Given crude steel production increases to 300 million ton by 2025, around 60 % of the production are produced by BF, and production of crude steel is equal to that of pig iron, CO2 emission could be reduced by around 6.43 million ton, comparing to the case that TRT is not introduced.

Figure 6: Estimation of annual CO2 emission reductions with TRT introduction (across India, 2025)

2.8.2 Summary of the policy recommendation contents

Policy recommendation contents which are considered beneficial based on investigation for documents and discussion with public/private sector are as follows.

<table>
<thead>
<tr>
<th>Issues</th>
<th>Policy recommendation contents (Proposal)</th>
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<tbody>
<tr>
<td>Information access of JCM</td>
<td>· Awareness of JCM in India is not enough. Therefore, after India and Japan establish JCM, the government is expected to offer specific information of the system such as possible financial support by governments, the way of proposal, and necessary data for monitoring CO2 emission using MRV etc.</td>
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<tr>
<td>Issues</td>
<td>Policy recommendation contents (Proposal)</td>
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<td>Establishment of implementation scheme of project</td>
<td>· In order to promote increasing the number of JCM project, it is very important that robust business collaboration between Indian and Japanese public and private sectors is established. Therefore, both governments are expected to offer opportunities for the awareness which enables public sector and private sector to regularly interact.</td>
</tr>
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</table>
| Securement of project budget (public financial support) | · There may be no large-scale financial support program by the government of India for actions for energy saving and climate change now. Instead, it is expected to promote activities such as Perform, Achieve, and Trade (PAT) which go with market mechanism.  
· Under the situation where inflow of steel made in China which is cheaper than that of the previous year has become obvious, achievement of challenging target of CO2 emission reductions which is announced in INDC and second period goal which is set in PAT is impossible to realize only by corporate efforts. Therefore, public financial is expected in order to secure budget by utilizing institutions which are accompanied with visualized achievements based on not only supports of the government of Japan but also MRV monitoring verification, that is JCM, of the government of India in the future. |
| Establishment of sustainable business scheme and attractive financial plan | · It is possible that ESCO (Energy Service Company) business in India is not completely working well. However, as for small projects, risk taking support of the |


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<td>government of India to ESCO is implemented, and concepts of benefit and risk share need to be considered in detail in order to make ESCO business incentive fee type.</td>
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<td>· In addition, as for large projects of iron and steel industry, introduction of public support which relieves burden of company side needs to be considered from now on, in order to make it possible to consider collaboration with external related supporting organizations which leases facilities. For example, each tax (such as added-value tax, service tax) related to implementation of energy saving facility is partly exempted.</td>
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2.9 Step forward

First of all, the bilateral document would be expected to be signed in the near future between Indian and Japanese Government. Ultimate goal for JCM scheme is to increase the number of project formation as many as possible based on JCM scheme after establishment of JCM between Indian and Japanese government, to enhance utility and effect of JCM, and to realize JCM’s original goals: to promote spread of Japanese excellent low-carbon technologies and products in India and to reduce GHG emission on a worldwide scale.

From the Japanese private sector side also, it is greatly welcomed that based on issues and lessons learned which have become obvious when CDM scheme was introduced, utility convenience and value of JCM scheme are established and JCM scheme become beneficial method to sell energy saving technologies to developing countries. Therefore, it is thought important to continuously make the F/S results more detailed and sophisticated even after this project is closed.