MOEJ/GEC JCM Feasibility Study (FS) 2013
Final Report

「High-efficiency Rice Husk-based Cogeneration」

（implemented by EJ Business Partners Co., Ltd.）

Study partners		PEAR Carbon Offset Initiative Ltd Grameen Shakti
Project site		Bangladesh, Rajshahi Division
Category of project		Waste, Biomass
Description of project		This project aims to install cogeneration facility into rice mills in Bangladesh to replace low-efficient, rice husk fired steam boilers that are currently in use and improve resource saving by effective utilization of rice husks as a valuable biomass resource. In addition, rice husk ash can be produced and sold as silica products
JCM methodology	**Eligibility criteria**	1. To introduce rice husk cogeneration systems (with optional silica production systems) with higher energy efficiency than existing biomass (rice husk) boilers without cogeneration used in rice mills. 2. Steam generated by the project is used for parboiling and other purposes in the target rice mill. The electricity generated by the project, is used for the rice mill's electricity demand and remained portion is sold to grid or other facilities in the vicinity of the rice mill. 3. Rice husks are sourced from the rice mill and other rice mills. The biomass cogeneration plant is designed based on the available amount of rice husks to be provided by the rice mill and not designed to be co-fired by any fossil fuel. 4. Diesel generators may be equipped for stand-by purpose for providing electricity to other facilities if any, only during scheduled or unscheduled shutdown of the biomass cogeneration plant. 5. The turbine generator of cogeneration power plant should be the one which have operational track record higher than 90% of operational availability at least 3 years.
	Default values	The grid CO2 emission factor (0.66 tCO2/MWh) uses an official data published by the Department of Environment,

		Bangladesh. Net calorific value of diesel oil and CO_2 emission factor of diesel oil use default values from IPCC guidelines. The CO_2 emission factor of rice husk transportation activities adopts the default value from the CDM methodology AM0090.
	Calculation of reference emissions	The amount of emission associated with power consumption at the rice mill or plant being supplied electrical power by the project (excluding newly established silica production plants). With business as usual (BaU) scenario defined as a continuation of the current state, the sharing of power consumption of the facility to be powered from this project between the project and BaU is valid.
	Monitoring method	- Total electricity supplied by the project cogeneration plant (Continuous by elec meter) - Electricity supplied by the project cogeneration plant to the silica plant (Continuous by elec meter) - Amount of rice husks transported (once a month by the bill) and Road distance between rice husk sources and the site of cogeneration plant (for each action) - Project diesel consumption for electricity generation (once a month by the bill)
GHG emission reductions		-The total supply of electrical power from the cogeneration plant = 9,979MWh/y. -The supply of electrical power from the cogeneration plant to the silica plant = 1,425 MWh/y. -Grid CO_2 emission factor = 0.66 tCO_2/MWh. -CO_2 emission factor of rice husk transport = 83 $gCO_2/t.km$ -Reference emission= (9,979-1,425) *0.66= 5,645 tCO_2/y. -Emission amount associated with rice husk transportation = 3,300 t/y × 10 km × 83 × 10-6＝3 tCO_2/y. -The estimated emission reduction = 5,642 tCO_2/y.
Environmental impacts		To comply the all environmental standards on the process of environmental impact assessment.
Project plan		JCM Subsidiary upto 50% ：P-IRR10.0%, E-IRR22.4%.
Promotion of Japanese technologies		The Japanese steam turbine generator is competitive in terms of long-term operation and maintenance against other Asian manufacturers.
Sustainable development in host country		Cogeneration can contribute to achieve efficient use of valuable biomass resources, improvement of the parboiling process, power shortage, environmental, and safety issues.

JCM Feasibility Study (FS) 2013
"High-efficiency Rice Husk-based Cogeneration"
(Host country: Bangladesh)

Study Entity: EJ Business Partners Co., Ltd

1. Study Implementation Scheme

- PEAR Carbon Offset Initiative Ltd (Japan), Subcontractor (JCM methodology study support)
- Grameen Shakti (Bangladesh), Subcontractor (onsite information gathering support)

2. Overview of Proposed JCM Project

(1) Description of Project Contents:

This project aims to introduce cogeneration equipment into rice mills in Bangladesh to replace low-efficient, rice husk fired steam boilers that are currently in use and improve resource saving by effective utilization of rice husks as a valuable biomass resource. The rice husk for the project which is generated from the large-scale rice mill "North Bengal Grain Industries Ltd (NBGI)" is used for high-efficient, rice husk steam cogeneration (cogeneration by boiler-turbine generation (BTG)). Generated power is supplied or sold to other nearby rice mills, and steam is supplied to N BGI rice mill. In addition, rice husk ash, which is a by-product after rice husk combustion, is manufactured and sold as products such as silica products or activated carbon.

(2) Situations of Host Country:

The Bangladesh Government and Japanese Government signed a bilateral agreement concerning the Bilateral Offset Carbon Credit Mechanism (BOCM) on March 19, 2013. In this bilateral agreement, the two counties established the BOCM system to promote a low-carbon growth partnership between both counties. In order to implement this system, a Joint Committee (JC) was established, and the two countries mutually recognized the system can be used in part to reduce and absorb emissions and contribute to respective greenhouse gas alleviation initiatives established around the world. The bilateral agreement also ensures transparency and environmental integrity of the system and ensures that the system is not used in other global alleviation mechanisms. The JCM is open between Japan and Bangladesh, and there is an understood willingness to increase the number of specific projects to as many as possible. Cogeneration projects that use rice husks, such as this project, are extremely beneficial for rice cultivation and the rice industry, which is the center of the agriculture industry of Bangladesh.

3. Study Contents

(1) JCM methodology development

a. Eligibility criteria

Criterion 1	A project activity that introduces rice husk cogeneration systems (with optional silica production systems) with higher energy efficiency than existing biomass (rice husk) boilers without cogeneration used in rice mills for steam generation for parboiling. [Reason] Low-efficient boilers are used in the rice mills in Bangladesh and parboiling processes exist as a general practice.
Criterion 2	Steam generated by the project is used for parboiling and other purposes in the target rice mill. On the other hand, electricity generated by the project, at first, is used for the rice mill's electricity demand and remained portion is sold to grid or other facilities (including other rice mills) in the vicinity of the rice mill. [Reason]: Both steam demand for the purposes of parboiling and husk drying before rice milling and power demand for rice milling equipment are necessary at rice mills in Bangladesh.
Criterion 3	Rice husks as fuel for the cogeneration system are sourced from the rice mill and other rice mills. The biomass cogeneration plant is designed based on the available amount of rice husks to be provided by the rice mill and not designed to be co-fired by any fossil fuel. [Reason]: A short distance of rice husk collection and a plant capable of providing stable supplies of rice husks are necessary for the project to be highly feasibility as previous cases demonstrate in Bangladesh and other countries.
Criterion 4	Diesel generators may be equipped for stand-by purpose for providing electricity to other facilities if any, only during scheduled or unscheduled shutdown of the biomass cogeneration plant. [Reason]: If power cannot be supplied by cogeneration, but power still needs to be supplied to external plants from the project, it is assumed that power will be supplied by a diesel generator instead.
Criterion 5	The turbine generator of cogeneration power plant should be the one which have operational track record higher than 90% of operational availability at least 3 years for its performance specification during durable period except for the shutdown time due to external factor such as no rice husk supply. [Reason]: There are no major differences between turbine generators made in Japan and turbine generators made in other countries; however, turbine generators made in Japan have a guaranteed availability of 90% per year over a long period of time.

b. Data and parameters fixed *ex ante*

<table>
<tr><th>Parameter</th><th>Description of data</th><th>Source</th></tr>
<tr><td>$EF_{CO2,grid}$</td><td>Grid CO_2 emission factor. Combined margin of 0.66 tCO_2/MWh is applied.</td><td>Latest official data from Bangladesh Government.
<table>
<tr><th></th><th>Operating Margin (ton CO_2/MWh)</th><th>Build Margin (ton CO_2/MWh)</th><th>Combined Margin (ton CO_2/MWh)</th></tr>
<tr><td></td><td>0.64619</td><td>0.674415</td><td></td></tr>
<tr><td>Weight of Operating Margin and Build Margin: 0.5:0.5 for the first crediting period</td><td></td><td></td><td>0.660302</td></tr>
<tr><td>Weight of Operating Margin and Build Margin: 0.25:0.75 for the second and the third crediting period</td><td></td><td></td><td>0.667359</td></tr>
</table>
</td></tr>
<tr><td>NCV_{diesel}</td><td>Net caloric value of diesel oil. Value of the upper level is used.</td><td>2006 IPCC Guidelines for National Greenhouse Gas Inventories. Table 1.2, Chapter 1, Volume 2.</td></tr>
<tr><td>$EF_{CO2,i}$</td><td>CO_2 emission factor of diesel oil. Value of the upper level is used.</td><td>2006 IPCC Guidelines for National Greenhouse Gas Inventories.
Table 1.4, Chapter 1, Volume 2.</td></tr>
<tr><td>$EF_{CO2,trasport}$</td><td>CO_2 emission factor of transportation activity. The value of 83 $gCO_2/t.km$ is applied.</td><td>CDM methodology AM0090: Modal shift in transportation of cargo from road transportation to water or rail transportation.
<table>
<tr><th>Type of cargo transported</th><th>Emission factor (g CO_2/tonne.km)</th></tr>
<tr><td>Agricultural products and live animals</td><td>83</td></tr>
<tr><td>Beverage</td><td>61</td></tr>
<tr><td>Groceries</td><td>76</td></tr>
<tr><td>Perishable and semi-perishable foodstuff and canned food</td><td>94</td></tr>
<tr><td>Other food products and fodder</td><td>74</td></tr>
<tr><td>Solid mineral fuels and petroleum products</td><td>76</td></tr>
<tr><td>Ores and metal waste</td><td>90</td></tr>
<tr><td>Metal products</td><td>80</td></tr>
<tr><td>Mineral products</td><td>57</td></tr>
<tr><td>Other crude and manufactured minerals and building materials</td><td>70</td></tr>
<tr><td>Fertilizers</td><td>76</td></tr>
<tr><td>Chemicals</td><td>70</td></tr>
<tr><td>Transport equipment</td><td>100</td></tr>
<tr><td>Machinery and metal products</td><td>119</td></tr>
<tr><td>Glass and ceramic and porcelain products</td><td>84</td></tr>
<tr><td>Grouped goods</td><td>94</td></tr>
<tr><td>Other manufactured articles</td><td>113</td></tr>
</table>
</td></tr>
</table>

The grid CO_2 emission factor in Bangladesh is published on the Department of Environment (DOE) homepage and dated August 19, 2013.
(DOE homepage：http://www.doe-bd.org/).
In regard to default values related to other diesels, refer to IPCC guidelines for 2006.
In regard to default values of rice husk transportation activities, refer to CDM methodology AM0090.

c. Calculation of GHG emissions (including reference and project emissions)

i) Reference emissions

$$RE_y = \left(EG_{PJ,y} - ES_{PJ,silica,y}\right) \times EF_{CO2,grid}$$

where

RE_y : Reference CO_2 emissions in a year y [tCO_2/y]

$EG_{PJ,y}$: Total electricity supplied by the project cogeneration plant [MWh/y]

$ES_{PJ,silica,y}$: Electricity supplied by the project cogeneration plant to the silica plant [MWh/y]

$EF_{CO2,grid}$: Grid CO_2 emission factor (fixed) [tCO_2/MWh]

In the BaU scenario, the rice mills would continue to use rice husks from their own mills to generate steam for parboiling and other purposes. Therefore, emissions from the emission source of (1) are zero.

The reference emission is established based on the BaU scenario in which the emission source (2) occurs that CO_2 is emitted by electricity consumption of the target rice mill and other facilities (including other rice mills but excluding silica plant)[1] from grid and stand-alone diesel generators.

Then, the reference emissions are calculated on the basis of amount of electricity supplied by the project to the target rice mill and other facilities. The target rice mill and other facilities may utilize diesel generator at the time of load shedding of the grid supply. However, the methodology recommends applying of grid CO_2 emission factor for all electricity consumption at the facilities shown above for conservativeness. It is noted that the CO_2 emission factor of the stand-alone diesel power generator (for back up) is higher than that of the grid.

ii) Project emissions

$$PE_y = FC_{PJ,diesel,y} \times NCV_{diesel} \times EF_{CO2,diesel} + TA_{PJ,y} \times EF_{CO2,trasport} / 1{,}000{,}000$$

PE_y : Project CO_2 emissions in a year y [tCO_2/y]

$FC_{PJ,diesel,y}$: Project diesel fuel consumption for electricity generation [t/y]

NCV_{diesel} : Net caloric value of diesel fuel [TJ/t]

$EF_{CO2,diesel}$: CO_2 emission factor of diesel fuel [tCO_2/TJ]

$TA_{PJ,y}$: Activity of transportation of rice husks in a year y [t.km/y]

$EF_{CO2,trasport}$: CO_2 emission factor of transportation activity [gCO_2/t.km]

Here,

$TA_{PJ,y} = TM_{PJ,y} \times D_{Transport}$

$TM_{PJ,y}$: Total amount of rice husk transported in a year y [t/y]

[1] Silica plant utilizing electricity from carbon-free power generation definitely reduces CO_2 emissions, while the methodology does not claim such CO_2 emission reductions, *i.e.*, excluding this process from calculation of emission reductions for conservativeness.

$D_{Transport}$: Road distance between rice husk sources and the site of cogeneration plant [km]

The project emission is calculated on the basis of the emission source (4) that is, the monitored fossil fuel (diesel) consumption to provide electricity to other facilities (including other rice mills and the silica plant) and activities in ton.km for transportation of rice husks from sources to the cogeneration power plant site.

iii) Emission reductions

$EG_{PJ,y}$: The total supply of electrical power [MWh/y] from the cogeneration plant.
= (1,460 kW – service station consumption 200 kW) *24hr *330 operation days.
= 9,979MWh/y.
$ES_{PJ,silica,y}$: The supply of electrical power [MWh/y] from the cogeneration plant to the silica plant.
= 180 kW *24hr *330 operation days.
= 1,425MWh/y.
$EF_{CO2,grid}$: Grid CO_2 emission coefficient = 0.66 tCO_2/MWh.
$EF_{CO2,trasport}$: CO_2 emission coefficient of rice husk shipping and transportation activities = 83 gCO_2/t.km.
Therefore, reference emission = (9,979-1,425) *0.66= 5,645 tCO_2/y.

In regard to the project emissions, it is currently set to zero count because it is calculated by monitoring the diesel fuel consumption used for power generation for the project. Furthermore, the emission amount associated with rice husk transportation = 3,300 t/y × 10 km × 83 × 10^{-6} ＝3 tCO_2/y.

Therefore, the estimated value of emission reduction is 5,645-3 = 5,642 tCO_2/y.

(2) Development of JCM Project Design Document (PDD)

1) Environmental Impact Assessment

According to The Environment Conservation Rules (1997), an environmental impact assessment of this project is necessary because power plants are classified as category "RED", which is the strictest category specified in the rules. Also, the procedure cannot be changed in accordance with the size of power generation capacity or the business type (for example coal-fired or biomass) and no preferential treatment is given to renewable energy. It should also be noted for silica production plants, it is possible to combine the environmental permit application with the cogeneration plant.

2) Local Stakeholder Consultation

There have been no stakeholder meetings held yet regarding this project; although, many stakeholders have been visited and their comments obtained. Stakeholders who have been visited include Bangladesh government agencies (Department of Environment, IDCOL, Bangladesh Power Development Board (BPDB), and the Rural Electrification Board (REB)), a rice mill (North Bengal Grain Industries Ltd), an NGO (Grameen Shakti), international agencies (JICA Bangladesh Office and GIZ Bangladesh Office), and other agencies (such as JETRO).

Each stakeholder was requested to collect onsite information for this study and respond to a questionnaire commissioned by Grameen Shakti, who is a local NGO with a number of offices and staff members located around the whole country of Bangladesh. They plan to summarize the comments.

3) Monitoring Plan

For this project, the amount of power (total amount of power sold to rice mills and grid), which is obtained by subtracting the power supplied to silica plants that does not exist in the reference from the remaining total power supply excluding power station consumption from power generated by cogeneration, is a minimum requirement for mandatory monitoring used for the calculation of emission reduction; however, the amount of power supplied from the cogeneration plant, which is measured using a watt-hour meter, is a convenient monitoring item because it is a mandatory monitoring item of the project operation itself. In addition, records are maintained such as the purchase Bill for purposes of cost management even for consumption of diesel fuel used to satisfy contractual power supply obligations such as for a rice mill or a backup power supply if a cogeneration plant or silica plant has suspended operations. In regard to the previously mentioned monitoring item, staff of the cogeneration plant records the measurement values in accordance with a monitoring sheet prepared in advance and report to the project sub-manager of the SPC. The project sub-manager of the SPC is in charge of overall monitoring activities.

4) Calibration of Measurement Equipment

According to electricity sale contractual guidelines of the Ministry of Energy and Natural Resources, power meters must be properly calibrated according to instructions and calibrated once a year based on international standards and in accordance with monitoring plans of the project.

(3) Project development and implementation

a. Project planning

i) Initial Investment Costs and Maintenance costs

Cost estimation was implemented based on the estimation from potential EPC contractor. Initial project costs are about 7.8 million US$ and maintenance costs are about 0.25 million US$/year.

ii) Funds Procurement Plan

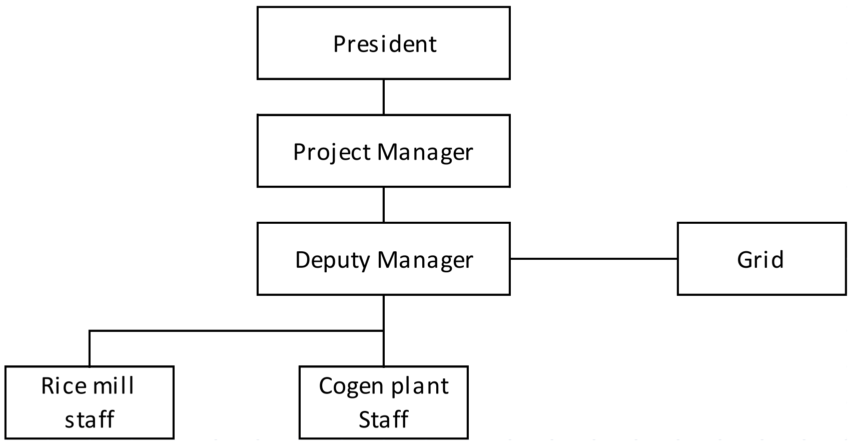
Of the approximately 7.8 million US$ required as the initial investment, 20% will be raised by EJBP, North Bengal, and other investors and 80% will be raised by project finance. It is assumed that the lender will be Infrastructure Development Company Limited (IDCOL), which is a government-affiliated financial institution of Bangladesh. Of the 80% from project finance, 17% will be short-term loan (2 years) and other 63% for long-term loan. The short-term loan will be repaid in a lump-sum by the JCM subsidy fund after completion of the construction of the cogeneration plant. Maintenance expenses of the first year are included in the initial investment and are managed in subsequent operating revenues and short-term loans.

iii) Estimated Schedule for Project Implementation

March 2014: Completion of the JCM feasibility study.
July 2014: Implementation of the JCM demonstration study.
April 2015: Joint venture agreement.
June 2015: JCM subsidy program application.
July 2015: Project implementation under the JCM subsidy program (construction start).
July 2017: Start of operations.

b. MRV structure

For this project, the amount of power (total amount of power sold to rice mills and grid), which is obtained by subtracting the power supplied to silica plants that does not exist in the reference from the remaining total power supply excluding power station consumption from power generated by cogeneration, is a minimum requirement for mandatory monitoring used for the calculation of emission reduction; however, the amount of power supplied from the cogeneration plant, which is measured using a watt-hour meter, is a convenient monitoring item because it is a mandatory monitoring item of the project operation itself. In regard to the previously mentioned monitoring item, staff of the cogeneration plant records the measurement values in accordance with a monitoring sheet prepared in advance and report to the deputy manager of the SPC. The project manager summarizes the measurement values and reports third-parties in accordance with the JCM monitoring manual.



c. Permission and authorization for the project implementation

i) Required approvals and licenses

- Environmental Impact Assessment (EIA): The Environment Conservation Rules, 1997.
- Power Generation and Electricity sales: The price of electricity is determined in negotiations with BPDB after obtaining approval to sell electricity from the Bangladesh Energy Regulatory Commission (BERC).
- Incorporation: Obtain a "Certificate of Incorporation" from a commercial registration office (RJSC & amp; F). There is a requirement to register the investment certificate with the Board of Investment (BOI).
- Export etc.: The prescribed form required to apply for the "Import Registration Certificate" is obtained at the BOI or the export/import management authorities (CCI & amp; E).

ii) Project Approval and License Acquisition Period

- March 2014: Completion of study.
- September to December 2015: EIA application form preparation and PPA application form preparation.
- March 2015: Completion of the JCM demonstration study.
- April 2015: Investment license application.
- May 2015: Year 2015 JCM/BOCM subsidy application.
- June 2015: Incorporation and import registration application.
- July 2015: Start of construction.
- July 2017: Start of operation.

d. Japan's contribution

In order to establish a boiler and turbine generator system with high efficiency, it is suggested that a method should achieve stable low excess air combustion, high-temperature and high-pressurization of boiler steam conditions, improvement of boiler efficiency, efficient use of steam (including district heating etc.), and improvement of turbine internal efficiency; however, in regard to the boiler in particular, it cannot be said that the advantages of adopting Japanese made technology will lead to significantly increased competitiveness relative to products manufactured in Thailand and India in recent years.

Therefore, the intention of this project is not for sales of Japanese made products only; instead, the intention is to improve biomass utilization efficiency and improve processes of rice mill, and introduce technology and knowledge to efficiently use rice husks as a biomass fuel while achieving a fusion of technology with other countries. Specifically, modernize existing low-efficient rice husk boilers to high-efficient rice husk steam cogeneration equipment to be used for the parboiling process, supply power and steam to nearby rice mill and the grid, and contribute to the promotion of biomass utilization and eliminate power shortages. Taking these points into consideration, the adoption of steam turbine generators made in Japan is planned because they are competitive against other Asian manufactures in terms of price and performance.

For Japanese made steam turbine generators expected to be used in this project, there are advantages in regard to build quality, serviceability period, and maintaining high capacity utilization rates over a long period of time. In particular, for power generation projects in terms of increasing the capacity utilization of the facilities and maintaining power generation, it is advantageous to introduce Japanese made equipment because it maintains the facilities at a high capacity utilization of 90% or more over a 10 year period, which leads to revenue gains from electricity sales and therefore has significant influence on project feasibility. The cost of manufacture of a turbine generator of about 1,500 kW is about 50 million yen if made in India as compared with 60 million yen if made in Japan; however, capacity utilization with a difference of 1% per year is the equivalent of about 800,000 yen of revenue difference for this project. Furthermore, if the capacity utilization declines 1% per year, this creates a loss of income equivalent to 1+2+3+4+5= capacity utilization 15% in five years. Therefore, 800,000 yen × 15 = 12 million yen, so it can be said that introduction of Japanese technology is advantageous because this capacity utilization difference exceeds the initial price difference of cost of manufacture over a 5 year period.

e. Environmental integrity

By understanding the environmental standards of exhaust gas, waste water related to cogeneration equipment, and establishing a plant plan based on equipment specifications that satisfy these standards, current problems to the environment can be solved such as health risks posed to workers from dust generation caused by the low-efficient rice husk steam boilers that currently exist, inadequate treatment of exhaust gas and waste water, and underground seepage of contaminated water caused by the deposition of ash. In addition, plans must be established to ensure exhaust gases and waste water from cogeneration equipment matches procedures required to obtain approval and licenses of the environmental impact assessment and ensure cogeneration equipment complies with standards for other issues such as noise levels. Furthermore, regular inspections of waste water and water quality are carried out as monitoring activities of the project to avoid the occurrence of any adverse effects.

f. Sustainable development in host country

Rice is the most important agricultural product in Bangladesh. Therefore, cogeneration can contribute to sustainable development in Bangladesh by efficiently utilizing energy (biomass) at rice mills to achieve efficient use of valuable biomass resources, improvements to the parboiling process, and improvements concerning power shortage, environmental, and safety issues. This project will use about 23,100 tons of rice husks per year. Similar projects will be expanded across Bangladesh because of a plan to use cogeneration to generate 1,460 kW of power and provide a steam supply for the parboiling process. It is estimated that there is a spread possibility of 632 MW (10,000,000 tons/23,100 tons × 1,460 kW = 632 MW).

g. Toward project realisation (planned schedule and possible obstacles to be overcome)

March 2014: Completion of the JCM feasibility study.
March 2014: JCM demonstration study preparation.
June 2014: JCM demonstration study proposal.
July 2014: Implementation of the JCM demonstration study.
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Challenges that hinder the feasibility of the project include details of the design and integration with the plant, various types of contract negotiations (such as electricity sales contracts to become a source of income and silica sales contracts), and marketing of silica products. For this project in particular, the prospect of selling of silica products and by-products is a very important aspect to project feasibility because this accounts for about 60% or more of total sales including revenue from electricity sales.

The technical level of silica production is already at a commercial level; however, there is still need for an established facility to meet product specifications in accordance with requirements and needs of customers (buyers), and in addition to marketing, there is also a need to install and implement a small-scale demonstration plant to investigate parameters of product specifications based on specific requirements of customers as part of the JCM feasibility study because it is important to have an understanding as to what kind of effect plant specifications will have on parameters (components of silica) that are to become product specifications. There are future plans to consult with manufacturers in regard to issues such as demonstration implementation methods and systems.