MOEJ/GEC JCM Feasibility Study (FS) 2014
Summary of the Final Report

"Waste Heat Recovery and Electricity Generation in Flat Glass Production Plant"

(Implementing Entity: Mitsubishi UFJ Morgan Stanley Securities Co. Ltd.)

1. Overview of the Proposed JCM Project

<table>
<tr><td>Study partners</td><td>
<table>
<tr><th>Country</th><th>Organization</th><th>Relationship with implementing Entity</th><th>Outline of tasks</th></tr>
<tr><td>Host country</td><td>PT. Takasago Thermal Engineering（Takasago）</td><td>Sub-contractor</td><td>Technical study, Cost estimation, Project implementation schedule development</td></tr>
<tr><td>Host country</td><td>Local consultant</td><td>Sub-contractor</td><td>Local coordination, collection of data/information, liaison with JCM Secretariat of Indonesia</td></tr>
<tr><td>Host country</td><td>PT.Asahimas Flat Glass Tbk（AMG）</td><td>Cooperating entity</td><td>Provision of project site information, participation in discussion about project implementation plan formulation.</td></tr>
<tr><td>Japan</td><td>Tsukishima Kankyo Engineering Co., Ltd.</td><td>Cooperating entity</td><td>Provision of technical information, support for technology study</td></tr>
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<tr><td>Project site</td><td>Sidoarjo, East Java Province, Indonesia</td></tr>
<tr><td>Category of project</td><td>Energy efficiency</td></tr>
<tr><td>Description of project</td><td>The Project involves installation of waste heat recovery and power generation system in a flat glass manufacturing plant. The Project aims to abate the impact of burden of rising electricity tariff while making efficient use of energy. By introduction of waste heat recovery and power generation system, the Project</td></tr>
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	displaces a part of grid electricity consumed at the project site and therefore contribute to GHG emissions reduction of fossil-fuel based grid connected power plants.		
Expected project implementer	Japan	Asahi Glass Co., Ltd.	
	Host country	PT. Asahimas Flat Glass Tbk.	
Initial investment	**JPY 480 million**	**Date of groundbreaking**	N/A
Annual maintenance cost	**JPY 1.5 million**	**Construction period**	Approximately 7 months
Willingness to investment	**Yes**	**Date of project commencement**	N/A
Financial plan of project	The project proponent plans to source 50% of initial investment from JCM equipment subsidy while utilizing its own equity for the remaining 50%.		
GHG emission reductions	4,900 tCO2/year		

2. Study Contents

(1) Project development and implementation

1) Project planning

(a)Project operation plan

The proposed operation will center around AMG (Asahimas) as the project owner. AMG will subcontract regular maintenance to the manufacturer and while carrying out daily maintenance and management with the cooperation of the manufacturer and Takasago, the engineering company. The Study confirmed the effectiveness of the Japanese technology. JCM consulting will be provided by Mitsubishi UFJ Morgan Stanley Securities (MUMSS).

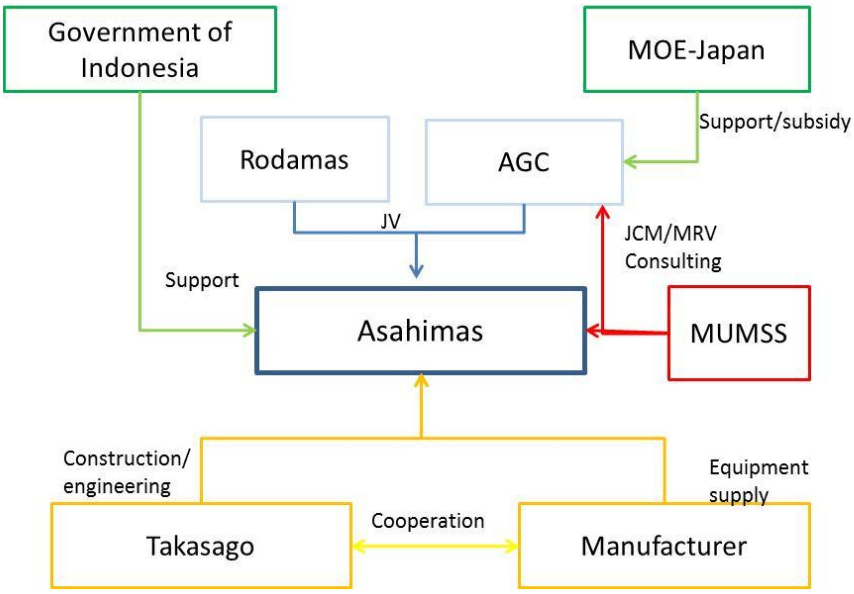

Figure 1 Project Operation Framework

(b)Construction plan

The following items were studied in order to estimate construction schedule

Table 1 Study of construction schedule

Study item	Study outcome
Identification of installation site	Sidoarjo plant, AMG
Soil quality research of installation site to determine soil bearing, confirmation of foundation improvement requirement	No problems were found. Foundation improvement is not required
Requirement for alteration of existing glass production facility	Alteration is not required.
Local procurement of construction materials and investigation of local contractors.	Confirmation of locally available materials.

Barriers for construction in relation to local particularities.	Confirmed restrictions due to rainy season and Muslim holidays.

Based on the study as conducted above, construction schedule was formulated. It is estimated that the minimum period required for equipment order to commercial operation start is 18 months.

(c)Management structure and track records of the project implementation entity

AMG is owned by both AGC of Japan and Rodamas of Indonesia who hold shares at 43% and 40.8% respectively while remaining shares are owned by individual investors and others. Led by robust Indonesian economy, 2013 recorded highest sales in AMG's history at IDR 3,216 billion, 7% above the target at the beginning of the year. Although the increase in sales and marketing costs have led to slight decrease in net operating profit, assets and equity of AMG are on the rising trend due to sound sales record. Total asset is IDR 1980 billion, 4.2 times total liability. Based on these records, it is clear the money for investment is adequately available. Also, it is to be noted that AMG has placed "environment" as its main management issues. AMG established targets for greening its operation and its plants have obtained environmental certification.

(d)Evaluation of financial feasibility

The initial investment and operating costs have been estimated as follows.

Table 2 Breakdown of costs

Item		Amount (thousand US$)
Initial investment cost	Design and equipment	2,900
	Local materials	420
	Construction and trial operation	670
	Total	4,000
	After equipment subsidy (50%)	2,000
O&M Costs (annual cost)	Consumable supplies and spare parts	6.7
	Maintenance labor costs	5.8
	Total	12.5

One half of initial investment cost is planned to be subsidized by the Japanese government's JCM support scheme while the remaining cost will be met by project owner's own funding.

Financial viability was studied by looking at the IRR and payback period. The following assumptions in addition to the initial costs mentioned above have been taken into account to calculate IRR and payback period.

Table 3 Assumptions for IRR and payback calculation

	Item	Value	Unit	Comment
Cost	Depreciation cost	0.2	thousand US$/year	Useful life= 20 years
Income	Amount of electricity consumption reduced	6,400	MWh/year	Based on project estimation
	Amount of electricity tariff saved	571	thousand US$/year	Based on latest Category T3 rate published by PLN

IRR and payback are calculated as approximately 21.76% and 3.5 years respectively. Sensitivity analysis was also conducted taking into account possibilities of further increase in electricity tariff and project electricity generation. As for the likelihood of such increase taking place in the future, although electricity tariff increase rate is not certain as the prices are set to float and will be determined by a variety of economic indicators, it is highly likely considering the electricity tariff for Category T3 which is applied to the project site was increased by approximately 28% during the year 2014. The project electricity generation increase is almost certain as the nature of glass melting furnace leads to increasing waste gas temperature over time. Nevertheless, since the electricity tariff fluctuation remains to be seen, efforts will be made on reducing initial investment cost by increasing the local portion of procurement.

Table 4 Result of IRR and Payback calculations

Case		IRR	Payback (years)
Case 1	Base case	21.76%	3.5
Case 2	8% increase of electricity tariff	23.55%	3.2
Case 3	10% increase in project electricity generation	24.00%	3.2
Case 4	Case 2 and Case 3	25.95%	2.9

(e)Financial scheme

The costs of initial investment and operation and maintenance are estimated in Table 2. In addition, MRV costs including costs of the third party entity and MRV consultant are estimated at JPY 10 million for validation and additional JPY 10 million for verification.

Project proponent aims to obtain 50% of initial investment cost from JCM equipment subsidy program. The remaining costs other than separate Japanese government support for MRV costs will be borne by AMG's own financial sources.

(f)Risk analysis

Although the following risks are foreseen in the project, measures are already being planned to minimize their impacts on the project; therefore. the effect on JCM project feasibility is negligible.

- Ensuring stable electricity generation throughout the year
  There are concerns of power outage and suspended cooling water supply. Such risk will be minimized by installing appropriate equipment and back-up equipment in order to prevent damage to the project operation.

- Local construction
  There are concerns of increase in construction costs due to conflict over space with other plant equipment. Such risk will be minimized by clearly indicating construction zone well in advance. There are also concerns of construction delay due to in-house restrictions. In-house restrictions will be studied and taken into considering when planning construction in order to minimize such risk.

- Equipment subsidy
  The project financial plan risks drastic change if JCM equipment subsidy is nor procured as planned. By engaging in thorough discussion with Japanese government and its related entities in advance, the risk will be minimized.

(g)Other

Nusantara Carbon Scheme (NCS), Indonesia's own market mechanism planned for GHG emission credits was studied. Based on the study, it has become clear that project proponent may transfer credits to NCS other than the credits to be transferred to the Japanese government. The presence of local demand for carbon credits will increase the value of the project as a whole and may provide greater incentives for project implementation.

2) Permits and License for the project development and implementation

As environmental impact assessment (EIA) is required only for power generation projects of 100MW in installed capacity or more based on Indonesian Ministry of Environment's order No.11.2006, EIA is not required for this project. Business license is also not required as the project does not sell electricity to PLN and it has been confirmed by Indonesian Investment Coordinating Board (BKPM).

3) Advantage of Japanese technology

The targeted technology for waste heat recovery and electricity generation under the FS is Organic Rankine Cycle (ORC) technology. As opposed to the conventional steam turbine technology, ORC uses an organic working medium with lower boiling point than water, therefore, is capable of converting low-mid temperature waste heat, which is what glass melting furnace typically emits, into electric energy. At the given waste gas temperature range of 300-500 degrees Celsius, ORC is capable of generating power at 15% efficiency while steam-turbine system is only able to generate power at 10%. ORC can also minimize cost and handling work of large boilers that steam-turbine system would require, which is estimated at 1.4 times the equivalent cost of ORC of the same specifications.

When compared to ORC of other countries' manufacturers, the Japanese product is designed and manufactured to meet higher safety standards of Japan, such as malfunction detection system and control system and is regarded as highly competitive. Moreover, compared to US or Italy made ORC which have high global market shares, Japanese product has an advantage of using safe and inexpensive working fluid. Based on the survey of international literature on ORC, it is estimated that when the proposed project is implemented as JCM project, the Japanese ORC can be introduced at 25% lower cost compared to a typical global standard ORC of similar specifications.

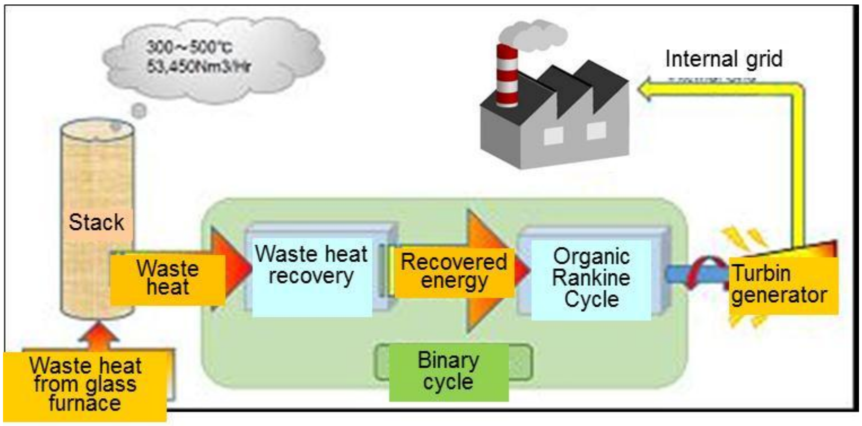

Figure 2 Process flow

Source: Tsukisima Kankyo Engineering

Figure 3 The image of ORC plant in Ibaraki, Japan

Source: Tsukisima Kankyo Engineering

4) MRV structure

Monitoring will be conducted by onsite by AMG with onsite support by Takasago if necessary. MUMSS will provide support in devising monitoring plan to be submitted to the third party entity. MUMSS will also act as the main liaison with the third party entity for carrying out verification activities.

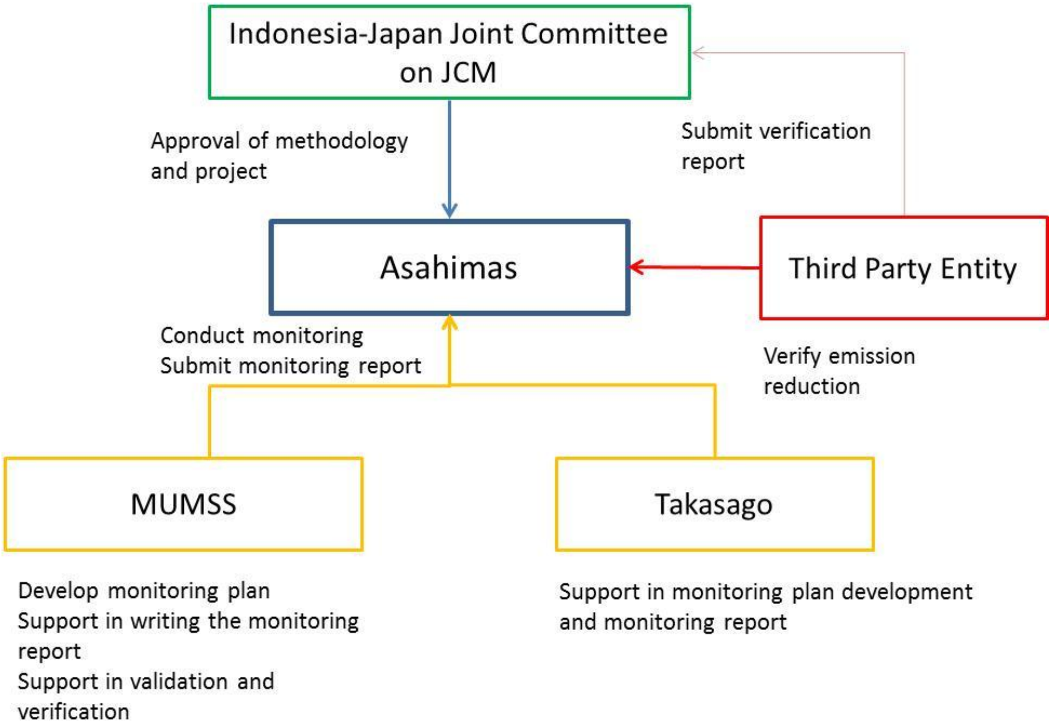

Figure 4 MRV implementation plan

The monitoring item of the project is electricity generated by the project plant and the monitoring equipment is electricity meter. Two electricity meters will be installed including one for back-up. The electricity meter used in the project is to meet international standards and calibration will be conducted in accordance with the manufacturer's specifications. Continuous monitoring results will be relayed to a computer system which will automatically record monitoring data. The monitoring system will be automated as much as possible in order to minimize the burden on local operation.

5) Environmental integrity and Sustainable development in host country

The project aims towards introducing state-of-the-art high efficiency equipment that reduces electricity consumption in an energy intensive production site and is in line with Indonesian government policy for climate change mitigation and its roadmap for the industry sector. When implemented, the project would make a great model case as there is still vast amount of untapped waste heat in production sites, especially the low-mid temperature waste heat the project technology targets. Such technology is capable of balancing technological and industrial development and climate change mitigation.

Although the project has little or no impact to the surrounding environment because no additional gas will be emitted from the ORC introduced by the project activity, in order to ensure environmental integrity, measures will be taken with regards to the working fluid of the ORC.

The ORC to be introduced in the project will utilize "R245fa", a HFC gas. Although it is considered safe gas and appropriate for use in production site due to its non-flammable nature, it has high global warming potential. In order to prevent leakage, the project will employ non-seal method in construction. Even though there will be no leakage or requirement for additional filling during normal operation, gas monitoring and volume check will be conducted regularly to ensure no leakage takes place. At time of overhaul and decommissioning, the gas will be stored in the designated tank to be installed in the project site. Any gas remaining in the equipment will be collected by specialists. The technology provider will offer training and know-how required in relation to the handling of the HFC gas. The collected HFC gas can be destructed in the cement kiln of Holcim Indonesia that provides manifesto as proof of destruction. In summary, the use of "R245fa" will be controlled to avoid leakage during operation and project proponents will make sure they will be properly destructed at the time of decommissioning.

6) Toward project realization (planned schedule and possible obstacles to be overcome)

The next steps and issues to resolve will involve finalizing a sound financial plan including efforts to reduce initial cost by increasing the share of local procurement and utilizing JCM equipment subsidy. The foreseen schedule is as follow.

- March-April 2015
  - Confirmation of costs for project investment decision
  - Formulation of consortium for equipment subsidy
  - Preparation for equipment subsidy application

- March 2015~continous
  - Formulation of response measures to minimize the aforementioned technical risks

- March 2015~continous
  - Brushing-up the applicability conditions of MRV methodology.

- April 2015
  - Estimated time for equipment subsidy application

- June 2015
  - Begin the process of application for MRV methodology for approval.

- August 2015
  - Estimated time for equipment subsidy selection result that allows for equipment order placement

(2) JCM methodology development

The JCM methodology was developed on the basis of the approved JCM methodology "ID_AM001: Power Generation by Waste Heat Recovery in Cement Industry" which is applied to a technology similar to the proposed project.

1) Eligibility criteria

The proposed eligibility criteria are as follows. The criteria are established in order to make explicit applicable technology and to ensure calculation methods described below are applicable.

Criterion 1	The project utilizes waste heat of temperature ranging from 300 to 500 degrees Celsius from the flat glass production facility by waste heat recovery (WHR) system to generate electricity.
Criterion 2	WHR system consists of thermal oil boiler and power generation unit.
Criterion 3	WHR system utilizes only waste heat and does not utilize fossil fuels as a heat source to generate power.
Criterion 4	The glass factory where the project is implemented is connected to a grid system and the theoretical maximum electricity output of the WHR system, which is calculated by multiplying maximum electricity output of the WHR system by the maximum hours per year (24 * 365 = 8,760 hours), is not greater than the annual amount of the electricity imported to the glass factory from the grid system: (1) During the previous year before the validation, if the validation of the project is conducted before the operation of the project, or (2) During the previous year before the operation of the project, if the validation of the project is conducted after the operation of the project.
Criterion 5	The WHR system is designed to be connected only to an internal power grid of the glass factory.
Criterion 6	In case working fluid containing greenhouse gas is utilized in the WHR system, the structure of the WHR system prevents leakage of such gas from the system.

2) Calculation of GHG emissions (including reference and project emissions)

Waste heat recovery for electricity generation is not a common technology in glass production plants in Indonesia. Therefore, the reference scenario is the continued use of grid electricity. Reference emissions are emissions from grid electricity consumption that would be displaced by the project activity and are calculated as the amount of electricity generated by the project multiplied by the CO2 emission factor of the grid supplying electricity to the project site.

To ensure conservative calculation of reference emissions, electricity consumption by auxiliary equipment is calculated at its maximum output capacity, to conservatively estimate the net electricity supplied by the project activity.

As there is no fossil fuel usage as a result of the project activity, there are no project emissions. Therefore, the amount of emissions reduction equals reference emissions.

Reference emissions are calculated in the following manner.

$$RE_p = EG_p \times EF_{grid}$$

Where,

Parameters	Explanation	Unit	Values applied
RE_p	Reference emissions during a given time period p	(tCO2/p)	4,900
EG_p	The quantity of net electricity generation by the WHR system which replaces grid electricity import during a given time period p	(MWh/p)	6,020
EF_{grid}	CO2 emission factor for an Indonesian regional grid system, from which electricity is displaced due to the project during a given time period p	(tCO2/MWh)	0.814

Determination of EGp

$$EG_p = EG_{SUP,p} - EC_{AUX,p}$$

Parameters	Explanation	Unit	Values applied
$EG_{SUP,p}$	The quantity of the electricity supplied from the WHR system to the glass production facility during a given time period p	(MWh/p)	10,400
$EC_{AUX,p}$	The quantity of electricity consumption by the WHR system except for the direct captive use of the electricity generated by itself during a given time period p	(MWh/p)	4,380

Determination of $EC_{AUX,p}$

$$EC_{AUX,p} = EC_{CAP} * 24\ (hours/day) * D_p$$

Parameters	Explanation	Unit	Values

			applied
EC_{CAP}	The total maximum rated capacity of equipments of the WHR system which consumes electricity except for the capacity of equipments which use the electricity generated by itself directly	(MW)	0.5
D_p	The number of days during a given time period p	(day/p)	8760

3) Data and parameters fixed *ex ante*

Parameter	Description of data	Source
EF_{grid}	CO2 emission factor for an Indonesian regional grid system, from which electricity is displaced due to the project during a given time period	The most recent value available at the time of validation is applied and fixed for the monitoring period thereafter. The data is sourced from "Emission Factors of Electricity Interconnection Systems", National Committee on National Council on Climate Change unless otherwise instructed by the Joint Committee.
EC_{CAP}	The total maximum rated capacity of equipments of the WHR system which consumes electricity except for the capacity of equipments which use the electricity generated by itself directly	Rated capacity of all installed equipments of the WHR system which consumes electricity except for the capacity of equipments which use the electricity generated by itself directly.