MOEJ/GEC JCM Project Planning Study (PS) 2014
Summary of the Final Report

"Installation of CHP (Combined Heat and Power) system in a hotel"

(Implementing Entity: Fuji Electric Co., Ltd.)

1. Overview of the Proposed JCM Project

Study partners	Name of participant: Fuji Electric Co., Ltd. Roles: Lead manager of the study Prepare construction plan and operational plan Examine implementation structure Name of participant: FUJI FURUKAWA ENGINEERING & CONSTRUCTION Co., Ltd. Roles: Prepare construction plan Name of participant: NTT DATA INSTITUTE OF MANAGEMENT CONSULTING, INC. Roles: Develop MRV methodology Prepare PDD draft Market Survey Name of participant: JAPAN QUALITY ASSURANCE ORGANIZATION Roles: Support for developing MRV methodology	
Project site	Republic of Indonesia, East Java province, Surabaya	
Category of project	1 Energy Industry 3 Energy demand	
Description of project	This project is to install a CHP (Combined Heat and Power) system at the Hotel A hotel located in Surabaya city, Indonesia. It supplies electricity generated by gas engines to the hotel, then an absorption type refrigerating machine utilizes waste heat from the process for air conditioning. Electric power from the system works to offset the power consumed by the chiller to reduce CO2 emission.	
Expected project implementer	Japan	Fuji Electric Co., Ltd.

	Host country	Hotel A		
Initial investment	300 (million yen)		**Date of groundbreaking**	November 2015
Annual maintenance cost	10 (million yen)		**Construction period**	Six months
Willingness to investment	Yes (based on this study)		**Date of project commencement**	May 2016
Financial plan of project	As it is a system upgrade by a private corporation, its project purchaser Hotel A currently plans to finance the initial investment with its own funds. JCM facility subsidy project is estimated to cover 50% of the initial investment amount. Funding plan will be examined further based on detailed system design and cost estimate produced through this study.			
GHG emission reductions	Approx. 2,800 (tCO_2/year)			

2. Study Contents

(1) Project development and implementation

1) Project planning

Project Background

In Indonesia, an insufficient supply capacity of state-owned power companies has caused unstable power quality. An increase in the number of these distributed power generation system installations will improve power supply stability for similar implementing operators, leading to a better power supply and demand environment over the entire country.

Objective of the PS

This study aims to confirm the business feasibility of installing a CHP system consisting of either an absorption type refrigerating system or a boiler at a hotel located in Surabaya, Indonesia, to secure an independent power source. A verification study will also be conducted to see the extent of possible CO2 emission reduction.

How the PS is conducted

This project will be carried out under a JCM facility subsidy project, through the formation of an international consortium. Its representative is Fuji Electric Co., Ltd., participated by Hotel A, as the implementer in the host country, Indonesia. Fuji Furukawa Engineering & Construction Co., Ltd. will be in charge of construction. Other supporting organizations expected to participate in the project include NTT Data Institute of Management Consulting, Inc. as the consultant for project registration and MRV implementation, and Japan Quality Assurance Organization (JQA) stands by as TPE. The following section illustrates its construction plan based on detailed studies.

Management system and record for the project implementers

Hotel A, which plans to adopt a CHP system, has shown a sound management system and record, with a good standing in credit limit screening (based on a leasing company study)

Business feasibility assessment

The total investment amount is currently projected at approximately 300 million yen. It includes: approximately 100 million yen for gas engines, 50 million for refrigerating machines and instrumentation systems, 60 million for construction/installation/piping/wiring work, 10 million for electric systems, 20 million for monitoring system/relevant field work/engineering, 30 million for VAT, and 30 million for import taxes. The import taxes are in tentative values, to be calculated separately in detail upon further examination.

The estimated sales income from the power cost reduction is at approximately 110 million yen. Profits calculated by subtracting fuel and maintenance costs from the sales income is projected around 38 million yen.

Project IRR (2015) estimates 24%, assuming half the above investment of 150 million yen to be funded

by a facility subsidy, with its investment recovery period set at four years. The natural gas cost is linked with fluctuating IDR/USD exchange rate. The above estimate is based on Rp 10,000/USD as an average rate to represent exchange rate trend since 2001. If rupiah weakens more than the assumed during the business operation, its profit will shrink, resulting in a longer investment recovery period. Estimate results are shown below (in Indonesian rupiah).

Financing plan

As it is a system upgrade by a private corporation, its project implementer Hotel A currently plans to finance the initial investment with its own funds. A JCM facility subsidy project is estimated to cover 50% of the initial investment amount. The maintenance cost will also be borne by Hotel A. With regard to MRV measurement, we aim to minimize on-site work for Hotel A by installing a system that automatically measures and collects data on many of the MRV monitoring items. While Hotel A will also produce reports, Fuji Electric Co., Ltd. and NTT Data Institute of Management Consulting, Inc. provide necessary assistance to reduce the work load.

Currently, we are in the consultation process with Hotel A over the estimate to finalize the order. It is our hope to reach an agreement on the price and the project duration by the end of March.

Risk analysis

The highest risk factors entail securing natural gas supply capacity and possible cost increase during the project. Although the gas supply company forecasts a stable supply during the five years of investment recovery, there is a risk of drastic demand increase in the surrounding area to cause a tight supply. Rising gas prices will reduce profits, and prolongs the time needed to recover the investment. One of the countermeasures to suppress the cost involves hiring local maintenance staff. Another promising option is to divert part of waste heat to the boilers.

2) Permits and License for the project development and implementation

The Surabaya Development Planning Department held a meeting with related bureaus (development planning, environmental affairs, residence/city planning, communications information, legal affairs, and East Java energy and minerals resources), to confirm necessary licensing and processes for the project. The results are listed below:

(Required permits and license)

(1) UKL/UPL (environmental monitoring/management methods) approval: Environmental affairs bureau

The target hotel should already have a UKLM/UPL in a normal circumstance.

No new approval is required, but the following procedure has to be followed. An approval granted in less than one month.

- Confirmation of licensed UKL/UPL.
- New CHP system specifications to be submitted (documents describing facility type, fuel, estimated environmental impact, etc.)

(2) IO (Izin Operasi, operation approval of a private power generation facility by ESDM ordinance Vol. 35, 2013): Communications Information Bureau

Apply after an UKL/UPL approval by above Step 1. Duration required for approval is approximately three months. This process should start once an agreement on facility installment is reached with Hotel A.

Target hotel representative will take initiative in the process with necessary support provided by Fuji Electric Co., Ltd.

3) Advantage of Japanese technology

This new main low-carbon technology encompasses CHP system's components; gas engines, an absorption type refrigerating machine, and managing EPC (engineering, procurement, and construction). No market has been developed yet in Indonesia.

As for gas engines, a survey on captive power generation in Indonesia conducted in 1998[1] revealed the ratio by fuel type for captive power generation as follows; 60% for diesel, 22% for steam-power, 11% for gas turbines, and 6% for hydro-power, based on generated power capacity. While nearly no gas engine installation has been made, future expansion is anticipated as GE has implemented gas engine powered generation system at Plaza Indonesia in recent years, and announced its intention to cultivate this new market. GE is projecting a strong presence by aggressively promoting its gas engine system through various activities including hosting a CHP information seminar at a hotel in Jakarta. GE is expected to become our fierce competitor with localized services including engineering, provided by its Indonesian representative Navigat Energy.

With regard to absorption type refrigerating machines, a BSRIA study shows the small Indonesian market with approximately 700 million yen annual sale, indicating being at its initial phase of development. Top five companies are Shuangliang (China), Broad (US), Huin (China), LS (Korea), and Thermax (India), for which 90% of the total share is accounted. Following key players are Hitachi and McQuay (Daikin). Absorption type refrigerators have already had a long technology development history, and a significant lead in efficiency is not attainable using the single-effect system with 0.6 to 0.8 COP that is planned to be adopted for this project, in particular.

To maintain competitiveness, our knowledge and expertise gained through this study, together with JCM's support, will build an EPC (engineering/procurement/construction) system featuring Japanese technologies. The source of engineering superiority lies on the technological capability that Japanese corporations have long cultivated. Procurement also incorporates expertise of Japanese businesses in selecting the optimum engine and refrigerating systems tailored to the specific hotel's electricity and thermal demand and other requirements. Work related to construction and maintenance will be based on advanced Japanese management technique for high quality services as it also aims to attain lower cost through localization.

Competing products will differ by how the CHP system succeeds in its diffusion process. In cases where CHP system successfully expands its market share, its competitor will be non-Japanese gas engines and absorption type refrigerating systems. If CHP fails to take hold in the market, electric power will be purchased from system power (PLN) and turbo-type refrigerating system will be adopted. While continued improvements are observed in surrounding environments of CHP systems, it still has a low penetration rate, and only few implementation examples are available especially when limited to consumer business field (Frost & Sullivan forecasts only a 70MW increase during 2014 in Indonesia[2]). At the same time, sharp increases in electricity prices, stable, improved gas supply situations centered on East Java area are serving as a favorable tailwind. In such a background, JCM's support is expected to give crucial momentum to the popularization process of CHP systems.

4) MRV structure

Development of MRV structure

We install a monitoring system which automatically measures and collect relevant data, to be individually confirmed by an engineering department employee of the hotel as data collection staff. The verified data then is approved by a person in charge of the facilities department as project manager. Fuji Electric Co., Ltd. and NTT Data Institute of Management Consulting, Inc. provide support in compiling reports, reporting, and verification. JQA stands by as TPE.

Selection of measuring instruments for monitoring

Device options of measuring instruments for monitoring (power meters, flow meters, and thermometers) have been already selected based on examinations to secure compatibility with JCM methodology.

Capacity building

Capacity building is carried out under the following two aspects; 1) MRV concept in JCM and 2) monitoring system usage methods. Depending on the situation, JQA conducts capacity building on Aspect 1 in this study associated with JCM methodology and PDD plan for hotel personnel. As for Aspect 2, Fuji Electric, Co., Ltd. explains the system overview. Following the actual system installation, Fuji Electric, Co., Ltd. will provide training for hotel employees on how to measure and store monitoring records.

5) Environmental integrity and Sustainable development in host country

Expected negative impact and its countermeasures

Possible adverse environmental effects include air pollution by gas engine exhaust, noise, and vibration. Measures to prevent such negative factors will be enforced observing the standard parameters defined by the Indonesian Environment Ministry. Regular monitoring of the relevant parameter is also being examined.

Air pollution	A denitration device installed to reduce NOX emissions
Noise	[Outdoors]Cooling tower → Sound proof walls are installed [Indoors]Engine exhaust sound → Silencer installed (2-stages), Exhaust fan → Rubber material is installed around the fan(sound absorption material)
Vibration	Vibrationproof rubber and coils are installed

Estimated positive effects and measures to ensure them

Positive effects include a securing stable power source by means of an on-site gas engine system, and a reduced environmental load by means of an absorption type refrigerating system. This study examines a system to allow the Fuji Electric, Co., Ltd. Tokyo main office to monitor operating status. The incorporation of this system will detect errors and malfunctions at the facility, and ensures expected favorable results.

Contributions for sustainable development in host country

In preparation for the future energy demand increase, Indonesia must effectively utilize precious domestic natural resources including natural gas. This project will enable utilization of energy from natural gas, with the incorporation of a system with high overall energy efficiency.

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

In view of attaining a JCM facility subsidy business approval for fiscal 2015, we plan to conclude an MOU with Hotel A. (Target: by the end of March 2015)

Following the MOU conclusion, we plan to provide support to obtain necessary licenses and permissions (captive power operation license and environmental impact survey).

(2) JCM methodology development

1) Eligibility criteria

This methodology development aims to investigate the CHP system installation project using gas engines and absorption type refrigerating systems. The eligibility criteria under examination are as follows:

System performance and technological advantages are considered to set benchmarks in Requirements 2 and 5 (absorption type refrigerating systems) and Requirement 6 (gas engines).

Although absorption type refrigerating systems enhance their COP values as it upgrades to double-effect and triple-effect systems, upon consideration of thermal demand and cost balance for the implementing facility, we are examining the possibility of a single-effect absorption type refrigerating system with relatively low COP value. Advanced technological performance and higher COP values are difficult to be set as requirements in this case. Benchmark COP values have been determined on a basis of a local survey of the absorption type refrigerating system market in Indonesia. We have listed products from the top share companies, to determine appropriate benchmarks.

Similar situations are also observed for gas engines, a small market share in Indonesia. We searched for gas engine suppliers (representative, etc.) in Indonesia, to verify their local development records. Gas engines supplied by these manufacturers are compiled into a list to set power generation efficiency benchmarks.

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

Reference emission amount setup and calculation

$RE_p = RE_{elec} + RE_{cool}$ ····· (Eq. 1)

Where,

RE_p	Total reference emissions during a given period p	(tCO_2/p)
RE_{elec}	Reference emissions from consumption of grid electricity during a given period p	(tCO_2/p)
RE_{cool}	Reference emissions from the production of chilled water during a given period p	(tCO_2/p)

$RE_{elec} = EG_{p,\,net} * EF_{elec}$ ····· (Eq. 2)

Where,

$EG_{p,\,net}$	Amount of net electricity generated by gas engine generator which displaces grid electricity during a given period p	(MWh/p)
EF_{elec}	CO_2 emission factor of regional grid electricity in Indonesia	(tCO_2/MWh)

$RE_{cool} = EC_{RE} * EF_{elec}$ ····· (Eq. 3)

Where,

EC_{RE}	Amount of electricity consumption equivalent to the COP of reference centrifugal chiller and the amount of electricity consumption equivalent to the heat capacity of chilled water produced by project *Absorption Chiller*	(MWh/p)

$EC_{RE} = [\, CG_{PJ} / (3.6 * 10^{-3}) \,] / COP_{RE}$ ····· (Eq. 4)

Where,

CG_{PJ}	Heat capacity of chilled water produced by *Absorption Chiller*s during a given period p	(TJ/p)
$3.6 * 10^{-3}$	Conversion factor from TJ to MWh	(TJ/MWh)

COP_{RE}	COP of reference centrifugal chiller under the standard temperature conditions	(–)

$$CG_{PJ}=\Sigma\{CW_{PJ,l} * C * (T_{CW,PJ,in,l} - T_{CW,PJ,out,l})\} \quad \cdots\cdots\cdots\cdots\cdots \quad \text{(Eq. 5)}$$

Where,

$CW_{PJ,l}$	Amount of chilled water produced by *Absorption Chiller* during the monitoring interval *l*	(ton)
C	Specific heat capacity of the chilled water (= 4.1868×10^{-6})	(TJ/ton)
$T_{CW,PJ,in,l}$	Average inlet temperature of the chilled water entering the *Absorption Chiller* during monitoring interval *l*	(° C)
$T_{CW,PJ,out,l}$	Average outlet temperature of the chilled water leaving the *Absorption Chiller* during monitoring interval *l*	(° C)
l	Monitoring intervals for monitoring the amount and temperature of chilled water produced during a given period p	(–)

Project emission amount calculation

$$PE_p = PE_{gen,p} + PE_{aux,p} \quad \cdots\cdots\cdots\cdots\cdots \quad \text{(Eq. 6)}$$

Where,

PE_p	Total project emissions during a given period p	(tCO_2/p)
$PE_{gen,p}$	Project emissions from natural gas consumed by gas engine generator during a given period p	(tCO_2/p)
$PE_{aux,p}$	Project emissions from electricity consumed by auxiliary equipment of project *Absorption Chiller* during a given period p	(tCO_2/p)

$$PE_{gen,p} = FC_{PJ,p} * NCV_p / 10^6 * CEF * 44 / 12 \quad \cdots\cdots\cdots\cdots\cdots \quad \text{(Eq. 7)}$$

Where,

$FC_{PJ,p}$	Amount of natural gas consumed by gas engine generator during a given period p	(Nm^3/p)
NCV_p	Net calorific value of natural gas consumed	(MJ/m^3)
CEF	Default emission factor of natural gas	(tC/TJ)

$PE_{aux,p} = \Sigma(EC_{aux,\,i,\,p} * EF_{elec})$ ····· (Eq. 8)

Where,

$EC_{aux,\,i,\,p}$	Amount of electricity consumed by auxiliary equipment i of project *Absorption Chiller* during a given period p	(MWh/p)

Calculation of emissions reductions

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

$ER_p = RE_p - PE_p$ ····· (Eq. 9)

3) Data and parameters fixed *ex ante*

Three pre-project parameters are being examined: reference refrigerator COP, grid emission factors, and carbon emission factors

As for the reference refrigerator COP, due to the fact this project is for a renovation on an existing facility, we have decided to substitute chilled-water production of a refrigerator with that of the largest refrigeration capacity in order to ensure maintainability of substituted refrigerators. It adopts the reference refrigerator COP value that corresponds to the largest refrigeration-capacity refrigerator.

Grid emission factor is determined by the latest data at validation defined in "Emission Factors of Electricity Interconnection Systems," in accordance with an approved methodology ID_AM001 "Power Generation by Waste Heat Recovery in Cement Industry" and ID_AM002 "Energy Saving by Introduction of High Efficiency Centrifugal Chiller," as long as there is no special command from the consortium.

Relevant data for natural gas carbon emission factor is taken from the "2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table 1.4."

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

1) Environmental impact assessment

According to the Ordinance Vol. 11, 2006, of the Environmental Minister, which defines businesses and activities mandated with appropriate environmental impact assessment, this project does not constitute the projects that require permission or license such as relevant assessments for conducting business.

2) Local stakeholder consultation

This project does not involve any interested parties other than those related to the hotel as the CHP system is installed on the hotel property, with no possible impact to local stakeholders beyond the hotel. Personnel at the hotel have expressed favorable comments regarding cost reduction and stable power supply.

3) Monitoring plan

An engineer and a hotel resident manager will be in charge of monitoring at the project site. The engineer will review directly-collected data for any abnormality or error. The data is then approved by the resident manager. The manager is also responsible for the monitoring process including calibrating facilities and meters. He/She will be held accountable for the project planning, enforcement, monitoring results and any reported details.

All the data except gas net heating values provided by gas companies will be automatically measured, collected, and saved by the monitoring system.

4) Calibration of measuring instruments

There are no adequate domestic regulations in place on calibrating measuring instruments for CO2 emission measuring in Indonesia. Therefore, the meters used in this project will comply with international standards, and calibration frequency will follow specifications and warranty provided by the relevant manufacturers. This method has also been adopted at an approved JCM methodology ID_AM001 Ver. 1.0 "Power Generation by Waste Heat Recovery in Cement Industry."

Conclusion and Next step

Through this study, we have confirmed the advantages in cost and CO_2 emission reduction, realized through the installation of CHP system using either an absorption type refrigerating system or a boiler at a hotel located in Surabaya, Indonesia, and to secure an independent power source.