MOEJ/GEC JCM Project Planning Study (PS) 2013
Final Report

「Energy Saving by High-efficiency Centrifugal Chiller」

（implemented by Nippon Koei Co., Ltd. and Ebara Refrigeration Equipment and Systems Co. Ltd.）

Study partners		PT. Ebara Indonesia PT Primatexco Indonesia PT. Argo Pantes
Project site		Banteng province, and West and Central Jawa provinces, Indonesia
Category of project		Energy efficiency
Description of project		The proposed JCM projects through this study aim to improve energy saving by introducing high-efficiency chiller in the factory of spinning industry in Indonesia. The project covers a spinning factory in Batang in Central Jawa province, Tangerang in Banteng province, and Bekasi in West Jawa province in Indonesia. Existing chillers will be replaced to high-efficiency chillers in these factories.
JCM methodology	**Eligibility criteria**	Following 5 eligibility criteria are set. [Criterion 1] Project chiller is a centrifugal water chiller using centrifugal compressor. [Criterion 2] COP for project chiller is more than 6.0. [Criterion 3] Regular check is done by manufacturer or agent who is authorized by the manufacturer on regular maintenance or equivalent activities. Frequency of the check is more than four (4) times annually. [Criterion 4] Ozone Depletion Potential (ODP) of the refrigerant used for project chiller is zero. [Criterion 5] The plan for recovery and destruction of refrigerant used for project chiller is prepared.
	Default values	Following 3 default values are set. a) Grid emission factor (EF) [tCO2/MWh]: official information from the government of Indonesia b) COP (reference chiller) (COP_{RE_PJ}) [---]: calculated based in the default values set ex ante c) COP (project chiller) (COP_{PJ}) [---]: specifications of project chiller prepared for the quotation or factory check by manufacturers
	Calculation of reference emissions	Reference emissions are calculated from the monitoring result of project chiller. $RE = EC_{PJ} * (COP_{RE\_PJ} / COP_{PJ}) * EF$ *RE : Reference Emissions [tCO2/y]* *EC_{PJ} : Power consumption by project chiller [MWh]* *COP_{RE_PJ} : COP of reference chiller (project condition) [---]*

		COP_{PJ} : COP of project chiller [---] *EF : Grid emission factor [tCO2/MWh]*
	Monitoring method	Monitoring point is the motor input of project chiller. Reading and recording based on the digital power consumption meter. The method and frequency is based in the current monitoring systems of factories (ref: in Primatexco, three times / day, recorded manually on the monitoring form)
GHG emission reductions		Following formula is employed for calculation of GHG emission reductions. ER = RE – PE ER : Emission reductions [tCO2] RE : Reference emissions [tCO2] PE : Project emissions[tCO2] The annual GHG emission reductions of PT Primatexco Indonesia and PT Argo Pantes are 156 [tCO2/y] and 205 [tCO2]/y], respectively.
Environmental impacts		The proposed JCM projects in this study are the renewal of existing chillers with high efficiency chillers. Thus, no additional environmental impacts are incurred by the projects. Local engineers confirmed that such renewal of chiller does not require any environmental impact assessment or applications to authorities.
Project and its financial plan		The proposed JCM projects in this study are the renewal of chillers in private spinning factories. The proposed JCM projects are already applied to Ministry of the Environment, Government of Japan as JCM model projects twice with concrete financial plan of the project.
Promotion of Japanese technologies		In this JCM project, Japanese technologies to be promoted are high-efficiency centrifugal chiller. Chillers manufactured by Japanese companies have COP over 6.0, which can achieve energy saving.
Sustainable development in host country		Indonesia is the land of perpetual summer and air-conditioning in factories and buildings are inevitable. The high efficiency chiller made by Japan contributes to not only saving energy but also improvement of working environment. Also, the Japanese manufacturer can provide after-sales service in order to maintain its performance properly.

JCM Project Planning Study (PS) 2013
"Energy Saving by High-efficiency Centrifugal Chiller"
(Host country: Indonesia)

Study Entity:

1. Study Implementation Scheme

This study was implemented by Nippon Koei Co., Ltd. and Ebara Refrigeration Equipment and Systems Co. Ltd., collaborating with following three companies.

PT. Ebara Indonesia	Local subsidiary company of Ebara Refrigeration Equipmentadn Systems Co., Ltd. Support for field work in the target textile companies and collection of local information on chiller and chiller market in Indonesia.
PT. Primatexco Indonesia	Textile and spinning company located in Pekalongang, Central Jawa Province. Collaborating on the study of chiller renewal.
PT. Argo Pantes	Textile and spinning company located near Jakarta. Collaborating on the study of chiller renewal.

2. Overview of Proposed JCM Project

(1) Description of Project Contents:

In this study, JCM methodology for energy efficiency in the spinning sector in Indonesia was elaborated. PT Primatexco and PT Argo Pantes collaborated for this study as the spinning factories in Indonesia and the study on renewal of chiller which is important for temperature management in factories and monitoring activities related to installation of high-efficiency chiller. In Indonesia, due to its tropical climate, chillers are operating all through the year and its ruinning cost is significant in the overall production cost. In this context, this study revealed the contribution of high-efficiency chiller for energy efficiency of the factories.

In this study, centrifugal chillers commonly used in such spinning factories are targeted and the JCM methodology on energy efficiency of chillers was developed.

(2) Situations of Host Country:

In September 2011, Indonesian government prepared National Action Plan for Reducing Greenhouse Gas Emissions (RAN-GRK) as a Presidential Regulation and has been promoting active mitigation measures in each sector. At the same time, National Energy Conservation Master Plan (RIKEN) was prepared and energy efficiency improvement in industrial and commercial sectors is promoted.

Indonesia agreed and signed the bilateral agreements on JCM with Japan in August 2013.

3. Study Contents

(1) JCM methodology development

a. Eligibility criteria

5 eligibility criteria are set for this methodology and all of them need to be met for application ofthis methodology. The reasons of selecting these criteria are as follows.

Table 1 Eligibility criteria

Criterion 1	Project chiller is a centrifugal water chiller using centrifugal compressor.
Criterion 2	COP for project chiller is more than 6.0.
Criterion 3	Regular check is done by manufacturer or agent who is authorized by the manufacturer on regular maintenance or equivalent activities. Frequency of the check is more than four (4) times annually.
Criterion 4	Ozone Depletion Potential (ODP) of the refrigerant used for project chiller is zero.
Criterion 5	The plan for recovery and destruction of refrigerant used for project chiller is prepared.

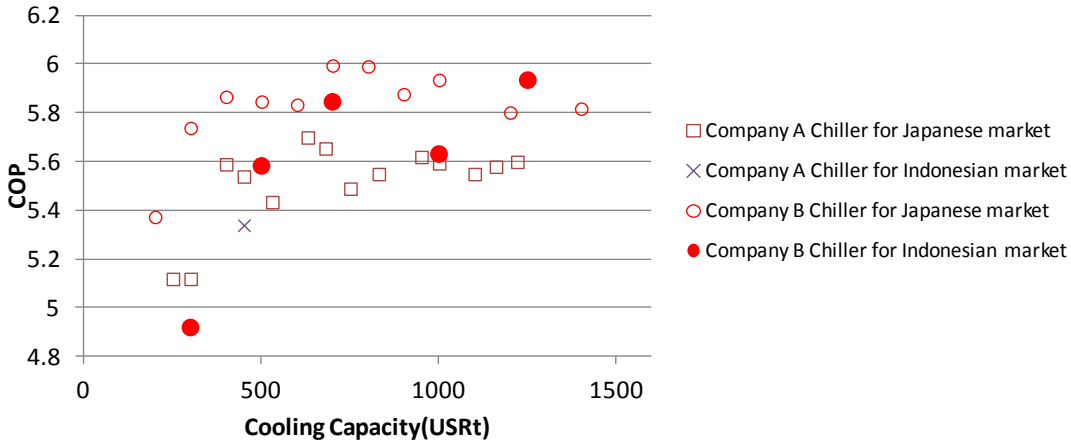
Source: Study Team

a) Eligibility criteria on「Type of chiller」

In Indonesia, air conditioning/chiller demand has increased because of high average temperature (more than 20 degree Celsius). This methodology was developed to calculate GHG emission reduction for renewal high-efficiency chiller or high-efficiency chiller newly introduced (hereinafter referred to as "project chiller"). The methodology is intended for the project chiller (i) that is functional effectively for large space, and (ii) that is utilized widely in Indonesia. Thus, centrifugal chillers which functions efficiently for the large space and requires only electricity for their operation, are selected.

b) Eligibility criteria on「COP of project chiller」

In order to ensure the eligibility of JCM project, project chiller should be a high efficiency model. Figure 1 shows COP values in cooling capacities of major manufacturers' chillers by except Japanese manufacturers. Also, the figure explains that all COPs are not greater than 6.0 in chiller market in Indonesia. To ensure that this methodology can contribute to energy efficiency, "COP value for project chiller is more than 6.0." is set as one of the eligibility citeria.



Source : Based on the manufacturer's information, Indonesian power specification, JIS etc., the above figure was prepared.[1] [2]

Figure 1 : COP Values of Major Chillers in Indonesia

c) Eligibility criteria on「Regular check」

Many manufacturing companies of Japan put emphasis in after sales care (checking and maintenance), and these activities are said to be evaluated as advantageous compared with

[1] Power specification in Indonesia : 400V/50Hz
[2] Conditions : chilled water in : 12 degree Celsius, chilled water out : 7 degree Celsius, cooling water in32 degree Celsius, cooling water out 37 degree Celsius

other companies. It is also the same in chiller market in Indonesia.

In Indonesia, currently the service contracts for the maintenance of chillers are limited. Remote monitoring which is common in Japan is not yet introduced in Indonesia though it is technically applicable.

While, PT. Ebara Indonesia regularly visits its customer at least 4 times a year to confirm the maintenance needs as technical sales activities.

To keep the high-efficiency and high reliability of chillers, regular checks are very important. Considering that the chillers are utilized all through the year, 4 times of regular check per year is recommended following the general practice in Japan.

As above, "Regular check is done by manufacturer or agent who is authorized by the manufacturer on regular maintenance or equivalent activities. Frequency of the check is more than four (4) times annually." is included as one of the eligibility criteria.

d) Eligibility criteria on「Ozone depletion potential」

In Japan, high environmental standards for refrigerant are set and manufactures are obliged to meet these standards. Most major chiller manufacturers (except for one manufacturer) apply HFC whose ODP is zero. Currently, HFC-134a and HFC-245fa are most commonly used refrigerant considering environmental impacts, efficiency and handling. Thus, "Ozone Depletion Potential (ODP) of the refrigerant used for project chiller is zero." is included in one of the eligibility criteria.

e) Eligibility criteria on「Collection and destruction plan of refrigerant」

Most refrigerants contain substances of ozone depletion and global warming. It is difficult to ignore them. In general, refrigerants are not emitted to the air without accident. However, it is possible that the refrigerants will be emitted to the air when it will be disposed. So it shall be handled properly.

In this methodology, it is required to prepare the plan for recovery and destruction of refrigerants when project chiller will be scraped. Consequently the eligibility criteria No. 5 was set. Descriptions of the plan mention that the user disposes the chiller properly with their responsibility.

b. Data and parameters fixed *ex ante*

Following default values are set with regard to calculation of reference emissions and project emissions in this methodology.

a) Grid Emission Factor (EF) [tCO2/MWh]

National Council on Climate Change (DNPI) announces in its website the grid emission factors in Indonesia. The target JCM projects are located in Jawa island, and they are expected to reduce the electricity consumption from JAMALI grid. Grid emission factor published by DNPI is shown in the table (right).

Thus, the latest JAMALI grid information, or the 2010 data is applied in this study. However, when these grid emission factors are updated, the latest data will be applied.

Table 2 Grid Emission Factor [tCO2/MWh]

Region	Year	Ex-ante	Ex-post
Jawa-Madura-Bali	2010	0.741	0.730
Sumatera	2010	0.748	0.749
West Kalimantan	2010	0.748	0.733
South/Central Kalimantan	2010	1.003	0.960
East Kalimantan	2010	0.820	0.861
Kotamobagu, Minahasa	2010	0.601	0.605
South/West Sulawesi	2010	---	0.625
Batam	2010	0.568	0.549

Source: National Council on Climate Change (DNPI)

b) Coefficient of Performance (reference) (COP_{RE_PJ}) [---]

Though COP is shown or is estimated based on the catalogues, actual figures may differ due to different concept of tolerance (error range), installation condition (cooling/chilled water temperatures and so on. Here in this methodology, COP_{RE_JIS} is set as the default values under the Japanese Industrial Standards (JIS) conditions. COP under the project condition COP_{RE_PJ} is calculated by adjusting this default value considering the project temperature setting.

$$COP_{RE\_PJ} = COP_{RE\_JIS} \times 33.0 / (T_{cooling\text{-}out} - T_{chilled\text{-}out} + 3.0)$$

COP_{RE_JIS}: COP of reference chiller in the JIS temperature condition.
$T_{cooling\text{-}out}$: Cooling water temperature, output [degree Celsius]
$T_{chilled\text{-}out}$: Chilled water temperature, output [degree Celsius]

COP_{RE_JIS} is shown in the table below. Currently, To set the COP_{RE_JIS}, COP of chillers by Company A, B and C which dominate Indonesian market were surveyed. Since Company C uses a refrigerant for their chiller that is under phase out by Montreal protocol, reference COP was calculated by averaging the COP of chillers manufactured by Company A and B. Since COP is different in each range of cooling capacity, COP_{RE_JIS} is calculated every 300 USRt.

Table 3 Default Value of COP_{RE_JIS}

Cooling capacity (USRt)	0 ~ 300	301 ~ 600	601 ~ 900	901 ~ 1,200	1,201 ~ 1,500
COP_{RE_JIS}	5.05	5.49	5.65	5.60	5.77

Source: Study Team

c) Coefficient of Performance (project) (COP_{PJ}) [---]

COP_{PJ} is the COP of the project chiller to be installed which meets all the eligibility criteria. To identify COP_{PJ}, conservative data (lower COP) of followings will be used based on the condition of the installation location.

1) Specifications of project chiller prepared for the quotation or factory check by manufacturer in accordance with the project conditions

2) Performance check result before shipping from the factory

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

In this methodology, leakage in CDM is not considered, and emissions reductions are calculated by subtracting project emissions from project emissions. The formula for calculation is shown below.

ER = RE – PE

ER :Emission Reductions [tCO2]
RE : Reference emission reductions [tCO2]
PE : Project emissins [tCO2]

Calculation method of reference emissions and project emissions are as follows. Applying COP_{RE_PJ} which is conservatively set for the calculation of calculating reference emission, contributes to the valid and conservative amount of emission reduction.

$RE = EF * EC_{PJ} * (COP_{RE\_PJ} / COP_{PJ})$

RE : Reference emissions [tCO2/y]
EF : Grid emission factor [tCO2/MWh]
EC_{PJ} : Power consumption of project chiller [MWh]
COP_{RE_PJ} : COP of reference chiller (under project condition) [---]
COP_{PJ} : Coefficient of performance (project chiller) [---]

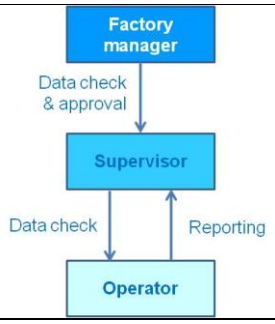
$PE = EF * EC_{PJ}$

PE : Project emissions [tCO2]
EF : Grid emission factor [tCO2/MWh]
EC_{PJ} : Power consumption of project chiller [MWh]

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

In parallel with this study, JCM PDD was prepared for two projects applied for the JCM Model Projects in FY 2013 (1^{st} batch and 4^{th} batch). The study items and result are as follows.

Table 4 Study on PDD

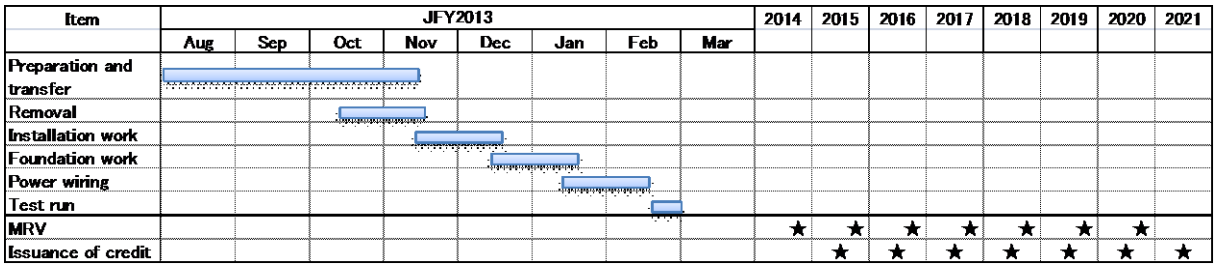
Study Items	Result
Project participants	International consortium made by both Japanese and Indonesian sides.
Duration	Starting operation from 2014, and MRV is conducted 7 years to accumulate credit between 2014 and 2020.
Eligibility criteria	5 eligibility criteria were confirmed. Criterion 1: Type of chiller→Electric centrifugal chiller Criterion 2: COP of Project Chiller→6.2 Criterion 3: Regular check→4 times annualy Criterion 4: Ozone depletion potential (ODP) =0 Criterion 5: Recovery and destruction of refrigerant→ consent
Project emissions and monitoring point	Project emissions: CO_2 from power consumption of project chiller Monitoring point: Motor input of project chiller
Monitoring plan	Power consumption is monitored with digital meter. Remote monitoring can also be applied. Reporting of monitoring data is done through making most of the existing flow in each factory so that the burden on project owner is reduced. 
Environmental impact assessment	There is no additional environmental burden originated from by project implementation. There is no need to conduct EIA on renewal of chillers or apply for government authorities. Thus two projects require no specific actions regarding environmental impact assessment.
Comments from local stakeholders	These projects are not the construction of new spinning factory and impact affecting outside the factory by the renewal of chillers is not expected. Thus, there is no impact on the local stakeholders besides the staff of the factory.

Source: Study Team

(3) Project development and implementation

a. Project planning

The target JCM projects are the renewal of chillers in the spinning factories by Indonesian private companies. As explained above, these projects prepared concrete financial plans before applying for the JCM model projects. In PT. Primatexco, one chiller was installed and test running was successfully done in February 2014. Following table shows the schedule of PT. Priamtexco, which was applied for JCM model project (1st batch).



Source: Study Team

Figure 2 Schedule of JCM Project of PT. Primatexco

b. MRV structure

Procedures of operation and maintenance of chillers are already established in both companies (PT. Primatexco and PT. Argo Pantes) as routine work because the JCM projects are renewal of chillers in the factories only. The MRV requirements for the project owners are monitoring and reporting, which are already included in the routine procedures of operation and maintenance.

c. Permission and authorization for the project implementation

The JCM projects are the renewal of chillers in spinning factories and no additional permissions are required. There is no additional equipment installation which needs permission and authorization as well.

Though general process related to custom clearance is requested, the chillers are general industrial products and do not require any special permissions.

d. Japan's contribution

Japanese technologies to be introduced by this JCM project are "high-efficiency centrifugal chillers". Through this study, Japanese centrifugal chillers have higher COP compared with the chillers commonly used in Indonesian market thus they can contribute better to energy saving. Top share chillers in Indonesian market are selected by the customers due to their cheaper initial cost (it is estimated the cost difference are around 20 to 50%), and support through JCM will work efficiently for introducing Japanese technologies more.

In reality, the spinning companies which submitted the application for the scheme of JCM model project mentioned that this scheme supported them to smoothly renew their chiller with Japanese technologies.

e. Environmental integrity

The proposed JCM projects are the renewal of chillers, cooling towers and related facilities such as piping in the factories of PT. Primatexco and PT. Argo Pantes. Environmental laws and regulations of Indonesia do not oblige any approval or survey for these projects. Followings were studied related to the positive and negative environmental impacts.

a) Assuring positive environmental impacts: improvement of working condition in factories, quality control of products in spinning factories
b) Avoiding negative environmental impacts: Freon gas is indicated as the hazardous wastes in 1999 and under the management of manifest system for the collection and transportation from the sources to treatment plant. Freon gas treatment plant was

constructed in Bogor, near Jakarta by the support of the Ministry of the Environment of Japan in 2007. It is necessary to prepare the collection and destruction plan of the refrigerant so that the refrigerant in the project chiller will not be disposed into air.

f. Sustainable development in host country

Indonesia is located near the equator and the air conditioning is inevitable for any factories and buildings. Hence the introduction of high-efficiency chillers will achieve higher energy efficiency and reduce the energy consumption in the country.

Improvement of air-conditioning also contributes to the higher labor efficiency by better working condition and better quality control of the products.

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

The studied JCM projects was already applied as JCM model projects funded by the Ministry of the Environment of Japan in this fiscal year. Generally speaking, spinning factories operate several chillers (500 USRt class). Thus, each factory will introduce a chiller every several years

There are many other clients of Ebara Refrigeration Equipment and Systems Co., Ltd. doing business in spinning, other industry and commercial sector. Thus, there are high potential of finding the partner for applying for JCM model projects.

The issues for this JCM methodology are that the technologies related to centrifugal chillers and refrigerant are being developed day by day and COP values and refrigerant on this methodologies needs updating while at this moment Japanese manufacturers have advantages on such technologies.