JCM Project Design Document Form

A. Project description

A.1. Title of the JCM project

Energy saving by installation of evaporator with mechanical vapor recompression and high-efficiency chiller.

A.2. General description of project and applied technologies and/or measures

A high-efficiency centrifugal chiller and an evaporator with mechanical vapor recompression are installed to reduce CO2 emissions in the amino acid manufacturing plant. The project chiller, whose COP is higher than a reference chiller, contributes to reduce the electricity consumption. Mechanical vapor recompression is introduced in vapor line and vapor can be recovered as Steam. Although electricity consumption by the re-compressor is increased, steam consumption can be reduced, which leads to reduction of total CO2 emissions.

A.3. Location of project, including coordinates

Country	Kingdom of Thailand
Region/State/Province etc.:	Rayong
City/Town/Community etc:	399 IRPC Industrial Zone, Moo 1, Choengnoen District
Latitude, longitude	12°41'00.8" N 101°19'14.8"E

A.4. Name of project participants

The Kingdom of Thailand	THAI KYOWA BIOTECHNOLOGIES CO., LTD
Japan	KYOWA HAKKO BIO CO., LTD.

A.5. Duration

Starting date of project operation	1/1/2019
Expected operational lifetime of project	8 years

A.6. Contribution from Japan

The proposed project was partially supported by the Ministry of the Environment, Japan through the Financing Programme for JCM Model projects, which provided financial support of less than half of the initial investment for the projects in order to acquire JCM credits.

B. Application of an approved methodology(ies)

B.1. Selection of methodology(ies)

Selected approved methodology No.	TH_AM005
Version number	Ver2.0
Selected approved methodology No.	TH_AM012
Version number	Ver1.0

B.2. Explanation of how the project meets eligibility criteria of the approved methodology [TH_AM005]

<table>
<tr><th>Eligibility criteria</th><th>Descriptions specified in the methodology</th><th>Project information</th></tr>
<tr><td>Criterion 1</td><td>Project chiller is a non-inverter type centrifugal chiller with a capacity which is less than or equals to 1,500 USRt.
Note : 1 USRt = 3.52 kW</td><td>A non-inverter type centrifugal chiller (RTBF150) manufactured by EBARA (THILAND) LIMITED., whose capacity is 1,500 USRt, is installed for this project.</td></tr>
<tr><td>Criterion 2</td><td>COP for project chiller i calculated under the standardizing temperature conditions*1 ($COP_{PJ,tc,i}$) is more than the threshold COP values set in the table below. (“x” in the table represents cooling capacity per unit.)

<table>
<tr><th>Cooling capacity per unit [USRt]</th><th>300≤x<500</th><th>500≤x<800</th><th>800≤x≤1500</th></tr>
<tr><td>Threshold COP value</td><td>5.67</td><td>5.81</td><td>6.05</td></tr>
</table>

$COP_{PJ,tc,i}$ is calculated by altering the temperature conditions of COP of project chiller i ($COP_{PJ,i}$) from the project specific conditions to the standardizing conditions. $COP_{PJ,i}$ is derived from specifications prepared for the quotation or factory acceptance test data by manufacturer.</td><td>COP for the project chiller calculated under the standardizing temperature conditions is 6.4 with a cooling capacity of 1,500 USRt, which is more than the threshold COP value set in this criterion.</td></tr>
</table>

	[equation to calculate $COP_{PJ,tc,i}$] $\mathbf{COP_{PJ,tc,i} = COP_{PJ,i} \times [(T_{cooling-out,i} - T_{chilled-out,i} + TD_{chilled} + TD_{cooling}) \div (37 - 7 + TD_{chilled} + TD_{cooling})]}$ $COP_{PJ,tc,i}$: COP of project chiller *i* calculated under the standardizing temperature conditions* [-] $COP_{PJ,i}$: COP of project chiller *i* under the project specific conditions [-] $T_{cooling-out,i}$: Output cooling water temperature of project chiller *i* set under the project specific conditions [degree Celsius] $T_{chilled-out,i}$: Output chilled water temperature of project chiller *i* set under the project specific conditions [degree Celsius] $TD_{cooling}$: Temperature difference between condensing temperature of refrigerant and output cooling water temperature 1.5 degree Celsius set as a default value [degree Celsius] $TD_{chilled}$: Temperature difference between evaporating temperature of refrigerant and output chilled water temperature, 1.5 degree Celsius set as a default value [degree Celsius] *1 : The standardizing temperature conditions to calculate $COP_{PJ,tc,i}$ Chilled water: output 7 degrees Celsius input 12 degrees Celsius Cooling water: output 37 degrees Celsius input 32 degrees Celsius	
Criterion 3	Periodical check is planned at least one (1) time annually.	Periodical check is annually planned by the manufacturer.
Criterion 4	Ozone Depletion Potential (ODP) of the refrigerant used for project chiller is zero.	The refrigerant used for project chiller is HFC-245fa whose ODP is zero.
Criterion 5	A plan for prevention of releasing refrigerant used for	The project chiller has been newly

	project chiller is prepared. In the case of replacing the existing chiller with the project chiller, a plan for prevention of releasing refrigerant used in the existing chiller to the air (e.g. re-use of the equipment) is prepared. Execution of this plan is checked at the time of verification, in order to confirm that refrigerant used for the existing one replaced by the project is prevented from being released to the air.	installed at the project site. Measures to prevent releasing refrigerant used in the project chiller to the air will be taken when it is used and replaced.

[TH_AM012]

Eligibility criteria	Descriptions specified in the methodology	Project information
Criterion 1	The project installs evaporator(s) which applies mechanical vapor recompression.	Evaporator with mechanical vapor recompression (VEV-2-8-LEP, plate evaporator type), manufactured by HISAKA WORKS LTD., is installed.

C. Calculation of emission reductions

C.1. All emission sources and their associated greenhouse gases relevant to the JCM project

[TH_AM005]

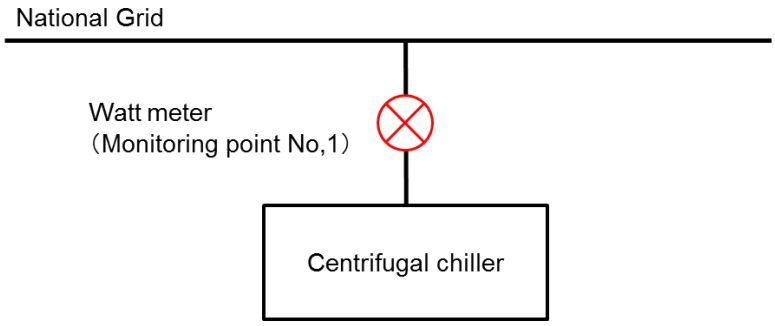
Reference emissions	
Emission sources	GHG type
Power consumption by reference chiller	CO_2
Project emissions	
Emission sources	GHG type
Power consumption by project chiller	CO_2

[TH_AM012]

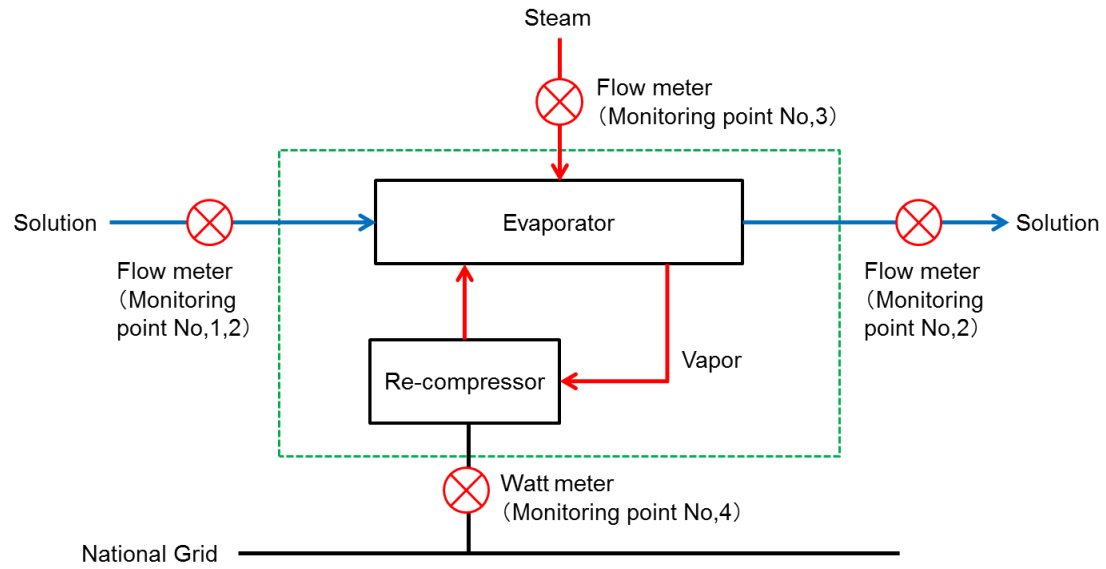
Reference emissions	
Emission sources	GHG type
Consumption of steam supplied from steam generator by reference evaporator	CO_2
Project emissions	
Emission sources	GHG type
Consumption of steam supplied from steam generator by project evaporator	CO_2
Electricity consumption by project evaporator	CO_2

C.2. Figure of all emission sources and monitoring points relevant to the JCM project

[TH_AM005]



[TH_AM012]



The data monitored and required for verification and issuance are kept and archived for two years after the final issuance of credits.

C.3. Estimated emissions reductions in each year

Year	Estimated Reference emissions (tCO_2e)	Estimated Project Emissions (tCO_2e)	Estimated Emission Reductions (tCO_2e)
2013	-	-	-
2014	-	-	-
2015	-	-	-
2016	-	-	-

2017	-	-	-
2018	-	-	-
2019	N/A	N/A	1,526
2020	N/A	N/A	1,526
2021	N/A	N/A	1,526
2022	N/A	N/A	1,526
2023	N/A	N/A	1,526
2024	N/A	N/A	1,526
2025	N/A	N/A	1,526
2026	N/A	N/A	1,526
2027	-	-	-
2028	-	-	-
2029	-	-	-
2030	-	-	-
Total (tCO_2e)			12,208

D. Environmental impact assessment	
Legal requirement of environmental impact assessment for the proposed project	No

E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

In order to collect comments from stakeholders, a local stakeholder consultation has been conducted on 9 May 2018 at the plant where the project was implemented in Rayong Prefecture, Thailand. The schedule and participants of the meetings are provided below.

Date: 9 May 2018

Venue: THAI KYOWA BIOTECHNOLOGIES CO., LTD.

Address: 399 IRPC Industrial Zone, Moo 1, Tambon Choengnoen, Amphur Muang Rayong, Rayong 21000, Thailand

Agenda:

1. Opening Remarks by THAI KYOWA BIOTECHNOLOGIES CO., LTD.
2. Introduction about THAI KYOWA BIOTECHNOLOGIES CO., LTD.

3. Project Overview and introduced Technology and Facility by KYOWA HAKKO BIO CO. LTD. 4. Q&A 5. Site tour 6. Closing After explanation about the proposed JCM project, questions and comments were solicited from the stakeholders. A summary of the comments received and consideration of those comments are provided in Section E.2. below.

E.2. Summary of comments received and their consideration

Stakeholders	Comments received	Consideration of comments received
Manager, Review and Monitoring Office, Thailand Greenhouse Gas Management Organization (TGO), Ministry of Natural Resources and Environment	Have both of the refrigerators been already installed? How much is the actual amount of CO_2 emissions reductions brought by installing the refrigerators?	Both refrigerators have been installed. Since the trial operation has been just implemented, the actual amount of reductions is still unknown. It is scheduled to start actual operation and monitoring from October 2018. No further action is needed.
	Have you taken measures against the leakage of refrigerant from the existing refrigerators?	Refrigerant recovery was carried out by the contractor according to the manufacturer's manual. No further action is needed.
	Are the emission reductions achieved by reducing steam consumption and electricity consumption? When will the methodology of vapor recompression be completed?	Yes. The emission reductions will be achieved by the reduction of steam consumptions and electricity consumptions. We anticipate that the methodology will be approved this year. No further action is needed.
	KYOWA HAKKO BIO CO. LTD. has Science based targets (SBT). On the other hand, does THAI	There is no SBT goal specifically set for THAI KYOWA BIOTECHNOLOGIES CO, LTD.

	KYOWA BIOTECHNOLOGIES CO, LTD. set SBT?	We are following 20% reduction goal as a group goal. No further action is needed.
Technical Officer, Approval and Monitoring Office, TGO	How much amount of the CO_2 emissions will be reduced by the refrigerator and the other equipment? (For example, how much t-CO_2 can be reduced per hour?)	Emissions reductions by introducing project refrigerators are calculated by the ratio of COP between project refrigerator and reference refrigerator. COP of Project refrigerator is 6.4, on the other hand, that of reference refrigerator is 6.05. The accurate amount of emissions reductions is unknown until the actual operation starts. No further action is needed.
	Does it need to monitor the temperature of inlet and outlet water to calculate the emissions reductions? How did you confirm that the project refrigerators meet the criteria for the operating conditions of the methodology?	The temperature of inlet and outlet, flow rate are monitored, but they are not needed to calculate the emission reductions. The emission reductions are calculated by the ratio of COP between project and reference. We confirmed the project refrigerators meet the criteria by catalogue and inspection of equipment by the manufacturer. No further action is needed.
	Do you have a plan to install any other energy-saving equipment than this project?	We have installed high efficiency air-conditioning and LED, etc. in parallel with this project. No further action is needed.

F. References

Reference lists to support descriptions in the PDD, if any.

Annex

Estimated emissions reductions in each year

[For centrifugal chiller]

Year	Estimated Reference emissions (tCO_2e)	Estimated Project Emissions (tCO_2e)	Estimated Emission Reductions (tCO_2e)
2013	-	-	-
2014	-	-	-
2015	-	-	-
2016	-	-	-
2017	-	-	-
2018	-	-	-
2019	3,910.5	3,696.7	213
2020	3,910.5	3,696.7	213
2021	3,910.5	3,696.7	213
2022	3,910.5	3,696.7	213
2023	3,910.5	3,696.7	213
2024	3,910.5	3,696.7	213
2025	3,910.5	3,696.7	213
2026	3,910.5	3,696.7	213
2027	-	-	-
2028	-	-	-
2029	-	-	-
2030	-	-	-
Total (tCO_2e)	31,284.1	29,573.2	1,704

[For Evaporator with Mechanical Vapor Recompression]

Year	Estimated Reference emissions (tCO_2e)	Estimated Project Emissions (tCO_2e)	Estimated Emission Reductions (tCO_2e)
2013	-	-	-
2014	-	-	-
2015	-	-	-

2016	-	-	-
2017	-	-	-
2018	-	-	-
2019	1,669.0	355.9	1,313
2020	1,669.0	355.9	1,313
2021	1,669.0	355.9	1,313
2022	1,669.0	355.9	1,313
2023	1,669.0	355.9	1,313
2024	1,669.0	355.9	1,313
2025	1,669.0	355.9	1,313
2026	1,669.0	355.9	1,313
2027	-	-	-
2028	-	-	-
2029	-	-	-
2030	-	-	-
Total (tCO_2e)	13,352.1	2,847.2	10,504

Revision history of PDD		
Version	Date	Contents revised
1.0	##/##/2021	First edition