JCM Project Design Document Form

A. Project description

A.1. Title of the JCM project

Installation of High Efficiency Air Conditioning System and Chillers in Semiconductor Factory

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

This project newly installs high efficiency Centrifugal Chillers and Swirling Induction type air-conditioning system for a newly constructed clean room (6,250m^2) to reduce CO_2 emissions from electricity consumption in the refurbishment of LSI (Large Scale Integration) and image sensor manufacturing plant at Bangkadi Industrial Park. The project air-conditioning system does not mix the air in the room and cools only the room's lower layer air, so less cooling capacity are required compare to the reference system. Air flow rate can also be set lower than that of the reference system, reducing power consumption of fan motor. In addition, the project chiller is equipped with an inverter which contributes to energy-saving by controlling the rotation speed of the compressor motor so as to continuously regulate the cooling capacity against the load to provide air conditioning system with chilled water.

A.3. Location of project, including coordinates

Country	Kingdom of Thailand
Region/State/Province etc.:	Pathumthani
City/Town/Community etc:	Tambol Bangkadi Amphur Muang
Latitude, longitude	13°58'47.6"N 100°33'23.0"E

A.4. Name of project participants

The Kingdom of Thailand	Sony Device Technology (Thailand) Co., Ltd.
Japan	Sony Semiconductor Manufacturing Corporation

A.5. Duration

Starting date of project operation	01/04/2017
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 (MOEJ) 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.

As for the transfer of technology, the manufacturers provided instruction and manuals for operation and maintenance during the initial installation. Maintenance support by the manufacturers will also be available upon request.

B. Application of an approved methodology(ies)

B.1. Selection of methodology (ies)

Selected approved methodology No.	TH_AM003
Version number	01.0
Selected approved methodology No.	TH_AM006
Version number	01.0

B.2. Explanation of how the project meets eligibility criteria of the approved methodology [TH_AM003]

<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 centrifugal chiller with a capacity which is less than or equal to 1,500 USRt.
* 1 USRt = 3.52 kW</td><td>The three installed chillers are the model “ETI-50” made by Mitsubishi Heavy Industries, Ltd. The project chillers are a centrifugal type with the capacity of 500 USRt each.</td></tr>
<tr><td>Criterion 2</td><td>COP for project chiller i calculated under the standardizing temperature conditions* ($COP_{PJ,tc,i}$) is more than the threshold COP values set in the table below. (“x” in the table represents cooling capacity per unit.)
<table><tr><td>Cooling capacity per unit (USRt)</td><td>300≤x≤450</td><td>450<x≤550</td><td>550<x≤825</td><td>825<x≤1,500</td></tr><tr><td>Threshold COP value</td><td>5.59</td><td>5.69</td><td>5.85</td><td>6.06</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>The COP of chiller 1, 2&3 ($COP_{PJ,\ tc,\ i}$) was calculated under the standardizing temperature conditions in the chiller inspection records provided by the manufacturer. It is 6.15 (chiller 1), 6.59 (chiller 2&3) and is more than 5.69 in the table on the left.

[Calculation result for chiller 1]
6.15 = 6.15 x [(37 - 7 + 1.5 + 1.5) ÷ (37 – 7 + 1.5 + 1.5)]</td></tr>
</table>

	[equation to calculate $COP_{PJ,tc,i}$] $COP_{PJ,tc,i} = COP_{PJ,i} \times [(T_{cooling\text{-}out,i} - T_{chilled\text{-}out,i} + TD_{chilled} + TD_{cooling}) \div (37 - 7 + TD_{chilled} + TD_{cooling})]$ $COP_{PJ,tc,i}$: COP of project chiller *i* calculated under the standardizing temperature conditions* [-] $COP_{PJ,i}$: COP of project chiller *i* under the project specific conditions [-] $T_{cooling\text{-}out,i}$: Output cooling water temperature of project chiller *i* set under the project specific conditions [degree Celsius] $T_{chilled\text{-}out,i}$: 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] *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	[Calculation result for chiller 2 and 3] $6.59 = 8.37 \times [(37 - 14 + 1.5 + 1.5) \div (37 - 7 + 1.5 + 1.5)]$ The value (6.15) is used not only for chiller1 but also for chiller 2&3 since the three project chillers are the exactly same model with the capacity of 500 USRt each. The value is more conservative and ensures net emission reductions of the proposed project.
Criterion 3	Periodical check is planned more than one (1) time annually.	An annual inspection, including washing of the tubes, is carried out by the manufacturer and a maintenance report is provided.
Criterion 4	Ozone Depletion Potential (ODP) of the refrigerant used for project chiller is zero.	The refrigerant type of the project chiller is "ASAHIKLIN AK-134a (HFC-134)" by AGC Chemicals, whose ODP is zero.
Criterion 5	A plan for prevention of releasing refrigerant used for 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	To prevent the release of refrigerant into the atmosphere due to the project, at the time of chiller removal, the project owner plans to

	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.	collect the refrigerant from the project chiller removed by using a refrigerant recovery machine and ensure the storage of the collected refrigerant. A letter of consent on not releasing refrigerant used for the project chiller was prepared by the participants from both sides.

[TH_AM006]

Eligibility criteria	Descriptions specified in the methodology	Project information
Criterion 1	Displacement ventilation air conditioning unit, whose specification of velocity of the discharged air is designed to be more than 0.5 m/s and equals to or less than 1.0 m/s, is installed in the cleanroom of semiconductor plant.	The velocity of discharged air in this air conditioning system is set at 0.83 m/s.
Criterion 2	The project displacement ventilation air conditioning unit is constituted of at least cooling coil, HEPA (high efficiency particular air) or ULPA (ultra low penetration air) filter and air supply fan in one unit.	HEPA is adopted in Class 10,000 areas with a cooling coil and air supply fan while ULPA is adopted in Class 1,000 areas with a cooling coil and air supply fan.
Criterion 3	The project displacement ventilation air conditioning unit is designed to meet the threshold values of Class 6 or class 7 of airborne particulate cleanliness class set by ISO 14644-1:2015[1].	Class 6 and Class 7 are adopted in the cleanroom.
Criterion 4	The project displacement ventilation air conditioning unit only supplies cooled air.	Only a cold water coil is installed in this system so only cooled air is supplied.

C. Calculation of emission reductions

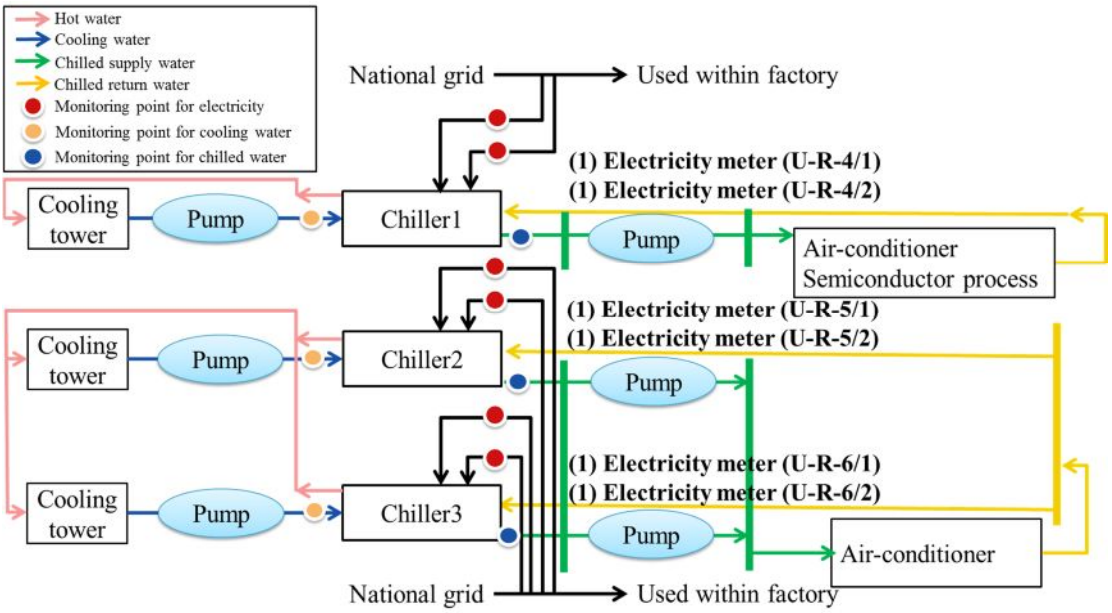
C.1. All emission sources and their associated greenhouse gases relevant to the JCM project

Reference emissions	
Emission sources	GHG type
Power consumption by mixing ventilation air conditioning unit	CO_2
Power consumption by reference outdoor-air processing unit (excluded from calculation of reference emissions)	CO_2
Power consumption by reference chiller (excluded from calculation of reference emissions)	CO_2

Power consumption by reference exhaust fan (excluded from calculation of reference emissions)	CO_2
Power consumption by reference chiller	CO_2
Project emissions	
Emission sources	GHG type
Power consumption by displacement ventilation air conditioning unit	CO_2
Power consumption by project outdoor-air processing unit (excluded from calculation of project emissions)	CO_2
Power consumption by project chiller (excluded from calculation of project emissions)	CO_2
Power consumption by project exhaust fan (excluded from calculation of project emissions)	CO_2
Power consumption by project chiller	CO_2

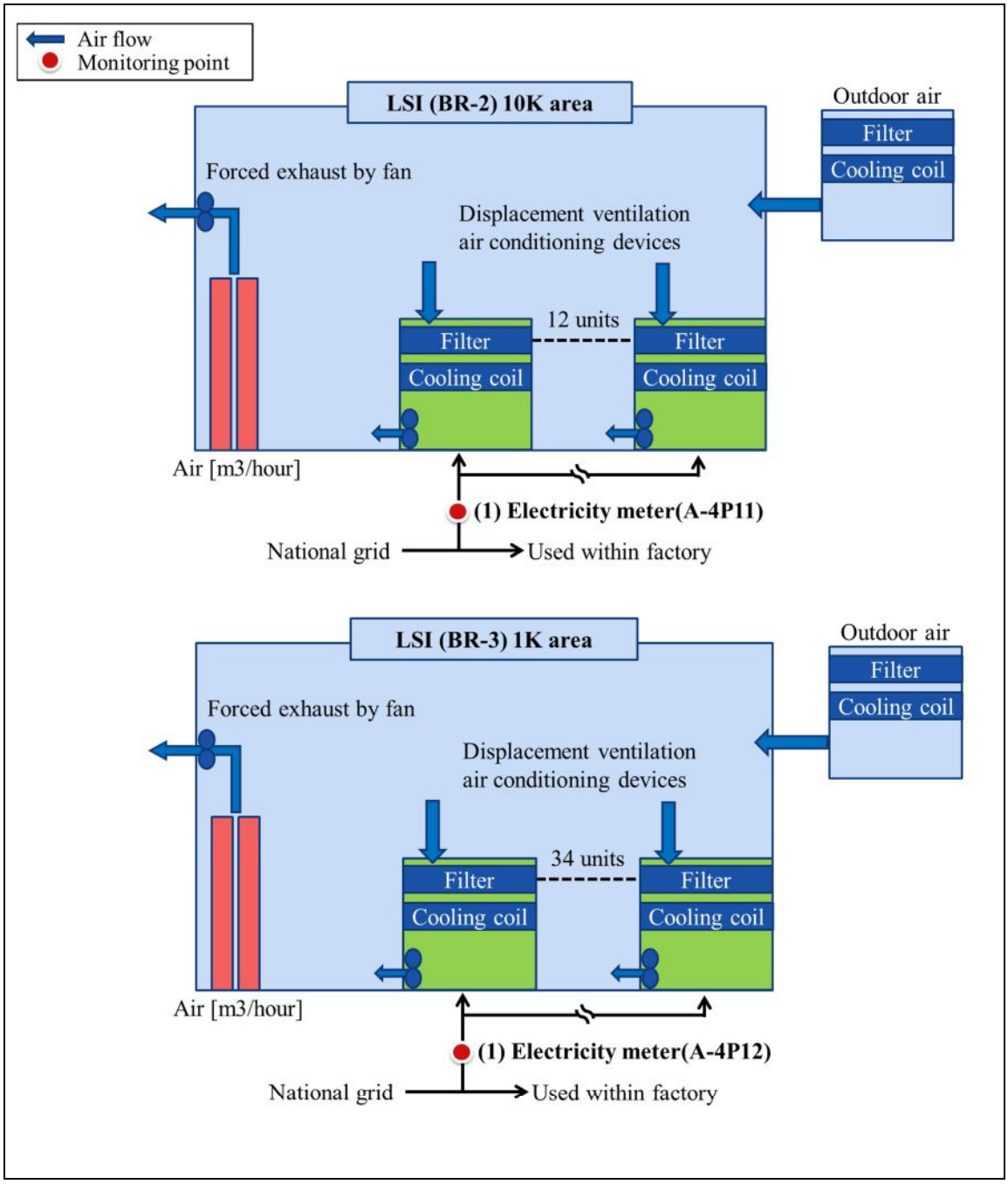
C.2. Figure of all emission sources and monitoring points relevant to the JCM project

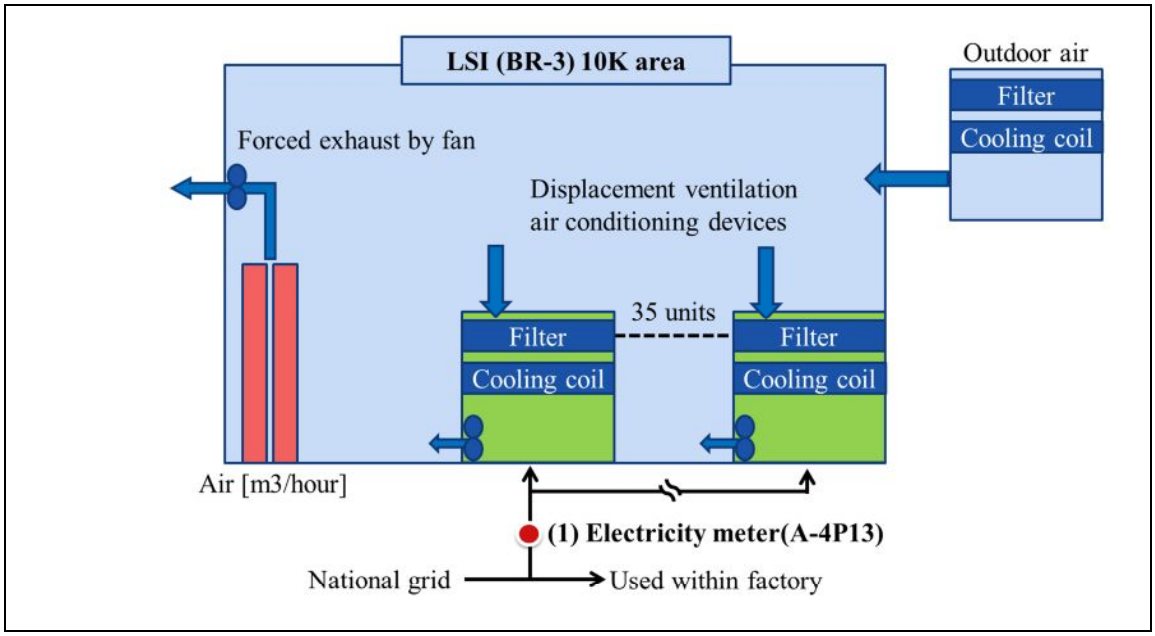
[TH_AM003]



* Two electricity meters are installed in each chiller, because each chiller has two compressors.

[TH_AM006]


Air flow
Monitoring point
LSI (BR-2) 10K area
Outdoor air
Filter
Cooling coil
Forced exhaust by fan
Displacement ventilation
air conditioning devices
12 units
Filter
Cooling coil
Filter
Cooling coil
Air [m3/hour]
(1) Electricity meter(A-4P11)
National grid
Used within factory
LSI (BR-3) 1K area
Outdoor air
Filter
Cooling coil
Forced exhaust by fan
Displacement ventilation
air conditioning devices
34 units
Filter
Cooling coil
Filter
Cooling coil
Air [m3/hour]
(1) Electricity meter(A-4P12)
National grid
Used within factory



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	n/a	n/a	2,820
2018	n/a	n/a	3,744
2019	n/a	n/a	3,744
2020	n/a	n/a	3,744
2021	n/a	n/a	3,744
2022	n/a	n/a	3,744
2023	n/a	n/a	3,744
2024	n/a	n/a	3,744
2025	n/a	n/a	922
2026	-	-	-
2027	-	-	-
2028	-	-	-
2029	-	-	-
2030	-	-	-

Total (tCO_2e)	29,950

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 cover a diverse group of stakeholders, Sony Device Technology (Thailand) Co., Ltd. held a local stakeholder consultation with the Thailand Greenhouse Gas Management Organization (TGO) and E-Square Inc. at Sony Device Technology (Thailand) Co., Ltd. on November 22nd, 2016. The member of TGO, Sony Device Technology (Thailand) Co., Ltd., Sony Corporate Services (Japan) Corporation. and E-Square Inc. participated in the consultation.

E.2. Summary of comments received and their consideration

Stakeholders	Comments received	Consideration of comments received
Thailand Greenhouse Gas Management Organization	How were the attendees selected for the LSC (Local Stakeholder Consultation) and would it be possible for organizing the LSC to be held for academic researchers, students and manufacturers of similar semiconductors in Thailand in order to promote knowledge and technology sharing with regard to the JCM projects?	The attendees were selected after consideration by TGO prior to the LSC. If third parties or organizations were invited to the LSC, the content of the consultation would need to be reconsidered and limited accordingly as confidential information regarding manufacturing is also included and reported through the LSC. *No action is needed.*
	Is an inverter applied to the project chillers?	An inverter is applied to all of the project chillers. *No action is needed.*
	How is the COP (Coefficient of Performance) value of the chillers calculated and how did Sony measure	The COP was calculated based on the cooling capacity and electricity consumption which were measured

	it?	and published at the time of the shipping by the manufacturer. *No action is needed.*
	Does the COP reach the maximum value at full load?	This project installs an inverter type chiller which can operate at the precise capacity needed to meet the demand. The COP value of the inverter type chiller in this project generally reaches its maximum in the following conditions: 1) cooling water is 12 degrees (lower limit) and 2) the part load ratio is between 40% and 60%. *No action is needed.*
	Is it possible to implement the JCM projects according to the original schedule of the JCM project cycle in spite of the fact that the two methodologies are still under approval?	We are currently moving forward with the implementation of these projects as per the original schedule and are aiming for the issuance of credits by March 2018 at the latest. *No action is needed.*
	What is the capacity of the project chillers?	The capacity is 500 USRt for each chiller in the proposed project. *No action is needed.*
Sony Device Technology (Thailand) Co., Ltd.	What is the benefit for Thailand through these JCM projects?	GHG emission reductions with advanced energy saving can be achieved by installing high efficiency technologies transferred from Japan through these projects. *No action is needed.*
Sony Corporate Services (Japan)	How will the credits acquired through these JCM projects be divided?	More than half of the total credits will be allocated to the Japanese

Corporation.		government. The project participants will divide and allocate the rest of credits through the consultation between Thailand and Japanese side. *No action is needed.*

F. References

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

Annex

Estimated emissions reductions in each year(TH_AM003)			
Year	Estimated Reference emissions (tCO_2e)	Estimated Project Emissions (tCO_2e)	Estimated Emission Reductions (tCO_2e)
2013	-	-	-
2014	-	-	-
2015	-	-	-
2016	-	-	-
2017	3,165.8	2,929.0	236
2018	4,202.0	3,887.7	314
2019	4,202.0	3,887.7	314
2020	4,202.0	3,887.7	314
2021	4,202.0	3,887.7	314
2022	4,202.0	3,887.7	314
2023	4,202.0	3,887.7	314
2024	4,202.0	3,887.7	314
2025	1,036.1	958.6	77
2026	-	-	-
2027	-	-	-
2028	-	-	-
2029	-	-	-
2030	-	-	-
Total (tCO_2e)			2,511

Estimated emissions reductions in each year(TH_AM006)			
Year	Estimated Reference emissions (tCO_2e)	Estimated Project Emissions (tCO_2e)	Estimated Emission Reductions (tCO_2e)
2013	-	-	-
2014	-	-	-
2015	-	-	-
2016	-	-	-
2017	2,916.2	331.5	2,584
2018	3,870.6	440.4	3,430
2019	3,870.6	440.4	3,430
2020	3,870.6	440.4	3,430
2021	3,870.6	440.4	3,430
2022	3,870.6	440.4	3,430
2023	3,870.6	440.4	3,430
2024	3,870.6	440.4	3,430
2025	954.3	108.4	845
2026	-	-	-
2027	-	-	-
2028	-	-	-
2029	-	-	-
2030	-	-	-
Total (tCO_2e)			27,439

Revision history of PDD		
Version	Date	Contents revised
1.0	06/11/2017	First edition
2.0	20/02/2018	Second edition