JCM Proposed Methodology Form

Cover sheet of the Proposed Methodology Form

Form for submitting the proposed methodology

Host Country	Republic of the Union of Myanmar
Name of the methodology proponents submitting this form	Kirin Holdings Company, Limited.
Sectoral scope(s) to which the Proposed Methodology applies	3. Energy demand
Title of the proposed methodology, and version number	Introduction of heat recovery system and high efficiency once-through boiler at the beer factory, ver.01.0
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☒Additional information
Date of completion	15/07/2020

History of the proposed methodology

Version	Date	Contents revised
01.0	15/07/2020	First Edition

A. Title of the methodology

Introduction of heat recovery system and high efficiency once-through boiler at the beer factory, Version.01.0

B. Terms and definitions

Terms	Definitions
Heat Recovery System (hereinafter referred to as HRS)	A system which has all of the following technological features. 1) It recovers waste steam from the process for boiling wort. 2) The recovered steam is used via a heat exchanger for pre-heating the wort before entering the boiling process. 3) After the heat is utilized for pre-heating, the steam is recompressed and used for boiling process of wort.
Once-through boiler	A boiler without recirculation where water flows through the economizer, furnace wall, and evaporating and superheating tubes, sequentially.
Boiler efficiency	The ratio of the total absorption heating value of outlet steam/hot water to the total heating value provided by a fuel.
Biogas boiler	A boiler which uses biogas generated by the fermentation and anaerobic digestion of biological waste, organic fertilizer, biodegradable substances, sludge, sewage, garbage, energy crops, etc.
Biomass boiler	A boiler which uses solid fuel from renewable, organic source of biological origin, such as rice husk or agricultural residue, wood pellet, etc. excluding fossil fuels.

C. Summary of the methodology

Items	Summary
GHG emission reduction	This methodology is applied to either of the following cases.

measures	Case 1) Installation of both HRS and high efficiency once-through boiler Case 2) Installation of only HRS [HRS] The recovered heat is used for preheating the wort before boiling process, which reduces the amount of steam supplied by project boiler. That leads to reduction of fuel consumed by the boiler for heating wort and consequently GHG emissions. [High efficiency once-through boiler] Installation of once-through boiler improves energy efficiency and reduces the fuel consumption, which leads to GHG emission reductions.
Calculation of reference emissions	Reference emissions are calculated with the following algorithms. [HRS] Reference emissions are calculated with the heat quantity of recovered waste steam, the boiler efficiency and the emission factor of fuel used by project boiler or reference boiler. [High efficiency once-through boiler] Reference emissions are calculated with the fuel consumption by project boiler, net calorific value of fuel used by project boiler, CO_2 emission factor of fuel used by reference boiler and the ratio of efficiency of project boiler and reference boiler.
Calculation of project emissions	Project emissions are calculated with the following algorithms. [HRS] Project emissions are calculated with the monitored electricity consumption by pump(s) and emission factor for consumed electricity. [High efficiency once-through boiler] Project emissions are calculated with the monitored fuel consumption and emission factor of the fuel of the project boiler.
Monitoring parameters	● Amount of wort flowing into wort boiling tank ● Amount of wort flowing out from wort boiling tank ● Amount of electricity consumption by project pump

	● Amount of fuel consumption by project boiler

D. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

<table>
<tr><td>Criterion 1</td><td>The project to which this methodology is applied implements either of the following cases.
Case 1) Installation of both HRS and once-through boiler(s) at the beer factory
Case 2) Installation of only HRS at the beer factory

In either case, the applicable technology is shown in Table 1 below.
Table 1: Applicable Technologies
<table>
<tr><td>No.</td><td>Technology</td><td>Applicable technology and their criteria</td></tr>
<tr><td>1</td><td>HRS</td><td>Newly installed.
Before the implementation of the project, waste steam has not been recovered and reused.</td></tr>
<tr><td>2</td><td>Once-through boiler(s)</td><td>Once-through boiler with a rated capacity of 7 ton/hour per unit or less (equivalent evaporation).</td></tr>
</table>
</td></tr>
<tr><td>Criterion 2</td><td>Biomass boiler is not connected to the project boiling process at the time of validation.</td></tr>
<tr><td>Criterion 3</td><td>Periodical check and maintenance by the manufacturer of HRS and/or boiler, or authorized agent is implemented at least once a year.</td></tr>
</table>

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Fuel consumption by reference boiler	CO_2
Project emissions	
Emission sources	GHG types
Fuel consumption by project boiler	CO_2
Electricity consumption by project HRS (pump)	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

[HRS]

Reference emissions are calculated with the heat quantity of recovered waste steam, the boiler efficiency and the emission factor of fuel used by project boiler or reference boiler.

Net emission reductions are ensured in the following manner;

- The catalog value of project boiler efficiency is applied to calculate reference emissions. The catalog value is usually higher than the actual efficiency, therefore, it leads to a conservative calculation of reference emissions. (Case 1)
- If the efficiency of project boiler is higher than that of reference boiler, the catalog value of project boiler efficiency is applied to calculate reference emissions. The catalog value is usually higher than the actual efficiency, therefore, it leads to a conservative calculation of reference emissions. (Case 2)
- If the efficiency of a reference boiler is higher than that of a project boiler, the highest efficiency of oil and gas boilers available in Myanmar (89%) is set as a default boiler efficiency value to calculate reference emissions in this methodology. (Case 2)

[High efficiency once-through boiler]

Reference emissions are calculated with the fuel consumption by project boiler, net calorific value of fuel used by project boiler, CO_2 emission factor of fuel used by reference boiler and the ratio of efficiency of project boiler and reference boiler.

Net emission reductions are ensured by setting the default reference boiler efficiency in a conservative manner as described above.

F.2. Calculation of reference emissions

Case 1) Installation of both HRS and once-through boiler(s)

$$RE_p = RE_{HRS,p} + RE_{OTB,p}$$

Where

RE_p	Reference emissions during the period p [tCO_2/p]
$RE_{HRS,p}$	Reference emissions from HRS during the period p [tCO_2/p]
$RE_{OTB,p}$	Reference emissions from once-through boiler(s) during the period p [tCO_2/p]

Measure 1: HRS

$$RE_{HRS,p} = \sum_i \left(RH_{PJ,i,p} \div \eta_{PJ,i} \times EF_{PJ,i} \right)$$

$$RH_{PJ,i,p} = \left(Q_{in,PJ,i,p} - Q_{out,PJ,i,p} \right) \times SG_{PJ} \times LHV_{PJ}$$

Where

$RE_{HRS,p}$	Reference emissions from HRS during the period *p* [tCO_2/p]
$RH_{PJ,i,p}$	The amount of heat recovered by the project HRS in production line *i* during the period *p* [GJ/p]
$\eta_{PJ,i}$	Efficiency of boiler which supplies heat to production line *i* [dimensionless]
$EF_{PJ,i}$	CO_2 emission factor of fuel used by boiler which supplies heat to production line *i* [tCO_2/GJ]
$Q_{in,PJ,i,p}$	The amount of wort flowing into wort boiling tank in production line *i* [L/p]
$Q_{out,PJ,i,p}$	The amount of wort flowing out from wort boiling tank in production line *i* [L/p]
SG_{PJ}	The specific gravity of saturated water [kg/L]
LHV_{PJ}	The latent heat of vaporization of water under the project condition (pressure, temperature) [GJ/kg]
i	Identification number of production line

Measure 2: Once-through boiler(s)

$$RE_{OTB,p} = \sum_j \sum_k \left(FC_{PJ,j,k,p} \times NCV_{PJ,j,k} \times EF_{RE} \times \frac{\eta_{PJ,j}}{\eta_{RE}} \right)$$

Where

$RE_{OTB,p}$	Reference emissions from once-through boiler(s) during the period *p* [tCO_2/p]
$FC_{PJ,j,k,p}$	The amount of fuel consumption by project boiler *j* for the fuel type *k* during the period *p* [mass or volume unit/p]
$NCV_{PJ,j,k}$	Net calorific value of fuel used by project boiler *j* for the fuel type *k* [GJ/mass or volume unit]
EF_{RE}	CO_2 emission factor of fuel used by reference boiler [tCO_2/GJ]
$\eta_{PJ,j}$	Efficiency of project boiler *j* [dimensionless]
η_{RE}	Efficiency of reference boiler [dimensionless]
j	Identification number of project boiler
k	Identification number of fuel type

<u>Case 2) Installation of only HRS</u>

$$RE_p = RE_{HRS,p}$$

Where

RE_p	Reference emissions during the period *p* [tCO_2/p]
$RE_{HRS,p}$	Reference emissions from HRS during the period *p* [tCO_2/p]

The same equation as Case 1 to calculate $RE_{HRS,p}$ is applied.

$\eta_{PJ,i}$ denotes "efficiency of boiler which supplies heat to production line *i* or reference boiler, whichever is higher".

G. Calculation of project emissions

Case 1) Installation of both HRS and once-through boiler(s)

$$PE_p = PE_{HRS,p} + PE_{OTB,p}$$

Where

PE_p	Project emissions during the period *p* [tCO_2/p]
$PE_{HRS,p}$	Project emissions from HRS during the period *p* [tCO_2/p]
$PE_{OTB,p}$	Project emissions from once-through boiler(s) during the period *p* [tCO_2/p]

Measure 1: HRS

$$PE_{HRS,p} = \sum_m \left(EC_{PJ,m,p} \times EF_{elec}\right)$$

Where

$PE_{HRS,p}$	Project emissions from HRS during the period *p* [tCO_2/p]
$EC_{PJ,m,p}$	Electricity consumption by project pump *m* during the period *p* [MWh/p]
EF_{elec}	CO_2 emission factor for consumed electricity [tCO_2/MWh]
m	Identification number of project pump

Measure 2: Once-through boiler(s)

$$PE_{OTB,p} = \sum_j \sum_k \left(FC_{PJ,j,k,p} \times NCV_{PJ,j,k} \times EF_{PJ,j,k}\right)$$

Where

$PE_{OTB,p}$	Project emissions from once-through boiler(s) during the period *p* [tCO_2/p]
$FC_{PJ,j,k,p}$	The amount of fuel consumption by project boiler *j* for the fuel type *k* during the period *p* [mass or volume unit/p]
$NCV_{PJ,j,k}$	Net calorific value of fuel used by project boiler *j* for the fuel type *k* [GJ/mass or volume unit]
$EF_{PJ,j,k}$	CO_2 emission factor of fuel used by project boiler *j* for the fuel type *k*

	[tCO_2/GJ]
j	Identification number of project boiler
k	Identification number of fuel type

Case 2) Installation of only HRS

$$PE_p = PE_{HRS,p}$$

Where

PE_p	Project emissions during the period p [tCO_2/p]
$PE_{HRS,p}$	Project emissions from HRS during the period p [tCO_2/p]

The same equation as Case 1 to calculate $PE_{HRS,p}$ is applied.

H. Calculation of emissions reductions

$$ER_p = RE_p - PE_p$$

Where

ER_p	Emission reductions during the period p [tCO_2/p]
RE_p	Reference emissions during the period p [tCO_2/p]
PE_p	Project emissions during the period p [tCO_2/p]

I. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below.

Parameter	Description of data	Source
$NCV_{PJ,j,k}$	Net calorific value of fossil fuel used by project boiler j for the fuel type k [GJ/mass or volume unit]	In the order of preference: a) values provided by fuel supplier; b) measurement by the project participants; c) regional or national default values; or d) IPCC default values provided in table 1.2 of Ch.1 Vol.2 of 2006

		IPCC Guidelines on National GHG Inventories. Upper value is applied.
$EF_{PJ,i}$	CO_2 emission factor of fuel used by boiler which supplies heat to production line *i* [tCO_2/GJ] $EF_{PJ,i}$ is calculated according to the following formula. (i) only fossil fuel fired boilers are installed to supply heat to production line *i*. $EF_{PJ,i} = EF_{fuel,PJ,i}$ (ii) both fossil fuel fired boilers and biogas boiler(s) are installed to supply heat to production line *i*. $EF_{PJ,i} = EF_{fuel,PJ,i} \times \gamma_{PJ,i}$ $\gamma_{PJ,i} = 1 - \frac{RO_{biofuel,i}}{RO_{total,i}}$ Where; $EF_{fuel,PJ,i}$: CO_2 emission factor of fossil fuel used by fossil fuel fired boiler which supplies heat to production line *i* $\gamma_{PJ,i}$: Ratio of total rated output of boilers which supply heat to production line *i* $RO_{biofuel,i}$: Total of rated output of biogas and/or biomass boilers which supply heat to production line *i* $RO_{total,i}$: Total of rated output of all the boilers including biogas and/or biomass boilers which supply heat to production line *i*	CO_2 emission factor of fuel in order of preference: a) values provided by fuel supplier; b) measurement by the project participants; c) regional or national default values; or d) IPCC default values provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Upper value is applied. Rated output of boilers; Manufacturer's specifications or catalog.
$EF_{PJ,j,k}$	CO_2 emission factor of fuel used by the project boiler *j* for the fuel type *k* [tCO_2/GJ]	In order of preference: a) values provided by

		fuel supplier; b) measurement by the project participants; c) regional or national default values; or d) IPCC default values provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Upper value is applied.
EF_{RE}	CO_2 emission factor of fuel used by the reference boiler [tCO_2/GJ] In case the project boiler replaces an existing boiler, or a planned boiler of which plan has been officially approved such as through boiler installation permit or initial environmental examination/ environmental impact assessment, the fuel of the existing or planned boiler is applied. Otherwise, the value is the same as $EF_{PJ,j,k}$.	In order of preference: a) values provided by fuel supplier; b) measurement by the project participants; c) regional or national default values; or d) IPCC default values provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied.
EF_{elec}	CO_2 emission factor for consumed electricity [tCO_2/MWh] When project pump consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When project pump may consume both grid electricity and captive electricity, the project participant applies the CO_2 emission factor	[Grid electricity] PDD of the most recently registered CDM project hosted in Myanmar or the latest version of the "Tool to calculate the emission factor for an electricity system" under the CDM at the time of validation. [Captive electricity]

	with lower value. [CO_2 emission factor] For grid electricity: The most recent value available from the source stated in this table at the time of validation For captive electricity, it is determined based on the following options: a) Calculated from its power generation efficiency (η_{elec} [%]) obtained from manufacturer's specification The power generation efficiency based on lower heating value (LHV) of the captive power generation system from the manufacturer's specification is applied; $$EF_{elec} = 3.6 \times \frac{100}{\eta_{elec}} \times EF_{fuel}$$ b) Calculated from measured data The power generation efficiency calculated from monitored data of the amount of fuel input for power generation ($FC_{PJ,p}$) and the amount of electricity generated ($EG_{PJ,p}$) during the monitoring period p is applied. The measurement is conducted with the monitoring equipment to which calibration certificate is issued by an entity accredited under national/international standards; $$EF_{elec} = FC_{PJ,p} \times NCV_{fuel} \times EF_{fuel} \times \frac{1}{EG_{PJ,p}}$$ Where: NCV_{fuel} : Net calorific value of consumed fuel [GJ/mass or weight]	For the option a) Specification of the captive power generation system provided by the manufacturer (η_{elec} [%]). CO_2 emission factor of the fossil fuel type used in the captive power generation system (EF_{fuel} [tCO_2/GJ]) For the option b) Generated and supplied electricity by the captive power generation system ($EG_{PJ,p}$ [MWh/p]). Fuel amount consumed by the captive power generation system ($FC_{PJ,p}$ [mass or weight/p]). Net calorific value (NCV_{fuel} [GJ/mass or weight]) and CO_2 emission factor of the fuel (EF_{fuel} [tCO_2/GJ]) in order of preference: 1) values provided by the fuel supplier; 2) measurement by the project participants; 3) regional or national default values; 4) IPCC default values provided in tables 1.2 and 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value

<table>
<tr>
<td></td>
<td>Note:
In case the captive electricity generation system meets all of the following conditions, the value in the following table may be applied to EF_{elec} depending on the consumed fuel type.

・ The system is non-renewable generation system
・ Electricity generation capacity of the system is less than or equal to 15 MW

<table>
<tr><th>fuel type</th><th>Diesel fuel</th><th>Natural gas</th></tr>
<tr><td>EF_{elec}</td><td>0.8 *1</td><td>0.46 *2</td></tr>
</table>

*1 The most recent value at the time of validation is applied.
*2 The value is calculated with the equation in the option a) above. The lower value of default effective CO_2 emission factor for natural gas (0.0543tCO_2/GJ), and the most efficient value of default efficiency for off-grid gas turbine systems (42%) are applied.</td>
<td>is applied.

[Captive electricity with diesel fuel]
CDM approved small scale methodology: AMS-I.A.

[Captive electricity with natural gas]
2006 IPCC Guidelines on National GHG Inventories for the source of EF of natural gas.
CDM Methodological tool "Determining the baseline efficiency of thermal or electric energy generation systems version 02.0" for the default efficiency for off-grid power plants.</td>
</tr>
<tr>
<td>$\eta_{PJ,i}$</td>
<td>Case 1)
Efficiency of boiler which supplies heat to production line i [dimensionless]

Case 2)
Efficiency of boiler which supplies heat to production line i or reference boiler, whichever is higher [dimensionless]

<table>
<tr><th>Efficiency</th><th>$\eta_{PJ,i}$</th></tr>
<tr><td>Boiler which supplies heat to</td><td>The highest efficiency of boiler which</td></tr>
</table>
</td>
<td>Boiler which supplies heat to production line i:
Specifications of the boiler or factory test data of the boiler by the manufacturer

Reference boiler:
[Additional information]
Market survey in Myanmar</td>
</tr>
</table>

	<table><tr><td>production line *i* > Reference boiler</td><td>supplies heat to production line *i* as the catalog value</td></tr><tr><td>Boiler which supplies heat to production line *i* < Reference boiler</td><td>0.89</td></tr></table> In case that a new boiler, whose efficiency is higher than the efficiency fixed ex ante, is installed in production line *i*, $\eta_{PJ,i}$ is to be revised.	
$\eta_{PJ,j}$	Efficiency of project boiler *j* [dimensionless]	Specifications of the project boiler or factory test data of the project boiler by the manufacturer
η_{RE}	Efficiency of reference boiler [dimensionless] The default value of η_{RE} is set as 0.89	[Additional information] Market survey in Myanmar
SG_{PJ}	The specific gravity of saturated water under the project condition [kg/L]	Design value provided by the manufacturer
LHV_{PJ}	The latent heat of vaporization of water under the project condition (pressure, temperature) [GJ/kg]	Design value provided by the manufacturer