JCM Proposed Methodology Form

Cover sheet of the Proposed Methodology Form

Form for submitting the proposed methodology

Host Country	Socialist Republic of Vietnam
Name of the methodology proponents submitting this form	DAIICHI JITSUGYO CO., LTD. Institute for Global Environmental Strategies
Sectoral scope(s) to which the Proposed Methodology applies	1. Energy industries (renewable- / non-renewable sources)
Title of the proposed methodology, and version number	Introduction of Biomass Boiler, Ver. 01.0
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☐Additional information
Date of completion	29/07/2022

History of the proposed methodology

Version	Date	Contents revised
01.0	29/07/2022	First Edition

A. Title of the methodology

Introduction of Biomass Boiler, Ver. 01.0

B. Terms and definitions

Terms	Definitions
Biomass	Biomass is non-fossilized and biodegradable organic material originating from plants, animals and microorganisms. This shall include products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes.
Biomass residue	Biomass residues are defined as biomass that is a by-product, residue or waste stream from agriculture, forestry and related industries. This shall not include municipal waste or other wastes that contain fossilized and/or non-biodegradable material (however, small fractions of inert inorganic material like soil or sands may be included).
Biomass boiler	A boiler which combusts biomass fuel to heat water and produce steam.
Boiler efficiency	The ratio of the total absorption heating value of the usable heat output to the heat amount contained in fuel fired in the boiler. In other words, it means that 1.0 minus the fraction of the heat loss. The heat loss includes the one by blow water.
Drain	Drain is a waste hot water which is trapped and condensed after waste steam at process of works is caught by steam trap.
Drain recovery system	Drain recovery system is equipment which recovers drain with some heating energy and reuses for boiler feed water.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	One or more biomass boilers are introduced and combust biomass fuel instead of fossil fuels to generate heat and produce steam, resulting in reduction of GHG emissions from fossil fuels.
Calculation of reference emissions	Reference emissions are CO_2 emissions from heat generation by a reference boiler which combusts fossil fuel(s). They are calculated by amount of produced steam by the project biomass boiler(s), specific enthalpies of steam and water, reference boiler efficiency and a CO_2 emission factor of fossil fuel.
Calculation of project emissions	Project emissions are CO_2 emissions from electricity consumed by the project biomass boiler(s), combustion of fossil fuel(s) by the project biomass boiler(s) and biomass transportation. CO_2 emissions from consumed electricity are calculated by amount of electricity consumed by the project biomass boiler(s) and its CO_2 emission factor. In case the project biomass boiler(s) combusts fossil fuel(s) as well as biomass fuel, project emissions include CO_2 emissions from the combustion of fossil fuel(s), which are calculated by amount of fossil fuel(s), net calorific value of fossil fuel(s) and its/their CO_2 emission factors. CO_2 emissions from biomass transportation are calculated by roundtrip distance of biomass transportation, mass of transported biomass and a CO_2 emission factor for biomass transportation.
Monitoring parameters	● Amount of steam produced by the project biomass boiler(s) ● Temperature of feed water into project biomass boiler(s) ● Temperature of drain recovery water reused by project biomass boiler(s) ● Amount of electricity consumed by the project biomass boiler(s) and ancillary equipment ● Amount of auxiliary fossil fuel(s) consumption at the start-up by the project biomass boiler(s) ● Round trip distance of biomass transportation ● Mass of transported biomass ● Class of vehicle (and/or ship) used for biomass

	transportation ● Date when biomass fuels imported to Viet Nam are used for the project

D. Eligibility criteria

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

Criterion 1	The project newly installs biomass boiler(s) or replaces an existing fossil fuel-fired boiler(s) with biomass boiler(s) to generate heat and steam .
Criterion 2	The project boiler(s) uses only solid biomass fuels made of biomass residues.
Criterion 3	Biomass residues utilized for the project are not used for energy application in the absence of the project activity. This can be demonstrated by the letter from suppliers of biomass.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Fossil fuel(s) consumed for generation of heat to produce steam by reference boiler	CO_2
Project emissions	
Emission sources	GHG types
Electricity consumed by the project biomass boiler(s) and ancillary equipment	CO_2
Auxiliary fossil fuel(s) consumed during the start-up by the project biomass boiler(s)	CO_2
Fossil fuel(s) consumption by biomass transportation between biomass supplier's stockyard and the project site	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated based on the amount of steam produced by the project boiler(s), specific enthalpies of produced steam and feed water, reference boiler efficiency and a CO_2 emission factor of reference fossil fuel.

In order to secure net emission reductions in this methodology, a default value for the reference boiler efficiency is conservatively set to 92% taking the default value provided as "Natural gas

without condenser" in table 1 (Default efficiency factor for thermal applications) of CDM Methodological tool 09 "Determining the baseline efficiency of thermal or electric energy generation systems" Version 03.0.

F.2. Calculation of reference emissions

$$\boldsymbol{RE_p = \frac{SP_{PJ,p} \times \left(h''_{steam} - h'_{fw,p}\right)}{10^3} \times \frac{1}{\eta_{RE}} \times EF_{fuel,RE}}$$

RE_p	Reference emissions during the period p [tCO_2/p]
$SP_{PJ,p}$	Amount of steam produced by the project biomass boiler(s) during the period p [t/p]
h''_{steam}	Specific enthalpy of produced steam [MJ/t]
$h'_{fw,p}$	Specific enthalpy of feed water into project biomass boiler(s) during the period p [MJ/t]
η_{RE}	Reference boiler efficiency [-]
$EF_{fuel,RE}$	CO_2 emission factor for fossil fuel consumed by the reference boiler [tCO_2/GJ]

In case that $T_{fw,p}$ is monitored

$$h'_{fw,p} = (T_{fw,p} - 0) \times C_p$$

In case that $T_{fw,p}$ is not monitored and $T_{dw,p}$ is monitored

$$h'_{fw,p} = (T_{dw,p} - 0) \times C_p$$

Where:

$h'_{fw,p}$	:	Specific enthalpy of feed water into project biomass boiler(s) during the period p [MJ/t]
$T_{fw,p}$	:	Temperature of feed water into project biomass boiler(s) during the period p [degree Celsius]
$T_{dw,p}$	:	Temperature of drain recovery water reused by project biomass boiler(s) during the period p [degree Celsius]
C_p	:	Specific heat capacity of water [MJ/(t·ΔK)]

G. Calculation of project emissions

$$\boldsymbol{PE_p = PE_{elec,p} + PE_{fuel,p} + PE_{tr,p}}$$

PE_p	Project emissions during the period p [tCO_2/p]

$PE_{elec,p}$	Project emissions from consumed electricity by the project biomass boiler(s) and ancillary equipment during the period p [tCO_2/p]
$PE_{fuel,p}$	Project emissions from combustion of fossil fuel by the project boiler(s) during the period p [tCO_2/p]
$PE_{tr,p}$	Project emissions from biomass transportation during the period p [tCO_2/p]

$PE_{elec,p}$ is calculated as below.

$$\boldsymbol{PE_{elec,p} = EC_{PJ,p} \times EF_{elec}}$$

$EC_{PJ,p}$	Amount of electricity consumed by the project biomass boiler(s) and ancillary equipment during the period p [MWh/p]
EF_{elec}	CO_2 emission factor of consumed electricity [tCO_2/MWh]

<Identification of $EC_{PJ,p}$>

Project participants may select either of the following two options to obtain a value for $EC_{PJ,p}$

Option R1: Monitor electricity consumption by the project biomass boiler(s) and ancillary equipment

Option R2: In case that electricity consumption by the project biomass boiler(s) and ancillary equipment is not monitored, calculate electricity consumption in a conservative manner as follows;

$$\boldsymbol{EC_{PJ,p} = RC_{PJ} \times 24 \times D_p}$$

RC_{PJ}	Total rated capacity of equipment consuming electricity [MW]
D_p	Number of days during a given time period p [day/p]

Note) If the total rated thermal output of the project biomass boiler(s) is equal to or less than 45 MW, $PE_{elec,p}$ may be neglected, following paragraphs 24 and 25 in CDM Methodological Tool "Project and leakage emissions from biomass (version 04.0)" and paragraph 114 (a) (iv) in "CDM project standard for project activities (version 02.0)" decided by CDM-EB meeting 101.

$PE_{fuel,p}$ is calculated as below.

$$PE_{fuel,p} = \sum_{i} FC_{PJ,i,p} \times NCV_{fuel,PJ,i} \times EF_{fuel,PJ,i}$$

i	Identification number of fossil fuel type [-]
$FC_{PJ,i,p}$	Amount of auxiliary fossil fuel consumed during the start-up by the project biomass boiler(s) for the fuel type i during the period p [mass or volume/p]
$NCV_{fuel,PJ,i}$	Net calorific value of auxiliary fossil fuel used by the project biomass boiler(s) for the fuel type i [GJ/mass or volume]
$EF_{fuel,PJ,i}$	CO_2 emission factor of auxiliary fossil fuel used by the project biomass boiler(s) for the fuel type i [tCO_2/GJ]

Note) If the total rated thermal output of the project biomass boiler(s) is equal to or less than 45 MW, the amount of fossil fuel consumed as auxiliary fuel to calculate $PE_{fuel,p}$ may be neglected, following paragraph 24 and 25 in CDM Methodological Tool "Project and leakage emissions from biomass (version 04.0)" and paragraph 114 (a) (iv) in "CDM project standard for project activities (version 02.0)" decided by CDM-EB meeting 101. However, the amount of fossil fuel consumed due to lack of biomass fuel cannot be neglected.

$PE_{tr,p}$ is calculated as below.

Option P1-1 (Normal option in case that there is not relay point(s) in biomass transportation *j*)

$$PE_{tr,p} = \sum_{j} D_{j,p} \times m_{j,p} \times EF_{tr}$$

j	Identification number of the round trip for biomass transportation between the place of biomass supplier's stockyard and the project site [-]
$D_{j,p}$	Round trip distance of the biomass transportation j during the period p [km]
$m_{j,p}$	Mass of biomass transported in the biomass transportation j during the period p [t]
EF_{tr}	CO_2 emission factor for biomass transportation [tCO_2/(tonne·km)]

Option P1-2 (Normal option in case that there is relay point(s) in biomass transportation *j*)

$D_{j,p}$ is regarded as the total round trip distance by way of the relay point. And then $PE_{tr,p}$ is calculated as follows:

$$PE_{tr,p} = \sum_{j}\sum_{k} D_{j,k,p} \times m_{j,k,p} \times EF_{tr}$$

$PE_{tr,p}$ Project emissions from biomass transportation during the period p [tCO_2/p]

j Identification number of the round trip for biomass transportation between the place of biomass supplier's stockyard and the project site [-]

k Identification number of transportation process in biomass transportation j between the place of biomass supplier's stockyard and the project site [-]

$D_{j,k,p}$ Round trip distance of transportation process k in the biomass transportation j during the period p [km]

$m_{j,k,p}$ Mass of biomass transported at transportation process k in the biomass residue transportation j during the period p [tonne/p]

EF_{tr} CO_2 emission factor for the biomass transportation [tCO_2/tonne-km]

Option P2-1 (Conservative option in case that vehicle class is monitored))

$$PE_{tr,p} = D_{max,p} \times m_{total,p} \times EF_{tr}$$

Option P2-2 (Conservative option in case that vehicle class is not monitored)

$$PE_{tr,p} = D_{max,p} \times m_{total,p} \times EF_{tr,higher}$$

$PE_{tr,p}$ Project emissions from biomass transportation during the period p [tCO_2/p]

$D_{max,p}$ The longest round trip distance of the biomass transportation during the period p [km]

$m_{total,p}$ Total mass of biomass brought to the project site during the period p [tonne/p]

EF_{tr} CO_2 emission factor for biomass transportation [tCO_2/ tonne-km]

$EF_{tr,higher}$ The higher value of CO_2 emission factor for biomass transportation [tCO_2/ tonne-km]

Note1) If the round trip distance for biomass transportation $D_{j,p}$ is less than 200 km, and the total rated thermal output of the project biomass boiler(s) is equal to or less than 45 MW, $PE_{tr,p}$ may be neglected, following paragraphs 27 and 28 in CDM Methodological Tool "Project and leakage emissions from biomass (version 02.0)" and paragraph 114 (a) (iv) in "CDM project standard for project activities (version 02.0)" decided in the CDM-EB meeting 101.

H. Calculation of emissions reductions

$$\boldsymbol{ER_p = RE_p - PE_p}$$

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]

Note) On days that biomass fuels imported to Viet Nam are used for the project because of lack of biomass fuel, emission reductions on those days are regarded as 0.

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
h''_{steam}	Specific enthalpy of produced steam [MJ/t].	Saturated steam table based on "IAPWS Industrial Formulation" (e.g. steam table published by The Japan Society of Mechanical Engineers), using the values for setting steam pressure according to vendor specification, contract condition by the steam buyer or operation manual on the site.
C_p	Specific heat capacity of water Default value is set to 4.184 [MJ/(t·ΔK)]	Theoretical value provided in table 6 of Cabinet Order No. 357 of 1992, Japan
η_{RE}	Reference boiler efficiency [-]. The default value is set to 0.92.	The default value provided as "Natural gas without condenser" in table 1 (Default efficiency factor for thermal applications) of CDM Methodological tool 09 "Determining the

		baseline efficiency of thermal or electric energy generation systems" Version 03.0
$EF_{fuel,RE}$	CO_2 emission factor for fossil fuel consumed by the reference boiler [tCO_2/GJ]. CO_2 emission factor of natural gas is applied in this methodology in a conservative manner.	In the order of preference: a) regional or national default values; or b) 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.
RC_{PJ}	Total rated capacity of equipment consuming electricity [MW]	Manufacture's specification of the equipment
EF_{elec}	CO_2 emission factor of consumed electricity [tCO_2/MWh]. When the biomass boiler(s) consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When both grid electricity and captive electricity may be consumed by the project biomass boiler(s), the project participant applies the CO_2 emission factor with higher 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	**Grid electricity:** Ministry of Natural Resources and Environment of Vietnam (MONRE), Vietnamese DNA for CDM unless otherwise instructed by the Joint Committee. **Captive electricity:** <u>For the option a)</u> Specification of the captive power generation system connected to the boiler, provided by the manufacturer (η_{cap} [%]). CO_2 emission factor of the fuel consumed by the captive power generation system connected to the boiler ($EF_{fuel,cap}$ [tCO_2/GJ])

	options: a) Calculated from its power generation efficiency (η_{cap} [%]) 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; $$EF_{elec} = 3.6 \times \frac{100}{\eta_{cap}} \times EF_{fuel,cap}$$ b) Calculated from measured data The power generation efficiency calculated from monitored data of amount of fuel input for power generation ($FC_{cap,p}$) and amount of electricity generated ($EG_{cap,p}$) 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; $$EF_{elec} = FC_{cap,p} \times NCV_{fuel,cap} \times EF_{fuel,cap} \times \frac{1}{EG_{cap,p}}$$ Where: $NCV_{fuel,cap}$: Net calorific value of the fuel consumed by the captive power generation system connected to the boiler [GJ/mass or volume] c) Conservative default value: A value of 1.3 tCO_2/MWh may be applied.	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 table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Upper value is applied. For the option b) Generated and supplied electricity by the captive power generation system connected to the biomass boiler(s) ($EG_{cap,}$ [MWh/p]). Fuel amount consumed by the captive power generation system connected to the biomass boiler(s) ($FC_{cap,}$ [mass or volume/p]). Net calorific value ($NCV_{fuel,cap}$ [GJ/mass or volume]) and CO_2 emission factor of the fuel ($EF_{fuel,cap}$ [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. Upper value is applied. <u>For the option c)</u> CDM methodological tool "TOOL 05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation, version 03.0"
$NCV_{fuel,PJ,}$	Net calorific value of auxiliary fossil fuel used by the project biomass boiler(s) for the fuel type *i* [GJ/mass or volume]	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.

<table>
<tr>
<td>$EF_{fuel,P,J,i}$</td>
<td>CO_2 emission factor of auxiliary fossil fuel used by the project biomass boiler(s) for the fuel type i [tCO_2/GJ]</td>
<td>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.</td>
</tr>
<tr>
<td>EF_{tr}</td>
<td>CO_2 emission factor for biomass transportation for the biomass transportation [$tCO_2/(tonne{\cdot}km)$]

The default value in the following table is applied.
<table>
<tr><th>Vehicle class</th><th>$EF_{tr,p}$ [$tCO_2/(tonne{\cdot}km)$]</th></tr>
<tr><td>Light vehicles</td><td>0.000245</td></tr>
<tr><td>Heavy vehicles</td><td>0.000129</td></tr>
</table>
Light vehicles: Vehicles with a gross vehicle mass being less or equal to 26 tonnes.
Heavy vehicles: Vehicles with a gross vehicle mass being higher than 26 tonnes.

Note1) If both vehicle classes are used in the project, the higher value (0.000245 $tCO_2/(tonne{\cdot}km)$) is applied.
Note2) If biomass is transported by river boat, the lower value (0.000129 $tCO_2/(tonne{\cdot}km)$) is applied in conservative manner.
According to a lot of materials by Ministry of</td>
<td>CDM methodological tool “TOOL 12: Project and leakage emissions from transportation of freight, version 01.1.0”</td>
</tr>
</table>

	Land, Infrastructure, Transport and Tourism, Japan (MLITJ), CO_2 emission intensity by ship (including on river) is much lower than the one by truck transportation.	
$EF_{tr,higher}$	The higher value of CO_2 emission factor for biomass transportation [$tCO_2/(t \cdot km)$] The default value of the parameter set as 0.000245 [$tCO_2/(t \cdot km)$] which is applied to the vehicle class of "Heavy vehicles" in $EF_{tr,p}$ in conservative manner.	CDM methodological tool "TOOL 12: Project and leakage emissions from transportation of freight, version 01.1.