JCM Proposed Methodology Form

| Cover sheet of the Proposed Methodology Form |
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Form for submitting the proposed methodology

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| Host Country | Socialist Republic of Vietnam |
| Name of the methodology proponents submitting this form | DAIICHI JITSUGYO CO., LTD.<br>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 Cogeneration System, Ver. 01.0 |
| List of documents to be attached to this form (please check): | ☐The attached draft JCM-PDD:<br>☐Additional information |
| Date of completion | 29/07/2022 |

History of the proposed methodology

| Version | Date | Contents revised |
|---|---|---|
| 01.0 | 29/07/2022 | First Edition |
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## A. Title of the methodology

Introduction of Biomass Cogeneration System, 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 includes 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 does 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. |
| Biomass Cogeneration System | A system that consists of biomass boiler(s), steam turbine(s) and power generator(s) and supplies both electricity and heat. |
| 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. |

## C. Summary of the methodology

| Items | Summary |
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| *GHG emission reduction measures* | Electricity and heat generated by a Biomass Cogeneration System installed in a project site replace all or part of grid and/or captive electricity (generated by fossil fuel) as well as heat (generated by fossil fuel), which leads to efficient energy use of recipient facility(ies) and results in GHG emission reductions. |
| *Calculation of reference emissions* | Reference emissions are $CO_2$ emissions for electricity supply and $CO_2$ emissions for heat supply.<br>$CO_2$ emissions for electricity supply are calculated with the amount of electricity (generated by project biomass cogeneration system) supplied to the recipient facility and $CO_2$ emission factor for the displaced electricity system.<br>$CO_2$ emissions for heat supply are calculated by heat quantity of steam (generated by project biomass cogeneration system) supplied to the recipient facility, reference boiler efficiency and $CO_2$ emission factor for fossil fuel consumed by the reference boiler. |
| *Calculation of project emissions* | Project emissions are $CO_2$ emissions from combustion of fossil fuel by biomass boiler(s) of project biomass cogeneration system and $CO_2$ emissions from biomass transportation.<br>$CO_2$ emissions from combustion of fossil fuel by biomass boiler(s) of project biomass cogeneration system are calculated by the amount of fossil fuel consumed by biomass boiler(s) of project biomass cogeneration system, net calorific value of fossil fuel used by biomass boiler(s) of project biomass cogeneration system and $CO_2$ emission factor of fossil fuel used by biomass boiler(s) of project biomass cogeneration system.<br>$CO_2$ emissions from biomass transportation are calculated by roundtrip distance of biomass transportation, mass of transported biomass and $CO_2$ emission factor for biomass transportation. |
| *Monitoring parameters* | ● Amount of electricity (generated by project biomass cogeneration system) supplied to the recipient facility<br>● Amount of steam (generated by project biomass cogeneration system) supplied to the recipient facility<br>● Temperature of feed water into biomass boiler(s) of project |

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|---|---|
| | biomass cogeneration system<br>● Temperature of drain recovery water reused by biomass boiler(s) of project biomass cogeneration system<br>● Amount of fossil fuel consumed by project biomass cogeneration system<br>● Amount of auxiliary fossil fuel(s) consumption at the start-up by the project biomass boiler(s) of project biomass cogeneration system<br>● Round trip distance of biomass transportation<br>● Mass of transported biomass<br>● 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.

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| Criterion 1 | A biomass cogeneration system is newly installed in the project site. |
| Criterion 2 | The biomass boiler(s) of the project biomass cogeneration system 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 | $CO_2$ |
| Grid electricity and/or captive electricity generated by fossil fuel | $CO_2$ |
| **Project emissions** | |
| Emission sources | GHG types |
| Auxiliary fossil fuel(s) combusted by the project cogeneration system | $CO_2$ |
| Fossil fuel(s) consumption by biomass transportation between the place of biomass supplier's stockyard and the project site | $CO_2$ |

## F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

In order to secure net emission reductions in this methodology, the reference emissions are conservatively calculated in the following manners.

- The reference $CO_2$ emission factor

  The default emission factors are set in a conservative manner based on the Viet Nam's national grid. The emission factor is calculated based on the electric power source mix of the past three years published by Vietnamese government identifying 1) primary fuel type which has the largest volume of generated electricity among the fossil fuel types used as a source and 2) the best heat efficiencies derived from the type of power plants currently operational in Viet Nam according to the identified primary fuel type.

  - In case the recipient facility in a project activity is connected to the national grid including through an internal grid which is not connected to a captive power generator

  or

  In case the recipient facility in a project activity is connected to an internal grid which is connected to both the national grid and a captive power generator

  The emission factor of 0.333 $tCO_2/MWh$ is applied, which is calculated based on the heat efficiency of the most efficient natural gas-fired power plant supplying electricity to the national grid. The value is lower than the emission factor of the Viet Nam grid published by the government of Viet Nam, which is 0.8458 $tCO_2/MWh$ (combined margin, 2019), and ensures net emission reductions.

  - In case the recipient facility in a project activity is connected to an internal grid which is not connected to the national grid

  The emission factor of a diesel power generator is calculated by applying the default heat efficiency of 49%, an efficiency level which is above the value of the world's leading diesel power generator, and set to 0.533 $tCO_2/MWh$.

- 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

$$\boldsymbol{RE_p = RE_{elec,p} + RE_{heat,p}}$$

$RE_p$ Reference emissions during the period $p$ [$tCO_2$/p]

$RE_{elec,p}$ Reference emissions for electricity supply during the period $p$ [$tCO_2$/p]

$RE_{heat,p}$ Reference emissions for heat supply during the period $p$ [$tCO_2$/p]

$$\boldsymbol{RE_{elec,p} = ES_{elec,p} \times EF_{elec,RE}}$$

$ES_{elec,p}$ Amount of electricity (generated by project biomass cogeneration system) supplied to the recipient facility during the period $p$ [MWh/p]

$EF_{elec,RE}$ Reference $CO_2$ emission factor for the displaced electricity system [$tCO_2$/MWh]

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

$SS_{PJ,p}$ Amount of steam (generated by project biomass cogeneration system) supplied to the recipient facility during the period $p$ [t/p]

$h''_{steam}$ Specific enthalpy of supplied steam [MJ/t]

$h'_{fw,p}$ Specific enthalpy of feed water into biomass boiler(s) of project biomass cogeneration system during the period $p$ [MJ/t]

$\eta_{RE}$ Reference boiler efficiency [dimensionless]

$EF_{fuel,RE}$ $CO_2$ 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

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

$T_{fw,p}$ Temperature of feed water into biomass boiler(s) of project biomass cogeneration system during the period $p$ [degree Celsius]

$T_{dw,p}$ Temperature of drain recovery water reused by biomass boiler(s) of project biomass cogeneration system during the period $p$ [degree Celsius]

$C_p$ Specific heat capacity of water [MJ/(t·ΔK)]

Note 1) In case that the displaced heat supply system includes biomass boiler(s), $\boldsymbol{RE_{heat,p}}$ is regarded as 0.

## G. Calculation of project emissions

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

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| $PE_p$ | Project emissions during the period $p$ [$tCO_2$/p] |
| $PE_{fuel,p}$ | Project emissions from combustion of fossil fuel by biomass boiler(s) of project biomass cogeneration system during the period $p$ [$tCO_2$/p] |
| $PE_{tr,p}$ | Project emissions from biomass transportation during the period $p$ [$tCO_2$/p] |

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

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|---|---|
| $i$ | Identification number of fossil fuel type [-] |
| $FC_{PJ,i,p}$ | Amount of auxiliary fossil fuel consumption at the start-up by biomass boiler(s) of project biomass cogeneration system 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 biomass boiler(s) of project biomass cogeneration system for the fuel type $i$ [GJ/mass or volume] |
| $EF_{fuel,PJ,i}$ | $CO_2$ emission factor of auxiliary fossil fuel used by biomass boiler(s) of project biomass cogeneration system for the fuel type $i$ [$tCO_2$/GJ] |

Note 2) If the combined rated output (corresponding value for thermal output) of the project cogeneration system is equal to or less than 45 MW, the amount of fossil fuel consumed as auxiliary fuel to calculate $\boldsymbol{PE_{fuel,p}}$ 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.

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

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|---|---|
| $j$ | 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/p] |
| $EF_{tr,}$ | $CO_2$ emission factor for biomass transportation [$tCO_2/t \cdot km$] |

Note 3) 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, $\boldsymbol{PE_{tr,p}}$ 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

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

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| $ER_p$ | 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) For the period when biomass fuels obtained out of the host country are used for the project because of lack of biomass fuel, emission reductions 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 |
|---|---|---|
| $EF_{elec,RE}$ | Reference $CO_2$ emission factor for the displaced electricity system<br><br>The value for $EF_{elec,RE}$ is selected from the | The default emission factor is derived from the result of the survey on the generation efficiency of major natural |

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| | emission factor based on the national grid ($EF_{RE,grid}$) or based on captive diesel power generator ($EF_{RE,cap}$) in the following manners:<br><br>In case the displaced electricity system in a project activity is connected to the national grid including through an internal grid which is not connected to a captive power generator, $EF_{RE,grid}$, 0.333 $tCO_2$/MWh is applied.<br><br>In case the displaced electricity system in a project activity is connected to an internal grid which is connected to both the national grid and a captive power generator, $EF_{RE,grid}$, 0.333 $tCO_2$/MWh is applied.<br><br>In case the displaced electricity system in a proposed project activity is connected to an internal grid which is not connected to the national grid, $EF_{RE,cap}$, 0.533 $tCO_2$/MWh is applied. | gas-fired power plants in Viet Nam and the default heat efficiency of 49% which is set above the value of the most efficient diesel power generator.<br>The default value is revised if deemed necessary by the JC. |
| $h''_{steam}$ | 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<br>Default value is set to 4.184 [MJ/(t·ΔK)] | Theoretical value provided in table 6 of Cabinet Order No. 357 of 1992, Japan |

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| $\eta_{RE}$ | Reference boiler efficiency [dimensionless].<br>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 [$tCO_2/GJ$].<br>$CO_2$ emission factor of natural gas is applied in this methodology in a conservative manner. | In the order of preference:<br>a) regional or national default values; or<br>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. |
| $NCV_{fuel,PJ,i}$ | Net calorific value of auxiliary fossil fuel used by the project biomass boiler(s) for the fuel type *i* [GJ/mass or volume] | In the order of preference:<br>a) values provided by fuel supplier;<br>b) measurement by the project participants;<br>c) regional or national default values; or<br>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>$EF_{fuel,PJ,i}$</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:<br>a) values provided by fuel supplier;<br>b) measurement by the project participants;<br>c) regional or national default values; or<br>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 [$tCO_2/t \cdot km$]<br><br>The default value in the following table is applied.
<table>
<tr><th>Vehicle class</th><th>$EF_{tr}$ [$tCO_2/t \cdot km$]</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.<br>Heavy vehicles: Vehicles with a gross vehicle mass being higher than 26 tonnes.<br><br>Note 4) If both vehicle classes are used in the project, the higher value (0.000245 $tCO_2/t \cdot km$) is applied.<br>Note 5) If biomass is transported by river boat, the lower value (0.000129 $tCO_2/t \cdot km$) is applied in conservative manner.<br>According to a lot of materials by Ministry of Land, Infrastructure, Transport and Tourism, Japan (MLITJ), $CO_2$ emission intensity by ship</td>
<td>CDM methodological tool “TOOL 12: Project and leakage emissions from transportation of freight, version 01.1.0”</td>
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|---|---|---|
| | (including on river) is much lower than the one by truck transportation. | |