Joint Crediting Mechanism Approved Methodology ID_AM027

"Electricity generation by a biomass power plant"

A. Title of the methodology

Electricity generation by a biomass power plant Version 01.0

B. Terms and definitions

Terms	Definitions
Biomass power plant	An electrical power plant which produces electricity through biomass combustion in a boiler and a steam generator that heats water to produce steam which then flows through steam turbines that spin an electrical generator to generate electricity.
Solid biomass fuel	A source of energy made of biological materials including wood, sawdust and crop waste, whose states of matter are neither liquid nor gas.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Displacement of grid electricity including national/regional and isolated grid and/or captive electricity by installing and operating a biomass power plant.
Calculation of reference emissions	Reference emissions are calculated from net electricity generation by a biomass power plant multiplied by a CO_2 emission factor of grid electricity and/or captive electricity.
Calculation of project emissions	Project emissions include the emissions from combustion of solid biomass fuels in a biomass power plant, the emissions from combustion of fossil fuel at a biomass power plant and the emissions from transportation of solid biomass fuels. [Emissions from biomass fuel combustion] The emissions resulting from combustion of solid biomass fuels

	are zero since they are carbon neutral. [Emissions from fossil fuel combustion] The emissions from combustion of fossil fuel at a biomass power plant are calculated from the amount of fossil fuel consumption and a CO_2 emission factor of the fuel. [Emissions from transportation of sold biomass fuels] The emissions from transportation of solid biomass fuels are calculated from the amount of fossil fuel consumption by the transportation and a CO_2 emission factor of the fuel, if applicable. If not applicable, the emissions from transportation of solid biomass fuels are calculated from total mass of freight transported from each collecting site and distance between each collecting site and a biomass power plant.
Monitoring parameters	• Net quantity of electricity generated by a biomass power plant • On-site consumption of fossil fuel for operating a biomass power plant • Consumption of fossil fuel by transportation, if applicable • Round trip distance between collecting site and a biomass power plant, if applicable • Total mass of freight transported from collecting site, if applicable

D. Eligibility criteria

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

Criterion 1	A biomass power plant is newly installed on the project site.
Criterion 2	The project uses only solid biomass fuels made of biomass residues.
Criterion 3	Biomass residues utilized for the project are not used for energy and non-energy applications in absence of the project activity. This can be demonstrated by the letter from suppliers of biomass residues.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Grid electricity and/or captive power generation	CO_2
Project emissions	
Emission sources	GHG types
Biomass fuel combustion in a biomass power plant	N/A
Fossil fuel consumption for operating a biomass power plant	CO_2
Fossil fuel consumption by transportation of solid biomass fuels and/or materials of solid biomass fuels from collecting sites to a biomass power plant	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

The default emission factors are set in a conservative manner for the Indonesian regional grids. The default emission factors are calculated based on the conservative operating margin that reflects on the latest electricity mix including low cost/must run (LCMR) resources for each regional grid in Indonesia during the year 2016-2018 and refers to the conservative emission factor of each fossil fuel power plant to secure net emission reductions. The conservative emission factor of each plant is calculated as 0.795 tCO_2/MWh for coal-fired power plant and 0.315 tCO_2/MWh for gas-fired power plant based on the survey on heat efficiency of power plant in Indonesia. The emission factor for diesel power plant is calculated as 0.533 tCO_2/MWh based on a default heat efficiency of 49%, an efficiency level which is above the value of the world's leading diesel power generators.

In case a biomass power plant in a proposed project activity is directly connected or connected via an internal grid not connecting to either an isolated grid or a captive power generator, to a national/regional grid (Case 1), the value of operating margin including LCMR resources, calculated using the best heat efficiency among currently operational plants in Indonesia for the emission factors of fossil fuel power plants, is applied.

In case a biomass power plant in a proposed project activity is connected to an internal grid connecting to both a national/regional, and an isolated grid and/or a captive power generator

(Case 2), the lower value between emission factors of "Emission factor for Case 1 (tCO_2/MWh)" and the conservative emission factor of diesel-fired power plant of 0.533 tCO_2/MWh is applied.

In case a biomass power plant in a proposed project activity is only connected to an internal grid connecting to an isolated grid and/or a captive power generator (Case 3), the emission factor of a diesel generator calculated by applying a default heat efficiency of 49%, an efficiency level which is above the value of the world's leading diesel generator is applied, which is set as 0.533 tCO_2/MWh.

The emission factors to be applied for each case are explained in the Section I.

F.2. Calculation of reference emissions

$$RE_p = NEG_p \times EF_{RE,elec}$$

Where

RE_p	:	Reference emissions during the period p [tCO_2/p]
NEG_p	:	Net quantity of electricity generated by a project biomass power plant during the period p [MWh/p]
$EF_{RE,elec}$	:	CO_2 emission factor of national/regional and isolated grids and/or captive electricity [tCO_2/MWh]

NEG_p is a difference between quantity of gross generated electricity and quantity of electricity consumed by a project biomass power plant (e.g., building, plant, etc) during the period p.

G. Calculation of project emissions

$$PE_p = PE_{ONSITE,p} + PE_{TRANS,p}$$

Where

PE_p	:	Project emissions during the period p [tCO_2/p]
$PE_{ONSITE,p}$	:	Project emissions by on-site consumption of fossil fuel for operating a

biomass power plant during the period p [tCO_2/p]

$PE_{TRANS,p}$: Project emissions by transportation activity of solid biomass fuels from collecting sites to a biomass power plant during the period p [tCO_2/p]

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

$$\boldsymbol{PE_{ONSNITE,p} = \sum_{i} FC_{ONSITE,i,p} \times NCV_i \times EF_{fuel,i}}$$

Where

$FC_{ONSITE,i,p}$: On-site consumption of fossil fuel i for operating a biomass power plant during the period p [mass or volume/p]

NCV_i : Net calorific value of fossil fuel i used for operating a biomass power plant [GJ/mass or volume]

$EF_{fuel,i}$: CO_2 emission factor of fossil fuel i [tCO_2/GJ]

i : Indication number of fossil fuel type [-]

$PE_{TRANS,p}$ is calculated using one of the following options.

Option 1 : Monitoring fuel consumption

$$\boldsymbol{PE_{TRANS,p} = \sum_{j} FC_{TRANS,j,p} \times NCV_j \times EF_{fuel,j}}$$

Where

$FC_{TRANS,j,p}$: Consumption of fossil fuel j by transportation during the period p [mass or volume/p]

NCV_j : Net calorific value of fossil fuel j used for transportation activity of solid biomass fuels to a biomass power plant [GJ/mass or volume]

$EF_{fuel,j}$: CO_2 emission factor of fossil fuel j [tCO_2/GJ]

j : Indication number of fossil fuel type [-]

Option 2 : Monitoring trip road distance and mass of freight

$$\boldsymbol{PE_{TRANS,p} = \sum_{k}\sum_{l} D_k \times FR_{k,l,p} \times EF_{vehicle,l}}$$

Where

D_k : Round trip distance between collecting site k and a biomass power plant [km]

$FR_{k,l,p}$	:	Total mass of freight transported from collecting site *k* by vehicle type *l* during the period *p* [ton/p]
$EF_{vehicle,l}$	:	CO_2 emission factor of vehicle type *l* [tCO_2/ton-km]
k	:	Indication number of collecting site [-]
l	:	Indication number of vehicle type [-]

*If the round trip distance between collecting site *k* and a biomass power plant (D_k) is less than 200km and the total rated electrical output capacity of the project biomass power plant is equal to or less than 15 MW, the emissions from the transportation may be neglected.

H. Calculation of emissions reductions

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

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
$EF_{RE,elec}$	CO_2 emission factor of national/regional and isolated grids and/or captive electricity [tCO_2/MWh] The value for $EF_{RE,elec}$ is selected from the emission factor based on the national/regional grid ($EF_{RE,grid}$) or based on isolated grid and/or a captive diesel power generator ($EF_{RE,cap}$) in the following manner: In case a biomass power plant in a proposed project activity is directly connected, or connected via an internal grid not connecting to either an isolated grid or a captive power generator, to a national/regional	Default values are provided in the additional information. Once the default values are revised, the revised values are applied.

grid (Case 1), $EF_{RE,grid}$ is set as follows:

National/regional grid name	Emission factor (tCO_2/MWh)
Jamali, 3 Nusa, and Karimun Jawa grids	0.619
Sumatra grid	0.458
Nilas and Plau Tello grids	0.533
Siberut, Siberut Utara, Sipora, and Pagai Selatan grids	0.529
Alai, Batam, Batam-Tanjung Pinang, Durai, Kelong, Ladan, letung, Midai, Moro, Penuba, Ranai, Sedanau, Serasan, Tambelan, Tanjung Balai Karimun, Tanjung Batu, and Tarempa grids	0.499
Bengkalis, Benteng, Concong Luar, Kota Lama, Lemang, Selat Panjang, Sungai Guntung, Tanjung Samak, Teluk Dalam, Teluk Ketapang, and Masohi grids	0.545
Bangka and Belitung grids	0.628
Barito grid	0.653
Khatulistiwa grid	0.549
Mahakam and Tarakan grids	0.534
Sulutgo grid	0.274
Sulselbar grid	0.243
Kendari, Bau Bau, Kolaka, Lambuya, Wangi Wangi, and Raha grids	0.564
Ampana, Balantak, Bualemo, Bulungkobit, Bunta, Lelang, Lipulalong, Lumbi-lumbia, Luwuk, Palapas-Palu, Salakan, Toili, Toli-Toli, and Wakai grids	0.515
Lombok, Bima, and Sumbawa grids	0.568
Adonara, Alor, Ende, Maumere, Rote, Timor, and Waingapu grids	0.537
Ambon, Buano, Bula, Dobo, Geser, Haruku, Kairatu, Kesui, Kian Darat, Kisar, Kobisonta, Laimu, Larat, Liran, Mako, Moa, Ondor, Pasanea, Piru, Saumiaki, Serwaru, Taniwel, Tehoru, Tual, Wahai, Werinama, and Wetar grids	0.557
Bere-Bere, Bicoli, Buli, Daruba, Ibu, Kedi, Lolobata, Maba, Ternate - Tidore, and Tobelo grids	0.532
Biak, Genyem, Jayapura, Merauke, Nabire, Serui, and Timika grids	0.491

	Manokwari and Sorong grids	0.518	
	Bantal, Ipuh, Kota Bani, and Mukomuko grids	0.532	
	In case a biomass power plant in a proposed project activity is connected to an internal grid connecting to both a national/regional grid, and an isolated grid and/or a captive power generator (Case 2), $EF_{RE,grid}$ is set as follows:		
	National/regional grid name	Emission factor (tCO_2/MWh)	
	Jamali, 3 Nusa, and Karimun Jawa grids	0.533	
	Sumatra grid	0.458	
	Nilas and Plau Tello grids	0.533	
	Siberut, Siberut Utara, Sipora, and Pagai Selatan grids	0.529	
	Alai, Batam, Batam-Tanjung Pinang, Durai, Kelong, Ladan, letung, Midai, Moro, Penuba, Ranai, Sedanau, Serasan, Tambelan, Tanjung Balai Karimun, Tanjung Batu, and Tarempa grids	0.499	
	Bengkalis, Benteng, Concong Luar, Kota Lama, Lemang, Selat Panjang, Sungai Guntung, Tanjung Samak, Teluk Dalam, Teluk Ketapang, and Masohi grids	0.533	
	Bangka and Belitung grids	0.533	
	Barito grid	0.533	
	Khatulistiwa grid	0.533	
	Mahakam and Tarakan grids	0.533	
	Sulutgo grid	0.274	
	Sulselbar grid	0.243	
	Kendari, Bau Bau, Kolaka, Lambuya, Wangi Wangi, and Raha grids	0.533	
	Ampana, Balantak, Bualemo, Bulungkobit, Bunta, Lelang, Lipulalong, Lumbi-lumbia, Luwuk, Palapas-Palu, Salakan, Toili, Toli-Toli, and Wakai grids	0.515	
	Lombok, Bima, and Sumbawa grids	0.533	
	Adonara, Alor, Ende, Maumere, Rote, Timor, and Waingapu grids	0.533	
	Ambon, Buano, Bula, Dobo,	0.533	

	Geser, Haruku, Kairatu, Kesui, Kian Darat, Kisar, Kobisonta, Laimu, Larat, Liran, Mako, Moa, Ondor, Pasanea, Piru, Saumiaki, Serwaru, Taniwel, Tehoru, Tual, Wahai, Werinama, and Wetar grids 0.532 Bere-Bere, Bicoli, Buli, Daruba, Ibu, Kedi, Lolobata, Maba, Ternate - Tidore, and Tobelo grids 0.491 Biak, Genyem, Jayapura, Merauke, Nabire, Serui, and Timika grids 0.518 Manokwari and Sorong grids 0.532 Bantal, Ipuh, Kota Bani, and Mukomuko grids In case a biomass power plant in a proposed project activity is connected to an internal grid which is not connected to a national/regional grid, and only connected to an isolated grid and/or a captive power generator (Case 3), $EF_{RE,cap}$: 0.533 tCO_2/MWh is applied.	
NCV_i	Net calorific value of fossil fuel *i* used for operating a biomass power plant [GJ/mass or volume]	In the order of preference: a) Values provided by the fuel supplier; b) Measurement by the project participants; c) Regional or national default values; d) IPCC default values provided in 2006 IPCC Guidelines on National GHG Inventories. Upper value is applied.
NCV_j	Net calorific value of fossil fuel *j* used for transportation activity of solid biomass fuels to a biomass power plant [GJ/mass or volume]	

<table>
<tr><td>$EF_{fuel,i}$</td><td>CO_2 emission factor of fossil fuel i used for operating a biomass power plant [tCO_2/GJ]</td><td rowspan="2">In the order of preference:
a) Values provided by the fuel supplier;
b) Measurement by the project participants;
c) Regional or national default values;
d) IPCC default values provided in 2006 IPCC Guidelines on National GHG Inventories. Upper value is applied.</td></tr>
<tr><td>$EF_{fuel,j}$</td><td>CO_2 emission factor of fossil fuel j used for transportation activity of solid biomass fuels to a biomass power plant [tCO_2/GJ]</td></tr>
<tr><td>$EF_{vehicle,l}$</td><td>CO_2 emission factor of vehicle type l [tCO_2/ton-km]

<table><tr><th>Vehicle class</th><th>$EF_{vehicle,l}$</th></tr><tr><td>Light vehicle</td><td>0.000245 tCO_2/ton-km</td></tr><tr><td>Heavy vehicle</td><td>0.000129 tCO_2/ton-km</td></tr></table>
Vehicles with a gross vehicle mass being less or equal to 26 tonnes are classified in light vehicle. Vehicles with a gross vehicle mass being higher than 26 tonnes are classified in heavy vehicle.</td><td>The default values provided in the CDM methodological tool “Project and leakage emissions from transportation of freight.”</td></tr>
</table>

History of the document

Version	Date	Contents revised
01.0	17 February 2021	Electronic decision by the Joint Committee Initial approval.