Joint Crediting Mechanism Approved Methodology ET_AM003

"Introduction of Biomass Combined Heat and Power Plant"

A. Title of the methodology

Introduction of Biomass Combined Heat and Power Plant, Version 01.0

B. Terms and definitions

Terms	Definitions
Biomass combined heat and power plant	A biomass combined heat and power (CHP) plant consists of a biomass boiler and a generator set (genset) which uses the heat produced by the biomass boiler to generate electricity.
ORC genset	An ORC (Organic Rankine Cycle) genset uses an organic fluid with a boiling point lower than water to drive a turbine to generate electricity.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Displacement of fossil fuel consumed for heat production and electricity generation by installation and operation of a biomass CHP plant.
Calculation of reference emissions	The reference emissions are the sum of the reference emissions from heat production and electricity generation. The former is calculated by multiplying the net heat quantity provided to the heat loads from the biomass CHP plant by the inverse of the conservative boiler efficiency and emission factor of diesel. The latter is calculated by multiplying the quantity of electricity generated from the biomass CHP plant by: 1) the conservative ratio of time when captive gensets are in use and conservative emission factor of captive gensets, in case the project site is connected to the national grid; or 2) the conservative emission factor of captive gensets, in case the project site is not connected

	to the national grid.
Calculation of project emissions	The project emissions are assumed to be zero.
Monitoring parameters	The quantity of net heat provided to the heat loads and electricity generated by the biomass CHP plant.

D. Eligibility criteria

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

Criterion 1	The project installs a biomass CHP plant consisted of a biomass boiler and an ORC genset at a biomass processing factory, and uses the residue of production activities as feedstock.
Criterion 2	The electricity generated from the biomass CHP plant is not fed into the national grid.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Production of heat using fossil fuel	CO_2
Generation of electricity using fossil fuel as power source	CO_2
Project emissions	
Emission sources	GHG types
Generation of heat and electricity from biomass CHP plant.	N/A

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

a) Reference emissions from heat generation

In Ethiopia, the common source of energy for boilers used in industries is diesel.

The efficiency of the latest fossil fuel-fired steam boilers is around 90%. The efficiency of the modern fossil fuel-fired thermal oil boilers can be as high as 93%. Normally, the actual efficiency during operation will be lower than these maximum figures as the boilers sometimes

run under partial loads.

In order to achieve net emission reductions, it is assumed that the heat provided to the heat loads from the biomass CHP plant displaces heat produced by a diesel-fired boiler running constantly at an efficiency of 93%.

b) Reference emissions from electricity generation

b-1) In case the project site is connected to the national grid

The power source of the national grid of Ethiopia is almost 100% renewable. However, power interruption is very common and industries requiring continuous operation resort to captive diesel power generation.

It is assumed that 2% of the electricity generated from the biomass CHP plant displaces electricity generated by a captive diesel genset using the most efficient diesel power generator in the world, and the balance displaces grid electricity, which is assumed to have an emission factor of zero. The value 2% corresponds to the percentage of time power was interrupted in the year which had the shortest average annual time of power interruption during the June 2013 to May 2016 period.

The most efficient diesel generator in the world has a generation efficiency close to 49%. The reference emission factor of captive gensets is set to 0.533 tCO_2/MWh, which is derived from a generation efficiency of 49%. This ensures net emission reductions because the default value for both the annual time of power interruption and emission factor of captive gensets is set in a conservative manner.

b-2) In case the project site is not connected to the national grid

It is assumed that all of the electricity generated from the biomass CHP plant displaces electricity generated by a captive diesel genset using the most efficient diesel power generator in the world. The same above-mentioned reference emission factor of 0.533 tCO_2/MWh is applied to achieve net emission reductions.

F.2. Calculation of reference emissions

$$RE_p = RE_{th,p} + RE_{el,p}$$

RE_p : Reference emissions during period *p* [tCO_2/p]

$RE_{th,p}$: Reference emissions from heat generation during period *p* [tCO_2/p]

$RE_{el,p}$: Reference emissions from electricity generation during period *p* [tCO_2/p]

$$RE_{th,p} = \sum_i HP_{i,p} / \eta \times EF_{th}$$

$RE_{th,p}$: Reference emissions from heat generation during period *p* [tCO_2/p]

$HP_{i,p}$: Net heat quantity provided to heat load *i* by project biomass CHP plant during period *p* [TJ/p]

η : Reference boiler efficiency [%]

EF_{th} : Reference CO_2 emission factor of reference fuel [tCO_2/TJ]

For calculation of reference emissions from electricity generation, either Option 1 or Option 2 is selected.

Option 1: In case the project site is connected to the national grid.

$$RE_{el,p} = EG_p \times PI \times EF_{el}$$

$RE_{el,p}$: Reference emissions from electricity generation during period *p* [tCO_2/p]

EG_p : Quantity of electricity generated by project biomass CHP plant during period *p* [MWh/p]

PI : Reference percentage of grid power interruption time [%]

EF_{el} : Reference CO_2 emission factor of captive gensets [tCO_2/MWh]

Option2: In case the project site is not connected to the national grid

$$RE_{el,p} = EG_p \times EF_{el}$$

$RE_{el,p}$: Reference emissions from electricity generation during period *p* [tCO_2/p]

EG_p : Quantity of electricity generated by project biomass CHP plant during period *p* [MWh/p]

EF_{el} : Reference CO_2 emission factor of captive gensets [tCO_2/MWh]

G. Calculation of project emissions

$PE_p = 0$

PE_p : Project emissions during period *p* [tCO_2/p]

H. Calculation of emissions reductions

$ER_p = RE_p - PE_p$
$= RE_p$

ER_p : Emission reductions during period *p* [tCO_2/p]
RE_p : Reference emissions during period *p* [tCO_2/p]
PE_p : Project emissions during 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
η	The reference boiler efficiency: set to 93% referring to the maximum efficiency of the modern fossil fuel-fired thermal oil boilers.	Additional information. The default boiler efficiency is derived from the website survey on the modern fossil fuel-fired thermal oil boilers. The default value is revised if deemed necessary by the JC.
EF_{th}	The reference CO_2 emission factor of the reference fuel: set to 74.1 tCO_2/TJ identifying diesel as the reference fuel.	The default emission factor of diesel oil for stationary combustion in energy industries in the "2006 IPCC Guidelines for National Greenhouse Gas Inventory."
PI	The reference percentage of grid power interruption time, derived from survey: the default value of 2% is applied.	Additional information. The default reference percentage of grid power interruption time is derived

		from the analyses of information on the power interruption in Ethiopia. The default value is revised if deemed necessary by the JC.
EF_{el}	The reference CO_2 emission factor of captive gensets, calculated based on the power generation efficiency of 49% using diesel fuel as the power source: the default value 0.533 tCO_2/MWh is applied.	Additional information. The default emission factor is derived from the result of the survey on the new high-efficient engines using diesel fuel as power source. The default value is revised if deemed necessary by the JC.

History of the document

Version	Date	Contents revised
01.0	21 March 2017	JC3, Annex 3 Initial approval.