16. Renewable Energy / Biomass

1. Typical Project

- Installations of a new power plant or a heat supply facility that utilizes biomass as a fuel.
- Fuel switch from fossil fuels to biomasses, or retrofit at an existing power plant or heat supply facility.

2. Applicability

(1) Utilization of biomass, e.g. agricultural/forestry co-products/residues/wastes not including general wastes.

(2) Installations of a new power plant or a heat supply facility that utilizes biomass as a fuel.

(3) Fuel switch from fossil fuels to biomasses or retrofit at an existing power plant or heat supply facility for biomass utilization.

3. Methodology of Emission Reduction Calculation

The emission reduction from the project activity is determined as the differences between the GHG emission of baseline scenario (use fossil fuels to obtain an equivalent amount of energy generated by the project) and project scenario (energy generation with utilization of biomasses)[1].

Details of sources of each data in the following formulae are provided in "4. Data and Parameters for the Estimation".

$$ER_y = BE_y - PE_y$$

ER_y : GHG emission reduction through the project in year y (t-CO_2e/y)

BE_y : GHG emission from the baseline scenario in year y (t-CO_2e/y)

PE_y : GHG emission from the project scenario in year y (t-CO_2e/y)

(1) Calculation of Baseline Emission

Baseline GHG emission is calculated based on the amount of annual electricity and thermal energy generated by the project and CO_2 emission factor of the electricity and fossil fuel respectively.

$$BE_y = BE_{elec,y} + BE_{heat,y}$$
$$= \left(EG_{PJ,y} \times EF_{elec}\right) + \left(HG_{PJ,y} \times EF_{fuel,i}/\eta_{therm} \div 10^3\right)$$

$BE_{elec,y}$: Baseline emission from the generation of electricity which is replaced by the biomass power plant in year y (t-CO_2e/y)

$BE_{heat,y}$: Baseline emission from the generation of heat which is replaced by the biomass heat plant in year y (t-CO_2e/y)

$EG_{PJ,y}$: Power generation by the biomass power plant in year y (MWh/y)

EF_{elec} : CO_2 emission factor of the electricity (t-CO_2/MWh)

$HG_{PJ,y}$: Amount of heat supply by the project in year y (TJ/y)

$EF_{fuel,i}$: CO_2 emission factor of the baseline fuel i (kg-CO_2/TJ)

η_{therm} : Baseline boiler efficiency

(2) Calculation of Project Emission

Project GHG emission is calculated based on the annual electricity and fossil fuel consumption associated with transportation of biomass residue and the biomass facility, and CO_2 emission factors of the electricity and fossil fuel.

[1] The target year shall be a representative year under average operation or an annual average of multiple years.

$$PE_y = PE_{elec,y} + PE_{fuel,y}$$

$$= \left(EC_{PJ,y} \times EF_{elec}\right) + \sum_i \left(FC_{PJ,i,y} \times NCV_i \times EF_{fuel,i} \div 10^6\right)$$

$PE_{elec,y}$: Project emission associated with electricity consumption (t-CO_2e/y)

$PE_{fuel,y}$: Project emission associated with fossil fuel consumption (t-CO_2e/y)

$EC_{PJ,y}$: Electricity consumption by biomass transportation and facility in year y (MWh/y)

EF_{elec} : CO_2 emission factor of the electricity (t-CO_2/MWh)

$FC_{PJ,j,y}$: Consumption of the fuel j by biomass transportation and facility in year y (t/y)

NCV_j : Net calorific value of the fuel j (TJ/Gg = TJ/kt)

$EF_{fuel,j}$: CO_2 emission factor of the fuel j (kg-CO_2/TJ)

4. Data and Parameters for the Estimation

Data	Description	Data Sources	
		For baseline emission calculation	For project emission calculation
$EG_{PJ,y}$	Power generation by the biomass power plant in year y (MWh/y)	A planned value	N/A
$HG_{PJ,y}$	Amount of heat supply by the project in year y (TJ/y)	A planned value	
EF_{elec}	In the case of the grid connection: CO_2 emission factor of the grid electricity (t-CO_2/MWh)	A default value (Table 3, "Intermittent Energy", Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	
	In the case of the captive power generation or mini-grid: CO_2 emission factor of the diesel power generation (t-CO_2/MWh)	A default value (Table 4, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	
$EF_{fuel,i}$	CO_2 emission factor of the baseline fuel i (kg-CO_2/TJ)	A default value (Table 2, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	N/A
$EF_{fuel,j}$	CO_2 emission factor of the fuel j (kg-CO_2/TJ)	N/A	A default value (Table 2, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.
η_{therm}	Baseline boiler efficiency	A default value (Table 5, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	N/A
$EC_{PJ,y}$	Electricity consumption by biomass transportation and facility in year y (MWh/y)	N/A	A planned value

$FC_{PJ,j,y}$	Consumption of the fuel j by biomass transportation and facility in year y (t/y)		A planned value
NCV_j	Net calorific value of the fuel j (TJ/Gg = TJ/kt)		A default value (Table 1, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.

5. Others

(1) Project Boundary

The physical boundary for estimating GHG emissions includes the facility in the project site and other sites where biomass residues generated.

(2) Leakage

There are indirect emissions that potentially lead to leakage due to activities such as manufacturing and transport of materials and construction processes. However, these emissions are temporary and negligible compare to the project scale. Therefore, they can be ignored.

(3) Comparison with existing methodologies

There are CDM methodologies such as AMS I.D. (Grid connected renewable electricity generation) and ACM0006 (Consolidated methodology for electricity and heat generation from biomass residues) can be references for development of the methodology.

Compared with AMS I.D., the logic of emission reduction calculation in the methodology is basically same. However, this methodology simplifies the calculation way by providing default values for the grid CO_2 emission factor. ACM0006 includes the baseline emission associated with uncontrolled burning and decay of biomass residue, and the project emissions associated with methane emissions associated with combustion of biomass residues, wastewater treatment etc. On the other hand, this methodology does not consider these aspects. The CDM methodology is applicable to the projects that the generation capacity may not exceed 15 MW (AMS I.D.); however, these applicability conditions are not included in this methodology. In regard to leakage, the CDM methodology considers assessment of leakages such as an increase in emissions from fossil fuel combustion or other sources due to diversion of biomass residues from other uses to the project plant as a result of the project activity. However, in this methodology this is not considered.

(4) CH_4 and N_2O

Since methane (CH_4) and nitrous oxide (N_2O) do not have a significant impact on emission reductions by the project, they were not considered for simplification.

(5) Revision history

Version	Year/Month	Revisions
2.0	March 2014	• Added default values for combined margins and operating margins of CO2 emission factors of electricity • Added a default value for baseline boiler efficiency

3.0	September 2019	• Prioritized the use of default values • Added instructions not to consider CH_4 and N_2O emissions
4.0	March 2023	• In the description of the calculation method and necessary data of baseline emissions, the words "before project implementation" was revised to use "the baseline scenario". The baseline scenario is the scenario that would have occurred in the absence of the project, such as continuation of the pre-project conditions. • Deleted the column "Ex-post" in "4. Data and Parameters Estimated and Need Monitoring": current version of Climate-FIT aims to quantify GHG emission reductions in the "planning phase").
5.0	March 2024	• No revision.