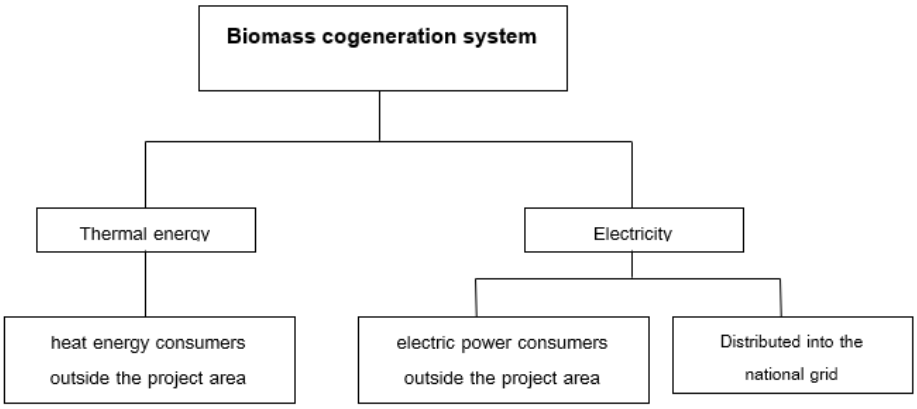
T-VER-P-METH-01-03

Electricity and Thermal Energy Cogeneration from Biomass for Dispatch

Version 01

Scope: 01 - Energy industries

Entry into force on 1 March 2023

1. Methodology Title	Electricity and Thermal Energy Cogeneration from Biomass for Dispatch
2. Project Type	Renewable energy or alternative energy substituted to fossil fuel
3. Scope	01 - Energy industries
4. Project Outline	Emission reduction from combined electric power heat generation (Cogeneration) using biomass as renewable fuel for selling to national grid or private off takers.
5. Applicability	Eligible activity includes new installation (greenfield) of combined electricity and heat generation system from biomass for selling to the national grid or private off takers.
6. Project Conditions	1. New installation of steam turbine cogeneration system for selling as per guideline shown below:  2. Biomass including both residue and cultivated shall be used as sole fuel for cogeneration.
7. Project Starting Date	The date is that the project owner (client) and the contractor have signed to construct the project of greenhouse gas emission reduction which will be developed to the T-VER project.
8. Definition	**Cogeneration -** means the simultaneous generation of heat and electrical energy in one process such as Steam turbine. Project activities that produce heat and electrical energy in separate element processes (for example heat from a boiler and electricity from a biogas engine) do not fit under the definition of cogeneration **Thermal energy** - means either heating (e.g. steam or hot water or hot air) or cooling (e.g. chilled water), or both **Biomass residues** – means non-fossilized and biodegradable organic material originating from plants, animals and micro-organisms which is a by-

	product, residue or waste stream from agriculture, forestry, and related industries;

Details of T-VER methodology for

Electricity and Thermal Energy Cogeneration from Biomass for dispatch

1. Greenhouse gas emission reduction activities used in the calculations

Table 1. Sources and types of greenhouse gases

Greenhouse gas emission	Source	Greenhouse Gas	Details of activities that emit greenhouse gas emissions
Baseline Emission	Thermal power generation	CO_2	Thermal power generation by combustion of fossil fuels
	Electricity generation of the national grid	CO_2	The burning of fossil fuels to generate electricity of the country's electric power generation structure. which is replaced by electricity generated from renewable energy and sold into the electricity grid, including MEA, PEA, EGAT
Project Emission	Energy use within the project plant	CO_2	Purchasing electricity from the national grid
			The use of fossil fuels such as backup generators, biomass loaders, etc.
	The use of biomass and biomass residue	CO_2, CH_4	● cultivation of biomass in a dedicated plantation ● transportation of biomass ● processing of biomass ● transportation of biomass residues (if any) ● processing of biomass residues (if any)
Leakage	Areas that have been converted to dedicated plantations/use of biomass residue	CO_2, CH_4	● shift of pre-project activities resulting from cultivation of biomass in a dedicated plantation ● diversion of biomass residues from other applications ● processing of biomass residues ● transportation of biomass residues

2. Scope of Project

It is a project that includes the installation of new machinery and equipment for the generation of electricity and combined heat from biomass for sale. It must be a new installation (Greenfield) for the whole system and not an installation to replace or increase the capacity of the existing electricity and heat generating system.

Project scope is the area of the electricity generation system and the combined heat (Cogeneration) from biomass fuel of the project including various activities arising from the energy production of the project.

3. Additionality

The project must undergo further proof of operation from normal operations. (Additionality) by using the "Guidelines to prove operations in addition to normal operations. (Additionality) under the Thailand Voluntary Emission Reduction Program (T-VER)" as prescribed by the TGO.

4. Baseline Scenario

Considering the guidelines for determining the baseline data based on the concept of Below Business as Usual (Below BAU), the baseline data for greenhouse gas emissions from fossil fuel combustion for electricity generation of the national grid substituting with renewable energy is the greenhouse gas emissions from electricity generation using natural gas in the national grid. For the baseline data for greenhouse gas emissions from fossil fuel combustion for thermal generation substituting with renewable energy is the greenhouse gas emissions from natural gas combustion.

5. Baseline Emission

Baseline emission consider only the carbon dioxide (CO_2) emissions from heat power generation and electric power generation for distribution by combined heat and power generation systems. using fossil fuels.

$$BE_y = BE_{cogen,CO2,y} \qquad \text{Equation (1)}$$

Where

BE_y = Baseline emissions in year y (tCO_2/year)

$BE_{cogen,CO2,y}$ = Baseline emissions from electricity and thermal energy displaced by the project activity during the year y (tCO_2)

5.1 Baseline emissions from electricity and thermal energy displaced by the project activity

$$BE_{cogen,CO2,y} = \left(\left[\frac{EG_{PJ,thermal,y} + EG_{PJ,electrical,y} \times 3.6}{\eta_{BL,cogen}} \right] \times EF_{CO2,NG} \right) \quad \text{Equation (2)}$$

Where

$BE_{cogen,CO2,y}$ = Baseline emissions from electricity and thermal energy displaced by the project activity during the year y (tCO_2)

$EG_{PJ,electrical,y}$ = Amount of electricity supplied by the project activity during the year y (GWh)

3.6 = Conversion factor (TJ/GWh)

$EG_{PJ,thermal,y}$ = Net quantity of thermal energy supplied by the project activity during the year y (TJ)

$EF_{CO2,NG}$ = CO_2 emission factor of natural gas fuel (tCO_2/GJ) equal to 56,100 tCO_2/GJ

$\eta_{BL,cogen}$ = Total annual average efficiency of the cogeneration plant

5.1.1 Calculation of efficiency $\eta_{BL,cogen}$ of electric power generation and combined heat (Cogeneration) in the case of a new fossil fuel base

There are options for calculation of $\eta_{BL,cogen}$:

Option 1 Calculated as a single value with consideration of the following:

Step 1

1) Get performance data for steam turbines and steam generators from at least 2 or more manufacturers in the region.
2) Choose efficiency values for steam turbines and steam generators. from manufacturers with requirements equivalent to the base case cogeneration system that will be used in the event of non-operation of project activities.

3) Select the efficiency value used from the maximum efficiency value of each section. (Over the life of an electric and combined cycle power generation system) can be achieved by steam turbines and steam generators.

Step 2

The total annual average efficiency of the cogeneration plant using fossil fuel is then calculated as the product of the highest efficiency value for the steam turbine(s) and the highest efficiency value of the steam generator(s), assuming both efficiencies are in the form of a percentage of output per input.

Option 2 Calculated as a single value with consideration of the following:

Step 1

1) A default steam turbine efficiency of 100 percent.

2) Default steam generator efficiency determined using the values provided in table 2.

Table 2 Default baseline efficiency values for different technologies

Default baseline efficiency values for different technologies	Default efficiency
New natural gas fired boiler (w/o condenser)	92%
New oil-fired boiler	90%
Old natural gas fired boiler (w/o condenser)	87%
New coal fired boiler	85%
Old oil-fired boiler	85%
Old coal fired boiler	80%

Step 2

The total annual average efficiency of the cogeneration or trigeneration plant using fossil fuel is then calculated as the product of the efficiency value for the steam turbine(s) and the efficiency value of the steam generator(s) assuming both efficiencies are in the form of a percentage of output per input.

6. Project Emission

$$PE_y = PE_{FF,y} + PE_{EC,y} + PE_{Biomass} \quad \text{Equation (5)}$$

Where

PE_y = Project emissions from the project activity during the year y (tCO_2/year)

$PE_{FF,y}$ = Project emissions from fossil fuel consumption during the year y (tCO_2/year)

$PE_{EC,y}$ = Project emissions from electricity consumption during the year y (tCO_2/year)

$PE_{Biomass}$ = Project emissions associated with biomass and biomass residues in year y (tCO_2/year)

6.1 Project emissions from fossil fuel consumption

To calculate greenhouse gas emissions from fossil fuel use due to project implementation, the Calculation is made using T-VER-P-TOOL-02-01 "Calculating Greenhouse Gas Emissions from the Burning of Fossil Fuels from Project Emission and Leakage Emission", latest edition. Fossil fuels required for the operation of equipment related to preparation, storage, processing and transporting of fuels and biomass (e.g. for mechanical treatment of the biomass, conveyor belts, driers, pelletization, shredding, briquetting processes, etc.) shall be treated under $PE_{Biomass,y}$

6.2 Project emissions from electricity consumption

Greenhouse gas emissions from the use of electricity from the project implementation can be calculated from the amount of electricity consumption. Greenhouse gas emissions from electricity generation and power loss in the electric grid as follows:

$$PE_{EC,y} = \sum_{j} EC_{PJ,j,y} \times EF_{Elec,y} \times (1 + TDL_{j,y}) \qquad \text{Equation (6)}$$

Where

$PE_{EC,y}$ = Project emissions from electricity consumption in year y (tCO_2/year)

$EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/year)

$EF_{Elec,y}$ = Emission factor for electricity generation/consumption in year y ($tCO/_2MWh$)

$TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source j in year y

j = Sources of electricity consumption in the project

Electricity for the operation of equipment related to the on-site or off-site preparation, storage, processing and transportation of fuels and biomass (e.g. for mechanical treatment of the biomass, conveyor belts, driers, pelletization, shredding, briquetting processes, etc.) shall be calculated under $PE_{EC,y}$

6.4 Project emissions associated with biomass and biomass residues

In the case of project activities that produce electricity from biomass or biomass residue Greenhouse gas emissions from project implementation, T-VER-P-TOOL-02-02 "Calculation of Greenhouse Gas Emissions from Project Emission and Leakage Emission for Biomass", latest edition is applied for the activities below.

1) Cultivation of biomass in a dedicated plantation
2) Transportation of biomass
3) Processing of biomass
4) Transportation of biomass residues (if any)
5) Processing of biomass residues (if any)

7. Leakage Emission

For the generation of electricity from biomass and/or waste biomass, project developers must estimate greenhouse gas emissions outside the project scope using T-VER-P-TOOL-02-02 The latest edition of the "Calculation of Greenhouse Gas Emissions from Project Implementation and Outsourcing for Biomass" without considering the source of greenhouse gas emissions. The project developer must specify the appropriate justification in the project design document.

8. Emission Reduction

Emission reductions are calculated as follows :

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (7)}$$

Where

ER_y = Emission reductions in year y (tCO_2e/year)

BE_y = Baseline emissions in year y (tCO_2e/year)

PE_y = Project emissions in year y (tCO_2e/year)

LE_y = Leakage emissions in year y (tCO_2e/year)

9. Monitoring methodology procedure

9.1 Monitoring procedures

1) The project developer explains and specifies the steps for monitoring the project activity data (Activity data) or verify all measurement results in the project proposal document. including the type of measuring instruments used Person responsible for monitoring results and verifying information Calibration of measuring instruments (if any) and procedures for warranty and quality control Where methods have different options, such as using default values or on-site measurements The project developer must specify which option to use. In addition, the installation, maintenance, and calibration of measuring instruments should be carried out in accordance with the instructions of the equipment manufacturer and in accordance with national standards. or international standards such as IEC, ISO

2) All data collected as part of the greenhouse gas reduction monitoring. The data should be stored in electronic file format and the retention period is in accordance with the guidelines set by the Administrative Organization or the organization's quality system, but the period of time is not less than that specified by the TGO. Must follow the follow-up methods specified in the follow-up parameters specified in Table 9.2.

9.2 Parameters monitored

Parameter	$EG_{PJ,electtical,y}$
Data unit	GWh/year
Description	Amount of electricity supplied by the project activity during the year y
Source of data	Plant records

Measurement procedures	Measured by kWh Meter and continuously measured throughout the follow-up period. (Amount of electricity deducted from electricity generation for own use before being supplied to the transmission line)
Monitoring frequency	Continuous monitoring and at least monthly recording

Parameter	$EG_{PJ,thermal,y}$
Data unit	TJ/year
Description	Net quantity of thermal energy supplied by the project activity during the year y
Source of data	Plant records
Measurement procedures	Heat generation is determined as the difference of the enthalpy of the steam or hot fluid and/or gases generated by the heat generation equipment and the sum of the enthalpies of the feed-fluid and/or gases blow-down and if applicable any condensate returns. The respective enthalpies should be determined based on the mass (or volume) flows, the temperatures and, in case of superheated steam, the pressure. Steam tables or appropriate thermodynamic equations may be used to calculate the enthalpy as a function of temperature and pressure.
Monitoring frequency	Continuous monitoring, aggregated annually

Parameter	Hot air volume measurement for parameter calculation $EG_{PJ,thermal,y}$
Data unit	Nm^3/hr
Description	Quantity of hot air
Source of data	Plant records
Measurement procedures	Measured using calibrated meters. Where it is not feasible (e.g. because of too high temperature), spot measurements can be used through sampling with a 90 percent confidence level and a 10 per cent precision.
Monitoring frequency	Continuous monitoring, integrated hourly and at least monthly recording.

Parameter	Steam volume measurement for parameter calculation $EG_{PJ,thermal,y}$
Data unit	Nm^3/hr
Description	Quantity of steam
Source of data	Plant records
Measurement procedures	Measured using calibrated meters
Monitoring frequency	Continuous monitoring, integrated hourly and at least monthly recording

Parameter	$EC_{PJ,i,y}$
Data unit	MWh/year

Description	Quantity of electricity consumed by the project electricity consumption source j in year y
Source of data	Plant records
Measurement procedures	Measured by kWh Meter and continuously measured throughout the follow-up period. (Amount of electricity deducted from electricity generation for own use before being supplied to the transmission line)
Monitoring frequency	continuous monitoring and at least monthly recording

Parameter	TDL
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j in year y
Source of data	Option 1 Measurement Report In the case of information on the amount of electricity released from the producer and the amount of electricity received by the consumer Option 2 uses a Default Value of 0.03 (3%).
Measurement procedures	1) If using Option 1, the project developer will have to monitor the value every year throughout the monitoring of greenhouse gas emissions reductions. 2) If using Option 2, the project developer must use this value throughout the monitoring of greenhouse gas emissions reductions.
Monitoring frequency	Defined once in the first year of the credit period.
QA/QC procedure	If the measurement results differ from previous measurements or other sources that are significantly related make additional measurements.
Any comment	-

Parameter	$EF_{Elec,y}$
Data unit	tCO_2/MWh
Description	Emission factor for electricity generation/consumption in year y
Source of data	Report on greenhouse gas emissions (Emission Factor) from electricity generation/consumption for projects and activities of greenhouse gas reduction published by TGO.
Measurement procedures	**For the preparation of project design documents** Use the latest $EF_{Elec,y}$ published by TGO **For carbon credit issuance** Use the $EF_{Elec,y}$ values announced by TGO according to the year of the carbon credit issuance. However, in the case that the year of the carbon credit issuance does not have $EF_{Elec,y}$ values published by TGO, use the latest $EF_{Elec,y}$ values published by TGO in that year instead.

9.2 Parameters not monitored

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10. References

Clean Development Mechanism (CDM)

1) ACM0018 Electricity generation from biomas. Version.04
2) AMS-I.C. Thermal energy production. Version 22
3) TOOL 03 Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion. Version 03
4) TOOL 05 Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation. Version 03
5) TOOL16: Project and leakage emissions from biomass. Version 05

Document information T-VER-P-METH-01-03

Version	Amendment	Entry into force	Description
01	-	1 March 2023	- Change document code from TVER-METH-01-02 Version 01. - Revise methodology's title. - Add the definition of project starting date. Change the sign and the meaning for parameter of $EF_{grid,y}$ and revise the data sources.
01	-	24 August 2022	Initial adoption.