8. Energy Saving / Waste Energy Use in Industrial Facilities

1. Typical Project

- Waste energy, such as waste heat, waste gas and waste pressure, recovery and utilization at industrial facilities such as steel plants and cement factories.
- Power generation at existing fossil fuel fired power generation plants through utilizing waste gases (a combined cycle).
- Cogeneration at existing fossil fuel fired power generation plants through utilizing waste heats.

2. Applicability

(1) Introduction/renovation/improvement of waste energy recovery and utilization at industrial facilities such as steel plants and cement factories.

(2) Introduction of waste energy recovery and utilization at existing fossil fuel fired power generation plants.

(3) Utilization of waste energy as sources of electricity or/and heat.

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 (to obtain equivalent energy of the project without utilization of waste energy) and project scenario (with utilization of waste energy)[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 a year y (t-CO_2e/y)

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

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

(1) Calculation of Baseline Emission

Baseline GHG emission is calculated based on the annual electricity and fossil fuel consumption in the absence of the project and CO_2 emission factor of the electricity and fossil fuel respectively.

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

$BE_{elec,y}$: Baseline emission associated with electricity consumption in year y (t-CO_2e/y)

$BE_{heat,y}$: Baseline emission associated with heat consumption in year y (t-CO_2e/y)

$EG_{PJ,y}$: Power generation through the waste energy recovery and utilization in year y (MWh/y)

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

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

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

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

η_{therm} : Baseline boiler efficiency

ws : Rate of total heat from boiler in the baseline scenario

(2) Calculation of Project Emission

Project GHG emission is calculated based on the annual electricity and fossil fuel consumption in the absence of the project and CO_2 emission factor of the electricity and fossil fuel respectively.

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

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

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

$EC_{PJ,y}$: Electricity consumption at the waste energy recovery and utilization facility in year y (MWh/y)

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

$FC_{PJ,i,y}$: Consumption of the fuel i at the waste energy recovery and utilization facility in year y (t/y)

NCV_i : Net calorific value of fuel i (TJ/Gg = TJ/kt)

$EF_{fuel,i}$: CO_2 emission factor of fuel i (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 through the waste energy recovery and utilization 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 grid connection: CO_2 emission factor of the grid electricity (t-CO_2/MWh)	A default value (Table 3, "Energy Efficiency", Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	
	In the case of 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 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.	
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
ws	Rate of total heat from boiler in the baseline scenario	The rate is 1.0, in case the heat recovered and utilized equals to the heat supplied in the baseline.	N/A

$EC_{PJ,y}$	Electricity consumption at the waste energy recovery and utilization facility in year y (MWh/y)	N/A	A planned value
$FC_{PJ,i,y}$	Consumption of the fuel i at the waste energy recovery and utilization facility in year y (t/y)		A planned value
NCV_i	Net calorific value of fuel i (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.

(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-III.Q. (Waste Energy Recovery (gas/heat/pressure) Projects), ACM0012 (Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects), AM0048 (New cogeneration facilities supplying electricity and/or steam to multiple customers and displacing grid/off-grid steam and electricity generation with more carbon-intensive fuels) and JBIC J-MRV003 (The methodology for waste energy recovery/utilization projects) can be references for development of the methodology.

AMS III.Q sets a “the capping factor” to exclude increased waste energy utilization due to increased level of activity of the plant, relative to the level of activity in the baseline. However, this methodology does not consider the factor for simplification. The CDM methodology considers the leakage provided that equipment to be used in the project activity is currently being utilized elsewhere and is transferred from outside of the boundary to the project activity. This methodology does not include leakage at all.

Comparing with ACM0012 and AM0048, the logic of emission reduction calculation in the methodology is basically same; however, this methodology simplifies calculations by applying default values as more as possible.

The emission reduction calculation method of this methodology is almost similar to that of the J-MRV003. However, J-MRV003 uses the average OM (operating margin) emission factor that is calculated as an average emission rate of all power plants serving to the grid.

(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	• Combined two methodologies (8. Electricity and heat supply (Ver1.0) and 11.Thermal power with electricity and heat supply (Ver1.0)) as the methodological logic was identical • 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.