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).

$$ER_y = BE_y - PE_y$$

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.

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

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

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

$EG_{PJ,y}$: Power generation through the waste energy recovery and utilization in a 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 baseline fuel i (t-CO_2/TJ)

η_{therm} : Baseline boiler efficiency

ws : Rate of total heat from boiler without the project

(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.

$$PE_y = PE_{elec,y} + PE_{fuel,y}$$
$$= (EC_{PJ,y} \times EF_{elec}) + \sum_i (FC_{PJ,i,y} \times NCV_i \times EF_{fuel,i})$$

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

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

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

NCV_i : Net calorific value of fuel i (TJ/t)

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

4. Data and Parameters Estimated and Need Monitoring

<table>
<tr><th rowspan="3">Data</th><th rowspan="3">Description</th><th colspan="4">Data Sources</th></tr>
<tr><th colspan="2">For baseline emission calculation</th><th colspan="2">For project emission calculation</th></tr>
<tr><th>Ex-ante</th><th>Ex-post</th><th>Ex-ante</th><th>Ex-post</th></tr>
<tr><td>$EG_{PJ,y}$</td><td>Power generation through the waste energy recovery and utilization in a year y (MWh/y)</td><td>A planned value</td><td>A monitored value (Electric meter etc.)</td><td colspan="2" rowspan="2">N/A</td></tr>
<tr><td>$HG_{PJ,y}$</td><td>Amount of heat supply by the project in a year y (TJ/y)</td><td>A planned value</td><td>A monitored value (Heat meter etc.)</td></tr>
<tr><td rowspan="2">EF_{elec}</td><td>In the case of grid connection:
CO_2 emission factor of the grid electricity (t-CO_2/MWh)</td><td colspan="4">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.</td></tr>
<tr><td>In the case of captive power generation or mini-grid:
CO_2 emission factor of the diesel power generation (t-CO_2/MWh)</td><td colspan="4">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.</td></tr>
<tr><td>$EF_{fuel,i}$</td><td>CO_2 emission factor of baseline fuel i (t-CO_2/TJ)</td><td colspan="4">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.</td></tr>
<tr><td>η_{therm}</td><td>Baseline boiler efficiency</td><td colspan="2">A default value (Table 6, Appendix)
If there is no default value applied or if there is another appropriate value, that value may be used.</td><td colspan="2">N/A</td></tr>
<tr><td>ws</td><td>Rate of total heat from boiler without the project</td><td colspan="2">The rate is 1.0, in case the heat recovered and utilized equals to the heat supplied in the baseline.</td><td colspan="2">N/A</td></tr>
<tr><td>$EC_{PJ,y}$</td><td>Electricity consumption at the waste energy recovery and utilization facility in a year y (MWh/y)</td><td colspan="2">N/A</td><td>A planned value</td><td>A monitored value (Electric meter or purchase receipt)</td></tr>
</table>

$FC_{PJ,i,y}$	Consumption of the fuel i at the waste energy recovery and utilization facility in a year y (t/y)		A planned value	A monitored value (Purchase receipt)
NCV_i	Net calorific value of fuel i (TJ/t)		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.