Joint Crediting Mechanism Approved Methodology TH_AM007

"Power Generation by Waste Heat Recovery in Cement Industry"

A. Title of the methodology

Power Generation by Waste Heat Recovery in Cement Industry, Version 01.0

B. Terms and definitions

Terms	Definitions
Waste heat	Heat generated from cement production facility which would not have been recovered in the absence of the project.
Preheater boiler	Boiler which recovers waste heat from a preheater, which pre-heats raw materials fed into a rotary kiln, to generate steam.
Air Quenching Cooler boiler (AQC boiler)	Boiler which recovers waste heat from an air quenching cooler to generate steam.
Waste Heat Recovery system (WHR system)	Power generation system consisting of a preheater boiler and/or AQC boiler, turbine generator and cooling tower that utilizes waste heat from cement production facility.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Waste heat recovery (WHR) system which generates electricity through waste heat recovered from cement production facility. Electricity generated from the WHR system replaces grid electricity and/or captive resulting in GHG emission reductions of the connected electricity system.
Calculation of reference emissions	Reference emissions are calculated from net electricity generation by the project which replaces grid electricity and/or captive use where the project is implemented during a given time period.
Calculation of project	Project emissions are not considered as the WHR system does

emissions	not utilize any fossil fuel as a heat source to generate steam for power generation.
Monitoring parameters	The quantity of the electricity supplied from the WHR system to the cement production facility and the number of days during a monitoring period.

D. Eligibility criteria

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

Criterion 1	The project installs waste heat recovery (WHR) system in the cement production facility.
Criterion 2	WHR system utilizes only waste heat and does not utilize fossil fuels as a heat source to generate steam for power generation.
Criterion 3	WHR system has not been introduced to a corresponding cement kiln of the project prior to its implementation.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Grid electricity and/or captive power generation	CO_2
Project emissions	
Emission sources	GHG types
N/A	N/A

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated on the basis of net electricity generation by the project that replaces grid or captive electricity.

The quantity of electricity consumed by the WHR system except for direct captive use of the electricity generated by itself is subtracted from the quantity of the electricity supplied from the WHR system to the cement production facility to calculate net electricity generation.

In order to ensure conservativeness, the quantity of electricity consumption by the WHR system except for the direct captive use of the electricity generated by itself, is calculated by using the theoretically maximum load for the capacity of equipment in the above-mentioned WHR system.

F.2. Calculation of reference emissions

$RE_p = EG_p * EF_{elec}$

Where,

RE_p : Reference emissions during a given time p [tCO_2/p]

EG_p : The quantity of net electricity generation by the WHR system during a given time period p [MWh/p]

EF_{elec} : CO_2 emission factor for consumed electricity[tCO_2/MWh]

Determination of EG_p

$EG_p = EG_{SUP,p} - EC_{AUX,p}$

$EG_{SUP,p}$: The quantity of the electricity supplied from the WHR system to the cement production facility during a given time period p [MWh/p]

$EC_{AUX,p}$: The quantity of electricity consumption by the WHR system except for the direct captive use of the electricity generated by itself during a given time period p [MWh/p]

Determination of $EC_{AUX,p}$

$EC_{AUX,p} = EC_{CAP} * 24(hours/day) * D_p$

EC_{CAP}: The total maximum rated capacity of equipment of the WHR system which consumes electricity except for the capacity of equipment which use the electricity generated by itself directly [MW]

D_P : The number of days during a given time period p [day/p]

G. Calculation of project emissions

Project emissions are not assumed in the methodology as the WHR system utilizes only waste heat and does not utilize fossil fuels as heat source to generate steam for power generation,

which is prescribed in the eligibility criterion 2.
Therefore, the following formula is used to express the project emissions:

$PE_p = 0$

H. Calculation of emissions reductions

Emission reductions are calculated as the difference between the reference emissions and project emissions, as follows:

$ER_p = RE_p - PE_p$

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
EF_{elec}	CO_2 emission factor for consumed electricity. When the electricity supplied from the WHR system displaces only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When the electricity supplied from the WHR system displaces both grid electricity and captive electricity, the project participant applies the CO_2 emission factor with lower value. [CO_2 emission factor] For grid electricity: The most recent value available from the source stated in this table at the time of validation For captive electricity, it is determined based on the following options:	[Grid electricity] The most recent value available at the time of validation is applied and fixed for the monitoring period thereafter. The data is sourced from " Grid Emission Factor (GEF) of Thailand", endorsed by Thailand Greenhouse Gas Management Organization unless otherwise instructed by the Joint Committee. [Captive electricity] For the option a) Specification of the captive power generation system provided by the manufacturer (η_{elec} [%]). CO_2 emission factor of the

	a) Calculated from its power generation efficiency (η_{elec} [%]) obtained from manufacturer's specification The power generation efficiency based on lower heating value (LHV) of the captive power generation system from the manufacturer's specification is applied; $$EF_{elec} = 3.6 \times \frac{100}{\eta_{elec}} \times EF_{fuel}$$ b) Calculated from measured data The power generation efficiency calculated from monitored data of the amount of fuel input for power generation ($FC_{PJ,p}$) and the amount of electricity generated ($EG_{PJ,p}$) during the monitoring period p is applied. The measurement is conducted with the monitoring equipment to which calibration certificate is issued by an entity accredited under national/international standards; $$EF_{elec} = FC_{PJ,p} \times NCV_{fuel} \times EF_{fuel} \times \frac{1}{EG_{PJ,p}}$$ Where: NCV_{fuel} : Net calorific value of consumed fuel [GJ/mass or volume] Note: In case the captive electricity generation system meets all of the following conditions, the value in the following table may be applied to EF_{elec} depending on the consumed fuel type. ・ The system is non-renewable generation system	fossil fuel type used in the captive power generation system (EF_{fuel} [tCO_2/GJ]) For the option b) Generated and supplied electricity by the captive power generation system ($EG_{PJ,p}$ [MWh/p]). Fuel amount consumed by the captive power generation system ($FC_{PJ,p}$ [mass or volume/p]). Net calorific value (NCV_{fuel} [GJ/mass or volume]) and CO_2 emission factor of the fuel (EF_{fuel} [tCO_2/GJ]) in order of preference: 1) values provided by the fuel supplier; 2) measurement by the project participants; 3) regional or national default values; 4) IPCC default values provided in tables 1.2 and 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied. [Captive electricity with diesel fuel] CDM approved small scale methodology: AMS-I.A.

<table>
<tr>
<td></td>
<td>
・ Electricity generation capacity of the system is less than or equal to 15 MW
<table>
<tr><td>fuel type</td><td>Diesel fuel</td><td>Natural gas</td></tr>
<tr><td>EF_{elec}</td><td>0.8 *1</td><td>0.46 *2</td></tr>
</table>
*1 The most recent value at the time of validation is applied.
*2 The value is calculated with the equation in the option a) above. The lower value of default effective CO_2 emission factor for natural gas (0.0543tCO_2/GJ), and the most efficient value of default efficiency for off-grid gas turbine systems (42%) are applied.
</td>
<td>[Captive electricity with natural gas]
2006 IPCC Guidelines on National GHG Inventories for the source of EF of natural gas.
CDM Methodological tool "Determining the baseline efficiency of thermal or electric energy generation systems version02.0" for the default efficiency for off-grid power plants.</td>
</tr>
<tr>
<td>EC_{CAP}</td>
<td>The total maximum rated capacity of equipment of the WHR system which consumes electricity except for the capacity of equipment which use the electricity generated by itself directly</td>
<td>Rated capacity of all installed equipment of the WHR system which consumes electricity except for the capacity of equipment which use the electricity generated by itself directly.</td>
</tr>
</table>

History of the document

Version	Date	Contents revised
01.0	20 April 2018	JC4, Annex 1 Initial approval.