Joint Crediting Mechanism Approved Methodology ID_AM016

"Installation of gas engine cogeneration system to supply electricity and heat to facility"

A. Title of the methodology

Installation of gas engine cogeneration system to supply electricity and heat to facility, Version 01.0

B. Terms and definitions

Terms	Definitions
Cogeneration System (CGS)	A system that consists of power generator(s) and boiler(s) supplying both electricity and heat, recovering waste heat exhausted by the power generator(s). The power generator is a gas engine in this methodology.
Facility	A cluster of buildings and/or plants (or building/plant itself) to which electricity and heat generated by CGS is supplied.
Power Generation Efficiency	Net quantity of electricity generated per quantity of energy contained in fuel fired in the power generator.
Boiler Efficiency	Net quantity of heat generated per quantity of energy contained in fuel fired in the boiler.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Electricity and heat generated by CGS(s) installed in the project facility(ies) substitutes all or part of grid and/or captive electricity consumed and heat generated by fossil fuel, which leads to efficient energy use of the facility(ies) and in turn GHG emission reductions.
Calculation of reference emissions	Reference emissions are CO_2 emissions from the use of grid and/or captive electricity and heat generated by reference boiler in the facility(ies), which are calculated based on: the amount of electricity consumption by the facility(ies) which is generated

	by the CGS(s); the amount of heat consumption by the facility(ies) which is generated by the CGS(s); reference boiler efficiency; and CO_2 emission factors for consumed electricity and fossil fuel consumed by the reference boiler in the facility(ies).
Calculation of project emissions	Project emissions are CO_2 emissions from the use of CGS(s), which are calculated based on: the amount of gas fuel consumption by the CGS(s); net calorific value of gas fuel consumed by the CGS(s); and CO_2 emission factor for gas fuel consumed by the CGS(s).
Monitoring parameters	• Amount of electricity consumption by the facility(ies) which is generated by the CGS(s) [MWh/p] • Amount of heat consumption by the facility(ies) which is generated by the CGS(s) [GJ/p] (Option 1) • Amount of heat supply to the facility(ies) which is generated by the CGS(s) [GJ/p] (Option 2) • Number of days during the monitoring period [day/p] (Option 2) • Amount of gas fuel consumption by the CGS(s) [Nm^3/p]

D. Eligibility criteria

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

Criterion 1	Gas engine CGS(s) is installed and supplies electricity and heat to facility(ies).
Criterion 2	The power generation efficiency of the CGS(s) stated in catalogs or other information prepared by its manufacturer is equal to or greater than the threshold value in the following table corresponding to the electrical output of CGS(s) installed.

Electrical output	Efficiency threshold
$x < 2$ [MW]	40 [%]
2 [MW] $\leq x$	47 [%]

E. Emission Sources and GHG types

Reference emissions

Emission sources	GHG types
Electricity consumed in facility(ies)	CO_2
Fossil fuel to generate heat in facility(ies)	CO_2
Project emissions	
Emission sources	GHG types
Gas fuel consumption by CGS(s)	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated based on: the amount of electricity consumption by the facility(ies) which is generated by the CGS(s); the amount of heat consumption by the facility(ies) which is generated by the CGS(s); reference boiler efficiency; and CO_2 emission factors for consumed electricity and fossil fuel consumed by the reference boiler in the facility(ies).

A default value for the reference boiler efficiency is conservatively set *ex ante* to 89.0 [%] so as to ensure net emission reductions.

F.2. Calculation of reference emissions

$$RE_p = \sum_i \sum_j RE_{elec,i,j,p} + \sum_i \sum_j RE_{heat,i,j,p}$$

$$= \sum_i \sum_j \left(EG_{i,j,p} \times EF_{elec,RE,j}\right) + \sum_j \left(\sum_i HG_{i,j,p} \times \frac{100}{\eta_{RE}} \times EF_{fuel,RE,j}\right)$$

Where

RE_p : Reference emissions during the period *p* [tCO_2/p]

$RE_{elec,i,j,p}$: Reference emissions for electricity consumption by the facility *j* which is generated by the CGS *i* during the period *p* [tCO_2/p]

$RE_{heat,i,j,p}$: Reference emissions for heat consumption by the facility *j* which is generated by the CGS *i* during the period *p* [tCO_2/p]

$EG_{i,j,p}$: Amount of electricity consumption by the facility *j* which is generated by the CGS *i* during the period *p* [MWh/p]

$EF_{elec,RE,j}$: CO_2 emission factor for consumed electricity in the facility *j* [tCO_2/MWh]

$HG_{i,j,p}$	: Amount of heat consumption by the facility *j* which is generated by the CGS *i* during the period *p* [GJ/p]
η_{RE}	: Reference boiler efficiency [%]
$EF_{fuel,RE,j}$	: CO_2 emission factor for fossil fuel consumed by the reference boiler in the facility *j* [tCO_2/GJ]
i	: Identification number for the CGS
j	: Identification number for the facility to which electricity and heat generated by the CGS *i* is supplied

<**Monitoring Options for $HG_{i,j,p}$**>

Project participants may select either of the following two monitoring options to obtain a value for $HG_{i,j,p}$.

Option 1: Monitor the amount of heat consumption by the facility *j* which is generated by the CGS *i* during the period *p* [GJ/p]

Option 2: Monitor the amount of heat supply to the facility *j* which is generated by the CGS *i* during the period *p* [GJ/p]

Option 1 can be selected when the project participants monitor the amount of heat "consumption".

Option 2 can be selected when the project participants monitor the amount of heat "supply", instead of "consumption", and there has been existing boiler(s) generating steam and/or hot water and supplying to the facility prior to the implementation of the JCM project. In this option, no emission reductions can be claimed from the amount of heat generated by the CGS *i* and supplied to the facility *j* which exceeds the maximum capacity of heat generation by the existing boiler(s) supplying to the facility *j*. The formula written below is applied.

$$\sum_{i} \boldsymbol{HG_{i,j,p}} = \textbf{min}\left[\sum_{i} \boldsymbol{HGS_{i,j,p}}, \sum_{k} \boldsymbol{\widehat{HG}_{k,j,p}}\right} \quad \textbf{, for any facility } \boldsymbol{j}$$

$$\boldsymbol{\widehat{HG}_{k,j,p}} = \begin{cases} \dfrac{\boldsymbol{HGC_k \times 24 \times DYS_p \times 2,257}}{\boldsymbol{10^6}} & \textbf{, for steam boiler} \\ \dfrac{\boldsymbol{HGC_k \times 24 \times DYS_p \times 3.6}}{\boldsymbol{10^3}} & \textbf{, for hot water boiler} \end{cases}$$

Where

$HG_{i,j,p}$	: Amount of heat consumption by the facility *j* which is generated by the CGS *i* during the period *p* [GJ/p]
$HGS_{i,j,p}$	: Amount of heat supply to the facility *j* which is generated by the CGS *i* during the period *p* [GJ/p]
$\widehat{HG}_{k,j,p}$	: Maximum capacity of heat generation by the existing boiler *k* supplying to the facility *j* during the period *p* [GJ/p]
HGC_k	: Heat generative capacity of the existing steam boiler *k* [kg/h] or hot water boiler *k* [kW]
DYS_p	: Number of days during the period *p* [day/p]
i	: Identification number for the CGS
j	: Identification number for the facility to which electricity and heat generated by the CGS *i* is supplied
k	: Identification number for the existing boiler which supplies steam or hot water to the facility *j*

G. Calculation of project emissions

$$\boldsymbol{PE_p} = \sum_i \boldsymbol{PE_{i,p}}$$

$$= \sum_i \left(\boldsymbol{FC_{i,p}} \times \boldsymbol{NCV_i} \times \boldsymbol{10^{-3}} \times \boldsymbol{EF_{fuel,PJ,i}}\right)$$

Where

PE_p	: Project emissions during the period *p* [tCO_2/p]
$PE_{i,p}$	: Project emissions for the CGS *i* during the period *p* [tCO_2/p]
$FC_{i,p}$	: Amount of gas fuel consumption by the CGS *i* during the period *p* [Nm^3/p]
NCV_i	: Net calorific value of gas fuel consumed by the CGS *i* [MJ/Nm^3]
$EF_{fuel,PJ,i}$	: CO_2 emission factor for gas fuel consumed by the CGS *i* [tCO_2/GJ]
i	: Identification number for the CGS

H. Calculation of emissions reductions

$$\boldsymbol{ER_p} = \boldsymbol{RE_p} - \boldsymbol{PE_p}$$

Where

ER_p : Emission reductions during the period p[tCO_2/p]

RE_p : Reference emissions during the period p [tCO_2/p]

PE_p : Project emissions during the period p [tCO_2/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
η_{RE}	Reference boiler efficiency. Default value is set to 89.0 [%].	Value derived from the result of survey. The default value, 89.0 [%], should be revised if necessary.
NCV_i	Net calorific value of gas fuel consumed by the CGS i [MJ/Nm^3].	In the order of preference: a) value provided by fuel supplier; b) value measured by the project participants; c) regional or national default value; or d) IPCC default value provided in table 1.2 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Upper value is applied.
$EF_{elec,RE,j}$	CO_2 emission factor for consumed electricity in the facility j [tCO_2/MWh]. When the facility consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When the facility consumes both grid electricity and captive electricity, the project participant applies the CO_2 emission factor	**[Grid electricity]** The data is sourced from "Emission Factors of Electricity Interconnection Systems", National Committee on Clean Development Mechanism (Indonesian DNA for CDM), based on data obtained by Directorate General of Electricity, Ministry

	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: 0.8* [tCO_2/MWh] *The most recent value available from CDM approved small scale methodology AMS-I.A at the time of validation is applied.	of Energy and Mineral Resources, Indonesia, unless otherwise instructed by the Joint Committee. **[Captive electricity]** CDM approved small scale methodology AMS-I.A.
$EF_{fuel,RE,j}$	CO_2 emission factor for fossil fuel consumed by the reference boiler in the facility *j* [tCO_2/GJ]. CO_2 emission factor of natural gas is applied in this methodology in a conservative manner.	In the order of preference: a) value provided by fuel supplier; b) value measured by the project participants; c) regional or national default value; or d) IPCC default value provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied.
$EF_{fuel,PJ,i}$	CO_2 emission factor for gas fuel consumed by the CGS *i* [tCO_2/GJ].	In order of preference: a) value provided by fuel supplier; b) value measured by the project participants; c) regional or national default value; or d) IPCC default value provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Higher value is applied.
HGC_k	Heat generative capacity of the existing steam	Catalogs, specifications

	boiler *k* [kg/h] or hot water boiler *k* [kW]. The value prepared by manufacturer is applied in the use of Option 2 only. Equivalent evaporation is used for steam boilers, and rated thermal output for hot water boilers.	prepared for the quotation or factory acceptance test data by manufacturer.

History of the document

Version	Date	Contents revised
01.0	10 July 2018	JC8, Annex 5 Initial approval.