Joint Crediting Mechanism Approved Methodology TH_AM009

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

A. Title of the methodology

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

B. Terms and definitions

Terms	Definitions
Cogeneration System (CGS)	A system that consists of power generator(s) and heat generating equipment (e.g. heat recovery steam generator, exhaust heat exchanger, etc.) and supplies both electricity and heat, recovering waste heat exhausted from the power generator(s). The power generator(s) is a gas engine(s) in this methodology.
Recipient Facility	A cluster of buildings and/or plants (or building/plant itself) to which electricity and heat generated by CGS are supplied.
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 a CGS installed in a project site substitute all or part of grid and/or captive electricity as well as heat, which leads to efficient energy use of recipient 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 a reference boiler, which are calculated based on: the amount of electricity consumed by the recipient facility(ies) which is generated by the CGS; the amount of heat consumed by the recipient facility(ies) which is generated by the CGS; CO_2 emission

	factors for consumed electricity in the recipient facility(ies); reference boiler efficiency and fossil fuel consumed by the reference boiler.
Calculation of project emissions	Project emissions are CO_2 emissions from the use of CGS, which are calculated based on: the amount of gas fuel consumed by the CGS; net calorific value of gas fuel consumed by the CGS; and CO_2 emission factor of gas fuel consumed by the CGS.
Monitoring parameters	● Amount of electricity consumed by the recipient facility(ies) which is generated by the CGS ● Amount of heat consumed by the recipient facility(ies) which is generated by the CGS ● Amount of gas fuel consumed by the CGS

D. Eligibility criteria

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

Criterion 1	A CGS, whose electricity is generated by a gas engine(s), is newly installed and supplies electricity and heat to recipient facility(ies).
Criterion 2	Electricity and heat, each of which is generated in separate systems, is supplied to and consumed by recipient facility(ies) before the installation of a project CGS.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Electricity consumption in recipient facility(ies)	CO_2
Fossil fuel consumption for production of heat consumed in recipient facility(ies)	CO_2
Project emissions	
Emission sources	GHG types
Gas fuel consumption by CGS	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 generated by the CGS and consumed by the recipient facility(ies); the amount of heat generated by the CGS and consumed by the recipient facility(ies); reference boiler efficiency; and CO_2 emission factors for consumed electricity in the recipient facility(ies) and fossil fuel consumed by the reference boiler.

A default value for the reference boiler efficiency is conservatively set to 89 [%] taking the highest value among those products sold in Thailand, so as to ensure net emission reductions.

F.2. Calculation of reference emissions

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

$$= \sum_i \left(EC_{i,p} \times EF_{elec,i}\right) + \sum_i HC_{i,p} \times \frac{100}{\eta_{RE}} \times EF_{fuel,RE}$$

Where

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

G. Calculation of project emissions

$$PE_p = FC_{CGS,p} \times NCV_{fuel,CGS} \times EF_{fuel,PJ}$$

Where

PE_p : Project emissions during the period p [tCO_2/p]

$FC_{CGS,p}$: Amount of gas fuel consumed by the CGS during the period p [mass or volume/p]

$NCV_{fuel,CGS}$: Net calorific value of gas fuel consumed by the CGS [GJ/mass or volume]

$EF_{fuel,PJ}$: CO_2 emission factor for gas fuel consumed by the CGS [tCO_2/GJ]

H. Calculation of emissions reductions

$$ER_p = RE_p - PE_p$$

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 [%].	Value derived from the result of survey. The default value, 89 [%], should be revised if necessary.
$NCV_{fuel,CGS}$	Net calorific value of gas fuel consumed by the CGS [GJ/mass or volume].	In the order of preference: a) values provided by fuel supplier; b) measurement by the

		project participants; c) regional or national default values; or d) IPCC default values provided in table 1.2 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Upper value is applied.
$EF_{elec,i}$	CO_2 emission factor for consumed electricity in the recipient facility *i* [tCO_2/MWh]. When the recipient facility consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When both grid electricity and captive electricity may be consumed in the recipient facility, 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 including cogeneration system, it is determined based on the following options: a) Calculated from its power generation efficiency ($\eta_{cap,i}$ [%]) obtained from manufacturer's specification The power generation efficiency based on lower heating value (LHV) of the captive power	**[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 connected to the recipient facility *i*, provided by the manufacturer ($\eta_{cap,i}$ [%]). CO_2 emission factor of the fuel consumed by the captive power generation system connected to the recipient facility *i*

	generation system from the manufacturer's specification is applied; $$EF_{elec,i} = 3.6 \times \frac{100}{\eta_{cap,i}} \times EF_{fuel,cap,i}$$ b) Calculated from measured data The power generation efficiency calculated from monitored data of the amount of fuel input for power generation ($FC_{cap,i,p}$) and the amount of electricity generated ($EG_{cap,i,p}$) 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; $$EF_{elec,i} = FC_{cap,i,p} \times NCV_{fuel,cap,i} \times EF_{fuel,cap,i} \times \frac{1}{EG_{cap,i,p}}$$ Where: $NCV_{fuel,cap,i}$: Net calorific value of the fuel consumed by the captive power generation system connected to the recipient facility *i* [GJ/mass or volume] Note: In case the captive electricity generation system connected to the recipient facility *i* meets all of the following conditions, the value in the following table may be applied to $EF_{elec,i}$ depending on the consumed fuel type. • The system is non-renewable generation system • Electricity generation capacity of the system is less than or equal to 15 MW fuel type | Diesel fuel | Natural gas	($EF_{fuel,cap,i}$ [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 table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied. For the option b) Generated and supplied electricity by the captive power generation system connected to the recipient facility *i* ($EG_{cap,i,p}$ [MWh/p]). Fuel amount consumed by the captive power generation system connected to the recipient facility *i* ($FC_{cap,i,p}$ [mass or volume/p]). Net calorific value ($NCV_{fuel,cap,i}$ [GJ/mass or volume]) and CO_2 emission factor of the fuel ($EF_{fuel,cap,i}$ [tCO_2/GJ]) in order of preference: 1) values provided by the fuel supplier; 2) measurement by the

	$EF_{elec,i}$ | 0.8 *1 | 0.46 *2 *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 (0.0543 tCO_2/GJ), and the most efficient value of default efficiency for off-grid gas turbine systems (42%) are applied.	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. [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.
$EF_{fuel,RE}$	CO_2 emission factor for fossil fuel consumed by the reference boiler [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) values provided by fuel supplier; b) measurement by the project participants; c) regional or national default values; or d) IPCC default values provided in table 1.4 of

		Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied.
$EF_{fuel,PJ}$	CO_2 emission factor for gas fuel consumed by the CGS [tCO_2/GJ].	In order of preference: a) values provided by fuel supplier; b) measurement by the project participants; c) regional or national default values; or d) IPCC default values provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Upper value is applied.

History of the document

Version	Date	Contents revised
01.0	14 January 2019	Electronic decision by the Joint Committee Initial approval.