# JCM Proposed Methodology Form

## Cover sheet of the Proposed Methodology Form

Form for submitting the proposed methodology

| | |
|---|---|
| Host Country | The Kingdom of Thailand |
| Name of the methodology proponents submitting this form | Institute for Global Environmental Strategies |
| Sectoral scope(s) to which the Proposed Methodology applies | 1. Energy industries (renewable – / non-renewable sources) |
| Title of the proposed methodology, and version number | Installation of gas engine cogeneration system to supply electricity and heat, Version 01.0 |
| List of documents to be attached to this form (please check): | ☐The attached draft JCM-PDD:<br>☒Additional information |
| Date of completion | 11/09/2018 |

History of the proposed methodology

| Version | Date | Contents revised |
|---|---|---|
| 01.0 | 11/09/2018 | First Edition |
| | | |
| | | |

## 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<br>● Amount of heat consumed by the recipient facility(ies) which is generated by the CGS<br>● 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 power generation is driven 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] |
| $\eta_{RE}$ | : | 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 |
|---|---|---|
| $\eta_{RE}$ | Reference boiler efficiency.<br>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:<br>a) values provided by fuel supplier;<br>b) measurement by the project participants;<br>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].<br><br>When the recipient facility consumes only grid electricity or captive electricity, the project participant applies the $CO_2$ emission factor respectively.<br><br>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.<br><br>[$CO_2$ emission factor]<br>For grid electricity: The most recent value available from the source stated in this table at the time of validation<br><br>For captive electricity including cogeneration system, it is determined based on the following options:<br><br>a) Calculated from its power generation efficiency ($\eta_{cap,i}$ [%]) obtained from manufacturer's specification<br>The power generation efficiency based on lower heating value (LHV) of the captive power generation system from the manufacturer's specification is applied; | **[Grid electricity]**<br>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.<br><br>**[Captive electricity]**<br>For the option a)<br><br>Specification of the captive power generation system connected to the recipient facility *i*, provided by the manufacturer ($\eta_{cap,i}$ [%]).<br>$CO_2$ emission factor of the fuel consumed by the captive power generation system connected to the recipient facility *i* ($EF_{fuel,cap,i}$ [$tCO_2$/GJ]) in order of preference:<br>1) values provided by the |

| | | |
|---|---|---|
| | $EF_{elec,i} = 3.6 \times \frac{100}{\eta_{cap,i}} \times EF_{fuel,cap,i}$<br><br>b) Calculated from measured data<br>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;<br>$EF_{elec,i} = FC_{cap,i,p} \times NCV_{fuel,cap,i} \times EF_{fuel,cap,i} \times \frac{1}{EG_{cap,i,p}}$<br>Where:<br>$NCV_{fuel,cap,i}$ : Net calorific value of the fuel consumed by the captive power generation system connected to the recipient facility *i* [GJ/mass or volume]<br><br>Note:<br>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.<br><br>• The system is non-renewable generation system<br>• Electricity generation capacity of the system is less than or equal to 15 MW<br><br>fuel type / Diesel fuel / Natural gas<br>$EF_{elec,i}$ / 0.8 *1 / 0.46 *2 | fuel supplier;<br>2) measurement by the project participants;<br>3) regional or national default values;<br>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.<br><br>For the option b)<br>Generated and supplied electricity by the captive power generation system connected to the recipient facility *i* ( $EG_{cap,i,p}$ [MWh/p]).<br>Fuel amount consumed by the captive power generation system connected to the recipient facility *i* ($FC_{cap,i,p}$ [mass or volume/p]).<br>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:<br>1) values provided by the fuel supplier;<br>2) measurement by the project participants;<br>3) regional or national default values; |

| | | |
|---|---|---|
| | *1 The most recent value at the time of validation is applied.<br>*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. | 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.<br><br>[Captive electricity with diesel fuel]<br>CDM approved small scale methodology: AMS-I.A.<br><br>[Captive electricity with natural gas]<br>2006 IPCC Guidelines on National GHG Inventories for the source of EF of natural gas.<br>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 [$tCO_2/GJ$].<br>$CO_2$ emission factor of natural gas is applied in this methodology in a conservative manner. | In the order of preference:<br>a) values provided by fuel supplier;<br>b) measurement by the project participants;<br>c) regional or national default values; or<br>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:<br>a) values provided by fuel supplier;<br>b) measurement by the project participants;<br>c) regional or national default values; or<br>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. |