# JCM Proposed Methodology Form

## Cover sheet of the Proposed Methodology Form

Form for submitting the proposed methodology

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| Host Country | Kingdom of Thailand |
| Name of the methodology proponents submitting this form | Marubeni Corporation |
| Sectoral scope(s) to which the Proposed Methodology applies | 1. Energy industries (renewable-/non-renewable sources) |
| Title of the proposed methodology, and version number | Introduction of digital solution (AI analysis, etc.) to improve boiler combustion efficiency |
| List of documents to be attached to this form (please check): | ☐The attached draft JCM-PDD:<br>☐Additional information |
| Date of completion | 11/07/2022 |

History of the proposed methodology

| Version | Date | Contents revised |
|---|---|---|
| 1.0 | 11/07/2022 | First edition |
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## A. Title of the methodology

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| Introduction of digital solution (AI analysis, etc.) to improve boiler combustion efficiency, Version 1.0 |

## B. Terms and definitions

| Terms | Definitions |
|---|---|
| Power generation optimization technology | Digital solution which analyzes the power generation system operation data and provides the control of power generation system with the optimized command to improve the efficiency as a result of optimized power generation. |
| Power generation system | System consisting of boiler, generator and auxiliary equipment to generate electricity. |
| Commissioning | Performance verification of the power generation optimization technology. |

## C. Summary of the methodology

| Items | Summary |
|---|---|
| *GHG emission reduction measures* | Introduction of power generation optimization technology into power generation system improves power generation efficiency, which leads to reduction of fuel and hence GHG emissions. |
| *Calculation of reference emissions* | Reference emissions are GHG emissions from reference power generation system, calculated with project emissions and rate of power generation efficiency improvement due to introduction of the project power generation optimization technology. |
| *Calculation of project emissions* | Project emissions are GHG emissions from project power generation system, calculated with fuel consumption by the project power generation system, net calorific value and $CO_2$ emission factor for consumed fuel.<br>Although project power generation optimization technology |

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| | requires additional electricity consumption, it is small and negligible in calculation of project emissions. |
| *Monitoring parameters* | ● Fuel consumption of the project power generation system<br>● Electric power of the project generator |

## D. Eligibility criteria

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

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| Criterion 1 | Power generation optimization technology is newly introduced to the power generation system. |

## E. Emission Sources and GHG types

| Reference emissions | |
|---|---|
| Emission sources | GHG types |
| Fuel consumption by reference power generation system | $CO_2$ |
| Project emissions | |
| Emission sources | GHG types |
| Fuel consumption by project power generation system | $CO_2$ |

## F. Establishment and calculation of reference emissions

### F.1. Establishment of reference emissions

Reference emissions are calculated by multiplying the project emissions by rate of power generation efficiency improvement due to introduction of the project power generation optimization technology, denoted by "η".
η is fixed *ex-ante* in a conservative manner to ensure net emission reductions. How to set η is instructed in Section I of this methodology.

### F.2. Calculation of reference emissions

$$RE_p = \sum_i \left( FC_{PJ,i,p} \times NCV_{PJ,fuel,i} \times EF_{PJ,fuel,i} \times \eta_i \right)$$

*Where*

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| $RE_p$ | Reference emissions during the period *p* [$tCO_2$/p] |
| $FC_{PJ,i,p}$ | Fuel consumption by the project power generation system *i* during the period *p* [mass or volume/p] |
| $NCV_{PJ,fuel,i}$ | Net calorific value of fuel consumed by the project power generation system *i* [GJ/mass or volume] |
| $EF_{PJ,fuel,i}$ | $CO_2$ emission factor for fuel consumed by the project power generation system *i* [$tCO_2$/GJ] |
| $\eta_i$ | Ratio of project power generation system *i* to reference power generation system *i* [dimensionless] |
| i | Identification number of the power generation system |

Multiple test data with a load factor of generator are used to determine the value of $\eta_i$ *ex ante* as instructed in Section I of this methodology. The lowest load factor amongst the test data is set as a threshold value. Fuel consumption by the project power generation system with the load factor of generator being less than the threshold value is excluded from calculation of reference emissions. The threshold value of load factor is determined at the time of validation.

## G. Calculation of project emissions

$$PE_p = \sum_i \left( FC_{PJ,i,p} \times NCV_{PJ,fuel,i} \times EF_{PJ,fuel,i} \right)$$

*Where*

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| $PE_p$ | Project emissions during the period *p* [$tCO_2$/p] |
| $FC_{PJ,i,p}$ | Fuel consumption by the project power generation system *i* during the period *p* [mass or volume/p] |
| $NCV_{PJ,fuel,i}$ | Net calorific value of fuel consumed by the project power generation system *i* [GJ/mass or volume] |
| $EF_{PJ,fuel,i}$ | $CO_2$ emission factor for fuel consumed by the project power generation system *i* [$tCO_2$/GJ] |
| i | Identification number of the power generation system |

Multiple test data with a load factor of generator are used to determine the value of $\eta_i$ *ex ante* as instructed in Section I of this methodology. The lowest load factor amongst the test data is set as a threshold value. Fuel consumption by the project power generation system with the

load factor of generator being less than the threshold value is excluded from calculation of project emissions. The threshold value of load factor is determined at the time of validation.

## H. Calculation of emissions reductions

$$ER_p = RE_p - PE_p$$

*Where*

$ER_p$ Emissions 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 |
|---|---|---|
| $\eta_i$ | Ratio of project power generation system *i* to reference power generation system *i*<br><br>$\eta_i$ is calculated with the following equation.<br><br>$\eta_i = PGE_{PJ,i} \div PGE_{RE,i}$<br><br>*Where*<br>$PGE_{PJ,i}$ Power generation efficiency of the project power generation system *i*<br>$PGE_{RE,i}$ Power generation efficiency of the reference power generation system *i*<br>Reference power generation system is the same as the project generation system without activation of the project power generation optimization technology.<br><br>$PGE_{PJ,i}$ and $PGE_{RE,i}$ are calculated by means specified in the latest version of ASME PTC4 | Commissioning result<br>ASME PTC4<br>ASME PTC6 |

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| | and ASME PTC6. Then, $\eta_{i,test}$ is calculated for each data set obtained for different time periods, and p values in null-hypothesis significance testing are calculated for each $\eta_{i,test}$ obtained to exclude outliers.<br>A default value $\eta_i$ is obtained and fixed *ex-ante* at the time of validation to ensure net emission reductions with the following procedure:<br>1) $\eta_{i,test}$ whose p value is less than 0.05 is excluded from the data set since it is not statistically significant.<br>2) An averaged ratio of power generation efficiency change (defined as $\eta_{ave}$) is obtained by averaging the remained $\eta_{i,test}$ with statistical significance.<br>3) A standard deviation is also obtained from the remained $\eta_{i,test}$ with statistical significance.<br>4) A default value $\eta_i$ is obtained by subtracting standard deviation ($\sigma$) from averaged energy saving factor ($\eta_{i,ave}$).<br>$$\eta_i = \eta_{i,ave} - \sigma_i$$<br>*Where*<br>$$\eta_{i,ave} = \frac{i}{n}\sum_i \eta_{i,test}$$<br>$$\sigma = \sqrt{\frac{1}{n}\sum_i \left(\eta_{i,test} - \eta_{i,ave}\right)^2}$$<br>n Number of data ($\eta_{i,test}$) used to calculate standard deviation<br>When the power generation system *i* is replaced, $\eta_i$ is recalculated and fixed in the same manner as described above. | |
| $NCV_{PJ,fuel,i}$ | Net calorific value of fuel consumed by the project power generation system *i* | In the order of preference:<br>a) values provided by fuel |

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| | | supplier;<br>b) measurement by the project participants;<br>c) regional or national default values; or<br>d) IPCC default values provided in table 1.2 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied. |
| $EF_{PJ,fuel,i}$ | $CO_2$ emission factor for fuel consumed by the project power generation system *i* | 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. |