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	Nippon Koei Co., Ltd.
Sectoral scope(s) to which the Proposed Methodology applies	3. Energy Demand
Title of the proposed methodology, and version number	Energy Saving by Introduction of High Efficiency Once-through Boiler and Installation of Economizer into Existing Boiler, Version 01.0
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☒Additional information Appendix 1. Additional Information for the Proposed Methodology
Date of completion	02/08/2019

History of the proposed methodology

Version	Date	Contents revised
01.0	02/08/2019	First Edition

A. Title of the methodology

Energy Saving by Introduction of High Efficiency Once-through Boiler and Installation of Economizer into Existing Boiler, Version 01.0

B. Terms and definitions

Terms	Definitions
Once-through boiler	A once-through boiler is a boiler without recirculation where water/steam flows through the economizer, furnace wall, and evaporating and superheating tubes, sequentially. Once-through (OT) boiler is used to supply heat in factory and commercial facility.
Periodical check	Periodical check is a scheduled examination of the project boiler conducted by manufacturer or agent who is authorized by the manufacturer in order to maintain performance of the boiler.
Boiler efficiency	Boiler efficiency is the percentage of heat quantity used to generate steam against total heat quantity provided by a fuel.
Fuel switching	Fuel switching involves the change of fuel from the one with higher CO_2 emission factor to lower CO_2 emission factor (i.e. from coal to natural gas).
Economizer	Economizer is a mechanical device that recovers and transfers the heat from the boiler exhaust gases to the incoming boiler feed water, which increases the overall boiler's thermal efficiency.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	This methodology covers one or both of the following two measures: (1) the introduction of high efficiency once-through boiler (hereinafter called "project boiler (OT)") and (2) the installation of economizer into existing

	boiler (hereinafter called "project boiler (EC)"). (1) Compared with the fire tube boilers which dominate Thailand market (hereinafter called "reference boiler (OT)"), the efficiency of "project boiler (OT)" is higher and its fuel consumption is lower. (2) Through the installation of economizer to the existing boiler, feed water to the boiler is preheated by using exhaust gas heat from the boiler. It will contribute to the reduction of fuel consumptions of existing boiler without economizer (hereinafter called "reference boiler (EC)"). Thus, the introduction of once-through boiler and the installation of economizer into the existing boiler will contribute to GHG emission reduction.
Calculation of reference emissions	Reference emissions are calculated from one or both of the following two measures: (1) the introduction of once-through boiler, and (2) the installation of economizer into the existing boiler. (1) Reference emissions for the introduction of once-through boiler (hereinafter called "reference emission (OT)") are calculated based on the efficiency of the boiler currently dominant in the Thailand market and emission factor of the fuel of reference boiler (OT). Conservative estimation of reference emission (OT) is made by taking into consideration the following points: (i) higher efficiency is applied for the reference boiler (OT), especially in low load range (ii) lower CO_2 emission factor of fuel used in reference boiler (OT) is selected from IPCC guideline. (2) Reference emissions for the installation of economizer into existing boiler (hereinafter called "reference emission (EC)") are calculated based on the efficiency of reference boiler (EC) and emission factor of the fuel of reference boiler (EC). Conservative estimation of reference emission (EC) is

	made by taking into consideration that lower CO_2 emission factor is selected from IPCC guideline with regard to the fuel used in reference boiler (OT).
Calculation of project emissions	Project emissions are calculated from one or both of the following two measures: (1) the introduction of once-through boiler, and (2) the installation of economizer into existing boiler. (1) Project emissions for the introduction of once-through boiler (hereinafter called "project emission (OT)") are calculated on the basis of monitored fuel consumption and emission factor of the fuel of project boiler (OT). (2) Project emissions for the installation of economizer into existing boiler (hereinafter called "project emission (EC)") are calculated on the basis of monitored fuel consumption and emission factor of the fuel of project boiler (EC).
Monitoring parameters	- The amount of fuel consumption of project boiler (OT) - The amount of fuel consumption of project boiler (EC)

D. Eligibility criteria

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

Criterion 1	Projects involve implementation of one or both of the following two energy efficiency improvement measures: the introduction of once-through boiler and the installation of economizer into existing boiler.
Criterion 2	For projects that involve the introduction of once-through boiler, the project boiler (OT) is a once-through boiler with a rated capacity of 7 ton/hour per unit or less (equivalent evaporation).
Criterion 3	For projects that involve the installation of economizer into existing boiler, the fuel for the project boiler (EC) shall not be heavy oil nor coal.
Criterion 4	Periodical check and maintenance by the manufacturer of boiler or authorized agent is implemented in accordance with the manufacturer's requirement.

E. Emission Sources and GHG types

Reference emissions

Emission sources	GHG types
Fuel consumption by reference boiler (OT)	CO_2
Fuel consumption by reference boiler (EC)	CO_2
Project emissions	
Emission sources	GHG types
Fuel consumption by project boiler (OT)	CO_2
Fuel consumption by project boiler (EC)	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

This methodology involves implementation of one or both of the following two energy efficiency improvement measures: (1) the introduction of once-through boiler, and (2) the installation of economizer into existing boiler. Therefore, reference emissions are calculated from one or both of the following two measures, depending on the measures implemented by the project.

(1) The emissions from reference boilers (OT):

The reference emissions (OT) are calculated based on the efficiency of the fire tube boilers which dominates the Thailand boiler market for industries and emission factor of the fuel of reference boiler (OT). In order to ensure the net emission reductions, a higher efficiency of the reference boiler (89%) is adopted as a default value to calculate the reference emissions (OT). In addition, 1) compared with reference boiler (OT), once-through boiler (project boiler (OT)) can maintain high efficiency even at low load range, which improves the operating efficiency of project boiler (OT). In addition, to calculate the reference emission (OT) in a conservative manner, the lower emission factor stated in 2006 IPCC guideline is adopted to secure the net emission reduction from this measure.

(2) The emissions from reference boiler (EC)

The reference emissions (EC) are calculated based on the efficiency of reference boiler (EC) and project boiler (EC) with the emission factor of the fuel of reference boiler (EC). The efficiency of project boiler (EC) is improved by the heat recovery function of economizer. The efficiencies of reference boiler (EC) and project boiler (EC) are provided in the specifications of each boiler given by boiler manufacture or supplier.

F.2. Calculation of reference emissions

$$RE_p = \sum_i \sum_j \left(FC_{p,i,j,PJ(OT)} \times NCV_{i,j,PJ(OT)} \times \frac{\eta_{i,PJ(OT)}}{\eta_{RE(OT)}} \times EF_{RE(OT)} \right) + \sum_i \sum_j \left(FC_{p,i,j,PJ(EC)} \times NCV_{i,j,PJ(EC)} \times \frac{\eta_{i,PJ(EC)}}{\eta_{i,RE(EC)}} \times EF_{j,RE(EC)} \right)$$

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

$FC_{p,i,j,PJ(OT)}$: The amount of fuel consumption of project boiler (OT) *i* for the fuel type *j* during the period *p* [mass or volume unit/p]

$NCV_{i,j,PJ(OT)}$: Net calorific value of fuel used by project boiler (OT) *i* for the fuel type *j* [GJ/mass or volume unit]

$\eta_{i,PJ(OT)}$: Efficiency of project boiler (OT) *i* [-]

$\eta_{RE(OT)}$: Efficiency of reference boiler (OT) [-]

$EF_{RE(OT)}$: CO_2 emission factor of fuel used by reference boiler (OT) [tCO_2/GJ]

$FC_{p,i,j,PJ(EC)}$: The amount of fuel consumption of project boiler (EC) *i* for the fuel type *j* during the period *p* [mass or volume unit/p]

$NCV_{i,j,PJ(EC)}$: Net calorific value of fuel used by project boiler (EC) *i* for the fuel type *j* [GJ/mass or volume unit]

$EF_{j,RE(EC)}$: CO_2 emission factor of fuel used by reference boiler (EC) for the fuel type *j* [tCO_2/GJ]

$\eta_{i,PJ(EC)}$: Efficiency of project boiler (EC) *i* [-]

$\eta_{i,RE(EC)}$: Efficiency of reference boiler (EC) *i* [-]

G. Calculation of project emissions

$$PE_p = \sum_i \sum_j \left(FC_{p,i,j,PJ(OT)} \times NCV_{i,j,PJ(OT)} \times EF_{i,j,PJ(OT)} \right) + \sum_i \sum_j \left(FC_{p,i,j,PJ(EC)} \times NCV_{i,j,PJ(EC)} \times EF_{i,j,PJ(EC)} \right)$$

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

$FC_{p,i,j,PJ(OT)}$: The amount of fuel consumption of project boiler (OT) *i* for the fuel type *j* during the period *p* [mass or volume unit]

$NCV_{i,j,PJ(OT)}$: Net calorific value of fuel used by project boiler (OT) *i* for the fuel type *j* [GJ/mass or volume unit]

$EF_{i,j,PJ(OT)}$: CO_2 emission factor of fuel used by project boiler (OT) *i* for the fuel type *j*

[tCO_2/GJ]

$FC_{p,i,j,PJ(EC)}$: The amount of fuel consumption of project boiler (EC) *i* for the fuel type *j* during the period *p* [mass or volume unit]

$NCV_{i,j,PJ(EC)}$: Net calorific value of fuel used by project boiler (EC) *i* for the fuel type *j* [GJ/mass or volume unit]

$EF_{i,j,PJ(EC)}$: CO_2 emission factor of fuel used by project boiler (EC) *i* for the fuel type *j* [tCO_2/GJ]

H. Calculation of emissions reductions

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

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
$NCV_{i,j,PJ(OT)}$	Net calorific value of fuel used by project boiler (OT) *i* for the fuel type *j* [GJ/mass or volume unit]	(1) Net calorific value (lower heating value) provided by fuel supplier, (2) IPCC default values at the lower limit in Table 1.2 of Chapter 1 of Vol. 2 of "2006 IPCC Guidelines for National GHG Inventories" (when (1) is not available, apply (2))
$NCV_{i,j,PJ(EC)}$	Net calorific value of fuel used by project boiler (EC) *i* for the fuel type *j* [GJ/mass or volume unit]	(1) Net calorific value (lower heating value) provided by fuel supplier, (2) IPCC default values at the lower limit in Table 1.2 of Chapter 1 of Vol. 2 of "2006 IPCC Guidelines for National GHG Inventories" (when (1) is not available, apply (2))

$EF_{i,j,PJ(OT)}$	CO_2 emission factor of fuel used by project boiler (OT) *i* for the fuel type *j* [tCO_2/GJ]	IPCC default value from Table 1.4 of Chapter 1 of Vol. 2 of "2006 IPCC Guidelines for National GHG Inventories"
$EF_{RE(OT)}$	CO_2 emission factor of fuel used by the reference boiler (OT) [tCO_2/GJ] In case the project boiler replaces the existing boiler, or the planned boiler whose plan is once approved officially, such as with boiler installation permit or environmental impact assessment, CO_2 emission factor of the fuel used by the existing or planned boiler is applied. Otherwise, the value of the fuel use by the project boiler (OT) *i* is applied.	IPCC default value at the lower limit in Table 1.4 of Chapter 1 of Vol. 2 from "2006 IPCC Guidelines for National GHG Inventories"
$EF_{i,j,PJ(EC)}$	CO_2 emission factor of fuel used by project boiler (EC) *i* for the fuel type *j* [tCO_2/GJ]	IPCC default value from Table 1.4 of Chapter 1 of Vol.2 of "2006 IPCC Guidelines for National Greenhouse Gas Inventories"
$EF_{j,RE(EC)}$	CO_2 emission factor of fuel used by reference boiler (EC) for the fuel type *j* [tCO_2/GJ]	IPCC default value at the lower limit in Table 1.4 of Chapter 1 of Vol. 2 from "2006 IPCC Guidelines for National GHG Inventories"
$\eta_{i,PJ(OT)}$	Efficiency of project boiler (OT) *i* [-]	Specifications of the project boiler or factory test data of the project boiler by the manufacturer
$\eta_{RE(OT)}$	Efficiency of reference boiler (OT) [-] The default value of η_{RE} is set as 89% in this methodology.	Default value in the methodology
$\eta_{i,PJ(EC)}$	Efficiency of project boiler (EC) *i* [-]	Specifications, boiler performance sheets, or test data of project boiler

		(EC) by the boiler manufacturer or supplier
$\eta_{i,\mathrm{RE(EC)}}$	Efficiency of reference boiler (EC) *i* [-]	Specifications, boiler performance sheet, or test data of reference boiler (EC) by the boiler manufacturer or supplier.