Joint Crediting Mechanism Approved Methodology VN_AM010

"Introduction of tunnel and/or shuttle kiln with waste heat recovery system"

A. Title of the methodology
Introduction of tunnel and/or shuttle kiln with waste heat recovery system, Version 01.0

B. Terms and definitions	
Terms	Definitions
Tunnel kiln	Long-shaped, continuous type firing kiln for ceramics, refractory materials, which is equipped with firing and cooling unit. First, product is installed on the top of a kiln car. Second, the kiln car enters the kiln, moves to the firing unit of the kiln and the product is fired. Then the kiln car moves to the cooling unit of the kiln and the product is cooled with ambient air. Lastly the kiln car moves out from the kiln. The movement of the kiln car is continuous and homogeneous products are produced in large quantity.
Shuttle kiln	Batch type firing kiln for ceramics, refractory materials. First, product is placed in the kiln. Then the kiln fires the product. After the firing is completed, the product is cooled in the kiln with ambient air and moves out from the kiln.
Waste heat recovery system	Equipment and/or system to recover heat from exhaust gas or hot air after cooling. Heat will be recovered directly from the hot air after cooling the product in tunnel kiln and from exhaust gas through heat exchanger in shuttle kiln. In case of the tunnel kiln, the system has a structure which leads hot air after cooling product taken out from the cooling unit to flow into the firing unit, in order to use that air as combustion air in the firing unit. In case of the shuttle kiln, the system has a structure which leads exhaust gas from the kiln to heat exchanger for pre-heating the combustion air.

C. Summary of the methodology	
Items	Summary
GHG emission reduction measures	This methodology involves the installation of tunnel kiln and/or shuttle kiln with waste heat recovery system. Tunnel kiln and/or shuttle kiln is typically installed without waste heat recovery system. Thus the introduction of tunnel and/or shuttle kiln with waste heat recovery system will contribute to the reduction of natural gas as fuel for the kiln, and thus to the GHG emission reductions.
Calculation of reference emissions	Reference emissions are calculated by net supplied heat quantity recovered by the project waste heat recovery system and emission factor of natural gas.
Calculation of project emissions	Project emissions are not considered as waste heat recovery system does not utilize any fossil fuel.
Monitoring parameters	● Quantity of supplied air for combustion which was pre-heated by waste heat recovery system ● Annual average temperature of supplied combustion air entering the firing unit of project tunnel and/or shuttle kiln

D. Eligibility criteria

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

Criterion 1	The project introduces tunnel and/or shuttle kiln with waste heat recovery system.
Criterion 2	Periodical check is planned more than one (1) time annually.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Consumption of natural gas by reference tunnel kiln and/or shuttle kiln	CO_2
Project emissions	
Emission sources	GHG types
N/A	N/A

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated by net supplied heat quantity recovered by the project waste heat recovery system and emission factor of natural gas. Heat quantity recovered from waste heat will be calculated by multiplying supplied combustion air quantity which was pre-heated by waste heat recovery system, specific heat of combustion air and temperature difference between the temperature of combustion air and temperature of ambient.

The ambient temperature is determined conservatively on the basis of the data from the mean monthly maximum temperature per the unit of special city or province in Vietnam. The default value is set at the highest value among the mean monthly maximum temperature which is 35.8 °C

F.2. Calculation of reference emissions

$$RE_p = RH_p \times EF_{NG}$$

Where

RE_p	:	Reference emissions during the period *p* [tCO_2/p]
RH_p	:	Net supplied heat quantity recovered by the project during the period *p* [GJ/p]
EF_{NG}	:	CO_2 emission factor of natural gas [tCO_2/GJ]

$$RH_p = \sum_i RG_{i,p} \times SF \times TD_{PJ,i,p} \times 10^{-3}$$

Where

$RG_{i,p}$	:	Supplied combustion air quantity of project tunnel and/or shuttle kiln *i* which was pre-heated by waste heat recovery system during the period *p* [t/p]
SF	:	Specific heat of supplied combustion air [MJ/t·K]

$TD_{PJ,i,p}$	:	Temperature difference of project tunnel and/or shuttle kiln *i* and ambient during the project period *p* [K/p]

$$RG_{i,p} = DG \times RGV_{i,p} \times 10^{-3}$$

Where

DG	:	Density of supplied combustion air [kg/Nm^3]
$RGV_{i,p}$	:	Supplied combustion air quantity of project tunnel and/or shuttle kiln *i* which was pre-heated by waste heat recovery system during the period *p* [Nm^3/p]

$$TD_{PJ,i,p} = TM_{rg,i,p} - TM_{am}$$

Where

$TM_{rg,i,p}$	:	Temperature of supplied combustion air entering the firing unit of the project tunnel and/or shuttle kiln *i* during the project period *p* [°C/p]
TM_{am}	:	Temperature of ambient of project tunnel and/or shuttle kiln [°C]

G. Calculation of project emissions

$$PE_p = 0$$

Where

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

H. Calculation of emissions reductions

$$ER_p = RE_p - PE_p$$

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
EF_{NG}	CO_2 emission factor of natural gas 0.0543 tCO_2/GJ	IPCC default value from "2006 IPCC Guidelines for National Greenhouse Gas Inventory, Volume2"
SF	Specific heat of supplied combustion air 1.006 MJ/t·K	
DG	Density of supplied combustion air 1.293 kg/Nm^3	JIS K 2249-1：2011, 6 a)
TM_{am}	Temperature of ambient of project tunnel and/or shuttle kiln [°C] 35.8 °C	Default value set in the methodology

History of the document

Version	Date	Contents revised
01.0	29 August 2018	Decision by the Joint Committee Initial approval.