Joint Crediting Mechanism Approved Methodology CR_AM003

"Installation of Electric Heat Pump Type Water Heater for Hot Water Supply Systems"

A. Title of the methodology

Installation of Electric Heat Pump Type Water Heater for Hot Water Supply Systems, Version 1.0

B. Terms and definitions

Terms	Definitions
Electric heat pump type water heater	Electric heat pump type water heater is a type of heat pumps for supplying hot water in a systemic manner in a building. Run by electricity, the electric heat pump in this methodology is also equipped with power optimization devices (e.g. inverters) to minimize the electricity consumption of compressors by adjusting heating energy against the demand.
Supply water heater system	Supply water heater system consists of electric heat pump type water heater and auxiliary boiler which compensates the lack of heating energy by heating up the water flowing from electric heat pump type water heater(s) as necessary. It will intake water supply from tap water and/or well.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Reducing fossil fuel consumption with introducing (an) electric heat pump type water heater(s).
Calculation of reference emissions	Calculated by the net supplied heating energy for hot water supplied for utilization in the project building, efficiencies of the reference equipment (boiler) and CO_2 emission factor of fuel.

Calculation of project emissions	Calculated based on the monitored electricity consumption by the electric heat pump type water heater(s) and its auxiliary electric equipment and fuel consumption by auxiliary boiler if applicable.
Monitoring parameters	・ Electricity consumed by the project electric heat pump type water heater(s) ・ Electricity consumed by auxiliary electric equipment of the electric heat pump type water heater system (e.g., water pumps) ・ Fuel consumption of project auxiliary boiler where applicable ・ Average water temperature flowing from tap water and/or well to inlet of supply water heater system. ・ Average water temperature flowing from outlet of supply water heater system to utilization side ・ Quantity of water flowing from tap water and/or well to inlet of supply water heater system ・ Electricity imported from the grid, where applicable ・ Operating time of captive electricity generator, where applicable ・ The amount of fuel consumed and/or the amount of electricity generated by captive power, where applicable.

D. Eligibility criteria

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

Criterion 1	A project introduces (an) electric heat pump type water heater(s) to supply hot water utilized in a building. In case (an) project electric heat pump type water heater(s) replaces existing equipment, the existing one is not (an) heat pump type water heater(s).
Criterion 2	Ozone Depletion Potential (ODP) of the refrigerant used in project electric heat pump is zero.
Criterion 3	A plan for not releasing refrigerant used for the project electric heat pump type water heater(s) is prepared.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Fuel consumption by reference equipment (boiler)	CO_2
Project emissions	
Emission sources	GHG types
Electricity consumption by (an) electric heat pump type water heater(s) and its auxiliary electric equipment	CO_2
Fuel consumption by auxiliary boiler where applicable	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated from the net supplied quantity of heating energy by the project electric heat pump type water heater(s) divided by the efficiency of reference boiler and multiplied by the emission factor of the fuel.

Net quantity of heating energy supplied is calculated by water quantity supplied to/from the supply water heater system and temperature difference between the hot water supplied from the supply water heater system and feed water supplied to that system and physical property values of water (density and specific heat of water).
The net emission reductions are ensured by conservatively setting the efficiency of reference boiler at 92% which is the highest efficiency for a new boiler available from CDM methodological tool as default value.

F.2. Calculation of reference emissions

$$RE_p = (Q_{PJh,p} / \eta_{REh}) \times EF_{fuel}$$

Where

$$Q_{PJh,p} = \sum_i m_{PJ,i,p} \times (T_{ave,out,i,p} - T_{ave,in,i,p}) \times C_p \times \rho \times 10^{-3}$$

RE_p	Reference emissions during the period p [tCO_2/p]
$Q_{PJh,p}$	Quantity of heating energy utilized by the project building during the period *p* [GJ/p]
η_{REh}	Efficiency of the reference boiler for heating energy generation [-]
EF_{fuel}	CO_2 emission factor for fuel [tCO_2/GJ]
$m_{PJ,i,p}$	Quantity of water flowing from tap water and/or well to inlet of supply water heater system *i* during the period *p* [m^3 /p]
$T_{ave,out,i,p}$	Averaged water temperature flowing from outlet of supply water heater system *i* to utilization side during the period *p* [degree Celsius]
$T_{ave,in,i,p}$	Averaged water temperature flowing from tap water and/or well to inlet of supply water heater system *i* during the period *p* [degree Celsius]
C_p	Specific heat capacity of water [MJ/tonne- degree Celsius] * The specific heat of water at a standard temperature of 20 ° C is 4.186 M J / (tonne · K)
ρ	Density of water [tonne /m^3] * The density of water at a standard temperature of 20 ° C is 0.99822 tonne /m^3.
'i'	Identification number of the supply water heater system

G. Calculation of project emissions

$$PE_p = (\sum_j EC_{PJHP,j,p} + \sum_k EC_{PJaux,k,p}) \times EF_{elec} + \sum_l AC_{PJB,l} \times EF_{fuel} \times NCV_{fuel}$$

PE_p	Project emissions during the period *p* [tCO_2/p]
EF_{elec}	CO_2 emission factor for consumed electricity [tCO_2/MWh]
$EC_{PJHPj,p}$	Electricity consumed by the project electric heat pump type water heater *j* of the supply water heater system *i* during the period *p* [MWh/p]
$EC_{PJaux,k,p}$	Electricity consumed by auxiliary electric equipment *k* of the supply water heater system *i* during the period *p* (e.g., water pumps) [MWh/p]
$AC_{PJB,l,p}$	Fuel consumption of auxiliary boiler *l* in the project during the period *p* (if applicable) [tonne/p]
EF_{fuel}	CO_2 emission factor for fuel [tCO_2/GJ]
NCV_{fuel}	Net calorific value for fuel [GJ/tonne]

'j'	Identification number of the electric heat pump type water heater
'k'	Identification number of the auxiliary electric equipment of supply water heater system (e.g., water pumps)
'l'	Identification number of the auxiliary boiler

H. Calculation of emissions reductions

Emission reductions are calculated as below:

$$ER_p = RE_p - PE_p$$

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
η_{REh}	Efficiency of the reference boiler for heating energy generation default value: 92%	Default value in the methodology (from the CDM methodological tool "Determining the baseline efficiency of thermal or electric energy generation systems", ver. 2.0).
EF_{fuel}	CO_2 emission factor for fuel [tCO_2/GJ] Note: In the case that there is auxiliary boiler(s) in the project, CO_2 emission factor for the fuel consumed by the auxiliary boiler(s) in the project is applied.	In the order of preference: a) values provided by the fuel supplier; b) measurement by

		the project participants; c) regional or national default values; 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.
NCV_{fuel}	Net calorific value for fuel [GJ/tonne] Note: In the case that there is auxiliary boiler(s) in the project, Net calorific value for the fuel consumed by the auxiliary boiler(s) in the project is applied. Otherwise Net calorific value of natural gas is applied.	In the order of preference: a) values provided by the fuel supplier; b) measurement by the project participants; c) regional or national default values; 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}	CO_2 emission factor for consumed electricity. When project (an) electric heat pump type water heater(s) consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When project (an) electric heat pump type water heater(s) may consume both grid electricity and captive electricity, the project participant applies the	[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

	CO_2 emission factor for grid and captive electricity proportionately. Proportion of captive electricity is derived from dividing captive electricity generated by total electricity consumed at the project site. The total electricity consumed is a summation of grid electricity imported ($EI_{grid,p}$) and captive electricity generated ($EG_{PJ,p}$)* during the monitoring period. * Captive electricity generated can be derived from metering electricity generated or multiplying monitored operating time ($h_{gen,p}$) by rated capacity of generator (RC_{gen}). [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, it is determined based on the following options: <u>a) Calculated from its power generation efficiency (η_{elec} [%]) obtained from manufacturer's specification</u> The power generation efficiency based on lower heating value (LHV) of the captive power generation system from the manufacturer's specification is applied; $$EF_{elec} = 3.6 \times \frac{100}{\eta_{elec}} \times EF_{gen,fuel}$$ <u>b) Calculated from measured data</u> The power generation efficiency calculated from monitored data of the amount of fuel input for power generation ($FC_{PJ,p}$) and the amount of electricity	"Factores de emisión de gases efecto invernadero", Instituto Meteorológico Nacional unless otherwise instructed by the Joint Committee. [Captive electricity] For the option a) Specification of the captive power generation system provided by the manufacturer (η_{elec} [%]). CO_2 emission factor of the fossil fuel type used in the captive power generation system ($EF_{gen,fuel}$ [tCO_2/GJ]) For the option b) Generated and supplied electricity by the captive power generation system ($EG_{PJ,p}$ [MWh/p]). Fuel amount consumed by the captive power generation system ($FC_{PJ,p}$ [mass or volume/p]). Net calorific value ($NCV_{gen,fuel}$ [GJ/mass or volume]) and CO_2 emission factor of the fuel ($EF_{gen,fuel}$ [tCO_2/GJ]) in order of preference: 1) values provided by the fuel supplier;

<table>
<tr>
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<td>generated ($EG_{PJ,p}$) 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;
$EF_{elec} = FC_{PJ,p} \times NCV_{gen,fuel} \times EF_{gen,fuel} \times \frac{1}{EG_{PJ,p}}$
Where:
$NCV_{gen,fuel}$: Net calorific value of consumed fuel [GJ/mass or volume]

Note:
In case the captive electricity generation system meets all of the following conditions, the value in the following table may be applied to EF_{elec} 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

<table><tr><td>fuel type</td><td>Diesel fuel</td><td>Natural gas</td></tr><tr><td>EF_{elec}</td><td>0.8 *1</td><td>0.46 *2</td></tr></table>
*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 (0.0543tCO_2/GJ), and the most efficient value of default efficiency for off-grid gas turbine systems (42%) are applied.</td>
<td>2) measurement by the 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.</td>
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<tr>
<td>C_p</td>
<td>Specific heat capacity of water
4.186MJ/tonne-degree Celsius in case of standard</td>
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	water temperature of 20 ° C	
ρ	Density of water 998.22 kg /m^3 in case of standard water temperature of 20 ° C	

History of the document

Version	Date	Contents revised
01.0	12 March 2018	Electronic decision by the Joint Committee Initial approval.