Joint Crediting Mechanism Proposed Methodology Form

Cover sheet of the Proposed Methodology Form

Form for submitting the proposed methodology

Host Country	Kingdom of Cambodia
Name of the methodology proponents submitting this form	Metawater 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 Introducing Inverter-control System to Pumps_ver01.0
List of documents to be attached to this form (please check):	☒The attached draft JCM-PDD: ☒Additional information
Date of completion	February 17, 2015

History of the proposed methodology

Version	Date	Contents revised
1.0	February 17, 2015	First version

A. Title of the methodology

Energy Saving by Introducing Inverter-control System to Pumps

B. Terms and definitions

Terms	Definitions
Inverter	A piece of equipment which controls the motor's speed in accordance with the flow rate of a pump.
Project pump	A pump which has inverter-control system in a JCM project.
Reference pump	A pump which will be selected in a way that the GHG emissions will be calculated more conservatively compared with the calculation when the pump is continuously used or newly installed if a JCM project is NOT implemented.
Periodical check	A periodical performance evaluation done by a manufacturer or an agent who is authorized by the manufacturer in order to maintain pumps' and inverter's performance.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	An inverter-control system helps to save energy during a pump's operation. By introducing an inverter-control system to pumps in Cambodia, GHG emissions will be decreased through reduction of electricity consumption from a grid.
Calculation of reference emissions	Reference emissions are GHG emissions emitted by using reference pumps without an inverter-control system. Reference emissions are calculated using the amount of electricity consumed by project pumps, the ratio of electricity consumption ratio of reference pumps to project pumps and the emission factor of a grid.
Calculation of project emissions	Project emissions are GHG emissions emitted by using project pumps with an inverter-control system.

	Project emissions are calculated using the amount of electricity consumed by project pumps and the emission factor of a grid.
Monitoring parameters	- Amount of electricity consumed by project pumps or the electric current of those pumps. (at the primary side of inverter) - Number of hours for project pumps to operate non-stop at least 60 minutes during a given period.

D. Eligibility criteria

This methodology is applicable to projects that meet all of the following criteria:

Criterion 1	A project which introduces an inverter-control system to pumps without an inverter-control system.
Criterion 2	The capacity of project pump motors is more than 100 kW.
Criterion 3	The rated electricity conversion efficiency is more than 97% and rated power factor is more than 95% of a high-voltage inverter.
Criterion 4	Periodical check is planned to perform more than 2 times annually.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Electricity consumption of reference pumps	CO_2
Project emissions	
Emission sources	GHG types
Electricity consumption of project pumps	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are the amount of GHG emitted by reference pumps (without an inverter-control system) to distribute a given amount of water during a given period.
The amount of GHG emissions is calculated by using electricity consumed by project pumps (with an inverter-control system), the ratio of electricity consumption ratio of reference pumps to project pumps, and an electricity emission factor from a grid.

In order to calculate the GHG emissions reduction in a conservative way, the reference pump is determined in the following manner :

- Those pumps whose electricity consumption ratio is comparatively small for a given flow rate will be selected for the reference pumps

F.2. Calculation of reference emissions

$RE_p = \{EC_{PJ,p} * (P_{REF,LF,p} / P_{PJ,LF,p})\} * EF_{grid}$

RE_p	Reference emissions during a given period p [tCO_2/p]
$EC_{PJ,p}$	Amount of electricity consumed by project pumps during a given period p [MWh/p]
LF	Operation load factor (flow rate) of project pumps [-]
$P_{REF,LF,p}$	Electricity consumption ratio of reference pumps at LF [-]
$P_{PJ,LF,p}$	Electricity consumption ratio of project pumps at LF [-]
EF_{grid}	CO_2 emission factor of a grid [tCO_2/MWh]

Determination of $P_{PJ,LF,p}$ and $P_{REF,LF,p}$ (refer to Fig. 1)

1. If project pumps operate non-stop exact 60 minutes, register $EC_{PJ,p}$ as $EC_{PJ,p,i}$.
   $EC_{PJ,p,i}$: Amount of electricity consumed by project pumps during an hour [kWh]
2. $P_{PJ,LF,p,i} = EC_{PJ,p,i} / EC_{rated}$
   EC_{rated} : Rated electricity consumption of project pumps per hour [kWh]
3. $P_{PJ,LF,p} = \sum_{i=1}^{h} P_{PJ,LF,p,i} / h$
   h : Number of hours for project pumps to operate non-stop at least 60 minutes during a given period
4. LF is the operation load factor of project pumps when the electricity consumption ratio is $P_{PJ,LF,p}$. LF is determined by visual measurement of the performance curve of a project pump in Fig. 1.
5. $P_{REF,LF,p}$ is the electricity consumption ratio of reference pumps when the operation load factor is LF.

The performance curve in Fig. 1 is adjusted so that the electricity consumption ratio will be 1 when the operation load factor is 1. By dividing experimental data from manufacturer by rated value, both the operation load factor and the electricity consumption ratio in Fig. 1 should be non-dimensionalized.

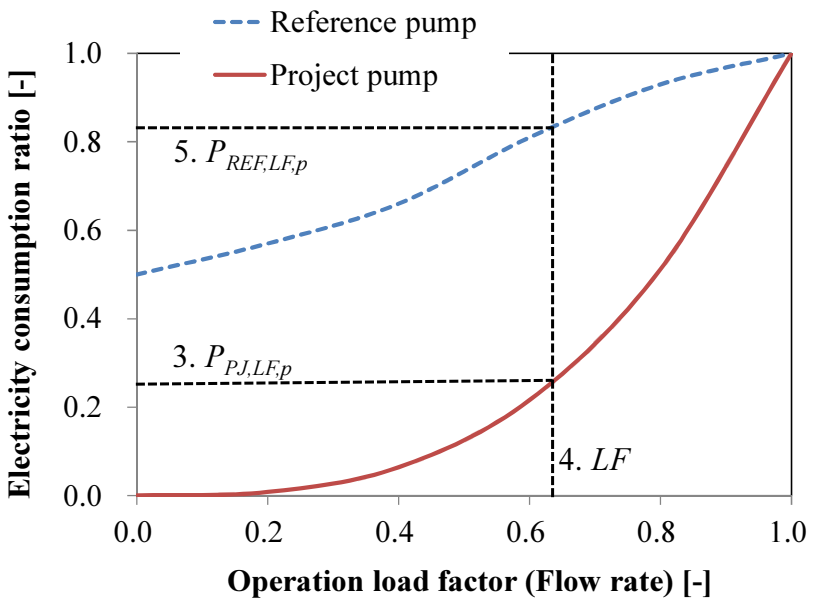

Fig. 1. Performance curve of a reference pump and a project pump

G. Calculation of project emissions

$PE_p = EC_{PJ,\,p} * EF_{grid}$

PE_p	Project emissions during a given period p [tCO_2/p]
$EC_{PJ,\,p}$	Amount of electricity consumed by project pumps with an inverter-control system during a given period p [MWh/p]

H. Calculation of emissions reduction

Emissions reduction is the difference between the reference emissions and the project emissions and calculated as follows:

$ER_p = RE_p - PE_p$

I. Data and parameters fixed *ex ante*

The sources of each data and parameter fixed *ex ante* are listed as below.

Parameter	Description of data	Sources
Performance curve of reference pumps	Fixed ex-ante: $P_{REF,LF,p} = -0.2641*LF^3 + 0.5108*LF^2 + 0.2536*LF + 0.5150$	By using pump manufacturers' test data, the performance curve can evaluate efficiency of pumps made by different manufacturers. Then the reference pump that has the lowest emission level was selected among six types of pumps which belong to Phnom Penh Water Supply Authority. The reference pump will be reselected every three years if necessary.
Performance curve of project pumps	Fixed ex-ante: Performance curve of project pumps	Manufacturers' test data will be used.
EC_{rated}	Fixed ex-ante: Rated electricity consumption of project pumps per hour.	Manufacturers' designated value will be used.
EF_{grid}	Fixed ex-ante: 0.6257 tCO_2/MWh CO_2 emission factor of a grid to which a target plant is connected.	Data is obtained from Climate Change Department, Ministry of Environment, Cambodia. This value will be updated each year, if necessary.