Joint Crediting Mechanism Approved Methodology ID_AM021
"Electricity generation by rehabilitation of run-of-river hydro power generation system(s) in Indonesia"

A. Title of the methodology

Electricity generation by rehabilitation of run-of-river hydro power generation system(s) in Indonesia, ver1.0

B. Terms and definitions

Terms	Definitions
Run-of-river hydro power generation	A method of power generation that uses water running in a river or a waterway directly into power generation unit.
Rehabilitation	A method to restore existing hydro power generations system(s) with or without adding new power plants and/or units, which may increase power generation capacity.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Displacement of grid electricity including national/regional and isolated grids and/or captive electricity by rehabilitation of hydro power generation system(s).
Calculation of reference emissions	Reference emissions are calculated with the net electricity output of the hydro power generation system(s), maximum output of reference hydro power generation system(s), maximum output of project hydro power generation system(s), multiplied by either; 1) conservative emission factor of the grid, or 2) conservative emission factor of the captive diesel power generator based on the location of the projects.
Calculation of project emissions	Project emissions are the emissions from the hydro power generation system(s), which are assumed to be zero.
Monitoring parameters	The quantity of the net electricity generated by the project hydro

	power generation system(s).

D. Eligibility criteria

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

Criterion 1	The project increases the power generation capacity of an existing run-of-river hydro power generation system(s) by rehabilitation.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Consumption of grid electricity including national/regional and isolated grids and/or captive electricity	CO_2
Project emissions	
Emission sources	GHG types
Generation of electricity from the hydro power generation system(s)	N/A

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated by the amount of net electricity generated by the project hydro power generation system(s), the maximum output of the reference hydro power generation system(s), the maximum output of the project hydro power generation system(s), and CO_2 emission factors of grid electricity including national/regional and isolated grids and/or captive electricity, which is displaced by the project.

The default emission factor is set in a conservative manner for the Indonesian regional grids. The default emission factor is calculated based on the conservative operating margin that reflects on the latest electricity mix including low cost/must run (LCMR) resources for each regional grid in Indonesia during the year 2013-2015 and refers to the conservative emission factor of each fossil fuel power plant in order to secure net emission reductions. The conservative emission factor of each plant is calculated as 0.795 tCO_2/MWh for coal-fired power plant and 0.320 tCO_2/MWh for gas-fired power plant based on the survey on heat efficiency of power plant in Indonesia. The emission factor for diesel power plant is calculated as 0.533 tCO_2/MWh based on a default heat efficiency of 49%, an efficiency level which is above the value of the world's leading diesel power generators.

In case the hydro power generation plant in a proposed project activity is directly connected or connected via an internal grid, not connecting to either an isolated grid or a captive power generator, to a national/regional grid (Case 1), the value of operating margin including LCMR resources, calculated using the best heat efficiency among currently operational plants in Indonesia for the emission factors of fossil fuel power plants, are applied. The emission factors to be applied are set as "Emission factor for Case 1 (tCO_2/MWh)" as shown in Section I. below.

In case the hydro power generation system(s) in a proposed project activity is connected to an internal grid connecting to both a national/regional, and an isolated grid and/or a captive power generator (Case 2), the lower values between emission factors of "Emission factor for Case 1 (tCO_2/MWh)" and the conservative emission factors of diesel-fired power plant of 0.533 tCO_2/MWh is applied. The emission factors to be applied are set as "Emission factor for Case 2 (tCO_2/MWh)" as shown in Section I. below.

In the case that the hydro power generation system(s) in a proposed project activity is only connected to an internal grid connecting to an isolated grid and/or a captive power generator (Case 3), the emission factor of a diesel generator calculated by applying a default heat efficiency of 49%, an efficiency level which is above the value of the world's leading diesel generator is applied, which is set as 0.533 tCO_2/MWh.

The emission factors to be applied for each case are shown in Section I.

F.2. Calculation of reference emissions

$$RE_p = \sum_i \{EG_{i,p} \times \left(1 - \frac{MO_{RE,i}}{MO_{PJ,i}}\right) \times EF_{RE,i}\}$$

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

$EG_{i,p}$: Quantity of the net electricity generated by the project hydro power generation system i during the period p [MWh/p]

$MO_{RE,i}$: Maximum output of the reference hydro power generation system i [MW]

$MO_{PJ,i}$: Maximum output of the project hydro power generation system i [MW]

$EF_{RE,i}$: Reference CO_2 emission factor for the project hydro power generation system i

[tCO_2/MWh]

G. Calculation of project emissions

$$PE_p = 0$$

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

H. Calculation of emissions reductions

$$ER_p = RE_p - PE_p$$
$$= RE_p$$

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
$MO_{RE,i}$	Maximum output of reference hydro power generation system *i*.	Specifications of reference hydro power generation system *i*.
$MO_{PJ,i}$	Maximum output of project hydro power generation system *i*.	Specifications of project hydro power generation system *i*.
$EF_{RE,i}$	Reference CO_2 emission factor for the project hydro power generation system *i*. The value for $EF_{RE,i}$ is selected from the emission factor based on the national/regional grid ($EF_{RE,grid}$) or based on isolated grid and/or a captive diesel power generator ($EF_{RE,cap}$) in the following manner: In case the hydro power generation system(s) in a	Additional information The default emission factor value is obtained from a study of electricity systems in Indonesia and the most efficient diesel power generator (a default

	proposed project activity is directly connected, or connected via an internal grid not connecting to either an isolated grid or a captive power generator, to a national/regional grid (Case 1), $EF_{RE,grid}$ is set as follows: Jamali grid — 0.616 tCO_2/MWh Sumatra grid — 0.477 tCO_2/MWh Batam – Bintan grid — 0.664 tCO_2/MWh Tanjung Balai Karimun, Tanjung Batu, Kelong, Ladan, Midai, P Buru, Ranai, Sedanau, and Tarempa grids — 0.555 tCO_2/MWh Bangka, Belitung, S Nasik, and Seliu grids — 0.553 tCO_2/MWh Khatulistiwa grid — 0.532 tCO_2/MWh Barito grid — 0.666 tCO_2/MWh Mahakam grid — 0.527 tCO_2/MWh Tarakan grid — 0.493 tCO_2/MWh Sulutgo grid — 0.325 tCO_2/MWh Sulselbar grid — 0.320 tCO_2/MWh Kendari, Bau Bau, Kolaka, Lambuya, Wangi Wangi, and Raha grids — 0.593 tCO_2/MWh Sulbangteng grid — 0.517 tCO_2/MWh Lombok, Bima, and Sumbawa grids — 0.561 tCO_2/MWh Kupang, Ende, Maumere, Waingapu, Labuan Bajo, and Larantuka grids — 0.507 tCO_2/MWh Ambon, Tual, and Namlea grids — 0.533 tCO_2/MWh Tobelo and Ternate Tidore grids — 0.532 tCO_2/MWh Jayapura, Timika, Merauke, and Biak grids — 0.523 tCO_2/MWh Sorong, Nabire, and Manokwari grids — 0.525 tCO_2/MWh In case the hydro power generation system(s) in a proposed project activity is connected to an internal grid connecting to both a national/regional grid, and an isolated grid and/or a captive power generator (Case 2), $EF_{RE,grid}$ is set as follows: Jamali – Bintan grid — 0.533 tCO_2/MWh Sumatra grid — 0.477 tCO_2/MWh Batam grid — 0.533 tCO_2/MWh Tanjung Balai Karimun, — 0.533 tCO_2/MWh	value of 49% heat efficiency is above the value of the world's leading diesel generator). The default value is revised if deemed necessary by the JC.

	Tanjung Batu, Kelong, Ladan, Midai, P Buru, Ranai, Sedanau, and Tarempa grids Bangka, Belitung, S Nasik, and Seliu grids — 0.533 tCO_2/MWh Khatulistiwa grid — 0.532 tCO_2/MWh Barito grid — 0.533 tCO_2/MWh Mahakam grid — 0.527 tCO_2/MWh Tarakan grid — 0.493 tCO_2/MWh Sulutgo grid — 0.325 tCO_2/MWh Sulselbar grid — 0.320 tCO_2/MWh Kendari, Bau Bau, Kolaka, Lambuya, Wangi Wangi, and Raha grids — 0.533 tCO_2/MWh Sulbangteng grid — 0.517 tCO_2/MWh Lombok, Bima, and Sumbawa grids — 0.533 tCO_2/MWh Kupang, Ende, Maumere, Waingapu, Labuan Bajo, and Larantuka grids — 0.507 tCO_2/MWh Ambon, Tual, and Namlea grids — 0.533 tCO_2/MWh Tobelo and Ternate Tidore grids — 0.532 tCO_2/MWh Jayapura, Timika, Merauke, and Biak grids — 0.523 tCO_2/MWh Sorong, Nabire, and Manokwari grids — 0.525 tCO_2/MWh In case the hydro power generation system(s) in a proposed project activity is connected to an internal grid which is not connected to a national/regional grid, and only connected to an isolated grid and/or a captive power generator (Case 3), $EF_{RE,cap}$: 0.533 tCO_2/MWh is applied.	

History of the document

Version	Date	Contents revised
01.0	31 October 2019	JC9, Annex 2 Initial approval.