JCM Proposed Methodology Form

Cover sheet of the Proposed Methodology Form	
Form for submitting the proposed methodology	
Host Country	The Federal Democratic Republic of Ethiopia
Name of the methodology proponents submitting this form	Mizuho Information & Research Institute, Inc.
Sectoral scope(s) to which the Proposed Methodology applies	1. Energy industries (renewable sources)
Title of the proposed methodology, and version number	Title: Installation of geothermal power plants/units in Ethiopia Version number: 01.0
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☐Additional information
Date of completion	07/10/ 2014

History of the proposed methodology

Version	Date	Contents revised
01.0	07/10/2014	First edition

A. Title of the methodology

Installation of geothermal power plants/units in Ethiopia Version 01.0

B. Terms and definitions

Terms	Definitions
Power plant/unit	a power plant/unit is a facility that generates electric power. Several power units at one site comprise one power plant, whereas a power unit is characterized by the fact that it can operate independently from other power units at the same site. Where several identical power units (i.e. with the same capacity, age and efficiency) are installed at one site, they may be considered as one single power unit
Grid power plant/unit	a power plant/unit that supplies electricity to an electricity grid and, if applicable, to specific consumers. This means that power plants supplying electricity to the grid and specific captive consumers at the project are considered as a grid power plant/unit, while power plants that serve only captive consumers and do not supply electricity to the grid are not considered as a grid power plant/unit
Off-grid power plant/unit	a power plant/unit that supplies electricity to specific consumers through a dedicated distribution network which is not used by any other power plants.
Net electricity generation	refers to the difference between the total quantity of electricity generated by the power plant/unit and the auxiliary electricity consumption (also known as parasitic load) of the power plant/unit (e.g. for pumps, fans, controlling etc.)
Installed power generation capacity (or installed capacity or nameplate capacity)	the installed power generation capacity of a power unit is the capacity, expressed in Watts or one of its multiples, for which the power unit has been designed to operate at nominal conditions. The installed power generation capacities of its power units;

Greenfield power plant	a new renewable energy power plant that is constructed and operated at a site where no renewable energy power plant was operated prior to the implementation of the project activity;
A grid/project electricity system	is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or the consumers where electricity is being saved) and that can be dispatched without significant transmission constraints;
Connected electricity system	is an electricity system that is connected by transmission lines to the project electricity system. Power plants within the connected electricity system can be dispatched without significant transmission constraints but transmission to the project electricity system has significant transmission constraint, and/or the transmission capacity of the transmission line(s) that is connecting electricity systems is less than 10 per cent of the installed capacity either of the project electricity system or of the connected electricity system, whichever is smaller;
NCG	Non Condensable Gases (NCGs) are natural components of geothermal fluids, and they are composed mainly of CO, CO2, H2 and CH4. In geothermal projects, NCG flow with the steam into the power plant. A small proportion of the CO2 is converted to carbonate/bicarbonate in the cooling water circuit.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Geothermal power plants supply electricity from project activity to the grid, and avoid greenhouse gas emissions from fossil fuel power plants.
Calculation of reference emissions	Reference emissions are calculated on the basis of generation of electricity in grid power plants and in baseline technologies to meet the minimum service level, which are replaced due to the

	project activity.
Calculation of project emissions	Project emissions are calculated on the basis of monitored fossil fuel consumption and emissions from the operation of the geothermal power plants due to the release of NCGs.
Monitoring parameters	Generated electricity to the grid, fossil fuel consumption and CO2 and CH4 in the produced steam are monitored.

D. Eligibility criteria

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

Criterion 1	The project activity is installation of a geothermal power plant at Ethiopia.
Criterion 2	Net electricity generated by the project activity is delivered to Ethiopian national power grid system.
Criterion 3	The project activity employs a geothermal power generation unit supplied by a company which has a past experience to supply a geothermal power generation unit which steadily operated for at least 15 years.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
CO2 emissions from combustion of fossil fuels for electricity generation at grid power plants that are replaced due to the project activity	CO2
CO2 emissions from combustion of fossil fuels for electricity generation from the baseline technology to meet suppressed demand for electricity that would be replaced due to the project activity	CO2
Project emissions	
Emission sources	GHG types
Fugitive emissions of CH4 and CO2 from NCG contained in geothermal steam	CO2
	CH4

CO2 emissions from combustion of fossil fuels for electricity generation in geothermal power plants	CO2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated on the basis of project emissions derived from monitored net electricity generation, under the assumption that the renewable electricity generated from geothermal source as a project activity will replace an equivalent amount of electricity composed of: the existing electricity which is currently generated by the grid power plants; and the electricity which would be additionally needed to meet a minimum service level (basic human needs) for electricity consumption.

According to IEA, electricity consumption per capita in Ethiopia in 2012 was 60 kWh/y which is lower than the energy poverty threshold defined in Sanchez, T. (2010), 120 kWh/y which can be regarded as a minimum service level. Therefore, Ethiopia has suppressed demand for electricity. A baseline technology to generate additional electricity is identified as kerosene which is widely used for off-grid power generation in Ethiopia.

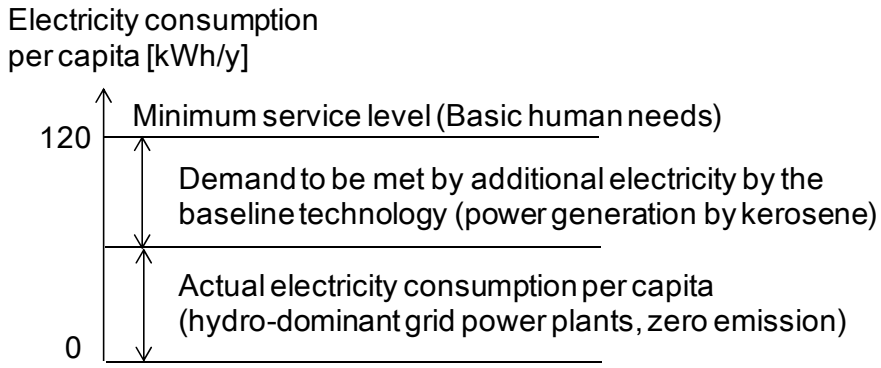

Figure: Basic concept to identify additional electricity to meet the minimum service level

F.2. Calculation of reference emissions

REy = RGPJ,y * RF,CM,y
REy: Reference emissions in year y [tCO2/y]
RGPJ,y: Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the JCM project activity in year y [MWh/y]
RF,CM,y: Combined margin CO2 emission factor for grid connected power generation in year y calculated the latest emission factor [tCO2/MWh]

RF,CM,y = RF,OM,y * 0.5 + RF,BM,y * 0.5
RF,OM,y: Operating margin CO2 emission factor for grid power plants and off-grid power plants in year y calculated the latest emission factor [tCO2/MWh]
RF,BM,y: Build margin CO2 emission factor for grid power plants and off-grid power plants in year y calculated the latest emission factor [tCO2/MWh]

Grid power plants and a baseline technology to generate additional electricity needed to meet a minimum service level are included in the calculation of the operating margin and build margin emission factor. The default CO2 emission factor can be applied in accordance with a type of fossil fuel used for power generation. A baseline technology shall be identified as the one which is commonly used for off-grid power generation in Ethiopia. The technology is kerosene for the moment.
Reference emission factor is calculated as follows:

$$RF_y = \frac{EF_{BT,y} * (MSL - EC_y) + EF_{grid,y} * EC_y}{MSL}, \text{ if } MSL - EC_y > 0$$

$$RF_y = EF_{grid,y}, \text{ if } MSL - EC_y \leq 0$$

Where
EFBT,y: CO2 emission factor from power generation by the baseline technology in year y [tCO2/MWh]
EFgrid,y: CO2 emissions factor from the grid power plants in year y [tCO2/MWh]
ECy: Electricity consumption per capita [kWh/y]
MSL: Minimum service level of electricity consumption per capita [kWh/y]

G. Calculation of project emissions

Project emissions are calculated on the basis of monitored electricity, fuel consumption and release of NCGs.

PEy = PEFF,y + PEGP,y
PEy: Project emissions in year y [tCO2/y]
PEFF,y: Project emissions from fossil fuel consumption in year y [tCO2/y]
PEGP,y: Project emissions from the operation of geothermal power plants due to the release of NCGs in year y [tCO2/y]

PEFF,y = PFCi,y * NCVi,y
PFCi,y: Project consumption of fossil fuel iof the applicable equipment in year y [kl, t, 1000Nm3/y]
NCVi.y: Net calorific value of fossil fuel i(diesel, kerosene, natural gas, etc.) in year y [tCO2/y]

PEGP,y = (wsteam,CO2,y + wsteam,CH4,y x GWPCH4) * Msteam,y
wsteam,CO2,y: Average mass fraction of CO2in the produced steam in year y [tCO2/t steam]
wsteam,CH4,y: Average mass fraction of CH4in the produced steam in year y [tCH4/t steam]
GWPCH4: Global warming potential of CH4valid for the relevant commitment period [tCO2/tCH4]
Msteam,y: Quantity of steam produced in year y [t steam/y]

H. Calculation of emissions reductions

Emissions reduction is calculated as the difference between the reference emissions and project emissions, as follows:
ERy = REy - PEy
Where
ERy: Emissions reduction in year y [tCO2/y]
REy: Reference emissions in year y [tCO2/y]
PEy: Project emissions in year y [tCO2/y]

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
GWPCH4	Global warming potential of methane valid for the project period: 21 [tCO2/CH4]	IPCC, Climate Change 2007: Working Group I: The Physical Science Basis
NCVi,y	Net calorific value of fossil fuel i (diesel, kerosene, natural gas, etc.) in year y [tCO2/y]	IPCC guideline 2006
	Default efficiency factors for power plants (oil) [30%]	Tool to calculate the emission factor for an electricity system version 4.0
MSL	Minimum service level of electricity consumption per capita	Sanchez, T. (2010)
RFgrid,BM, y	Build margin CO2 emission in year y: 0 [tCO2/MWh]	EEP master plan, EEP.
RFgrid,OM, y	Operating margin CO2 emission in year y: 0 [tCO2/MWh]	List of power generation plants in Ethiopia, EEP. Conservative default value.