Approved baseline and monitoring methodology/ methodological tool revision recommendation form (Version 02.0)

INFORMATION TO BE COMPLETED BY PANEL/ WG	
Date and number of Panel/ WG meeting:	04–08 April 2016 / MP69
Title/Subject of the request for revision:	Revision of ACM0002 to become applicable to geothermal technologies with binary or closed-loop heat exchange systems without accounting for project emissions
Reference number of the request for revision:	AM_REV_0256
Exact reference (number, title and version) of the methodology or methodological tool to which the request for revision applies:	ACM0002 "Grid-connected electricity generation from renewable sources --- Version 16.0"

Summary of the request for revision:

Original text from PP:

Background

Under the Clean Development Mechanism, power generation activities using geothermal technologies are eligible to apply large scale methodology ACM0002: Grid-connected electricity generation from renewable sources.

The methodology offers relatively straightforward baseline and monitoring approaches for the calculation of final emission reductions. Emission reductions are calculated by subtracting the project emissions from the baseline emissions. Emission reductions in geothermal power plants are mainly due to the replacement of carbon intensive grid power with cleaner electricity generated by the geothermal plant.

Under project emissions calculation in the methodology, one of the elements is introduced as "Project emissions from the operation of geothermal power plants due to the release of non-condensable gases in year y (t CO2e/yr)" as PEGP,y. The methodology then offers an approach on how to calculate these emissions (section 5.4.2.). The elements required to be monitored in this approach are:

- Average mass fraction of CO2 in the produced steam in year y (t CO2/t steam); W Steam, CO2, y
- Average mass fraction of CH4 in the produced steam in year y (t CO2/t steam); W Steam, CH4, y
- Quantity of steam produced in year y (t steam/yr); M Steam, y

Under paragraph 39 the methodology explains that "For geothermal project activities, project participants shall account fugitive emissions of CO2 and CH4 due to release of non-condensable gases from produced steam… In geothermal power projects, non-condensable gases flow with the steam into the power plant… In addition, parts of the non-condensable gases are re-injected into the geothermal reservoir. *However, as a conservative approach, this methodology assumes that all non-condensable gases entering the power plant are discharged to atmosphere via the cooling tower…"*

However, the above statement in the methodology is only valid for those geothermal plants that use open cycle (i.e. dry steam or flash steam) systems for their heat exchange between underground geothermal heat source and the plant's power generation facility. In a closed loop or binary geothermal technologies, the underground fluid is re-injected back to the heat source without any exposure to the atmosphere. In this case, non-condensable and other gases within the geothermal fluid are kept within the outgoing geothermal fluid and sent back into the heat source. Project emissions in this case are near to zero and negligible.

The above issue has been reflected in many studies and geothermal resources including the Geothermal Resources Council, Geothermal Energy Association, International Energy Agency as well as the EU commission. The reviewed studies and sources that confirm the above argument are listed as follows:

No.	Title	Organization	Authors	Year

1	Advanced Renewable Energy Systems (book)	CRC Press	S. C. Bhatia	2015
2	Geothermal Energy Association website article LINK	Geothermal Energy Association	-	2014
3	MOEJ/GEC JCM Feasibility Study (FS) 2013 Final Report: Geothermal Binary Power Generation LINK	Global Environment Centre Foundation (GEC) - Implemented by Nippon Koei Co., Ltd.	Nippon Koei Co., Ltd. - Hen Linn San Co., Ltd (HLS)	2013
4	The Values of Geothermal Energy: A Discussion of the Benefits Geothermal Power Provides to the Future U.S. Power System LINK	Geothermal Resources Council and Geothermal Energy Association	Benjamin Matek and Brian Schmidt	2013
5	Geothermal Electricity: Potential for CO2 Mitigation LINK	EU Commission: Intelligent Energy Europe Programme	Felina Schütz, Ernst Huenges (GFZ), Angela Spalek (GFZ),David Bruhn (GFZ) Paloma Pérez (APPA), Margarita de Gregorio (APPA)	2013
6	Geothermal Project Funding Through The Clean Development Mechanism (CDM) LINK	United Nations University Geothermal Training Programme	Ingimar G. Haraldsson	2012
7	Geothermal energy and greenhouse gas emissions LINK	Geothermal Energy Association	Alison Holm, Dan Jennejohn, and Leslie Blodgett	2012
8	Geothermal energy overview LINK	The Carbon Neutral Company	-	2012
9	Renewable Energy Sources and Climate Change Mitigation: Special Report of the Intergovernmental Panel on Climate Change	UNEP – IPCC and WHO - Cambridge University Press	Ottmar Edenhofer, Ramón Pichs-Madruga, Youba Sokona, Kristin Seyboth, Susanne Kadner, Timm Zwickel, Patrick Eickemeier, Gerrit Hansen, Steffen Schlömer, Christoph von Stechow, Patrick Matschoss	2011
10	Renewable Energy Essentials: Geothermal LINK	International Energy Agency (IEA)	-	2010

11	The State of Geothermal Technology, Part II: Surface Technology LINK	Geothermal Energy Association for the U.S. Department of Energy	Alyssa Kagel	2008
12	A Guide to Geothermal Energy and the Environment LINK	Geothermal Energy Association	Alyssa Kagel, Diana Bates, & Karl Gawell	2007

The authors would like to kindly request the UNFCCC Secretariat to consider a revision to the existing methodology and include closed loop geothermal systems for the calculation of project emissions under this methodology.

Additional information from the PPs (email dated 18/11/2015) in response to the issues raised by the Meth Panel 68:

1. Please clarify which fluids are normally used as working fluid in the secondary binary cycle ? The Panel noted that you have included the project emissions due to leakage of geothermal steam /fluid in case the system leaks during the operation. However, it is not clear how the emissions due to physical leakage of working fluid such as isobutene used in binary geothermal power plant is taken care of

Response from the PP: The project will be using types of hydrocarbons such as n-butane or isopentane as their binary fluid in their heat exchangers. The binary liquids are strictly monitored during any geothermal plant's operation, due to its vital role not only in the operation of the system but also to avoid serious damage to the machineries due to temperature fluctuations. Having this said, we have noted the meth panel's concern in regards to the physical leakage due to the working fluid in the binary system on the ground used for the heat exchangers. In the new proposed revision, we have included a phrase (as well as calculation equation) in the methodology in order to monitor the project's maintenance in regards to the binary fluids re-injected to the system and calculate the emissions in connection to the annually added working fluid to the binary system, representing the amount of fluid that has leaked from the system. We have mentioned that projects need to calculate such emissions if in any year during the operation the amount of lost (re-injected) working fluid is more than 1% of the whole working fluid in the closed cycle heat exchangers on the ground.

2. Please clarify whether alternate measures such as periodic checks can be considered in lieu of the proposed monitoring of the inflow and outflow of the geothermal steam. This means, if the leakage is detected in the system during the periodic checks, it can be used to estimate project emissions using equation (2) of the existing version of the methodology for leakage duration.

Response from the PP: We have already included such a monitoring provision and measures in our proposed revisions. It is unfortunately not possible for us to use Equation 2 in the current version of the methodology. The reason is that equation 2 in the methodology is referring to the CO2 content in the produced steam, while in the binary system the geothermal fluid from underground including its non-condensable gases are not mixed at all with the steam generated in the heat exchangers on the ground, hence equation 2 in the methodology can only be used by open cycle geothermal plants as mentioned in the proposed revisions. We have included a detailed monitoring plan to ensure that all emissions (if any) due to leakage of non-condensable gases from the closed geothermal cycle are calculated and taken into account.

Recommended decision to the Board on the request for revision

☒ Approve the proposed revised methodology or methodological tool ("A case")
☐ Reject the proposed revised methodology or methodological tool ("C case")

Type of the revision if the recommendation is A case

☒ The revision is a major revision
☐ The revision is a minor revision

Reasons for rejection if the recommendation is C case
Any other issues arising from the request for revision
The Meth Panel (MP) of the Executive Board of the clean development mechanism (CDM) would like to thank the author for the submission. In response to the request for revision, the MP agreed to recommend a revision of the methodology ACM0002 to expand the applicability of the methodology to situations involving binary geothermal power plants and to account project emissions due to physical leakage of : (i) Non-condensable gases; (ii) Working fluid (hydrocarbon) (See paragraph 28(a) of the MP 69 report).

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Document information

Version	*Date*	*Description*
02.0	18 July 2013	Revised to remove the row “Date and signature of the chair and vice chair of Panel/WG”
01.0	4 July 2013	Initial publication. This document supersedes and replaces the following documents: • Recommendation form for Small Scale Methodologies (F-CDM-SSCwg) (Version 01.1) • Recommendation Form for Small Scale A/R Methodologies and Procedures (F-CDM-SSC-AR) (Version 01.1)

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