LANKAO GEOTHERMAL BASED SPACE HEATING SYSTEM

Document Prepared by CTI Certification Co., Ltd

Project Title	Lankao Geothermal Based Space Heating System
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Report Title	Joint Validation and 1st periodical VCS Verification report for Lankao Geothermal Based Space Heating System
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Summary

CTI Certification Co., Ltd (CTI), commissioned by Hangzhou Chaoteng Energy Technology Co., Ltd., has performed the validation of Lankao Geothermal Based Space Heating System (hereafter referred to as "the project") on the basis of requirements of Verified Carbon Standard (VCS) Version 4.5.

• *A description of the project*

The Project activity involves the installation of geothermal water resources wells in Lankao County, Henan province, People's Republic of China, to provide hot water for space heating in the County. The aim of the project is to provide space heating from renewable source of energy (geothermal resources) and leads to reduction in GHG emissions, compared with the fossil fuel generated heat in the baseline fossil fuel boilers.

The project is a green-field geothermal energy based project /17/. The project uses geothermal resources as heat source for heat total areas of 3.7361 million m^2 residential areas in winter season, to realize heat supply to a series of residential buildings in Lankao County over winter season, which will displace heat supply from isolated coal-fired boilers as a business-as-usual scenario in the project area. There are 12 sub-areas involved in the project activity including 36 geothermal wells with a design depth of 2,000 meters are constructed, of which the 12 production wells with an average flow rate of 120 m^3/h will supply the feed geothermal water at temperature of 72°C to 17 heat substations in 12 sub-areas through primary heating network. The 24 injection wells will receive the return water at temperature of 10°C after secondary heat exchange. The 17 heat substations will supply the feed water at temperature of 45°C to the project buildings and receive the return water at temperature of 35°C /16/ /17/ from them. The design, spot selection and drilling of the re-injection wells for the project used the oil well drilling

technology from Zhejiang Lute Energy Technology Co., Ltd. /23/. The areas of buildings heating supplied by the Project are 3.7361 million m^2 with the total heat load of 112.08 MW.

The flowchart of the heat substations is depicted in the following picture.

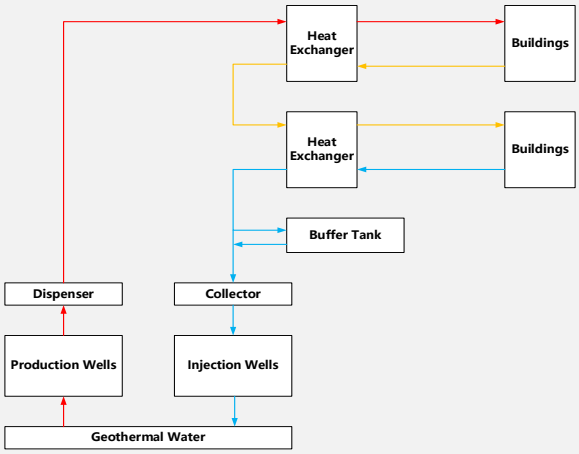


Figure 1 Technologies and Measures Employed by the Project Activity

The buildings within the proposed project boundary are the newly buildings /16/ /23/, which are constructed recently. These buildings are constructed in the areas which did not have any heat distribution network prior to implementation of the project. So, no existing heat distribution network is available for these buildings to be connected to, and all the heat distribution networks connected by these buildings are recently constructed. Thus, the baseline scenario is that there is no any heat distribution network for the buildings included in the project.

The project started the space heating supply on 15/11/2021/30/. The expected operational lifetime of the project is 20 years /16/. A fixed crediting period of 10 years has been chosen for the project, starting from 15/11/2021 /30/. The annual average emission reductions are estimated to be 78,508 tCO_2e/year and thus 785,080 tCO_2e over the fixed crediting period.

Onsite investigation and follow-up interview with project proponent representatives, FSR /16/, FSR approval /17/, EIA /18/ and EIA approval /19/ as well as other relevant background documents such as construction contract /23/, equipment purchase contract /27/, Commencement report of the Project/25/, and VCS monitoring manual, are used by the validation team to validate the correctness of the information provided in the VCS Joint-PD-MR. Thus, the validation team can confirm the following: A complete and accurate description of the Project activity is provided in the VCS Joint-PD-MR version 02 dated 20/10/2023, covering all relevant aspects. Precise nature of the Project activity and the technical aspects of its implementation are presented in an understandable manner. The project does not involve alteration of an existing installation or process. The technology employed is environmentally safe and sound. There is no technology transfer.

Project Characteristics

Essential data of them project is presented in the following Table

Item	Data

Project title	Lankao Geothermal Based Space Heating System		
Project size	☐ Large Project ☒ Project		
Project Scope (according to UNFCCC sectoral scope numbers for VCS)	☒	1	Energy Industries (renewable /non-renewable sources)
	☐	2	Energy distribution
	☐	3	Energy demand
	☐	4	Manufacturing industries
	☐	5	Chemical industry
	☐	6	Construction
	☐	7	Transport
	☐	8	Mining/Mineral production
	☐	9	Metal production
	☐	10	Fugitive emissions from fuels (solid, oil and gas)
	☐	11	Fugitive emissions from production and consumption of halocarbons and hexafluoride
	☐	12	Solvents use
	☐	13	Waste handling and disposal
	☐	14	Afforestation and Reforestation
	☐	15	Agriculture
Applied Methodology	AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0		
Technical Area(s)	1.1		
Crediting period	☐ Renewable Crediting Period (7 y) ☒ Fixed Crediting Period (10 y)		
Start of crediting period	15/11/2021 /30/		
Starting date of the project	15/11/2021		

- *The purpose and scope of validation and verification*

The validation is an independent third party assessment of the project's baseline, estimated GHG emission reductions or net anthropogenic GHG removals, the monitoring plan and the crediting period using the applicable VCS requirements. Validation is a requirement for all VCS projects and is seen as necessary to provide assurance to stakeholders of the quality of the Project and its intended generation of estimated Verified Carbon Units (VCUs).

The scope of the validation is defined as an independent and objective review of the Project Description (hereafter refer to as "VCS Joint-PD-MR"), the project's baseline study and monitoring plan, the emission

reduction calculation spreadsheet and other relevant documents refer to VCS Standard Version **4.5** and all the GHG program requirements. In order to confirm that the Project activity, as documented, is sound reasonable and meets the identified criteria. The validation involves the assessment of: project conformance to VCS standards/programs, project conformance to the applied methodology, including the procedure for the demonstration of additionality specified in the methodology; and likelihood that methods and procedures set out in the project description will generate verifiable GHG data and information when implemented.

Validation is not meant to provide any consultancy towards the project participants. It is part of the VCS project cycle and will finally result in a conclusion by the executing VVB whether a project is valid to be submitted for VCS registration.

• *The method and criteria used for validation and verification*

Validation and verification is conducted using CTI Certification Co., Ltd (CTI) procedures in line with the requirements specified in the latest version of the VCS validation and verification Manual and applying auditing techniques. The validation team assessed the Project activity's compliance against the VCS Standard Version 4.5, the selected CDM methodology and the project description. The validation criteria followed the guidance documents provided by VCS included the VCS Standard Version 4.5, VCS Program Guide Version 4.4 and the applied CDM methodology AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0.

• *The number of findings raised during validation and verification*

In the course of the validation and verification, 17 Corrective Action Requests (CARs), 5 Clarification Requests (CLs) were raised and successfully closed. One forward action request was raised. The assessment is included in the report.

• Any uncertainties associated with the validation and verification

There are no restrictions of uncertainty for validation and verification.

• *summary of the validation and verification conclusion*

"Lankao Geothermal Based Space Heating System" (VCS ID 4383) with regard to the relevant requirements of VCS standard Version 4.5. CTI confirms all validation and verification activities including objectives, scope and criteria, reasonableness of assumptions, project description, and monitoring plan adhere to VCS Standard Version 4.5 and all associated updated as documented in this report, are complete.

In conclusion, it is CTI's opinion that the project "Lankao Geothermal Based Space Heating System" as described in the VCS Joint-PD-MR version 02 dated 20/10/2023, meets all relevant requirements for VCS validation and verification activities and all relevant host Party criteria and correctly applies the methodology AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0.

CONTENTS

1 INTRODUCTION

1.1 Objective

Hangzhou Chaoteng Energy Technology Co., Ltd. has commissioned the CTI to perform the validation of Lankao Geothermal Based Space Heating System (hereafter referred to as "the project") on the basis of requirements of Verified Carbon Standard (VCS) Version 4.5 /12/.

CTI as the validation body (VB) of the project has been accredited as a DOE by UNFCCC and meets the competence requirements as set out in ISO 14065:2020.

The objective of the Validation is to have an independent evaluation of a Project activity by a designated operational entity against the requirements of the Verified Carbon Standard (VCS) Version 4.5 /12/ and GHG program applied, on the basis of the project design document. In particular, the project's baseline, monitoring plan, and the project's compliance with relevant VCS requirements, GHG program requirements and host Party criteria are validated in order to confirm that the project design, as documented, is sound and reasonable and meets the identified criteria. Validation is a requirement for all VCS projects and is seen as necessary to provide assurance to stakeholders of the quality of the Project and its intended generation of Verified Carbon Units (VCUs).

1.2 Scope and Criteria

The validation scope is defined as an independent and objective review of the project description (VCS Joint-PD-MR) to validate that (a) the project design is actual, (b) the baseline scenario is correctly defined as per the applied methodology and relate tools, (c) the project is additional, (d) the monitoring plan can be implemented and is transparent and adequate and (e) all data and information used for ex-ante calculation of emission reductions is of projected and/or hypothetical nature. The VCS Joint-PD-MR is reviewed against the criteria stated in VCS standard Version 4.5 /12/ and the approved baseline and monitoring methodology AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/. The validation was based on the requirements VCS Validation and Verification Manual and VCS Standard version 4.5 applying auditing techniques. The validation is not meant to provide any consulting towards the project participants. However, stated requests for clarifications and/or corrective actions may have provided input for improvement of the project design.

1.3 Reasonableness of Assumptions and Level of Assurance

CTI has assessed the claims and assumptions made in the PD, i.e., assumptions regarding the determination of baseline scenario, the investment analysis and additionality assessment, as well as validated the assumptions, limitations, and methods used for determining parameters

and calculation of baseline emission, project emission and leakage against the VCS Standard Version 4.5 /12/, applied methodology AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/, applicable tools /6/-/11/ and other VCS rules /12/-/15/. It is confirmed that the assumptions made in the PD are reasonable which are in line with the applied methodology and tools as well as the requirement of VCS. The project is expected to generate average GHG emission removal of 78,508 tCO_2e per year, and it is confirmed that outcome of future activities will be achieved as the assumptions and limitations are reasonable.

The validation report expresses a conclusion with a reasonable level of assurance about whether the reported GHG emissions reduction data is free from material misstatement. CTI applied a materiality threshold of 5% (for projects with ER less than 300,000 tCO_2e per year) with respect to emission or misstatements concerning reported quantities as per para 3.10.1 and 4.1.10 (4) of VCS Standard Version 4.5 /12/.

1.4 Summary Description of the Project

The project is implemented by Lankao Green Energy Clean Energy Co., Ltd. , in order to introduce geothermal energy based space heating system to realize heat supply to a series of new residential buildings over winter season. The project will displace heat supply from isolated coal-fired boilers as a business-as-usual scenario in the Project area in Lankao County, Henan province, People's Republic of China. The Project activity supply geothermal heat to 3,736.1 thousand m^2 of newly built residential buildings with a total heating load of 112.08 MW.

The Project started construction on 31/08/2020 /23/. The project was put into operation on 15/11/2021 /30/. Emission reduction credits will be earned using geothermal energy instead of the combustion of fossil fuel for space heating.

The annual average CO_2 emission reductions are estimated as 78,508 tCO_2e, and total estimated GHG emission reductions for the 10-years crediting period are 785,080 tCO_2e.

2 VALIDATION AND VERIFICATION PROCESS

2.1 Method and Criteria

A project specific validation and verification plan was developed to guide the validation and verification auditing process to ensure efficiency and effectiveness. The purpose of the validation and verification is to present a risk assessment for determining the nature and extent of validation and verification procedures necessary to ensure the risk of auditing error is reduces to a reasonable level. According to the ISO14064-3, the criteria are the policy, procedure or

requirement used as reference against which evidence is compared. Therefore, validation of the project description and verification of the monitoring plan and the reported project results were measured for compliance against the following criteria:

- VCS Standard, v4.5 /12/
- VCS Program Guide, v4.4 /14/
- VCS Program Definitions, v4.4 /15/
- VCS-Joint-Project-Description-Monitoring-Report-Template-v4.2 /4/

The validation and verification process derived from all items in the validation and verification criteria stated above. Field inspection and techniques based on the project parameters, scope and best professional judgement of the validation and verification team in order to meet a reasonable level of assurance. The validation and verification consisted of the following three phase:

1) Desk review of documents;

2) On-site visit and follow-up interviews;

3) The resolution of outstanding issues and the issuance of the final joint validation and verification report and certification.

After commissioned by Hangzhou Chaoteng Energy Technology Co., Ltd., an validation and verification team was appointed by CTI and a kick-off meeting was held on 24-26/07/2023, in order to align all team members on the crucial details of the project including the goal of the validation, the timeline of the validation process, and review of the VCS Joint-PD-MR /1/ and related documents, A project specific validation plan was developed during the meeting to guide the validation auditing process to ensure efficiency and effectiveness. The validation plan, which includes the site visit schedule and the evidence to be collected was sent to the client on 15/07/2023. And the site visit was conducted on 24-26/07/2023, which was described in details in section 2.3 in this report. The validation opinion was then derived from the independent and objective assessment on the documents and information gathered from PP as per the VCS requirements.

The purpose of the validation and verification is to present a risk assessment for determining the nature and extent of validation procedures necessary to ensure the risk of auditing error is reduced to a reasonable level. According to the ISO14064-3, the criteria are the policy, procedure or requirement used as reference against which evidence is compared. Therefore, validation of the project description and verification of the monitoring plan and the reported project results were measured for compliance against the criteria including VCS standard version 4.5 /12/, VCS registration and issuance process version 4.3 /13/, VCS program guide version 4.4 /14/, VCS-Joint-Project-Description-Monitoring-Report-Template version 4.2 /4/ and other relevant VCS requirements.

2.2 Document Review

The VCS Joint-PD-MR version 01 dated 24/04/2023 and version 03 dated 22/02/2024 /1/, in particular the applicability of the methodology, the baseline determination, the additionality, the starting date, the monitoring plan, and the emission reduction calculations provided in the form of a spreadsheet version 02 /2/, were assessed as part of the validation based on the latest version of VCS requirements.

Appendix B of this report contains a complete list of all documents and proofs reviewed by the validation team.

2.3 Interviews

The objective of the interview process was to solicit important information from personnel related to the Project and relevant to the validation process. The objective of the interview process was to solicit important information from personnel related to project and relevant to the validation and verification process.

CTI performed the on-site assessment at the physical site of the project on 24-26/07/2023.

During the on-site assessment, the validation team has interviewed with key personnel from the project owner (the project participant), local government officer, stakeholders and the consultancy.

Date: 24-26/07/2023	
Interview topics	**Interviewed Organizations and persons**
-- Project design. -- Status of the project. -- Onsite inspection. --Compliance with National Laws and Regulations. -- Participation under other GHG programs and other forms of credit -- Local stakeholder consultation process and its outcomes. -- Environmental impacts. -- No net harm.	Project owner: Lankao Green Energy Clean Energy Co., Ltd. Zhang Jie, General Manager Fan Yantao, Technical Director Liu Xiaoxin, Operation Staff

-- Monitoring plan.	
-- Heat supply area --Time of residence -- Indoor temperature during heating season -- Comments to the project	Local Stakeholders/End users: Mu Qun, Resident in the residential buildings of Project Wang Damin, Resident in the residential buildings of Project
-- Local Stakeholder Consultation issues, -- Environmental impacts, -- Local legislation applicable to the project	Lankao County Environmental Protection Bureau Ma Wentao, Office chief Lankao County Spacing Heat Supervision Department Dai Bo, Office chief
-- Applicability of selected methodology -- Proposed project boundary -- Baseline scenario -- Additionality -- Quantification of GHG emission reductions -- Monitoring plan	Consultancy: Hangzhou Chaoteng Energy Technology Co., Ltd., Wang Han, Project manager Hu Ye, Project manager Rao Xiaoguang, Project manager

2.4 Site Visits

The validation and verification site visit was conducted on 24-26/07/2023. A ground inspection of the project was conducted during the site visit. VVB visited project sites for both sub-projects and inspected the implemented facilities as described in section 3.3 of VCS Joint-PD-MR version 03 dated 22/02/2024 /1/. VVB interviewed the project implementer, operation staffs, local officers, representatives of end users and VCS consultant. The interviewed personnel and objective are listed in the table in section 2.3 of this report. During the site inspection, the project site was inspected and documents evidence were checked. Details and inspection procedures were listed in the following table:

No.	Activity performed on-site	Site location	Date
1	Opening meeting: introduce the objective and the scope of the on-site inspection	Office in Lankao Green Energy Clean Energy Co., Ltd.	24-26/07/2023
2	Interview with key personnel of PP, local government officer, representative of end user/local stakeholders	Office in Lankao Green Energy Clean Energy Co., Ltd.	24-26/07/2023
3	Project site inspection, check the facilities on site, interview with technical expert and operating staff	Project site, Lankao County, Henan province, People's Republic of China	24-26/07/2023
4	Document check	Project site, Lankao County, Henan province, People's Republic of China	24-26/07/2023
5	Finding summary	Office in Lankao Green Energy Clean Energy Co., Ltd.	24-26/07/2023
6	Close meeting	Office in Lankao Green Energy Clean Energy Co., Ltd.	24-26/07/2023

2.5 Resolution of Findings

As an outcome of the validation and verification process, the team can raise different types of findings.

A corrective action request (CAR) is raised if one of the following occurs:

a) Non-compliance with the monitoring plan or methodology are found in monitoring and reporting and has not been sufficiently documented by the project participants, or if the evidence provided to prove conformity is insufficient;

b) Modifications to the implementation, operation and monitoring of the registered Project activity has not been sufficiently documented by the project participants;

c) Mistakes have been made in applying assumptions, data or calculations of emission reductions that will impact the quantity of emission reductions;

d) Issues identified in a FAR during validation and verification to be verified during verification or previous verification(s) have not been resolved by the project participants.

The validation and verification team shall raise a Clarification Request (CL) if information is insufficient or not clear enough to determine whether the applicable CDM or VCS requirements have been met.

All CARs and CLs raised during validation and verification shall be resolved prior to submitting a request for registration.

The objective of this phase of the validation and verification was to resolve the requests for corrective actions and clarification and any other outstanding issues which need to be clarified for CTI' s positive conclusion on the project design.

The Corrective Action Requests and Clarification Requests raised by CTI were resolved during communications between the Client and CTI to guarantee the transparency of the validation and verification, the concerns raised, and responses given are summarized below in the appendix C.

The final VCS Joint-PD-MR version 03 dated 22/02/2024 /1/ serves as the basis for the final assessment presented. Additional changes to the project during the validation and verification process are not considered to be significant with respect to the main VCS objectives. The two VCS main objectives are the reduction of anthropogenic GHG emissions and the contribution of sustainable development to the host country.

There are 17 CARs and 5 CLs raised during the validation and verification. The assessment is included in the report. The details of the findings are listed in the appendix C at the end of this report.

2.5.1 Forward Action Requests

One Forward Action Requests was raised during the validation and verification.

3 VALIDATION FINDINGS

3.1 Project Details

- Project type, technologies and measures implemented, and eligibility of the project

Through the onsite visit, interviewing the project developer and reviewing the VCS Joint-PD-MR /1/, it was confirmed that the project is to introduce geothermal energy-based space heating system to realize heat supply to a series of new residential buildings over winter season, which will displace heat supply from isolated coal-fired boilers as a business-as-usual scenario in the Project area in Lankao County, Henan province, People's Republic of China. Therefore, it was confirmed that the sectoral scope is scope 01: Energy industries (renewable-/non-renewable sources) as per the UNFCCC Standard "Applicability of sectoral scopes version 01.0" /11/. It was confirmed that the project is not a grouped project.

The information and descriptions reported in section 1.1 of the VCS Joint-PD-MR /1/ have been checked. The Project involve the construction and operation of geothermal wells, injection pipes, production pipes, heat substations and heat supply pipelines. The Project activity involves the construction and operation of geothermal system with a total heating load of 112.08 MW, which can supply geothermal heat to total 3.7361 million m^2 of a series of residential buildings, which has been verified by checking the Heating supply contracts /26/ and on-site inspection. The project uses geothermal resources in cascade levels. The high-temperature water can be used to supply heat directly through heat exchanger, and the low-temperature water enters the geothermal heat pumps after the heat exchangers. It is confirmed during the site inspection that a total of 36 geothermal wells with a design depth of 2,000 meters were constructed and implemented on the project site. 36 geothermal wells for Project supply heat for 3.7361 million m^2 of a residential building complex. In the demand side of Project, the buildings can receive the hot water with average flow rate of 120 m^3/h at temperature of 45°C and return the water at 35°C to heat substations.

Besides, a total of 17 heat substations in 12 sub-areas were constructed and implemented to enable the heat exchange between geothermal water transported by the primary heating network and the clean circulation water transported by the secondary network. The main equipment of the heat substations includes plate heat exchangers, water source heat pumps, circulating pumps, submersible pumps, fixed-pressure water-supplying devices, cyclone desanders, tanks, and water-softening facilities. All the geothermal wells, heat substations and related facilities (for proposed project) were newly constructed and confirmed by site inspection.

The project reduces fuel consumption through enables new residential buildings to use of geothermal energy instead of the combustion of fossil fuel for space heating. Via checking the Business License /21/ of PP, FSR /16/, Project approval /17/, and the heating supply contracts /26/, it is verified that project owner invested in purchasing the geothermal system. By implementing the project, it has provided an opportunity for local community to generate steady and continual income for their livelihood.

The project is applicable to the applied CDM Methodology AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/.

The expected total emission reduction of the Project in the fixed crediting periods of 10 years (from 15/11/2021 to 14/11/2031) is 785,080 tCO_2e, and the annual emission reduction is estimated to be 78,508 tCO_2e.

In conclusion, it is verified that the summary description of the project in section 1.1 pf VCS Joint-PD-MR /1/ is in line with the VCS joint PD-MR Template (Version 4.2) /4/ requirements and all the information has been provided and verified as correct.

The PP has described and justified how the project is eligible under the scope of the VCS Program in the VCS Joint-PD-MR as per the section 2.1.1 of VCS standard Version 4.5 /12/. The assessment is provided as below,

1. The Project activity generates GHG emission reductions only including CO_2 which belong to the six Kyoto Protocol greenhouse gases.

2. "The scope of the VCS Program excludes projects that can reasonably be assumed to have generated GHG emissions primarily for the purpose of their subsequent reduction, removal or destruction." Via checking the VCS Joint-PD-MR of the project /1/, it is verified that the project is implemented to introduce geothermal energy-based space heating system to realize heat supply to a series of new residential buildings over winter season, which will displace heat supply from isolated coal-fired boilers as a business-as-usual scenario in the Project area, and the additionality is verified as actual, thus there is no assumption of having generated GHG emissions primarily for the purpose of their subsequent reduction, removal or destruction for this project.

3. The VCS Program also excludes the following Project activities under the circumstances indicated in Table 1 of VCS Standard Version 4.5 /12/, via checking all the excluded Project activities in the table, it is verified that this project type is not excluded by the scope of VCS program.

In conclusion, the validation and verification team confirmed that the project is eligible to the scope of the VCS Program.

- Project design, including eligibility criteria for grouped projects

The project includes multiple locations/Project activity instances, but is not being developed as a grouped project.

- Project proponent and other entities involved in the project

Through document review and site interview, the validation and verification team confirmed the details of the project proponent as:

Organization name	Lankao Green Energy Clean Energy Co., Ltd.
Contact person	Yinglan Xuan
Title	General Manager
Address	3rd Floor, Chengchun Community, Intersection of Health Road and Shengli Road, Lankao County, Henan province, People's Republic of China
Telephone	-
Email	xuanyinglan@luter.cn

Through document review and site interview, the validation and verification team confirmed the details of the other entities as:

Organization name	Hangzhou Chaoteng Energy Technology Co., Ltd.

Role in the project	VCS Consultant
Contact person	Sandy Xie
Title	General Manager
Address	Floor 27, International Sunyard Building A, No.1750 Jianghong Rd, Binjiang District, Hangzhou, Zhejiang Province, China
Telephone	-
Email	sandy@ct-cdm.com

The project proponent, VCS Consultant and their contact information reported in the VCS Joint-PD-MR /1/ have been confirmed by checking the business license, the Project approval and interviewing with the PP representative during onsite inspection /21/ /17/.

- Ownership

Via checking the legal approval to the Environmental Impact Assessment (EIA) /18/, Project approval /17/, and the business license of the Lankao Green Energy Clean Energy Co., Ltd. /21/, it is verified that the PP has the legal right to control and operate the Project activity.

By checking the existing water extraction permit /20/, Commencement report of the Project /25/, Construction Contract /23/ and equipment purchase contract /27/, the validation and verification team confirm that the project proponent has the legal right to construct the project. Furthermore, via checking the Heating supply contracts /26/ which signed between Lankao Green Energy Clean Energy Co., Ltd. and the end users, CTI confirmed that Lankao Green Energy Clean Energy Co., Ltd. has the legal right to operate the Project activity.

In conclusion, the validation and verification team confirm that Lankao Green Energy Clean Energy Co., Ltd. has the legal right to control and operate the project.

- Project start date

As per VCS Standard version 4.5 /12/, the start date of a non-AFOLU project is the date on which the proposed project began generating GHG emission reductions or removals. By checking the operation log/30/ and Project completion acceptance /28/ and on-site interviews, the validation and verification team confirm that the earliest group of geothermal space heating systems to be constructed started commissioning on the same day (15/11/2021), including 6 sub-areas (6 production wells) with a total of 11 heat substations. Thus, it is confirmed that the start date of the project is 15/11/2021.

By checking the operation log/30/ and Project completion acceptance /28/ and through on-site inspection and interviews, it is verified that until the end of this monitoring period (18/03/2023), there are 10 sub-areas (10 production wells) in operation with a total of 14 heat substations. The remaining 2 sub-areas (Jinxiuyuan Station and Tianshenggongguan Station) are still under construction. And the details of the commissioning dated of all 10 sub-areas in operation and

the expected dated of commissioning of the two remaining sub-areas are summarized in the table below:

Sub-areas	Heat-Substations	Commissioning date
Fenghuangcheng Station	1#FHC	15-November-2021
	2#FHC	15-November-2021
	3#FHC	15-November-2021
	4#FHC	15-December-2023 (After this monitoring period)
Gongyuanshoufu Station	1#GYSF	15-November-2021
Dongfangyujing Station	1#DFYJ	15-November-2021
	2#DFYJ	15-November-2021
	3#DFYJ	15-November-2021
Donghuyiyuan Station	1#DHYY	22-December-2021
Qinghuayuan Station	1#QHY	15-November-2021
Xiangxiehuating Station	1#XXHT	15-November-2021
Hualancheng Station	1#HLC	15-November-2021
Jiuhaoyuan Station	1#JHY	14-January-2023
Jinxiuyuan Station	1#JXY	End of 2024 (Expected)
Tianshenggongguan Station	1#TSGG	End of 2024 (Expected)
Qianxizhuangyuan Station	1#QXZY	15-November-2021
Yehaowanghu Station	1#YHWH	19-January-2023

- Project crediting period

This Project adopts fixed crediting periods of 10 years. The crediting period is 10 years from 15-15/11/2021 to 14/11/2031 (both days included).

- Project scale and estimated GHG emission reductions or removals

The annual GHG emission reduction of the project is estimated to be 78,508 tCO_2e which is less than 300,000 tonnes of CO_2e per year. Therefore, the validation and verification team confirm that the project scale falls under "Project".

Through checking emission reductions calculation spreadsheet provided by PP, the validation and verification team confirm that the estimated GHG Emission Reductions of the project is as follows:

Year	Estimated GHG emission reductions or removals (tCO_2e)
15/11/2021~14/11/2022	78,508
15/11/2022~14/11/2023	78,508
15/11/2023~14/11/2024	78,508
15/11/2024~14/11/2025	78,508
15/11/2025~14/11/2026	78,508
15/11/2026~14/11/2027	78,508
15/11/2027~14/11/2028	78,508
15/11/2028~14/11/2029	78,508
15/11/2029~14/11/2030	78,508
15/11/2030~14/11/2031	78,508
Total estimated ERs	785,080
Total number of crediting years	10
Average annual ERs	78,508

The above estimated emission reduction is confirmed by the validation and verification team via emission reduction calculation spreadsheet /2/. The validation and verification team confirm that the calculation is correct and conservative.

- Project location

The project is in Lankao County, Henan province, People's Republic of China. The geographical coordinates of Project is Longitude east 114°47' E to 114°50' E and Latitude North 34°48' N to 34°51' N. The project location was confirmed during site visit by GPS devices.

Furthermore, PP has completed the KML file /71/ of the project and the location of the substations, geothermal wells and the heated areas are confirmed to be correctly included in the KML file.

- Conditions prior to project initiation

Via interview with end users and local government officers during on-site inspection, CTI verified that there are no geothermal space heating systems at the project sites before the construction of the Project activities. The baseline scenario is the same as the conditions existing prior to the project initiation. Refer section 3.4 below for detailed baseline scenario assessment.

- Project compliance with applicable laws, statutes and other regulatory frameworks

The project complies with all Chinese relevant laws and regulations. Mainly include:

1. the Plan for Clean Heating in Winter in Northern China (2017-2021) /42/ (Development and Reform of Energy resources (2017) No. 2100)

2. Catalogue for the Guidance of Industrial Structure Adjustment (2019 version) /44/.

3. Implementation Plan of Air Pollution Prevention and Control in Henan Province in 2018 /45/.

4. Green Industry Guidance Directory (2019 version) /46/

As per the VCS Joint-PD-MR version 03 dated 22/02/2024 /1/, the project has obtained the Project approval /17/ and EIA approval /19/ from local government authorities. For Project, Project approval is obtained from Lankao DRC (Development and Reform Committee) and EIA approval is obtained from Lankao County Environment Protection Bureau /19/.

By reviewing the mentioned regulations and approvals above, CTI verified that the project is to be subject to regular inspection by local government during the implementation period to ensure continuous compliance. In conclusion, the project complies with all relevant local, regional and national laws, statutes and regulatory frameworks in China.

Furthermore, via checking the existing Water Extraction Permits /20/, CTI confirmed that all the 10 sub-areas (10 production wells) currently in operation have their respective Water Extraction Permit. As confirmed by interviewing with PP and officer from Lankao County Spacing Heat Supervision Department, the 2 remaining Sub-areas (Jinxiuyuan Station and Tianshenggongguan Station), corresponding to 2 production wells have not been put into operation yet, those two sub-areas will obtain their Water Extraction Permit before operation in the following years.

FAR01 was raised, please refer to Appendix C for details.

- Sustainable development contributions

Via on-site inspection, checking the evidence provided and interviewing with the project implementer, CTI verified that the project contributes the sustainable development through the following aspects:

1. Project will supply geothermal energy-based heat to the project site. Thus, the project will achieve SDG 7 “Ensure access to affordable, reliable, sustainable and modern energy for all”. It is verified by interview with representatives of end users and by checking FSR /16/and heating supply contract /26/ that the actual total heating area of Project is 3.7361 million

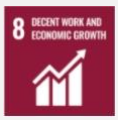
m^2. The local residents have accesses to and relied on renewable energy heating. Hence the contribution to SDG 7 is confirmed.

2. The project will achieve a GHG emission reduction during the crediting period. Thus, the project will achieve SDG 13"Take urgent action to combat climate change and its impacts". The validation and verification team confirmed that total 785,080 tCO_2e in a 10-year crediting period by checking the Emission Reduction Calculation sheet /2/. Hence the contribution to SDG 13 is confirmed.

3. This project will increase the income of local residences and accelerate economy development in rural areas. During the crediting period, direct and indirect employment opportunities will be generated. Thus, the project will achieve SDG 8 "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all". The validation and verification team verified, through checking FSR /16/ of the project and interview with staffs during on-site inspection, the project will create 60 full employment positions regardless of gender or other status. Hence the contribution to SDG 8 is confirmed.

The details of the project contribution to sustainable development are listed in the following table:

SDG	Indicators	Chinese Sustainable Development Progress	Project activity contribution
	SDG 7: "Ensure access to affordable, reliable, sustainable and modern energy for all - 7.2.1 Renewable energy share in the total final energy consumption	China has implemented an innovation-driven development strategy, focusing on deepening supply-side structural reforms, building a clean, low-carbon, safe and efficient energy system, and continuing to promote international cooperation in the energy field, energy utilization efficiency has been significantly improved, and energy has entered a new stage of high-quality development.	The Project activity is designed to introduce geothermal energy-based space heating system to realize heat supply to a series of residential buildings (off grid solutions for targeted users and/or applications) in Lankao County, Henan province, People's Republic of China over winter season, which will displace heat supply from isolated coal-fired boilers as a business-as-usual scenario in the Project area. The local residents can have access to and rely on renewable energy. During this monitoring period, by checking the Heating Supply Contracts /26/, Operation log and operation records/30/, Project completion acceptance/28/ and through onsite visit and interview, it is confirmed that: ● The project has started to heat 1,927.91 thousand m^2 of residential buildings with the occupancy rate of 62.65% during the

			heating season 2021-2022 (from 15-November-2021 to 21-March-2022). Actual heating area is 1,207.8 thousand m^2. ● The project has started to heat 611.38 thousand m^2 more of residential buildings, totaling 2,539.30 thousand m^2 with the occupancy rate of 57.87% during the heating season 2022-2023 (from 15-November-2022 to 18-March-2023). Actual heating area is 1,469.5 thousand m^2
	SDG 8 "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all".- 8.3.1 Proportion of informal employment in non - agriculture employment, by sex	China continuously improves the quality and efficiency of development. In-depth implementation of the innovation-driven development strategy, the rapid development of small and medium-sized enterprises. Adhering to the policy of giving priority to employment, the unemployment rate has remained at a low level. By coordinating epidemic prevention and control with economic and social development, it has become the only major economy to achieve positive growth in 2020 and has made positive contributions to the recovery of the global economy.	The Project activity provides job opportunities for all locals during project implementation and monitoring activities irrespective of gender or any other status. Equal pay for work of equal value is made to both men and women During this monitoring period, through checking the Labor contact, roster, payroll /35/and interview during onsite visit, it is confirmed that 60 people were employed for operation and maintenance of this project. Among them, the number of female workers is at least 30%.
	SDG 13 "Take urgent action to combat climate change and its	In 2020, China's energy consumption per unit of GDP was reduced by 24.4% compared with 2012;	The Project activity is designed to introduce geothermal energy-based space heating system to realize heat supply to a series of residential buildings (off grid solutions for

	impacts". - Tonnes of greenhouse gas emissions avoided or removed	carbon dioxide emissions per unit of GDP was reduced by 18.8% compared with 2015 and 48.4% compared with 2005, all of which have already fulfilled China's commitment to the international community in 2020 ahead of schedule.	targeted users and/or applications) in Lankao County, Henan province, People's Republic of China over winter season, which will displace heat supply from isolated coal-fired boilers as a business-as-usual scenario in the Project area. Emission reduction credits will be earned by the use of geothermal energy instead of the combustion of fossil fuel for space heating. Besides, the project provided an opportunity for local residents to learn and raise awareness on climate change and mitigation measures on the stakeholder consultation fiscal meeting. During this monitoring period, through checking the ER calculation spreadsheet /2/, the Operation log and operation records /30/, Heating Supply Contracts /26/ and via onsite visit and interview, it is confirmed that: ● For the monitoring period from 15-November-2021 to 21-March-2022, 1,207.8 thousand m^2 of residential buildings with a heating load of 36.23 MW, generating an actual emission reduction of 31,096 tCO_2e ● For the monitoring period from 22-March-2022 to 14-November-2022, the project is not implementing heating for the residential buildings, generating an actual emission reduction of 0 tCO_2e. ● For the monitoring period from 15-November-2022 to 18-March-2023, 1,469.5 thousand m^2 of residential buildings with a heating load of 44.08 MW, generating an actual emission reduction of 36,541 tCO_2e.

- Additional information relevant to the project, including:

• Leakage management for AFOLU projects

According to the methodology, the leakage of the project is zero, thus the leakage management is not applicable to the project.

• Commercially sensitive information

No commercially sensitive information has been excluded from the public version of the project description. The details are presented transparently to the validation and verification team for analysis which lead to positive conclusion for this validation and verification.

Based on above assessment and demonstration, it is concluded that the description in the project description version 03 dated 22/02/2024 /1/ is accurate, complete, and the nature of the project is actual and understandable. And it is confirmed that the project has been implemented as described in the project description via site inspection.

CL 1, CL 4, CAR 1, CAR 2, CAR 3, CAR 4, CAR 7 were raised and successfully closed. Refer to Appendix C for detailed assessment.

3.2 Participation under Other GHG Programs

• Projects registered (or seeking registration) under other GHG program(s):

The validation and verification team checked the registry of CDM EB (http://cdm.unfccc.int), Gold Standard (http://www.goldstandard.org), China Certified Emission Reduction (CCER) Program (http://cdm.ccchina.org.cn/ccer.aspx) and other GHG program. It is confirmed that the project has neither been registered nor seeking registration under any other GHG programs. The project is seeking registration only in VCS program.

• Rejection by other GHG programs

The project proponent claimed that the project is not rejected by other GHG programs. It was confirmed by checking the registry of CDM EB (http://cdm.unfccc.int), Gold Standard (http://www.goldstandard.org), China Certified Emission Reduction (CCER) Program (http://cdm.ccchina.org.cn/ccer.aspx), VCS program (http://verra.org) and other GHG program to confirm the same. The project is seeking registration only in VCS program.

• Other forms of credit and supply chain (Scope 3) emissions":

Emissions trading programs and other binding limits

The validation and verification team confirms that the Net GHG emission reductions generated by the project will not be used for compliance with an emissions trading program or to meet binding limits. The validation and verification team checked Chinese Emission Trading System (China ETS) and found that the project is not accredited/registered under China ETS. Thus, the validation and verification team concluded that the Project activity is not involved in other Emissions trading programs or other binding limits. Hence, it is confirmed that the emission reductions will not be double counted.

Via interview with the project proponent and based on above assessment, it is confirmed that the project has not sought or received any other form of environmental credit.

CL 4 was raised and successfully closed. Refer to Appendix C for detailed assessment.

3.3 Safeguards

3.3.1 No Net Harm

In China, an Environmental Impacts Assessment (EIA) or Environmental Impact Registration is required according to Chinese legislation. By document review, the validation and verification team verified that the Environmental Impact Registration of Project was obtained for Phase I 12/2017, Phase II 05/2019, Phase III 06/2020 /18/. The qualification certificate of Henan Zhengde Environmental Protection Technology Co., Ltd. was also checked /39/. The validation and verification team confirms that all environmental impacts have been analysed and proper measures have been taken to minimize the impacts, thus no net harm was detected. Refer to section 3.3.3 in this report for detailed environmental impacts arising from the Project construction and operation.

Through interview with local officer and stakeholders, it is confirmed by the validation and verification team that the implementation of the project will improve local socio-economic development and contribute to the sustainable development as described in section 3.1 of this report above. It is also verified that the project does not cause adverse effect to their daily life.

In conclusion, CTI confirmed that the project has no negative impacts on local environment and socio-economy. And no net harm on local environment and social community has been detected for the project.

3.3.2 Local Stakeholder Consultation

As per the VCS requirements, it is necessary to hold the relevant stakeholder's consultation prior to the project construction. The validation and verification team checked the relevant dates during the desk review and site inspection. A stakeholder survey was carried out by the project developer on 13/08/2020 to 15/08/2020 which was prior to the start date of construction indicated in the Commencement Report of Project /25/.

The project owner invited local stakeholders to participate in the questionnaire distributed proportionally to the resident representatives from each community involved in the project and to the government departments related to the project. The survey was conducted through distributing and collecting responses of questionnaires. The questionnaire was reasonably designed to assess the project impacts on the local environment and social economic development. In total, 100 questionnaires were distributed and received with a 100% response rate.

By checking the filled questionnaires /32/, it was verified that all respondents knew or heard about the Project. Most of them are supportive of the project construction, and think the Project will bring more benefit than loss. And the survey shows that many local stakeholders think the Project will help improve the life of local people and promote local economic development without any adverse environmental impact. Therefore, the validation and verification team confirm that the local stakeholder has no negative comments for the construction of the Project activity. Via interview with the local officer and local residents during site inspection, it is verified that there were no negative comments received during the implementation period.

Ongoing Communication with Stakeholders:

Through the on-site inspection of the feedback collection book, on-site visits with the PP, and the review of the ongoing communication manual set up by the PP, the assessment team confirmed that the PP keep communicating with Local stakeholders at periodic intervals. Key implementation schedules or changes of the project will be communicated to the local authority, who will inform the neighbourhood committee and the residents, the comments and suggestions from residents will be collected by the local authority meanwhile. And the local government agencies and competent authorities will conduct spot checks on the implementation of the project from time to time and give suggestions on the involved rectification problems.

Via checking the "Repair Orders"/66/ and on-site visit as well as calling the hotline, it is verified by CTI that a 24-hour customer service online is in use by the PP. Within one hour after receiving the heat problem reflected by the user, the technician will enter the house to measure the temperature and investigate to ensure the fastest speed to solve the user's problem. An on-site feedback collection book has also been established by the PP to continuously gather feedback. All repair requests during this monitoring period have been resolved /66/.

Through the on-site visits with stakeholders, and the review of the EIA Report and EIA Approval /19/, the validation and verification team confirmed that the PP has offered some measures for mitigating noise. The effect of the noise from the plant is little to local residents. These measures are a part of the project design. Thus, no updates to the project design are needed.

In conclusion, CTI confirms that the local stakeholder consultation has been conducted adequately and appropriately as per VCS standard /12/. And no need to change the project design based on the stakeholder inputs.

3.3.3 Environmental Impact

In China, an Environmental Impact Assessment or an Environmental Registration is required according to Chinese legislation. The validation and verification team reviewed the EIA registration for Project /18/, EIA Report and EIA Approval /19/, and confirms the correctness of the approaches used by PP against the adverse environmental impacts. The EIA report was prepared by Henan Zhengde Environmental Protection Technology Co., Ltd. Thus the validation and verification team checked the business license and the certification /39/ of the company

and confirmed it is qualified to carry out the environmental impact assessment. The assessment results showed that the environmental impact caused by the project will be minor. In conclusion, the PP have followed the requirements of the host country with regards to addressing environmental impacts as below:

Construction Phase

Noise

The construction period mainly involved the installation and commissioning of equipment and is relatively short. Via reviewing the EIA /18/ and its approval /19/and interview with the local stakeholders, it is verified that the major environmental impact during this period is the construction noise. During the construction period, the main noise sources are mud pumps, drilling rigs, transport vehicles, etc. During drilling operations, noise is reduced by preferentially selecting low-noise machinery and equipment, rationally arranging the working frequency of strong-noise construction machinery, and shortening the operation period /18/. After taking the corresponding measures mentioned above, the noise impact on the surrounding sound environment can be effectively reduced. After the completion of construction, the mechanical noise has ended. Through interview with officers from the local Environmental Protection Bureau, it is confirmed that the noise control measures have been taken according to the EIA and the noise level during construction has met the national standard Emission Standard of Environment Noise for Boundary of Construction Site (GB12532-2011) /77/.

The impact has been solved and there is no further significant environmental impact was detected during construction.

Operation Phase

Wastewater

The wastewater of the project is discharged from the soft water system and the heating circulation system. The wastewater enters the municipal sewage pipe network /18/ through the sewage pipe network of the heating community, and finally enters the sewage treatment plant of city for centralized treatment.

Noise

The noise generated by the project mainly comes from the air source heat pump unit of the heat source station and the mechanical noise generated by the equipment of the heat supply station. Through low-noise equipment, base vibration reduction, flexible pipeline connection, indoor installation, building sound insulation, and distance attenuation, the noise during the operation has been diminished effectively. Through onsite inspection and interview with officers from local environment protection bureau, it is confirmed that noise control measures have been applied as per the EIA and the noise level at 1m outside the facility is lower than 45dB(A) which meets the requirement of <Emission Standard for Industrial Enterprise Noise at Boundary (GB12348-2008)> /60/.

Solid waste

Waste ion exchange resin: Recycling and disposal by relevant hazardous waste disposal units; Waste oil: Recycling and disposal by relevant hazardous waste disposal units; Oily cotton yarn and gloves: Regularly handed over to the sanitation department for removal and disposal; Domestic waste: Regularly handed over to the sanitation department for removal dispose of.

Via checking the EIA report /18/ and on-site inspection, CTI confirms that appropriate approaches have been taken to minimize the adverse impact and the environmental impact caused by the project will be minor /18/ /19/.

CAR4 was raised and successfully closed. Refer to Appendix C for detailed assessment.

3.3.4 Public Comments

The project sought the registration with the VCS Program, according to VCS requirements the Project Description was submitted for public comment period. The project was allocated with VCS ID 4383. The public comment period started on 30/06/2023 and ended on 30/07/2023 (https://registry.verra.org/app/projectDetail/VCS/4383). No comments were received during this period which has been verified by checking the dedicated website.

3.3.5 AFOLU-Specific Safeguards

This section is not required as the project is not AFOLU project

3.4 Application of Methodology

3.4.1 Title and Reference

The validation and verification team checked that following methodology and tools are applicable for the Project activity as below: the approved consolidated methodology applied in the Project activity is AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/. This methodology also refers to the latest approved version of the following tools and guidelines: Tool 02 Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0) /6/; Tool 05 Baseline, Project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0) /8/; Tool 07 Tool to calculate the emission factor for an electricity system (Version 07.0) /9/; Tool 03 Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (Version 03.0) /7/; Tool 24 Common practice (Version 03.1) /10/.

3.4.2 Applicability

Demonstration and justification regarding the applicability of the methodology and tools selected by the project proponent are shown in the table below.

AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/	
Eligibility Criteria	**validation and verification Assessment**
The methodology is applicable for space heating in buildings by introducing centralized geothermal heat supply system. The methodology can apply to new build facilities, or to a geothermal district heating system seeking to expand its operations through the addition of extra geothermal wells to the system	Via site inspection and checking the FSR /16/, Project approval /17/ and Contracts for Construction of Geothermal Space Heating System for Project /23/, CTI verified that this Project activity is to introduce geothermal energy based space heating system to realize heat supply to a series of new residential buildings. All the facilities related to the geothermal heating system were proved to be newly built which didn't involve any capacity expansion through the addition of extra geothermal wells. Hence this criterion is applicable for this Project activity.
The methodology is applicable under the following conditions: (a) The geographical extent of the proposed project boundary can be clearly established, in terms of the location of buildings connected to existing heating systems and new buildings to be constructed that will use geothermal heat, in the case of expansion of existing facilities, the location and capacity of existing geothermal wells, and heating system infrastructure can be clearly identified;	Via site inspection and checking the FSR /16/, Project approval /17/ and Contract for Construction of Geothermal Space Heating System /23/, CTI verified that geographical extent of the proposed project boundary has been clearly established in VCS Joint-PD-MR version 03 dated 22/02/2024/1/ includes the newly built 36 geothermal wells, newly built 17 heat substations, 12 sub-areas of residential buildings that will use geothermal heat, and newly built primary networks and secondary network. The location of 12 sub-areas of the project have been verified by GPS during site inspection, which is consistent with the information provided in VCS Joint-PD-MR. Hence, this criterion is applicable for this Project activity.
(b) Project will use geothermal resources for centralized space-heating system of	Via site inspection and review Feasibility Study Report /16/ and heating supply contracts for Project /26/, it is verified that

residential areas, commercial areas and/or industrial areas;	the Project activity is designed to introduce geothermal energy-based space heating system to realize heat supply to a residential area in Lankao County, Henan province, People's Republic of China. And the project can supply geothermal heat to the residential buildings with a total area of 3.7361 million m^2, according to the heating supply contracts.
(c) The methodology is applicable for installing new heating systems in new buildings and replacing existing fossil fuel space heating systems. Current use of fossil fuel(s) for space heating is partially or completely replaced by heat drawn from geothermal water, in the case of expansion of existing facilities the methodology is applicable to expanding the existing geothermal heating system;	By checking FSR /16/ and via on-site inspection, CTI verified that the project uses geothermal resources for centralized space-heating system of total of 12 sub-areas including a series of newly-built residential buildings. Hence this criterion is applicable for the Project activity
(d) The installed heat capacity may increase as a result of the Project activity. But this increase is limited to 10 percent of the previous existing capacity; otherwise, a new baseline scenario has to be determined for the new capacity;	Via site inspection and checking the FSR /16/, Project approval /17/, contract for construction and heating supply contracts /23/ /26/, CTI confirmed that there was no existing capacity prior to implementation of the project. This condition is not applicable.
(e) All fossil fuel heat-only boiler(s) used in the baseline must operate to supply the heat to the district heating system which is only used for heating of buildings and/or hot tap water supply in the residential and/or commercial sector, but not for industrial processes;	Via site inspection and checking FSR /16/, CTI verified that the residential buildings were supplied by the fossil fuel heat-only boilers used in the baseline. No industrial processes were involved. Hence this criterion is applicable for the Project activity.
(f) The use of GHG emitting refrigerants is not permitted under this methodology.	By checking the Flow Chart of the Feasibility Study Report /16/, CTI verified that the project is a closed circulating cycle and no GHG emitting refrigerants is used. Hence this criterion is applicable for the Project activity
In addition, the applicability conditions included in the tools referred to below apply	Assessment for the choice of the selected tools is shown in the following tables.

Tool 02 Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0)	
The tool is applicable to all types of proposed Project activities. However, in some cases, methodologies referring to this tool may require adjustments or additional explanations as per the guidance in the respective methodologies. This could include, inter alia, a listing of relevant alternative scenarios that should be considered in Step 1, any relevant types of barriers other than those presented in this tool and guidance on how common practice should be established.	The tool is applicable to all types of proposed Project activities, and in section 15 of the applied methodology, it requires project proponents determine the most plausible baseline scenario through the use of the "Combined tool to determine the baseline scenario and demonstrate additionality". Thus, this tool is applicable to the project.

Tool 05 Baseline, Project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0)	
If emissions are calculated for electricity consumption, the tool is only applicable if one out of the following three scenarios applies to the sources of electricity consumption: (a) Scenario A: Electricity consumption from the grid. The electricity is purchased from the grid only, and either no captive power plant(s) is/are installed at the site of electricity consumption or, if any captive power plant exists on site, it is either not operating or it is not physically able to provide electricity to the electricity consumer. (b) Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants are installed at the site of the electricity consumer and supply the consumer with electricity. The captive power plant(s) is/are not connected to the electricity grid; or	Via site inspection, CTI verified that the project is connected to the Centre China Power Grid (CCPG), which falls under scenario A of Tool 05 (Version 03.0). Therefore, emissions related to electricity consumption from the grid only need to be calculated. Hence this criterion is applicable for this Project activity.

(c) Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants operate at the site of the electricity consumer. The captive power plant(s) can provide electricity to the electricity consumer. The captive power plant(s) is/are also connected to the electricity grid. Hence, the electricity consumer can be provided with electricity from the captive power plant(s) and the grid	
This tool can be referred to in methodologies to provide procedures to monitor amount of electricity generated in the project scenario, only if one out of the following three project scenarios applies to the recipient of the electricity generated: (a) Scenario I: Electricity is supplied to the grid; (b) Scenario II: Electricity is supplied to consumers/electricity consuming facilities; or (c) Scenario III: Electricity is supplied to the grid and consumers/electricity consuming facilities	Via on-site inspection, CTI verified that the project only consumes electricity from CCPG. There is no electricity generation involved in the Project activity. So, this criterion is not applicable.
This tool is not applicable in cases where captive renewable power generation technologies are installed to provide electricity in the Project activity, in the baseline scenario or to sources of leakage. The tool only accounts for CO_2 emissions.	Via checking FSR /16/, Project approval /17/ and heating supply contracts /26/, CTI verified the project installs geothermal-based space heating system to displace fossil fuel consumption. No captive renewable power generation technologies will be installed to provide electricity in the Project activity. This criterion is not applicable

Tool 07 Tool to calculate the emission factor for an electricity system (Version 07.0)	
This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a Project activity that substitutes	Via site inspection, CTI verified that the project consumes electricity from grid CCPG, no baseline emissions related to supplying

grid electricity that is where a Project activity supplies electricity to a grid or a Project activity that results in savings of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects).	electricity to a grid or a Project activity that results in savings of electricity that would have been provided by the grid. Hence this criterion is not applicable.
Under this tool, the emission factor for the project electricity system can be calculated either for grid power plants only or, as an option, can include off-grid power plants. In the latter case, two sub-options under the step 2 of the tool are available to the project participants, i.e., option IIa and option IIb. If option IIa is chosen, the conditions specified in "Appendix 1: Procedures related to off-grid power generation" should be met. Namely, the total capacity of off-grid power plants (in MW) should be at least 10 per cent of the total capacity of grid power plants in the electricity system; or the total electricity generation by off-grid power plants (in MWh) should be at least 10 per cent of the total electricity generation by grid power plants in the electricity system; and that factors which negatively affect the reliability and stability of the grid are primarily due to constraints in generation and not to other aspects such as transmission capacity	The Project activity uses electricity from CCPG only. Emission factor for the project electricity system will be calculated for grid power plants only.
In case of CDM projects the tool is not applicable if the project electricity system is located partially or totally in an Annex I country	Via site inspection and desk review, CTI verified that the project electricity system is located totally in Henan province, China, which is not an Annex I country. Hence this criterion is applicable for the project.
Under this tool, the value applied to the CO_2 emission factor of biofuels is zero.	The project doesn't involve biofuel.

Tool 24 Common practice (Version 03.1)	
This methodological tool is applicable to Project activities that apply the methodological	As assessed above, the Project applies the methodological tool "Combined tool to

tool "Tool for the demonstration and assessment of additionality", the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality", or baseline and monitoring methodologies that use the common practice test for the demonstration of additionality.	identify the baseline scenario and demonstrate additionality" for the demonstration of additionality. The project can use the common practice test for the demonstration of additionality. Hence this criterion is applicable for this Project activity.
In case the applied approved baseline and monitoring methodology defines approaches for the conduction of the common practice test that are different from those described in this methodological tool, the requirements contained in the methodology shall prevail.	Via checking the section 31 of applied methodology /5/, CTI confirmed that the methodology defines approaches for the conduction of the common practice test that are same to those described in this methodological tool. Hence this criterion is applicable for this Project activity.

The validation and verification team hereby confirms that the selected methodologies and tools are approved CDM methodologies and tools, and are applicable to the Project activity.

3.4.3 Project Boundary

The proposed project boundary basically defines the physical and geographical boundary of the project facility and it is well defined in the VCS Joint-PD-MR version 03 dated 22/02/2024 /1/ section 3.3 according to AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/. The proposed project boundary includes:

(a) The site of geothermal heat extraction including, geothermal wells, re-injection wells, pumps, geothermal water storage tanks etc.

The project includes 36 geothermal wells, 12 production pipes and 24 injection pipes.

(b) Centralized heating systems, including pipes, stations, sub-stations, and buildings that are or will be connected to the geothermal heating system.

The project includes 17 substations, residential in 12 sub-areas.

(c) Decentralized heating equipment, including fossil fuel fired stoves etc.

For the Project, only the floor radiation system was installed in residential buildings connected to the substations. There is no decentralized heating equipment involved in the project boundary.

Via site inspection and checking the FSR /16/, it is verified that proposed project boundary is clearly defined in the VCS Joint-PD-MR version 02 dated 20/10/2023 /1/ as per the methodology /5/. Emissions sources included in the proposed project boundary have been appropriately included in the VCS Joint-PD-MR version 02 dated 20/10/2023 as well /1/.

The main emission sources and gases included in the proposed project boundary are determined as per the applied methodology, via the baseline scenario identification assessment as below section, CTI confirmed that the baseline emission sources included in baseline scenario is CO_2 emission from fossil fuel used for space heating. Via on-site inspection of the Project and checking the FSR /16/, in the project scenario, the main emission source including the CO_2 emission from electricity used for project operations have been confirmed. And via on-site inspection of the Project and checking the FSR /16/, CTI also confirmed that no fugitive emissions will be considered by the project as the low-temperature geothermal system is designed to operate by extracting geothermal water at approximately 72°C.

GHG sources included and excluded from the proposed project boundary is defined as correct and corresponding to the actual status of the project, through on-site inspection and checking the FSR /16/. It is verified that all the relevant sources have been selected.

In conclusion, CTI confirms that the proposed project boundary and selected sources are correctly justified.

CAR 8 was raised and successfully closed. Refer to Appendix C for detailed assessment.

3.4.4 Baseline Scenario

The PP has applied an approved baseline and methodology AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/ which is approved under CDM scheme. The VCS Joint-PD-MR applies the stepwise approach as given by section 5.2 of the AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/ and "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 07.0) /6/.

Step 1: Identification of alternative scenarios

Step 1a: Define alternative scenarios to the proposed project

As required by the methodology AM0072 /5/, para. 16, the PP has provided an overview of other technologies or practices used for generation of heat in the relevant geographical area. Via on-site inspection of the Project and checking the FSR /16/, the public information on the official website of The People's Government of Lankao County /78/ and interview with officers from Lankao County Spacing Heat Supervision Department ,it is confirmed by CTI team that there is no municipal central heating system in the urban area of Lankao County and heating service in Lankao County is mainly the form of distributed central heating.. By checking the public information: The difference between municipal central heating system and distributed central heating /79/, it is confirmed that the distributed central heating is mainly based on a heating unit or facility as the center, supplying several surrounding buildings through a heat distribution network. Therefore, the heating demand for new buildings can only be met by constructing new heating facilities.

Through independent review of *Planning of Clean Heating in Winter of Northern China (2017-2021)* /42/ issued by the national government, it is confirmed that the coal is still the main energy used for heating in northern part of China and coal heating area accounts for about 83% of the total heating area. Via independent review of the research thesis of Zhejiang Univerisity /81/, it is confirmed that Kaifeng City, where Lankao County belongs to, is within the traditional heating area and traditional heating refers to the use of methods such as coal-fired boilers and cogeneration for heating. Furthermore, by checking *the Research on Heating in Winter of Kaifeng City* published by Housing and Urban Rural Development Department of Kaifeng City /41/ and interview with officers from Lankao County Spacing Heat Supervision Department, it is confirmed that coal-fired boiler is still the main source of heating energy in Kaifeng City and geothermal energy is still under development.

Through checking the FSR /16/, project approval /17/, EIA approval /19/ and interview with officers from Lankao County Spacing Heat Supervision Department, it is confirmed that prior to the implementation of the project, there are no existing geothermal space hearing project activities at the project sites and all the buildings covered by the project activity were newly built and there was no existing heating system prior to the project activity.

As the requirement of TOOL02, v.07.0/6/ para. 15, the PP needs to provide the information of ten facilities (projects) that provide the same output as the proposed project activity in the applicable geographical area. Through interview with officers from Lankao County Spacing Heat Supervision Department, it is verified that most of the existing coal-fired boiler capacity IN lANKAOis small and the management is decentralised and it is difficult to query the information of each heating facilities. There are less than ten facilities (or projects) that provide the same output as the proposed project activity are found in Lankao County, therefore the applicable geographical area is expanded to the whole host country as per TOOL02 V07.0 /6/. The joint PD&MR has listed the ten facilities (or projects) that provide the same output as the proposed project activity. The external sources /72/ providing information of these ten facilities have been checked and verified by CTI.

Due to the project installed new geothermal facility to supply heats to newly-built buildings, the VCS Joint-PD-MR /1/ follows the methodology by considering all realistic and credible alternatives for heat supply. The realistic and credible alternatives were assessed as shown in the table below.

No	Alternative scenarios	validation and verification assessment
1	a) Implementation of the Project activity without the benefits of the VCS;	**Included** - This is a realistic and credible alternative scenario.
2	b) Introduction of a new integrated district heating system(s) connected by a new primary network:	

	(i) Introduction of a district heating system;	**Excluded** –Via site inspection and by reviewing Feasibility Study Report (FSR) /16/, the public information on the official website of The People's Government of Lankao County /78/ and interview with officers from Lankao County Spacing Heat Supervision Department, it is confirmed that there was no municipal centralized heating system in the urban area of Lankao County and heating service in Lankao County is mainly the form of distributed central heating. Thus, the location of the project is not in the central heating area. There is no District heating provided in the project area. Therefore, this is not considered as a realistic and credible alternative scenario.
	(ii) The replacement of the heat-only boilers in the existing network(s) by new heat-only boilers.	**Excluded** – Via site inspection and checking the FSR /16/, project approval /17/, EIA approval /19/ and interview with officers from Lankao County Spacing Heat Supervision Department and local residents, it is confirmed that all the residential buildings included in the project were newly constructed. There are no existing onsite networks in project site prior to project construction. Therefore, this is not considered as a realistic and credible alternative scenario.
3	c) Continued operation or rehabilitation of an existing [isolated] district heating network(s) or establishment of a new [isolated] district heating network(s). Such [isolated] district heating network(s) employ the following technologies:	
	(i) Coal fired boilers in boiler houses, supplying several buildings through a heat distribution network;	**Included** – Via site inspection, reviewing the FSR /16/ and Project approval /17/, interview with local officers and local residents, CTI confirmed that this is a realistic and credible alternative scenario.
	(ii) Natural gas fired boilers in boiler houses, supplying several buildings through a heat distribution network;	**Included** – This is a realistic and credible alternative scenario.
	(iii) Oil fired boilers in boiler houses, supplying several buildings through a heat distribution network;	**Excluded** - Via checking the public information /67/, CTI confirmed that the use of oil-fired boilers not only had environmental and safety issues, but also occupy a certain amount of space and the transportation

		and storage of oil is dangerous and more prone to accidents. Furthermore, via interview the local officers from Lankao County Spacing Heat Supervision Department and checking Research on Heating in Winter of Kaifeng City /41/ issued by Housing and Urban Rural Development Department of Kaifeng City, CTI confirmed that there is no existing oil-fired boiler heating distributing network in Lankao County. Therefore, this is not considered as a realistic and credible alternative scenario.
	(iv) Decentralized cogeneration plants;	**Excluded** – Through interview with officers from Lankao County Spacing Heat Supervision Department and checking Research on Heating in Winter of Kaifeng City /41/ issued by Housing and Urban Rural Development Department of Kaifeng City, it is confirmed that decentralized cogeneration plants do not cover the Project area. Therefore, this is not considered as a realistic and credible alternative scenario.
	(v) Renewable energy sources, such as biomass or solar thermal collectors, connected to a heat distribution network.	**Excluded** – Via interview the technical expert and local environmental officer and checking Notice on Issuing the 13th Five Year Plan for Energy Development in Henan Province /80/ issued by the People's Government of Henan Province, CTI confirmed that due to the limit on biomass technique level, renewable energy sources, such as biomass energy, wind energy, and solar energy, are not stable for space heating. Renewable energy can only be used as supplementary energy sources in long term in China. Therefore, this option is not considered as a realistic and credible alternative scenario.
4	d) Continued use or introduction of individual heat supply solutions:	
	(i) Coal fired boilers for individual buildings	**Included** - This is a realistic and credible alternative scenario.
	(ii) Coal fired stoves for individual apartments	**Excluded** – Based on local expertise of the validation and verification team and checking news from Xinhua Net /53/, CTI confirmed that it's dangerous to use coal fired stoves inside the apartments due to carbon

		monoxide poisoning. Carbon monoxide poisoning incidents have occurred in many places therefore, this .is not considered as a realistic and credible alternative scenario.
	(iii) Natural gas fired boilers for individual buildings	**Included** - This is a realistic and credible alternative scenario.
	(iv) Natural gas fired stoves for individual apartments	**Included** – This is a realistic and credible alternative scenario.
	(v) Oil fired boilers for individual buildings	**Excluded** –Via checking the public information /67/, CTI confirmed that the use of oil-fired boilers not only had environmental and safety issues, but also occupy a certain amount of space and the transportation and storage of oil is dangerous and more prone to accidents. Furthermore, via interview the local officers from Lankao County Spacing Heat Supervision Department and checking Research on Heating in Winter of Kaifeng City /41/ issued by Housing and Urban Rural Development Department of Kaifeng City, CTI confirmed that there is no existing oil-fired boiler heating projects for individual building in Lankao County. Therefore, this is not considered as a realistic and credible alternative scenario.
	(vi) Oil fired stoves for individual apartments	**Included** - This is a realistic and credible alternative scenario.
	(vii) Electricity (e.g. off-peak storage heating)	**Excluded** – As per the articles published by China Solar Thermal Alliance, it is confirmed that the area of electric heating in the northern part of China accounts for only 2% at present. /69/ And via checking the public information, the power consumption of electricity-based heating technology is very high. A general household consume 25-35 kWh of electricity per day for electric heating./58/ According to the article *Power demand response capability calculation and reserve objective optimized decomposition of Henan province* published on the POWER DEMAND SIDE MANAGEMENT (ISSN 1009-1831 /73/, it is also known that the gap between power supply and

		demand in Henan province continues to increase It can be seen that in Henan Province, long-term use of electric heating in winter is unrealistic. As to the off-peak storage heating technology, as per the articles published by China Solar Thermal Alliance, it is confirmed that it is still currently one of the research directions, which is in the laboratory validation stage, not yet a large number of commercial applications in China/69/. Thus, electricity-based heating technologies not comparable with other alternatives due to low cost-effectiveness. And in the project site, electric heating technology is not yet widespread. Electricity-based heating devices are still a niche product. Therefore, this is not considered as a realistic and credible alternative scenario.
	(viii) Individual heating devises using renewable energy sources, e.g. solar thermal collectors	**Excluded** - Via interview the technical expert and local environmental officer and checking the published article /59/ and Notice on Issuing the 13th Five Year Plan for Energy Development in Henan Province /80/ issued by the People's Government of Henan Province, it is confirmed that due to the low solar energy density, a larger collection area is required to meet the heating demands. Generally, there are two kinds of heating media, air and water. The efficiency of the air heating solar system is lower and the water heating solar system is easy to freeze because of the low temperature in winter time in Henan province. There are no stable individual space heating devices using solar thermal collectors. Therefore, this is not considered as a realistic and credible alternative scenario.
	(ix) Individual heating devises using non-renewable biomass	**Excluded** - Via interview the technical expert and local environmental officer and checking Notice on Issuing the 13th Five Year Plan for Energy Development in Henan Province /80/ issued by the People's Government of Henan Province, CTI confirmed that

		due to the limit on biomass technique level, renewable energy sources, such as biomass energy, wind energy, and solar energy, are not stable for space heating. Renewable energy can only be used as supplementary energy sources in long term in China. Therefore, this option is not considered as a realistic and credible alternative scenario.

Via on-site inspection, reviewing relevant evidences and checking the links provided in the VCS Joint-PD-MR version 03 dated 22/02/2024, it is verified the pre-screening justification in the VCS Joint-PD-MR is correct and appropriate.

Existing geothermal based heat supply system is not involved in the Project activity and is not applicable, therefore options for expansion of a geothermal heat supply system is not considered in the baseline determination in the VCS Joint-PD-MR /1/.

Based on above assessment, CTI confirmed that the remaining realistic and credible alternative scenarios for the geothermal heating system are:

- 1 (a) Implementation of the Project activity without the benefits of VCS.

- 3 (i) Coal fired boilers in boiler houses, supplying several buildings through a heat distribution network.

- 3 (ii) Natural gas fired boilers in boiler houses, supplying several buildings through a heat distribution network.

- 4(i) Coal fired boilers for individual buildings.

- 4(iii) Natural gas fired boilers for individual buildings.

- 4(iv) Natural gas fired stoves for individual apartments.

- 4(vi) Oil fired stoves for individual apartments.

Step 1b: Consistency with mandatory laws and regulations

By checking the <Three-year Action Plan to Win the Blue Sky Defense War> /54/ issued by State Council, it is confirmed that new coal fired boilers built for individual buildings are forbidden by the government, therefore, alternative 4(i) is not in compliance with mandatory laws and regulations which should be eliminated.

By checking the relevant Chinese laws and regulations regarding space heating projects include:

1. Environmental Protection Law of the People's Republic of China /55/;

2. Plan for Clean Heating in Winter in Northern China (2017-2021) /42/;

3. Catalogue for the Guidance of Industrial Structure Adjustment (2019 version) /44/;

4. Green Industry Guidance Directory /46/;

5. Technical specification for geothermal space heating engineering /56/

6. Three-year Action Plan to Win the Blue Sky Defense War /54/;

It is confirmed that the remaining alternatives 1(a), 3(i), 3(ii), 4(i), 4(iv), 4(vi) are consistent with all mandatory applicable legal and regulatory requirements.

Outcome of step 1b:

Based on the assessment above, CTI confirms that the alternative scenarios to the project activity that are in compliance with mandatory legislation and regulations are:

- 1 (a) Implementation of the project activity without the benefits of VCS;

- 3 (i) Coal fired boilers in boiler houses, supplying several buildings through a heat distribution network.

- 3 (ii) Natural gas fired boilers in boiler houses, supplying several buildings through a heat distribution network.

- 4(iii) Natural gas fired boilers for individual buildings.

- 4(iv) Natural gas fired stoves for individual apartments.

- 4(vi) Oil fired stoves for individual apartments;

CAR 9 was raised and successfully closed. Refer to Appendix C for detailed assessment.

Step 2: Barrier analysis

According to the applied methodology AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 and TOOL02 Combined tool to identify the baseline scenario and demonstrate additionality, version 07.0, scenarios that face prohibitive barriers should be eliminated by applying this step, the barriers may include:

(a) Technological barriers

(b) Acceptability barriers

(c) Financial barriers

For alternatives: 3 (ii) Natural gas fired boilers in boiler houses, supplying several buildings through a heat distribution network, 4(iii) Natural gas fired boilers for individual buildings and 4(iv) Natural gas fired stoves for individual apartments

Through checking the published article: <Technology Status and Discussion on Challenges of Clean Heating in Northern China>/57/, it is confirmed that laying of natural gas pipeline is relatively complicated, and the cost is high. Once destroyed, it will cause great harm to the surrounding environment, people's life and property safety. Via checking the FSR /16/ and

interview with local officers during site inspection, CTI confirmed that the area where the project is located is not covered by natural gas pipe network. As per para 20.(b-ii) of the CDM Tool02 v07.0, "lack of infrastructure for implementation and logistics for maintenance of the technology (e.g. natural gas cannot be used because of the lack of a gas transmission and distribution network)", it is verified that scenario 3(ii), 4(iii) and 4(iv) faces the technological barriers.

For alternative 4(vi) Oil fired stoves for individual apartments:

Through checking the News on Sohu.net /58/, it is confirmed that the technology of using oil fired stoves for heat supply is mainly used in the industrial field while it is not yet mature for using in residential apartments. Thus, this alternative also faces technological barriers.

For alternative 1(a),

(a) Technological barriers. Via site interview with the project owner, operation staff and checking the Project approval /17/, CTI confirmed that there are skilled and/or properly trained staffs to operate and maintain the geothermal technology and all the skilled technicians have ability to maintain and repair the related equipment. Through checking the training record /34/, it is also verified that the PP provided technical training frequently. Besides, as per the FSR /16/, it is confirmed that there are rich geothermal resources in Lankao district, which ensure the normal operation of the equipment with the perspective of renewable energy supply. Furthermore, via site inspection and based on the expertise of validation and verification team, it is verified that the geothermal heating technology used in the project is relatively mature. Hence, it is confirmed that there is no technology barriers of the alternative 1(a).

(b) Financial barriers other than insufficient financial returns as analysed in Step 3. Via checking the Guidance on Promoting Clean Heating in Northern Areas /43/, it is confirmed that the national government encouraged to use renewable energy such as geothermal resources which is the project scenario. And via checking the company information in National Enterprise Credit Information Publicity System /22/, CTI confirmed that the project owner is financial healthy. Hence CTI confirmed that there are no financial barriers of the alternative 1(a);

(c) Acceptability barriers. Via checking the Renewable Energy Law of China, CTI confirmed that clean heating is promoted by China and geothermal energy is in line with the national policy orientation. And via checking the local stakeholder consultation results /32/ as assessed in 3.3.2, CTI confirmed that the geothermal space heating system is acceptable and welcome to the end-users. Hence, it is confirmed that there are no acceptability barriers of the alternative 1(a).

For alternative 3(i), as it is the mainstream situation in Northern China/80/, there is no technology barriers, acceptability barriers and financial barriers that may prevent this alternative scenario to occur.

Outcome of step 2:

Based on above assessments, it is concluded that both the alternatives 3(ii). 4(ii), 4(iv) and 4(vi) are eliminated due to technological barriers and the two alternatives 1(a) and 3(i) have no technology barriers, acceptability barriers and financial barriers. There are still two alternative scenarios (1(a) and 3(i)) remaining. Therefore, both alternatives come to Step 3 for further assessment.

Step 3: Investment analysis

The purpose of this step is to compare both the alternatives 1 (a) Implementation of the Project activity without the benefits of VCS; and 3 (i) coal fired boilers in the boiler houses, supplying several buildings through a small heat distribution network to determine which one is economic attractive.

The levelized cost of heat (LCOH, RMB/GJ) /49/ is used as a financial indicator in the investment analysis for all alternatives according to the combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0) /6/. Via checking the calculation formula and calculation process of the value of LCOH in the calculation sheet /3/, CTI confirmed that the formula and inputs values are correct and actual by checking the FSR /16/, Heat supply contracts /26/, and relevant research reports /41/, thus CTI verified that the calculation results of the LCOH for both alternatives are correct.

The data for investment analysis are assessed in the below table to calculate LCOH for Project respectively.

Project			
Item	Value		Assessment
	Project	Alternative baseline	
Investment expenditures (10,000 RMB)	56,042.42	9,340.25	The data source of Project value is FSR /16/ which are confirmed by CTI as correct and reasonable. For baseline, the value of investment in boiler house per m^2 has been provided in the FSR /16/ and Research on Heating in Winter of Kaifeng City /41/ and the final value is determined as area size multiply with unit value which is verified as reasonable.
Subsidy	0	0	N/A

O&M Cost (10,000 RMB/year)	1,617.78	1,587.84	The data source of Project value is FSR /16/ and data source of baseline value is FSR Annex, which are confirmed by CTI as correct. For baseline, the value of O&M Cost in boiler house per m^2 has been provided in the FSR /16/ and Research on Heating in Winter of Kaifeng City /41/ and the final value is determined as area size multiply with unit value which is verified as reasonable.
Fuel expenditure (10,000 RMB/year)	0	2,220.58	There is no Fuel expenditure in project scenario as Project doesn't involve fuel-usage during operation. The fuel expenditure in the baseline scenario is obtained by multiplying the coal price by the annual coal consumption. The baseline values of coal price and coal consumption are from FSR /16/ which have been confirmed by CTI as correct. The coal price value from FSR /16/ is from the Research on Heating in Winter of Kaifeng City /41/, which is published by Kaifeng Housing And Urban And Rural Bureau Of Construction. In this research, it is indicated that the coal price is measured based on the heat consumption and fuel prices of winter heating in Henan Province in recent years. In addition, PP has also provided a price list of coal (5,000 kcal) from *Mysteel.com* /65/, a website that provides reference market prices for steel as well as raw materials (e.g., metals, fossil fuels, etc.). Therefore, the value is confirmed by CTI as correct and reasonable. The annual coal consumption value from FSR /16/ is provided in "tce/a", which is verified according to the annual heat supply and the calorific value of standard coal (7,000 kcal) /47/. The annual heat supply in baseline is consistent with the project scenario. Furthermore, in order to align the unit of coal consumption with coal price, the PP has converted the annual consumption of standard coal to raw coal in calculating the baseline LCOH. Therefore, the annual coal consumption value is confirmed by CTI as correct and reasonable.

			For baseline, the final value can also be determined as coal price multiply with coal consumption per day and multiply with days for heating which is verified via checking the heating supply contracts /26/.
Residual value (10,000 RMB)	2,802.12	467.01	The data is from the feasibility study report /16/. residual value can be calculated as: 56,042.42 (10,000 RMB) *5%=2,802.12 (10,000 RMB) The baseline data is from the feasibility study report /16/, residual value can be calculated as: 9,340.25 (10,000 RMB) *5%=467.01(10,000 RMB)
Annual heat supply (GJ)	1,162,076.54	1,162,076.54	The value is calculated based on the Heat supply space and Installation Capacity which has been clearly calculated in the LCOH calculation sheet /3/ which is verified by CTI as correct.
Discount rate	8%	8%	Discount rate is 8% which is derived from FSR /16/, and confirmed in line with Economic Evaluation Method and Parameter of Construction Projects version 03 /40/.
Project lifetime (Years)	20 years	20 years	The lifetime of the Project is defined as 20 years checked from the FSR /16/ and Technical agreement and Operating Instruction of Geothermal Space Heating System /29/.

The levelized cost of provided heat for the proposed Project and the plausible baseline scenarios are calculated respectively, and the results are in following table. By comparing the results, CTI confirmed that the LCOH of 3(i) is the lowest.

Parameter	Project	Alternative baseline for Project
LCOH (RMB/GJ)	71.84	42.42

Furthermore, a sensitivity analysis has been provided in the VCS Joint-PD-MR /1/ and the LCOH calculation sheet /3/. The analysis is assessed as follow,

The sensitivity analysis was demonstrated through two manners:

1. Varying ± 10 % of four critical parameters (Investment expenditures, O&M cost, Total heat supply and Coal price). This selection is checked as in line with the requirements in investment analysis that “variables, including the initial investment cost, that constitute more than 20% of the either total project cost or total project revenue should be subject to reasonable variation”.

the Investment expenditures and total heat supply are checked as constitute more than 20% of total project cost. The total O&M cost throughout the project lifetime is checked as accounts for more than 20% of the project cost. The coal price is checked as accounts for more than 20% of the baseline cost.

Via checking the sensitivity analysis for these three critical parameters as provided in VCS Joint-PD-MR /1/ and the LCOH calculation sheet /3/, CTI verified that the LCOH values for Alternative baseline (3 (i)) are all lower than the proposed project (1 (a)) by varying ±10% of three critical parameters. The situation is correct for Project.

2. Threshold analysis by varying the above three parameters to make the LCOH values for Proposed project (1 (a)) more economical attractive than Alternative baseline (3 (i)). The threshold analysis of each parameter is assessed individually by the validation and verification team as below,

a) If the investment expenditure of Project decreases by 51.43%, the proposed project becomes economical attractive, however, via reviewing the price index of investment in fixed asset for Henan Province, it was confirmed that the price index increased 4.3% in 2020/50/. Therefore, it is not likely to implement the Project activity with the investment expenditure reducing by 51.43% for Project to make the proposed project becomes economical attractive.

b) If the O&M Costs for Project decrease by 211.32%, the LCOH of the project is equal to the LCOH of the baseline. The O&M costs mainly consist of salary for the employees, management fee etc. The average salary keeps increasing annually during the past five years /51/, it is impossible to decrease over 200% for the O&M cost of the Project to make the proposed project becomes economical attractive.

c) If the total heat supply of Project increased by 69.35%, the proposed project becomes financially attractive than alternative 3 (i). However, by checking the FSR of project /16/, the capacity load of the geothermal system is fixed, and the planned heating supply areas are also fixed. There is no possibility for the project geothermal system to supply 69.35% more than Project's installed capacity. Therefore, it is not likely to implement the Project activity with the total heat supply increasing by more than 60% to make the proposed project becomes economical attractive.

d) The proposed project is to introduce geothermal energy-based space heating system to realize heat supply to a series of residential buildings in Lankao County over winter season, which will displace heat supply from isolated coal-fired boilers as a business-as-usual scenario in the project area geothermal. Therefore, the LCOH for the proposed project is not affected by the price of coal.

When the Coal price increased by 153.95%, the LCOH of alternative baseline 3 (i) would be as high as in the proposed project. According to the Notice on Further Improving the Coal Market Price Formation Mechanism published by the National Development and Reform Commission /70/, when coal prices rise significantly or are likely to rise significantly, price intervention

measures will be initiated in a timely manner in accordance with Article 30 of the Chinese Price Law to guide coal prices back to a reasonable range. It can be verified from this Notice that the maximum reasonable coal price is 770 RMB/t, which is a 92.5% increase relative to the coal price for the alternative baseline 3 (i). It is therefore unlikely that the coal price will rise by as much as 153.95%. Thus, alternative baseline 3 (i) still remains more financially attractive.

Besides, from the Feasibility Study Report of the project, as the price of coal rises, the energy supply is getting tighter and tighter. In order to ensure the stability of residents' heating costs, it is urgent to promote the development of clean energy. Although, the LCOH of geothermal energy heating is higher, the proposed project has been developed and constructed due to the stability of residents' heating costs as well as the environmental benefits.

Outcome of Step 3:

The sensitivity analysis further confirms that construction of alternative 3 (i) is the most economically attractive option. Compared with the proposed Project activity undertaken without being registered as a VCS Project activity, construction of new coal fired boilers in boiler houses, supplying several buildings through a small heat distribution network is the lowest cost option and is selected as the most economically attractive alternative.

In conclusion, the investment analysis concludes that the Project activity without VCS benefit is unlikely to be financially attractive based on the assessment above. CTI confirms that the financial unattractiveness of the project is robust and thus the Alternative 3(i) is the most economically attractive option and plausible baseline scenario.

CL 2, CL 3 was raised and successfully closed. Refer to Appendix C for detailed assessment.

3.4.5 Additionality

Regulatory surplus

As per section 3.14.1 of VCS Standard, version 4.5: “The project shall demonstrate regulatory surplus at validation”, the project proponent has stated in the section 3.5 of the joint PD&MR that the project is not mandated by any law, statute, or other regulatory framework in the host country i.e., in China. CTI has checked the relevant laws and regulations regarding minimum energy requirements of new buildings:

(a) Environmental Protection Law of the People's Republic of China /55/ which encourages the production and use of clean energy.

(b) Plan for Clean Heating in Winter in Northern China (2017-2021) /42/ which encourages the use of clean energy for space heating.

(c) Catalogue for the Guidance of Industrial Structure Adjustment /44/, which lists projects in three categories: encouragement category, restriction category and elimination category. The

development of geothermal energy utilization technology belongs to the encouragement category of the Catalogue.

(d) Green Industry Guidance Directory (2019 version) /46/. It demonstrates that the Chinese Government's commitment to the development of renewable energy as part of the overall energy development strategy, and encourages clean heating from renewable sources.

(e) Technical specification for geothermal space heating engineering (CJJ 138-2010) /56/, which stipulates technical requirements for geothermal space heating engineering and it does not mandatory the utilization of geothermal space heating.

it is confirmed that none of the laws nor regulations mandated the application of geothermal space heating projects. Therefore, the regulatory surplus of the proposed project has been sufficiently demonstrated.

By means of comparison of the VCS Joint-PD-MR /1/ with Tool 2 "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 07.0) /6/, the validation and verification team has assessed the additionality demonstration in accordance with applicable methodology and tool.

To demonstrate the additionality, the common practice analyses was conducted.

Common practice analysis

Step 1: calculate applicable capacity or output range as +/-50% of the total design capacity or output of the proposed Project activity

As above, power projects with the heating load between 56.04 MW-168.12 MW for Project are included in the range of similar projects.

Step 2: identify similar projects (both VCS and non-VCS) which fulfil all the following conditions:

(a) The projects are located in the applicable geographical area.

Henan Province is selected as the applicable geographical area for the common practice, and the reasons are detailed as follows:

- Due to the differences of economic development level, population size, industrial structure, fundamental infrastructure, strategic planning etc., the investment environment of each province in China varies widely. All of these factors can affect the final investment decision.

- The unique geological conditions in Henan Province results in the different natural resources, such as geothermal resource, compared to the other provinces in north China that must supply space heating service in wintertime.

- Finally, many key economic factors of space heating projects vary from province to province, including the tariff, the cost of labor and services, and the types of loan that can be obtained. These all vary among different provinces.

In summary, the space heating projects within Henan province are selected for the common practice analysis.

(b) The projects apply the same measure as the proposed Project activity.

Same measure is defined as: Geothermal based space heating system

(c) The projects use the same energy source/fuel and feedstock as the proposed Project activity if a technology switch measure is implemented by the proposed Project activity

Geothermal energy should be used in cascade levels. The heat exchanger medium can be water or air.

(d) The plants in which the projects are implemented produce goods or services with comparable quality, properties and applications areas (e.g. clinker) as the proposed project plant;

The applicable project is to produce heat, same as the project.

(e) The capacity or output of the projects is within the applicable capacity or output range calculated in Step 1;

As defined in Step a, the applicable capacity range is from 56.04 MW-168.12 MW for the proposed project.

(f) The projects started commercial operation before the VCS Joint-PD-MR is published for global stakeholder consultation or before the start date of proposed Project activity, whichever is earlier for the proposed Project activity.

For common practice analysis, the start date should be as per CDM terminology. According to the "Glossary CDM terms", start date is defined that "for the CDM Project activity, where a contract is signed for such expenditures, it is the date on which the contract is signed. In other cases, it is the date on which such expenditures are incurred. If the CDM Project activity or CPA involves more than one of such contracts or incurred expenditures, it is the first of the respective dates." Therefore, the start date of Project is 15/08/2020, which is the Project construction contract between Lankao Green Energy Clean Energy Co., Ltd. and Zhejiang Lute Energy Technology Co., Ltd. /23/.

Therefore, for the Project, the geothermal heating projects with installed capacity 56.04 MW-168.12 MW, have started commercial operation before 15/08/2020 in Henan province are chosen for this analysis. Through searching the following website:

UNFCC website: https://unfccc.int

China CDM website: http://www.cdmcenter.com

China CER exchange info-platform: https://cdm.ccchina.org.cn/

GS website: https://www.goldstandard.org/

VCS website: https://verra.org/

local Local DRC (Development and Reform Commission) of Henan province website: https://fgw.henan.gov.cn/

there are no similar geothermal heating projects with 56.04 MW-168.12 MW which have started commercial operation before 15/08/2020 in Henan province.

Step 3: within the projects identified in Step 2, identify those that are neither registered CDM Project activities, Project activities submitted for registration, nor Project activities undergoing validation and verification. Note their number N_{all}.

As analyzed in Step 2, N_{all}=0

Step 4: within similar projects identified in Step 3, identify those that apply technologies that are different to the technology applied in the proposed Project activity. Note their number N_{diff}=0

In summary, N_{all}=N_{diff}=0

Step 5: calculate factor F=1-Ndiff/Nall representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the measure/technology used in the proposed Project activity that deliver the same output or capacity as the proposed Project activity.

F = 1 - N_{diff}/N_{all} = 0<0.2, $N_{all} - N_{diff} = 0 < 3$

Therefore, the project is NOT a "common practice" within a sector in the applicable geographical area.

In conclusion, the project meets the criteria and tool "Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0) /6/", thus deemed as additional.

3.4.6 Quantification of GHG Emission Reductions and Removals

Via verifying the data in VCS Joint-PD-MR /1/ and checking the applicable version of the methodology, it is confirmed the calculation of ERs /2/ is done as per the applied methodology (AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/ with follow steps listed below.

1. Baseline emissions

The project reduces CO_2 emissions using geothermal heat to replace heat generated from the coal-fired boiler district heating system. As per paragraph 39 of the applied methodology, there are three possibilities for the baseline as follows:

(a) Baseline scenario is identified as a fossil fuel based centralized heat supply system, different than cogeneration, using a single decentralized heat supply fossil fuel technology.

(b) The baseline scenario, is a fossil fuel based decentralized heat supply system with multiple technologies (of type i), the baseline emissions are specified as the summation over the technology suffix i;

(c) The baseline scenario is identified as a combination of the two following alternatives:

(i) Fossil fuel based centralized heat supply systems, different than cogeneration, using a single decentralized heat supply fossil fuel technology (as described in baseline scenario a above); and

(ii) Existing geothermal centralized heat supply systems.

For the project, the baseline scenario is the establishment of new isolated district heating networks using isolated coal-fired boilers in boiler houses. Therefore, it falls into (a) of the above categories, and the baseline emissions BEy in a year y are calculated as:

$$BEy=\sum I\ (HS^{BL}\ i,y)\times EF_{CO2,i}/\eta_{BL,i} \qquad (2)$$

Where:

BEy = The baseline emissions from heat displaced by the Project activity during the year y (tCO_2e/yr).

$EF_{CO2,i}$ = The CO_2 emission factor per unit of energy of the fuel of technology i that would have been used in the baseline heating technology in ($t\ CO_2/TJ$). Where several fuel types are used in the boiler, use the fuel type with the lowest CO_2 emission factor.

$\eta_{BL,I}$ = The net thermal efficiency of the heating technology i using fossil fuel that would have been used in the absence of the Project activity.

$HS^{BL}i,y$ = The net output of heat generated by the baseline heat supply system using the technologyi measured at the end point of the heat facility, during the year y (TJ/yr).

Relationship between the baseline scenario and the Project activity

The relationship between the baseline scenario and the Project activity that the heat demand at the end-use points is the same. For Project activities that involve new heating systems:

$$HS_y\text{-}Loss^{PJ}_y=\sum i\ HS^{BL}_{i,y}\text{-}Loss^{BL}_{i\ y} \qquad (3)$$

Where:

HSy = Net quantity of heat supplied by the geothermal heat resource(s) in the Project activity, during the year y (TJ/yr).

$Loss^{PJ}_y$ = The net distribution losses of the geothermal heat supply system during the year y (TJ/yr).

$Loss^{B}_{Ly}$ = The net distribution losses of the heat supply system, in the absence of Project activity, during the year y (TJ/yr).

Procedure to determine the heat generated by technology i ($HS^{BL}_{i,y}$)

$HS^{BL}_{i,y}=w_i\times(HS_y-Loss^{PJ}_y+Loss^{BL}_y)$ (4)

Where:

$HS^{BL}_{i,y}$ = The net output of heat generated by the baseline heat supply system using the technology i measured at the end point of the heat facility, during the year y (TJ/yr).

w_i = Assign weights for heat generated by technology i. As per section 4.1 of this Report, the baseline scenario of the project is 3(i) "Coal fired boilers in boiler houses, supplying several buildings through a heat distribution network". Only one technology will be used. As per paragraph 51(a)(ii) option 2 Assign weights based on available historical records of AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/, w_i is equal to 1.

HS_y = Net quantity of heat supplied by the geothermal heat resource(s) in the Project activity, during the year y (TJ/yr).

$Loss^{PJ}_y$ = The net distribution losses of the geothermal heat supply system during the year y (TJ/yr).

$Loss^{BL}_y$ = The net distribution losses of the heat supply system, in the absence of Project activity, during the year y (TJ/yr)

The parameters used for calculating baseline emissions can be grouped as ex ante measurement and ex post measurement categories.

Ex ante measurement parameters

(a) $\eta_{BL,i;}$

(b) $EF_{CO2,\ i;}$

(c) $Loss^{BL}_{y.}$

Ex post measurement parameters

(a) HSy;

(b) $Loss^{PJ}$

Step 1: Determine the baseline ex ante parameters of the project

Sub-step 1.a: For each identified technology i, efficiency of the baseline units shall be determined by adopting one of the following criteria:

The net thermal efficiency of the fossil fuel technology i ($\eta_{BL,i}$) remains fixed for the duration of the crediting period.

Project participants will determine $\eta_{BL,i}$ based on historical data of fuel consumption and output energy.

In the case that actual baseline data for a boiler at the Project activity site is not available, the following data can be used (from highest to lowest priority):

(a) Actual measurements of thermal efficiency and adjusted for conservativeness (project participants shall select (and justify) the appropriate conservativeness factor from the Table 3 below). Methods from recognized international standards shall be used to determine thermal efficiency, and uncertainty estimated (as directed in the standard). This uncertainty level shall be used to select the appropriate conservativeness factor from the table. For example, an uncertainty of 40 percent would mean that the project participant must multiply the baseline thermal efficiency by 1.12.

The boilers do not actually exist but would only exist in the assumed baseline scenario. This option is not applicable.

(b) A conservative thermal efficiency based on other boilers in the region, which are similar to that of the boiler on the Project activity site (in terms of age, technology, capacity, etc.). This shall be justified using data and/or published reports. The uncertainty level in this case will be assumed to be greater than 100 percent unless based on assessment of the above data/information an independent expert justifies a lower level of uncertainty. The DOE is to check the credentials of the independent expert at the time of validation and verify that there is no conflict of interest.

Other boilers used by the buildings in Lankao County, Henan province, People's Republic of China were old boilers, but the boilers used in the baseline of the project would be new boilers. The efficiency of old boiler is lower than the efficiency of new boiler. Thus, it is not reasonable to use the measured efficiency (low value) of old boiler instead of the efficiency (high) of new boiler in the calculation of the baseline emission, which is not conservative. This option is not applicable.

(c) The highest efficiency value provided by two or more manufacturers for units with similar specifications.

The Three manufacturers of coal-fired boiler were checked, and the efficiencies of their products were from 75% to 85% /52/. Thus, the highest efficiency value provided by the two manufacturers of 85% were confirmed.

(d) Use the default values from Table 4 of AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/.

As per Table 4 Default baseline efficiency for different boilers of AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/, the value of old coal-fired boiler is 80% and the value of new coal-fired boiler is 85%. To be conservative, the highest value of 85% for new coal-fired boiler is applicable for the project.

In summary, the efficiency of 85% is applied for the project.

Sub-step 1.b: Fossil fuel emission factors for each identified technology i, shall be determined using the following guidelines for data sources

As per Table 5 Data source for fossil fuel emission factors for each identified technology of AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/, Data source (a) and (b) are unavailable. As discussed in section 5.1 of the VCS Joint-PD-MR /1/, the boilers are not actually existing and there is no fuel supplier for the baseline coal-fired boilers. Data source (c) can only be used for liquid fuels. Therefore, data source (d) IPCC default values (87.3 tCO_2/TJ for coking coal) at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol.2 (Energy) of 2006 IPCC Guidelines on National GHG Inventories.

Sub-step 1.c: Baseline Losses ($Loss^{BLi}_{,y}$) for each identified technology i shall be determined using the following guidelines

Option 1: A conservative value of 0% of loss is used as historic information is not available.

Step 2: Determine the baseline ex post parameters of the project

Sub-step 2.a: Estimate net quantity of heat supplied by the geothermal heat resource in the Project activity

The net quantity of heat supplied by the Project activity is estimated based on the heat provided by the geothermal well. It considers flow rates, temperature, and usage time for each geothermal well to be considered by the Project activity.

$$HSy=\min\{H_{CAP},HS_{y,estimated}\} \quad (5)$$

$HSy,_{estimated}$ can be determined by the use of the flow and temperature of water supplied by the substation heat exchanger k to the demand side space heating.

$$HSy,_{estimated}= \sum j \ (Q_{j,d,y}\times T_j\times CF) \quad (6)$$

Where:

$HSy,_{estimated}$ = Estimated quantity of heat supplied by the geothermal heat resource(s) in the Project activity, during the year y (TJ)

$Q_{j,d,y}$ = Heat supplied at the downstream of heat exchanger (upstream of which is connected with water supply from the geothermal well j) (GW). It can be calculated as formula (6).

Tj = Number of hours per year heat utilization at well j.

CF = Conversion factor from GWh to TJ (3.6)

$$Qj,d,y= (FR_{j,d,y}\times\Delta t_{j,d,y}\times 4.18)/3.6 \times 10^{-9} \quad (7)$$

Where:

$FR_{j,d,y}$ = Average flow rate at the downstream of heat exchanger (upstream of which is connected with water supply from the geothermal well j) in year y (kg/hr).

$\Delta t_{j,d,y}$ = Average temperature difference between inlet and outlet temperatures at the downstream of heat exchanger (upstream of which is connected with water supply from the geothermal well j) in year y (°C).

To ensure that the geothermal well is providing the required amount of energy, a cap is defined. The basis to define the cap is from the space heating design, which considers the net heating area, the heating index, the type of construction that will utilize the heat and the time used throughout the year for each construction type.

$$H_{CAP}=(\sum A_m \times HI_m \times T_j) \times CF + Loss^{PJ}_y - H_{ff} \quad (8)$$

Where:

H_{CAP} = The net quantity of heat supplied by the geothermal heat resource(s) in the Project activity, during the year y (TJ).

A_m = Net heating area for construction type m (m^2).

HI_m = Heating index for construction type m (GW/m^2).

T_j = Number of hours per year heat utilization at well j.

CF = Conversion factor from GWh to TJ (3.6).

$Loss^{PJ}_y$ = Heat distribution losses from substation k to space heating areas (To be determined in Sub-step 2.b).

H_{ff} = Heat supplied by fossil fuel boiler, in case a boiler is used to meet the heat demand of network.

$$H_{ff} = FC_{i,j,y} \times NCV_{i,y} \quad (9)$$

Where:

$FC_{i,j,y}$ = The quantity of fuel type i combusted in process j during the year y (mass or volume unit/yr). For proposed project, natural gas was used for peak shaving.

$NCV_{i,y}$ = The weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit)

No fossil fuel boiler is utilized in the project activity and H_{ff} is 0 TJ.

Sub-step 2.b: Project emissions losses ($Loss^{PJ}_y$)

Heat distribution losses will be obtained as the difference between the heat supplied by the geothermal heat source and the aggregated heat demand of the end-use points.

$$Loss^{PJ}_y = HS_y - HD_y \quad (10)$$

Where:

HD_y = Aggregate space heat demand within the area of supplied heat (TJ).

As per the methodology AM0072, v.03.0, if It is not possible to determine HD_y, the heat losses ($Loss^{PJ}_y$) are determined based on heat losses from pipeline, valves, fittings based on maximum of following options:

(a) Design heat losses as provided by manufacturer/supplier of heating network;

(b) Measurement and estimation of surface heat losses (through radiation and convection) by measuring surface temperature (maximum), surface area of pipeline, valves and fittings (use engineering handbooks for calculating surface area of valves and fittings). Follow the recognized engineering handbooks/publications or national or international standards for calculation of surface heat losses.

Option (a) is selected to determine the heat losses.

The manufacturer of the heat network has provided the engineering specifications of the heating project. $Loss^{PJ}_y$ applied 10% of theoretical heat demand required by buildings. The ex-ante value of 10% design heat losses has also been described in the FSR /16/, which has been checked and confirmed by CTI. As the following:

$Loss^{PJ}_y = \sum m\ 10\% \times A_m \times HI_m \times Tj \times CF \times 10^{-9}$ (11)

Step 3: Calculate baseline emissions from heat produced

Baseline emissions from displacement of fossil fuels are calculated as follows:

$BE_y = \sum i\ (HS_{BLi,y} \times EF_{CO2,i} / \eta_{BL,i})$ (12)

2. Project Emissions

Project emissions are calculated taking into consideration fugitive carbon dioxide and methane released from geothermal vents (PE_{FE}), electricity consumption from the use the pumps to extract the geothermal water (PE_{EC}) and fossil fuel used to operate the geothermal facility (PE_{FF})

$PE_y = PE_{FE,y} + PE_{EC,y} + PE_{FF},y$ (13)

Step 1: Calculate project emissions from fugitive emissions resulting from non-condensable gases from the geothermal vents during the year y

The geothermal system of the proposed project is designed to operate by extracting geothermal water at approximately 72°C, which is considered to be a low-temperature system. As per paragraph 84 of AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/, fugitive emissions from low temperature geothermal system are considered negligible. Therefore, $PE_{FE,y}$=0 tCO_2.

Step 2: Calculate project emissions from additional electricity consumption as a result of the Project activity

Project emissions from electricity consumption (PE_{EC}) used to pump geothermal water and operate the geothermal facility shall be calculated using Tool 05 Baseline, Project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0). Electricity consumption from each relevant source should be monitored and summed up to ECy. As per paragraph 16 of Tool 05 (Version 03.0), project emissions from consumption of electricity are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and a factor to account for transmission losses, as follows

$$PE_{EC,y} = \sum j\ EC_{PJ,j,y} \times EF_{EL,j,y} \times (1+TDL_{j,y}) \quad (14)$$

Where:

$PE_{EC,y}$ = Project emissions from electricity consumption in year y (tCO_2/yr).

$EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr).

$EF_{EL,j,y}$ = Emission factor for electricity generation for source j in year y ($t\ CO_2/MWh$).

$TD_{Lj,y}$ = Average technical transmission and distribution losses for providing electricity to source j in year y.

Determination of the emission factor for electricity generation ($EF_{EL,j,y}$)

The electricity consumed by facilities of the geothermal system is sourced from local power grid connected to Centre China Power Grid (CCPG). **Thus, Scenario A: Electricity consumption from the grid** is applied to the project. For project electricity consumption sources, a default value of 20% is used for $TDL_{j,y.}$

The determination of the emission factor for generation is performed as per **Option A1: Calculate the combined margin emission factor of the applicable electricity system** using Tool to calculate the emission factor for an electricity system" (Version 07.0). $EF_{EL,j,y}=EF_{grid,CM,y}$.

Calculation of grid electricity emission factor

The grid electricity emission factor $EF_{grid,CM,y}$ is calculated through the TOOL07: Tool to calculate the emission factor for an electricity system (version 07.0). The following six steps are applied:

Step 1: Identify the relevant electricity systems;

Step 2: Choose whether to include off-grid power plants in the project electricity system (optional);

Step 3: Select a method to determine the operating margin (OM);

Step 4: Calculate the operating margin emission factor according to the selected method;

Step 5: Calculate the build margin (BM) emission factor;

Step 6: Calculate the combined margin (CM) emission factor.

Step 1: Identify the relevant electricity systems

The delineation of the electricity systems in China is provided by the Chinese DNA. As per 2019 baseline emission factors for regional power grids in China, among the six regional power grids, the Central China Power Grid (CCPG), which covers Henan Province, Hubei Province, Hunan Province, Jiangxi Province, Sichuan Province and Chongqing City, is the relevant electricity system as the project located in Henan Province.

Step 2: Choose whether to include off-grid power plants in the project electricity system (optional)

Project participants may choose between the following two options to calculate the operating margin and build margin emission factor:

Option I: Only grid power plants are included in the calculation.

Option II: Both grid power plants and off-grid power plants are included in the calculation.

Considering the structure of China's power system, only grid power plants (**Option I**) are included in the calculation.

Step 3: Select a method to determine the operating margin (OM)

The calculation of the operating margin emission factor $EF_{grid,OM,y}$ is based on one of the following methods:

(a) Simple OM, or

(b) Simple adjusted OM, or

(c) Dispatch data analysis OM, or

(d) Average OM.

In China, detailed data from each power plant are sensitive business information and are mostly confidential and thus not publicly available. Therefore, method (b) and method (c) are not suitable for the calculation.

The simple OM method can be used if low-cost/must-run resources constitute less than 50% of total grid generation in average of the five most recent years. According to China Electric Power Yearbook released from 2014 to 2018, for CCPG to which the project activity is connected, the low-cost/must-run power generation accounted for 39.13%, 45.07%, 47.01%, 49.05% and 49.08% of total grid generation in 2013, 2014, 2015, 2016 and 2017, respectively; considering the average of the five years from 2013 to 2017, the low-cost/must-run power generation accounted for 45.87% of total grid generation, lower than 50%. Therefore, method (a) is applicable, and the simple OM method is applied for the calculation of the operating margin emission factor $EF_{grid,OM,y}$.

For the simple OM, the emissions factor can be calculated using either of the two following data vintages:

(a) Ex ante option: if the ex-ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation. For off-grid power plants, use a single calendar year within the five most recent calendar years prior to the time of submission of the CDM-PDD for validation.

(b) Ex post option: if the ex-post option is chosen, the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year y−1 may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year y−2 may be used. The same data vintage (y, y−1 or y−2) should be used throughout all crediting periods.

Based on the most recent data available at the time of this Joint PD&MR submission, the first option (ex-ante) for the calculation of the OM emission factor is chosen for the project, in line with 2019 baseline emission factors for regional power grids in China published by the Chinese DNA.

Step 4: Calculate the operating margin emission factor according to the selected method;

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost /must-run power plants /units. It may be calculated by one of the two following options:

Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit; or

Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system. Option B can only be used if:

i. The necessary data for Option A is not available; and

ii. Only nuclear and renewable power generation are considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by these sources is known; and

iii. Off-grid power plants are not included in the calculation (i.e. if Option I has been chosen in Step 2)

The data of each power plant serving the system is difficult to obtain. In this case, Option A is not preferred. In addition, according to the China Energy Statistical Yearbook, only nuclear and

renewable power generation are considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by these sources is known; also, off-grid power plants are not included in the calculation, as discussed in Step 2), which justifies the applicability of Option B for the calculation of the OM emission factor.

Therefore, **Option B is chosen to calculate the OM emission factor.**

Under this option, the simple OM emission factor is calculated based on the net electricity supplied to the grid by all power plants serving the system, not including low-cost/must-run power plants/units, and based on the fuel type(s) and total fuel consumption of the project electricity system, as the following equation:

$$EF_{grid,OMsimple,y} = \frac{\sum_i FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_y} \quad (15)$$

$EF_{grid,OMsimple,y}$= Simple operating margin CO_2 emission factor in year y (t CO_2/MWh)

$FC_{i,y}$= Amount of fuel type i consumed in the project electricity system in year y (mass or volume unit)

$NCV_{i,y}$= Net calorific value (energy content) of fuel type i in year y (GJ/mass or volume unit)

$EF_{CO2,i,y}$= CO_2 emission factor of fuel type i in year y (tCO_2/GJ)

EG_y= Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost / must-run power plants/units, in year y (MWh)

i= All fuel types combusted in power sources in the project electricity system in year y

If available, values of $NCV_{i,y}$ and $EF_{CO2,i,y}$ provided by the fuel supplier of the power plants in invoices may be used; otherwise, regional or national average default values may be used. For the Project, the values of $NCV_{i,y}$ for each type of fuel are obtained from China Energy Statistical Yearbook 2018, and the emission factors $EF_{CO2,i,y}$ for each type of fossil fuel come from default values in 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Fuel consumption data and electricity generation data are obtained from China Electric Power Yearbook 2016~2018 and China Energy Statistical Yearbook 2016~2018.

The above simple OM calculation is derived from the notification '2019 Baseline Emission Factors for Regional Power Grids in China' published by China's DNA, which is the only most recent available official statistics at the time of submission for the crediting renewal request.

Therefore, based on the latest data published by China DNA, the Simple OM emission factor $EF_{grid,OMsimple,y}$for the CCPG is 0.8587 tCO_2/MWh.

Step 5: Calculate the build margin (BM) emission factor;

As per Section 6.5 of TOOL07 (version 07.0), in terms of vintage of data, project participants can choose between one of the following two options:

(a) **Option 1** - for the first crediting period, calculate the build margin emission factor ex ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period;

(b) **Option 2** - For the first crediting period, the build margin emission factor shall be updated annually, ex post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex ante, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

In line with 2019 baseline emission factors for regional power grids in China published by the Chinese DNA, **Option 1 is chosen for the project**; the BM emission factor is calculated ex ante for the first crediting period based on the most recent information available on units already built for sample group m at the time of this project description submission.

The sample group of power units m used to calculate the build margin should be determined as per the following procedure, consistent with the data vintage selected above:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-}units}$, in MWh);

(b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEG_{SET\text{-}\geq 20\%}$, in MWh);

(c) From $SET_{5\text{-units}}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample});

Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin. In this case ignore Steps (d), (e) and (f).

(d) Exclude from SET_{sample} the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activities, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises 20% of the annual electricity generation of the proposed project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set ($SET_{sample-CDM}$) the annual electricity generation ($AEG_{SET-sample-CDM}$, in MWh); If the annual electricity generation of that set comprises at least 20% of the annual electricity generation of the proposed project electricity system (i.e. $AEG_{SET-sample-CDM} \geq 0.2 \times AEG_{total}$), then use the sample group $SET_{sample-CDM}$ to calculate the build margin. Ignore steps (e) and (f).

Otherwise:

(e) Include in the sample group $SET_{sample-CDM}$ the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual electricity generation of the proposed project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation);

(f) The sample group of power units m used to calculate the build margin is the resulting set ($SET_{sample- CDM-}$>10yrs).

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad (16)$$

Where :

$EF_{grid,BM,y}$= Build margin CO_2 emission factor in year y (t CO_2/MWh)

$EG_{m,y}$= Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)

$EF_{EL,m,y}$= CO_2 emission factor of power unit m in year y (t CO_2/MWh)

m= Power units included in the build margin

y= Most recent historical year for which electricity generation data is available

Since the data of installed capacities can not be separated to coal fired, oil fired and gas fired currently, BM is calculated with the following steps and formula:

As it is difficult to obtain the detailed data on the power generation, fuel consumption and thermal efficiency of each newly built power unit from public documents, a deviation of TOOL07 is adopted following the clarifications given by the CDM EB concerning the BM emission factor

calculation: adopted following the clarifications given by the CDM EB concerning the BM emission factor calculation:

(1) The CDM EB suggested using the efficiency level of the best technology commercially available in the provincial/regional or national grid of China, as a conservative proxy, for each fuel type in estimating the fuel consumption to estimate the build margin.

(2) The EB agreed the use of capacity additions during last 1 ~ 3 years for estimating the build margin emission factor for grid electricity.

(3) The EB also agreed to use of weights estimated using installed capacity in place of annual electricity generation.

The newly built power plants in the past few years are bundled into "grouped new power plant" according to their construction year, their province and their fuel type. The annual net electricity generation in the year y of each "grouped new power plant" $EG_{m,y}$ is estimated according to their total capacity and the average utilization hours, as the following equation:

$$EG_{m,y} = CAP_m \times H_{m,y} \quad (17)$$

Where :

$EG_{m,y}$= Annual net electricity generation the unit m in year y (MWh)

CAP_m= Installed capacity of the unit m (MW)

$H_{m,y}$= Utilization hour of the unit m in the year y (h), determined according to the average utilization hour of the same type of unit in the same province

y= The most recent year for which the generation data is available. For the calculation of BM in 2019, y=2017

m= grouped new power plant

Since the newly built power plants in the same province (A), in the same year (t) and using the same fuel type (k) are grouped into "a grouped new power plant", CAP_m represents the total installed capacity of fuel type k power plants located in the province A and in the year t:

$$CAP_m = CAP_{A,t,k} \quad (18)$$

Where :

CAP_m= Installed capacity of the unit m (MW), with m representing the specified combination of A, t, and k

$CAP_{A,t,k}$= Total installed capacity of fuel type k power plants located in the province A and in the year t

A= Provinces covered by the CCPG, namely, Henan Province, Hubei Province, Hunan Province, Jiangxi Province, Sichuan Province and Chongqing City

t=Years related to the grouped new power plants, for the 2019 calculation, t represents 2017, 2016, 2015…. Until the aggregated electricity generation of the grouped new power plants reaches 20% of the total electricity generation of the Central China Power Grid

k= Fuel type of the grouped new power plants, including hydro, thermal (coal, gas, oil, waste incineration, other thermal), nuclear, wind, solar and others.

Figure 4.1 shows the procedure to determine the sample group of power units m.

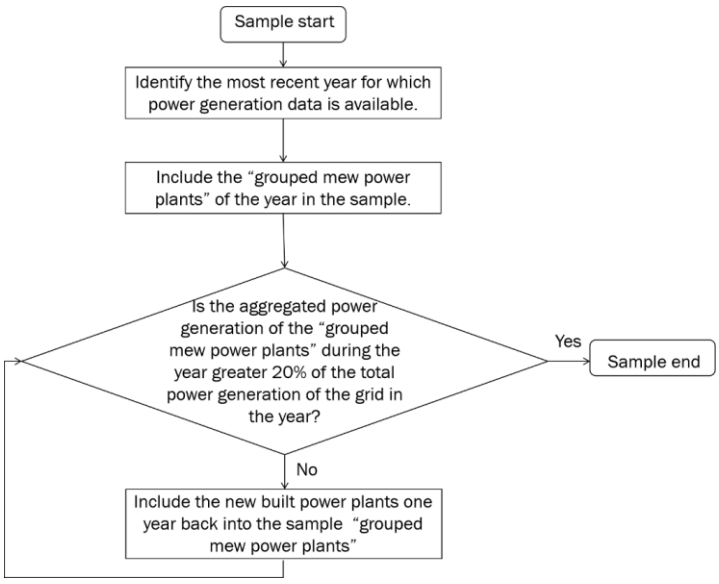


Figure 4.1 Procedure to determine the sample group of power units m

The emission factors of each fuel type $EF_{EL,m,y}$ are determined according to the Option A2 in the TOOL07, as the following equation:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{m,y}} \quad (19)$$

where:

$EF_{EL,m,y}$= CO_2 emission factor of power unit m in year y (t CO_2/MWh)

$EF_{CO2,m,i,y}$= Average CO_2 emission factor of fuel type i used in power unit m in year y (tCO_2/GJ)

$\eta_{m,y}$= Average net energy conversion efficiency of power unit m in year y (ratio)

m= All power units serving the grid in year y except low-cost/must-run power units

3.6= Conversion factor (GJ/MWh)

Among the fuel types, the emission factors of hydro, nuclear, wind, solar, other thermal and others are 0. Concerning the emission factors of coal, gas, oil and waste incineration, the Equation (20) takes the following form due to conservativeness:

$$EF_{best,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{best,y}} \quad (20)$$

where:

$EF_{best,m,y}$ = Emission factor of power unit m with the best technology commercially available in year y (t CO_2/MWh)

$\eta_{best,y}$ = Power generation efficiency of the best technology commercially

m = Power units serving the grid with coal, gas, oil or waste incineration in year y

$EF_{grid,BM,y}$ of the project adopts the calculation results published by the national development and Reform Commission. According to the latest and available data at the time of this PSF submission, $EF_{grid,BM,y}$ =0.2854 tCO_2/MWh.

Step 6: Calculate the combined margin (CM) emission factor.

The combined margin (CM) emission factor $EF_{grid,CM,y}$ of the baseline scenario is calculated as follows:

$EF_{grid,CM,y}=EF_{grid,OM,y} \times \omega om + EF_{grid,BM,y} \times \omega_{BM}$ (21)

Where:

$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year y, tCO_2/MWh. As per 2019 Baseline Emission Factors for Regional Power Grids in China, published by China DNA /62/, $EF_{grid,OM,y}$= of CCPG is 0.8587 tCO_2/MWh.

$EF_{grid,BM,y}$ = Building margin CO_2 emission factor in year y, tCO_2/MWh. As per 2019 Baseline Emission Factors for Regional Power Grids in China, published by China DNA /62/. $EF_{grid,BM,y}$= CCPG is 0.2854 tCO_2/MWh.

ω_{OM} = Weighting of operating margin emissions factor. As per paragraph 86(b) of Tool 07 (Version 07.0), ω_{OM}=0.5 is used for the 1st crediting period.

ω_{BM} = Weighting of build margin emissions factor. As per paragraph 86(b) of Tool 07 (Version 07.0), ω_{BM}=0.5 is used for the 1st crediting period.

Based on formula (13), $EF_{grid,CM,y}$ can be calculated as 0.8587 tCO_2/MWh *0.5+0.2854 tCO_2/MWh *0.5=0.5721tCO_2/MWh.

Step 3: Calculate project emissions from fossil fuel consumed as a direct result of the operations of the Project activity

No fossil fuel will be used to operate the geothermal facilities. Therefore, $PE_{FF,y}$=0 tCO_2.

3. Leakage

No leakage emissions have been identified for the Project activity. Therefore, LE_y=0 tCO_2

4. Emission Reductions

Emission reductions are calculated as follows:

$ER_y=BE_y-PE_y-LE_y$ （22）

Where:

ER_y = Emission reductions in year y (tCO_2e/yr).

BE_y = Baseline emissions in year y (tCO_2e/yr).

PE_y = Project emissions in year y (tCO_2/yr).

LE_y = Leakage emissions in year y (tCO_2/yr)

Based on the formulae and descriptions above, the Ex-ante value and the calculated value of the parameters for Project were shown in the following tables:

Ex-ante value of parameters to calculate BE_y

Parameter	Value	Data sources
$\eta_{BL,i}$	85%	Table 4 AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/
$EF_{CO2,i}$	87.3 tCO_2/TJ	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol.2 (Energy) of 2006 IPCC Guidelines on National GHG Inventories
$Loss^{BL}_y$	0 TJ/yr	Option 1: a conservative value of 0 per cent of losses can be used when historic information is not available.
w_i	1	As per paragraph 51(a)(ii) option 2 Assign weights based on available historical records of *AM0072* (Version 03.0), w_i is equal to 1.
$FR_{j,d,y}$	120 t/hr for Project	Average flow rate at the downstream of heat exchanger is unavailable for ex ante estimation. For ex ante estimation, average flow rate at upstream of heat exchanger (water supply from the geothermal well j) was used. As per *Feasibility Study Report* of the project, the average flow rate of the geothermal well is 120 m^3/h (120,000 kg/h)
$\Delta t_{j,d,y}$	62°C	FSR
T_j	2,880 hr=120*24	Kaifeng City Central Heating Management Measures /63/ and Heat supply contract /26/

CF	3.6	AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/
HI_m	30W/m^2 for Project	FSR
A_m	3.7361 million m^2 for Project	Heat supply contract /26/
$FC_{i,j,y}$	0 for Project	FSR

Ex-ante $HS_{y,estimated}$

Sub-projects	Heat supplied at the downstream of heat exchanger ($Q_{j,d,y}$) (GW)	Estimated quantity of heat supplied by the geothermal heat resource(s) in the Project activity, during the year y ($HS_{y,estimated}$) (TJ)
	$Q_{j,d,y} = (FR_{j,d,y} \times \Delta t_{j,d,y} \times 4.18)/3.6 \times 10^{-9}$	$HS_{y,estimated} = \sum_j (Q_{j,d,y} \times T_j \times CF)$
Project	0.11208 (112.08MW)	1,075

Ex-ante HS_{CAP}

Sub-projects	Heat distribution losses from substation k to space heating areas (TJ)	Heat supplied by fossil fuel boiler (TJ)	The net quantity of heat supplied by the geothermal heat resource(s) in the Project activity, during the year y (TJ)
	$Loss^{PJ}_y = \sum_m 10\% \times A_m \times HI_m \times T_j \times CF \times 10^{-9}$	$H_{ff} = FC_{i,j,y} \times NCV_{i,y}$	$H_{CAP} = (\sum A_m \times HI_m \times T_j) \times CF + Loss^{PJ}_y - H_{ff}$
Project	10%	0	1,278

Ex-ante Baseline Emission

Sub-projects	Net quantity of heat supplied by the geothermal heat resource(s) in the Project activity, during the year y (TJ/yr).	The net output of heat generated by the baseline heat supply system using the technology i measured at the end point of the heat facility, during the year y (TJ/yr).	The baseline emissions from heat displaced by the Project activity during the year y (t CO_2e/yr).

	$HS_y=\min\{H_{CAP},HS_{y,estimated}\}$	$HS^{BL}_{i,y}=w_i\times(HS_y-Loss^{PJ}_y+Loss^{BL}_y)$	$BE_y=\sum_i (HS^{BL}_{i,y}\times EF_{CO2,i}/\eta_{BL,i})$
Project	1,048	931,50	95,670

Ex-ante value of parameters to calculate project emissions

Parameter	Value	Data sources
$EC_{PJ,J,y}$	Project: 25,000MWh	FSR
$EF_{EL,j,y}$	0.5721(tCO_2/MWh)	2019 Baseline Emission Factors for Regional Power Grids in China, published by China DNA
TDLj,y	20%	Tool 05
$FC_{i,j,y}$	Project: 0	FSR

Ex-ante calculate project emission from electricity consumption.

Sub-projects	Project emissions from electricity consumption in year y (tCO_2/yr).
	$PE_{EC,y}=\sum_j EC_{PJ,j,y}\times EF_{EL,j,y}\times(1+TDL_{j,y})$
Project	17,162

Ex-ante calculate project emission form fossil fuel consumption

Sub-projects	The CO_2 emissions from fossil fuel combustion in process j during the year y (tCO_2/yr)
	$PE_{FF}=\sum_l FC_{i,j,y}$ x $COEF_{i,y}$
Project	0

As per equation (18) and the values obtained in the tables above, the estimated annual emission reductions of the project is shown in the following table.

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
15/11/2021~14/11/2022	95,670	17,162	0	78,508
15/11/2022~14/11/2023	95,670	17,162	0	78,508
15/11/2023~14/11/2024	95,670	17,162	0	78,508
15/11/2024~14/11/2025	95,670	17,162	0	78,508
15/11/2025~14/11/2026	95,670	17,162	0	78,508
15/11/2026~14/11/2027	95,670	17,162	0	78,508
15/11/2027~14/11/2028	95,670	17,162	0	78,508
15/11/2028~14/11/2029	95,670	17,162	0	78,508
15/11/2029~14/11/2030	95,670	17,162	0	78,508
15/11/2030~14/11/2031	95,670	17,162	0	78,508
Total	956,700	171,620	0	785,080

Based on the assessment of the ex-ante determined values, it is verified that the annual ex ante determined ERs calculated result is 78,508 tCO_2/yr.

In conclusion, the validation and verification team confirm the following:

- All assumptions and parameters along with their references and sources used for determine the ex-ante of emission reduction, are listed in the VCS Joint-PD-MR (version 03 dated 22/02/2024) /1/,
- All documentation used as the basis for assumptions and source of data is correctly quoted and interpreted in the VCS Joint-PD-MR version 03 dated 22/02/2024 /1/ ;
- All values used for calculating project emission reductions in the VCS Joint-PD-MR (version 03 dated 22/02/2024) are considered reasonable in the context of the Project activity;
- The baseline methodology has been appropriately justified and applied correctly to calculate project emissions, baseline emissions, and leakage;

- All estimates of the baseline, Project and leakage emissions can be replicated using the data and parameter values provided in VCS Joint-PD-MR , which is consistent with the ER calculation sheet /2/.

CTI confirms that the methodology and the referenced tools assessed in section 3.3.2 in this report have been applied correctly to calculate baseline emissions, project emissions, leakage and net GHG emission reductions and removals.

CL 5, CAR 11, CAR 12were raised and successfully closed. Refer to Appendix C for detailed assessment.

3.4.7 Methodology Deviations

There are no any methodology deviations applied to the project.

3.4.8 Monitoring Plan

1. Data and parameters available at validation and verification

Each parameter determined ex-ante only used to calculate the ex-ante emission reduction. These parameters and corresponding assessment are listed in the table below.

Data / Parameter	$EF_{CO2,i}$
Data unit	tCO_2/TJ
Description	CO_2 emission factor per unit of energy of the technology i, that would have been used in the baseline heating technology without the Project activity
Source of data	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol.2 (Energy) of 2006 IPCC Guidelines on National GHG Inventories
Value applied	87.3
Justification of choice of data or description of measurement methods and procedures applied	Values provided by the fuel supplier are unavailable. IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol.2 (Energy) of 2006 IPCC Guidelines on National GHG Inventories are used. For coking coal, it is 87.3 tCO_2/TJ.
Purpose of Data	To calculate baseline emissions
Comments	Where several fuel types are used in the boiler, use the fuel type with the lowest CO_2 emission factor. CO_2 emission factor of other bituminous coal and sub-bituminous coal are 89.5 tCO_2/TJ and 92.8 tCO_2/TJ separately, which are higher than that of coking coal.

	Coking coal and brown coal briquettes have the same CO_2 emission factor. Coking coal is usually used for heating in coal boiler, which was also stated in the Feasibility Study Report (FSR).

Data / Parameter	$\eta_{BL,i}$
Data unit	Dimensionless
Description	Net thermal efficiency of the boiler technology i using fossil fuel that would have been used in the absence of the Project activity
Source of data	Follow the guidance given in the applied methodology AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/.
Value applied	85%
Justification of choice of data or description of measurement methods and procedures applied	The highest efficiency of coal-fired boilers provided by Zozen Boilers (79%), Xinli Boiler (75%-85%), Henan Hengde Boiler (85%) /52/. As per Table 4 Default baseline efficiency for different boilers of AM0072 (Version 03.0), the highest value of 85% for new coal-fired boiler is applicable for the proposed project. In summary, the efficiency of 85% is applied for the proposed project.
Purpose of Data	To calculate baseline emissions
Comments	N/A

Data / Parameter	$Loss^{BL}_{i,y}$
Data unit	TJ/yr
Description	The net distribution losses of the heat supply system, in the absence of Project activity, during the year y
Source of data	Section 5.4.6.3 of AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/.
Value applied	0
Justification of choice of data or description of measurement methods and procedures applied	The historic information is not available, a conservative value of 0% of losses can be used as per paragraph 66 option 1 of AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 /5/.

Purpose of Data	To calculate baseline emissions
Comments	N/A

Data / Parameter	Subscript i
Data unit	-
Description	Type of technology used in the baseline scenario
Source of data	Sourced from Feasibility Study Report of the proposed project
Value applied	-
Justification of choice of data or description of measurement methods and procedures applied	As per section 5.2 of AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0, the most plausible baseline scenario shall be determined through the use of Tool 02 Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0) /6/. Heat supply system using coal-fired boilers is identified as the baseline scenario of the proposed Project activity.
Purpose of Data	To calculate baseline emissions
Comments	Data shall be stored in an excel sheet/database

Data / Parameter	Subscript j
Data unit	-
Description	Geothermal well number.
Source of data	Feasibility Study Report of the proposed project
Value applied	Geothermal wells number j = 1 to 36
Justification of choice of data or description of measurement methods and procedures applied	There are a total of 36 geothermal wells including 12 production pipes and 24 re-injection pipes in the boundary of the proposed Project activity per Feasibility Study Report, which can be identified through unique identification code.
Purpose of Data	To calculate baseline emissions
Comments	Distinct geothermal well with distinct properties of temperature, pressure and flow volume.

Data / Parameter	Subscript m
Data unit	-
Description	Space heating construction type
Source of data	FSR
Value applied	Residential
Justification of choice of data or description of measurement methods and procedures applied	Identified by local urban planners under a short to medium term development plan for the area.
Purpose of Data	To calculate baseline emissions
Comments	Areas designated for space heating under the categories of residential, commercial and industrial space heat

Data / Parameter	Subscript k
Data unit	-
Description	Sub-station number
Source of data	*Feasibility Study Report* of the proposed project
Value applied	Sub-station number k=1 to 17
Justification of choice of data or description of measurement methods and procedures applied	There is a total of 17 sub-stations in the boundary of the proposed Project activity.
Purpose of Data	To calculate baseline emissions
Comments	Includes a heat exchanger as part of the sub-station.

Data / Parameter	w_i
Data unit	-
Description	Heat generation ratio for baseline heating technology i
Source of data	Paragraph 51(a)(ii) option 2 Assign weights based on available historical records of *AM0072* (Version 03.0).

Value applied	1
Justification of choice of data or description of measurement methods and procedures applied	The baseline scenario of the project is 3(i) "Coal fired boilers in boiler houses, supplying several buildings through a heat distribution network". Only one technology would be used. Only one technology would be used. As per paragraph 51(a)(ii) option 2 Assign weights based on available historical records of *AM0072* (Version 03.0), w_i is equal to 1.
Purpose of Data	To calculate baseline emissions
Comments	N/A

Data / Parameter	H_{ff}
Data unit	TJ
Description	Heat supplied by fossil fuel boiler, in case a boiler is used to meet the heat demand of network.
Source of data	On site metering of heat (e.g. flow of steam/hot water multiplied by enthalpy) at the outlet of the boiler.
Value applied	H_{ff}=0 TJ. There are no fossil fuel boilers used to meet the heat demand of the project heating network.
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	To calculate baseline emissions
Comments	Yearly average data to be used

Data / Parameter	$Loss^{PJ}_{y}$
Data unit	TJ/yr
Description	Net distribution loss of the geothermal heat supply system during the year *y*.
Source of data	Calculated based on design heat losses from heat network manufacturer per the methodology.
Value applied	Refer to ER calculation sheet for more details.

Justification of choice of data or description of measurement methods and procedures applied	$Loss^{PJ}_{y} = \sum_{m} 10\% \times A_m \times HI_m \times T_j \times CF \times 10^{-9}$ Where: A_m=Net heating area for construction type *m* HI_m=Heating index for construction type *m* T_j=Hours per hear heat utilization in well *j* *CF*=Conversion factor from GWh to TJ (3.6).
Purpose of Data	To calculate baseline emissions
Comments	N/A

2. Data and parameters monitored

The monitoring parameters required by the methodology and applicable tools for the Project are summarized in the table below.

No.	Parameter	Description and Data Unit	Monitoring procedure
1	$\Delta t_{j,d,y}$	Average temperature difference between inlet and outlet temperatures at the downstream of each heat exchanger in year y. (°C)	Measurement of temperature at inlet and outlet by temperature meters and calculation of the average temperature difference based on these measurements. Measured hourly/Recording monthly Temperature meters are installed at downstream inlet and outlet points of substation heat exchanger. The temperature readings should be taken at immediate inlet and outlet point of the heat exchanger. The temperature should be measured hourly and recorded monthly. The temperature data will be collected by the management system, and the average temperature difference between inlet and outlet will be calculated accordingly. The temperature meters will be checked regularly by the VCS monitoring team to ensure the accuracy. The Ex-ante value 62°C , was confirmed to be

			consistent with that of FSR by validation and verification team.
2	$FR_{j,d,y}$	Average flow rate at the downstream of heat exchanger (upstream of which is connected with water supply from the geothermal well j) in year y (kg/hr)	Average flow rate at the downstream of each heat exchanger will be monitored by Flow Meters, which are installed at the downstream of heat exchanger Data measured hourly/Recording Monthly The Flow Meters will be checked regularly in order to ensure measurements with a low degree of uncertainty. Ex-ante value: 120 m^3/h for Project. The values were confirmed by checking the FSR for Project.
3	T_j	Number of hours per year heat utilization in well j (hours)	The actual number of heating hours will be sourced from operation record /30/ of the geothermal based space heating system. Monthly operation time of the heat exchange system should be exported by the monitoring team at the beginning of the next month. The data will be recorded monthly Time given for the heating service provided will be measured and the date should be cross-checked with Urban-rural development Bureau. Ex ante value applied is 2880 hours, which was confirmed via checking the FSR /16/, Kaifeng City Central Heating Management Measures /63/ and heating supply contract /26/ for Project.
4	HI_m	Heating index for construction type m (W/m^2)	The conservative standard index for construction type m as provide by FSR /16/. The data will be validated by space heating experts at the project site. Applied value 30 W/m^2 for Project were confirmed through checking FSR /16/.

5	Am	Net heating area for construction type m (m^2)	For ex ante estimation, the data is from Feasibility Study Report /16/ of the project. Actual measurements are available from heating supply contracts /26/. The heating area should be updated yearly. The net heating area is subject to change because of the moving of the residents. The data should be recorded every year to ensure the accuracy. The applied values are 3.7361 million m^2 for Project, which were confirmed via checking the heating supply contracts /26/.
6	$EF_{EL,j,y}$	Combined margin emission factor for the grid in year y	tCO_2e/ MWh "2019 Baseline Emission Factors for Regional Power Grids in China" published by DNA of China /62/
7	$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*.	20%
8	$EC_{PJ,j,}$	Electricity consumption for the year y in operating the geothermal heating system (MWh)	Data sourced from the reading of Electric meters. Electricity consumptions of the geothermal heating system are monitored by the electricity meters installed at each heat substation. Measured hourly and recorded monthly Calibration of the electricity meters will be done according to national standard by qualified organizations. Readings will be verified using electricity bill of the geothermal heating system. Value applied is 25,000 MWh for Project, which are confirmed by checking FSR /16/.

3. Monitoring plan

The validation and verification team has checked the monitoring plan described in the VCS Joint-PD-MR against the applied methodology. The monitoring plan in the VCS Joint-PD-MR version 03 dated 22/02/2024 /1/ has been designed to comply with the latest applicable version of the methodology (AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0) /5/.

The validation and verification team evaluated the feasibility and sufficiency of the monitoring plan. The key components of the monitoring plan are as follows.

(A) Monitoring equipment and Installation

Installation and configuration of meters are shown in a diagram in the VCS Joint-PD-MR /1/. To ensure measurements with a low degree of uncertainty, the data metering equipment and gauges will be calibrated and checked by an appropriately qualified third party according to an appropriate national standard. The calibration records will be appropriately maintained and made available for review by VVB.

Figure 1 below shows the diagram of project monitoring system.

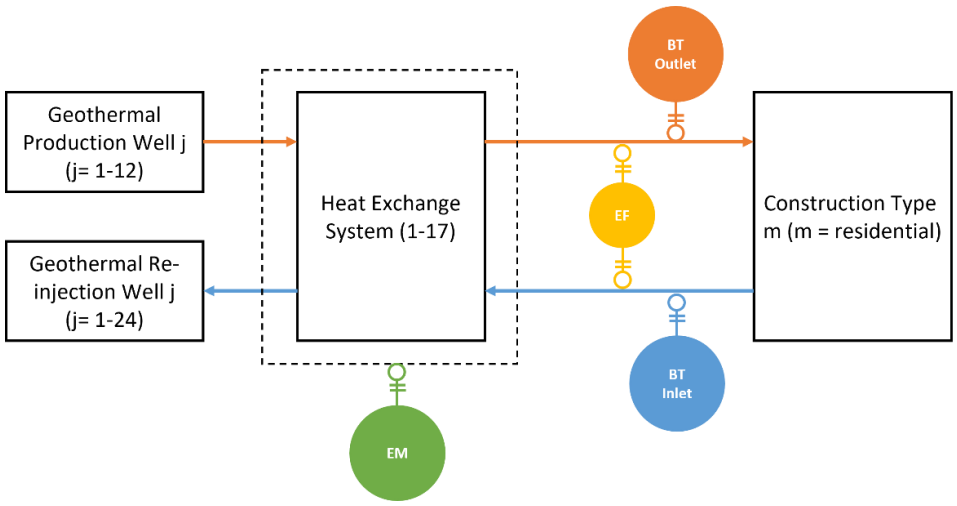


Figure 1. Project monitoring diagram

EM: Electricity meters installed at the State Grid Lankao County Power Supply Company

BT Outlet: Bimetallic thermometer installed at downstream of each heat exchange system to monitor the supply water temperature from the geothermal heating system.

BT Inlet: Bimetallic thermometer installed at downstream of each heat exchange system to monitor the supply water temperature from the end users.

EF: Electromagnetic flowmeter installed at downstream of each heat exchange system to monitor the flow rate.

（B） Management Structure

The monitoring system only need to address the monitoring of parameter $\Delta t_{j,d,y}$, $FR_{j,d,y}$ and $EC_{PJ,j,y}$ (EC_y). The VCS Joint-PD-MR /1/ contains a flowchart illustrating the Organization Structure of the Monitoring Team responsible for data collection, supervision and witness the whole process of data measuring and recording. The VCS monitoring team will be responsible for the monitoring of all the parameters to be monitored. All the data will be reviewed by the project developer and VVB. The Figure 2 below shows the Organization Structure of the Monitoring Team.

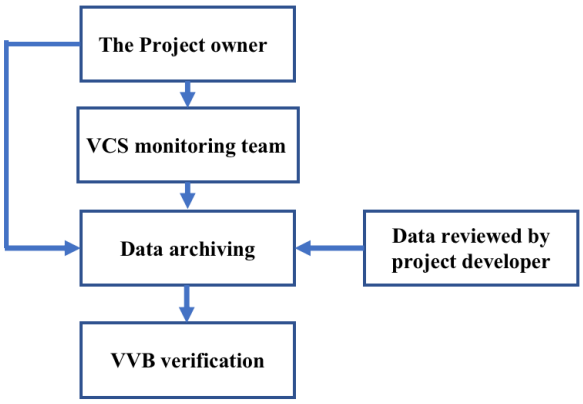


Figure 2. Organization Structure of the Monitoring Team

（C） Data collection

All heat supplied to end-users were measured at each substation k as part of the monitoring plan. For each isolated district heating network connected to a heat exchange station (k), the quantity of heat supplied was measured continuously.

Meters installed in a manner ensures that only the quantity of heat supplied for space heating purposes and supplied by geothermal well j is metered. Besides, the meters shall be installed in a manner that ensures that metering of flow conditions at the heat exchanger be satisfied.

If point of heat measurement is changed or added during the crediting period, this should be documented transparently in the monitoring reports, and the procedure for post registration changes shall be followed.

（D） Quality assurance

A quality management system will be established, which ensures the quality and accuracy of the measured data.

（E） Data file management

All data collected as part of monitoring plan should be saved with at least 1 backup copy until the end of the crediting period. After the crediting period ends, the data should be archived electronically on hard disks and be kept at least 2 years after the end of the last crediting period.

Via checking the monitoring plan in the VCS Joint-PD-MR /1/ as described above, CTI validation and verification team confirms that the monitoring plan contains all necessary parameters which have been clearly described in VCS Joint-PD-MR and that the means of monitoring described in the monitoring plan complies with the requirements of the methodology. A Management Structure of the Monitoring Team is provided in the VCS Joint-PD-MR. The functions such as data collection, aggregation, verification, calculation, archiving, as well as the maintenance of equipment etc. have been defined. Quality assurance and quality control procedures for recording, maintaining and data archiving etc. will be ensured according to Verra rules. The monitoring system equipment will be implementation properly as per relevant standard and regulations. The monitoring data would be cross checked for the purpose of quality control. The project owner will record the readings of the meter monthly. The calibration of the meters will be implemented as per relevant national standards. An emergency treatment process has also been addressed in the VCS Joint-PD-MR version 03 dated 22/02/2024 when the meter is in malfunction.

In conclusion, based on document review, on-site inspection and stakeholder interview, together based on CTI's local and sectoral expertise, CTI confirms that:

-The monitoring plan is in compliance with the requirements of the methodology.

-Monitoring arrangements described in the monitoring plan are feasible within the project design.

-The PP's ability to implement the monitoring plan can be guaranteed.

CAR 13, CAR 14, CAR 15, CAR16 were raised and successfully closed. Refer to Appendix C for detailed assessment.

3.5 Non-Permanence Risk Analysis

N/A

4 VERIFICATION FINDINGS

4.1 Accuracy of GHG Emission Reduction and Removal Calculations

By means of an in-depth review of the Joint-PD-MR and the checks carried out during the on-site visit, an assessment has been carried out whether the project has been implemented and operated in line with the Joint-PD-MR and whether all physical features of the project are in place. The

following has been checked: implemented technology, project equipment as well as monitoring equipment.

The verifier has performed a site visit to check the project plant and equipment and interview with staffs from geothermal heat supply stations and representatives from end users, in addition by all the provided evidence, it is found that the project is implemented with schedules as planned.

The project started construction on 31/08/2020 /23/ which has been confirmed by checking the Project Commencement Report Form /25/, and was put into operation on 15/11/2021 which has been confirmed by checking the operation log /30/ and Project completion acceptance /28/. The factors and parameters used during this monitoring period to arrive at the emission reduction calculations are transparently described in the Joint-PD-MR /1/.

Through the onsite visit, interviewing the project developer and reviewing the project description in JointPD-MR/1/, it was confirmed that the project has signed heating contract, and supplied heating areas (heating season 2021-2022 and heating season 2022-2023), summarized as the following table.

Sub-areas	Heat-Substations	15/11/2021 - 14/11/2022		15/11/2022 - 18/03/2023	
		A_m (m^2) - heating contract	A_m (m^2) – Actual heating areas	A_m (m^2) - heating contract	A_m (m^2) – Actual heating areas
Fenghuangcheng Station	1#FHC	79,200	73,806.45	79,200	73,806.45
	2#FHC	64,000	48,326.53	64,000	48,326.53
	3#FHC	190,000	119,080.78	222,962	136,634.33
	4#FHC	constructing	constructing	constructing	constructing
Gongyuanshoufu Station	1#GYSF	213,000	138,638.65	213,000	138,638.65
Dongfangyujing Station	1#DFYJ	60,700	48,727.06	60,700	48,727.06
	2#DFYJ	58,283	53,330.85	58,283	53,330.85
	3#DFYJ	152,948.18	100,749.96	152,948.18	100,749.96
Donghuyiyuan Station	1#DHYY	126,247	69,662.23	163,345	87,637.42
Qinghuayuan Station	1#QHY	238,881.47	157,747.75	276,380	174,664.59
Xiangxiehuating Station	1#XXHT	226,422	83,921.05	249,998	95,477.43
Hualancheng Station	1#HLC	150,000	64,432.99	360,000	137,039.37
Jiuhaoyuan Station	1#JHY	constructing	constructing	127,061.00	65,439.14

Jinxiuyuan Station	1#JXY	constructing	constructing	constructing	constructing
Tianshenggongguan Station	1#TSGG	constructing	constructing	constructing	constructing
Qianxizhuangyuan Station	1#QXZY	368,231.84	249,371.65	368,231.84	249,371.65
Yehaowanghu Station	1#YHWH	constructing	constructing	143,187.00	59,661.25
Total		1,927,914.8	1,207,795.95	2,539,296.19	1,469,504.68

For the 1st monitoring period from 15/11/2021 to 18/03/2023:

From 15/11/2021 to 21/03/2022, 1,927,914.8 m^2 of residential buildings can access to geothermal energy-based space heating system in winter season.

From 22/03/2022 to 14/11/2022, the project is not implementing heating for the residential buildings.

From 15/11/2022 to 18/03/2023, 2,539,296.19 m^2 of residential buildings can access to geothermal energy-based space heating system in winter season.

During this monitoring period (15/11/2021~18/03/2023), the actual operations were found in accordance with the descriptions provided in the Joint-PD-MR. There is no deviation / change evidenced during this monitoring period and there were no delays compared to information in approved project.

This verification covers the period from 15/11/2021 to 18/03/2023 (including both days). 67,637 tCO_2e emission reductions are claimed as VCUs during this monitoring period.

CAR 16, CAR 17 was raised and successfully closed. Refer to Appendix C for detail assessment.

1. Assessment of Data and parameters available at validation

Via checking the Joint-PD-MR /1/, it is confirmed that all the ex-ante data and parameters are same to the Joint-PD-MR which is verified as correct. Refer to section 3.6.2 for the detail assessment of ex-ante parameters.

2. Assessment of Data and parameters monitored

During the verification all relevant monitoring parameters (as listed in chapter 3.6.2 of this report) have been verified with regard to the

(i) appropriateness of the applied measurement / determination method,

(ii) the correctness of the values applied for ER calculation,

(iii) the accuracy, and applied QA/QC measures.

The monitoring results as well as the verification procedure are described parameter-wise in the below tables,

$\Delta t_{j,d,y}$	Average temperature difference between inlet and outlet temperatures at the downstream of each heat exchanger in year y.
Title in line with Methodology?	Yes
Data unit correctly expressed?	°C
Appropriate description?	Yes
Monitored Value?	15-November-2021 to 21-March-2022 (actual heating period during monitoring period)

Sub-areas	Heat-Substations	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22
Fenghuangcheng Station	1#FHC	7.53	7.33	7.42	8.29	7.77
	2#FHC	7.60	8.23	8.16	8.08	8.58
	3#FHC	8.80	8.31	8.14	7.99	8.28
	4#FHC	constructing				
Gongyuanshoufu Station	1#GYSF	8.68	9.16	8.54	7.71	7.91
Dongfangyujing Station	1#DFYJ	8.93	7.14	7.52	7.46	8.00
	2#DFYJ	7.43	8.00	8.00	8.00	8.00
	3#DFYJ	8.00	8.00	8.04	8.00	8.00
Donghuyiyuan Station	1#DHYY	Constructing	8.30	8.39	7.00	8.60
Qinghuayuan Station	1#QHY	8.44	7.53	8.71	8.04	7.59
Xiangxiehuating Station	1#XXHT	8.38	8.19	7.57	7.73	7.58
Hualancheng Station	1#HLC	8.88	7.81	7.94	8.86	7.81
Jiuhaoyuan Station	1#JHY	constructing				
Jinxiuyuan Station	1#JXY	constructing				
Tianshenggongguan Station	1#TSGG	constructing				
Qianxizhuangyuan Station	1#QXZY	8.39	8.08	7.58	7.21	7.21

	Yehaowanghu Station | 1#YHWH | constructing 22-March-2022 to 14-November-2022 The project is not implementing heating for the residential buildings. 15-November-2022 to 18-March-2023 (actual heating period during monitoring period)

Sub-areas	Heat-Substations	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22
Fenghuangcheng Station	1#FHC	8.87	7.61	7.53	7.97	8.53
	2#FHC	7.63	8.81	8.53	7.57	8.13
	3#FHC	8.41	8.04	8.60	8.20	7.91
	4#FHC	constructing				
Gongyuanshoufu Station	1#GYSF	7.37	8.35	7.49	8.25	8.00
Dongfangyujing Station	1#DFYJ	8.09	8.43	7.53	7.44	8.00
	2#DFYJ	6.00	7.87	8.00	8.00	8.40
	3#DFYJ	7.00	7.93	8.03	8.00	8.00
Donghuyiyuan Station	1#DHYY	8.00	8.68	7.86	8.00	8.81
Qinghuayuan Station	1#QHY	7.69	8.96	7.29	7.96	8.61
Xiangxiehuating Station	1#XXHT	8.06	7.04	7.97	8.00	8.66
Hualancheng Station	1#HLC	7.88	8.87	8.00	7.00	7.67
Jiuhaoyuan Station	1#JHY	constructing		8.00	8.00	9.34
Jinxiuyuan Station	1#JXY	constructing				
Tianshenggongguan Station	1#TSGG	constructing				
Qianxizhuangyuan Station	1#QXZY	8.25	7.28	8.37	7.80	8.97
Yehaowanghu Station	1#YHWH	constructing		8.46	7.22	8.33

Correct value provided?	Yes
Source clearly referenced? (appropriate?)	Yes– Outlet temperature minus inlet temperature at the downstream of each heat exchanger j. All the temperature data are measured by the bimetallic thermometer installed at downstream inlet and outlet points of each heat exchanger
Choice of data correctly justified?	Yes – The measuring and reporting frequency are in line with the monitoring plan and applied tool.
Measurement method and	Yes – Inlet and outlet temperatures at the downstream of each heat exchanger are monitored by the bimetallic thermometer. There are 12 production wells and

<table>
<tr><td>procedures correctly described?</td><td>24 re-injection wells. There are totally 17 sets of heat exchange system. At least 34 bimetallic thermometers are needed to monitor the inlet and outlet temperatures of all the heat exchange system. Refer to Figure 6-2 of the Joint-PD-MR for more details on installation and configuration of the bimetallic thermometer.</td></tr>
<tr><td>Calculation method?</td><td>Average temperature difference between inlet and outlet temperatures at the downstream of each heat exchanger</td></tr>
<tr><td>Monitoring frequency correctly described?</td><td>Measured Hourly/Recording Monthly</td></tr>
<tr><td>Monitoring equipment correctly described?</td><td>The bimetallic thermometer can monitor the inlet and outlet temperature of each heat exchange system continuously and record the temperature data per hour. All the hourly temperature data are exported by the VCS monitoring team to form the monthly record at the beginning of the next month. The average daily inlet and outlet temperature are calculated based on the 24-hourly temperature data separately. The average monthly inlet and outlet temperature are calculated based on all the daily inlet and outlet temperature of this month. Finally, the operation record /30/ of the geothermal heating system during the related heating season are summarized by all the monthly record.</td></tr>
<tr><td>QA/QC procedure correctly described?</td><td>Yes- Calibration of the bimetallic thermometers is done according to national standard (JJF 1664-2017 Calibration Specification for Temperature Indicators) by qualified organizations. All bimetallic thermometers are calibrated before the operation period of the geothermal heating system. Calibration of the bimetallic thermometers during the 1st monitoring period is shown as the following table. If the bimetallic thermometers can be used normally, re-calibration is not required. The calibration interval is 12 months.
<table>
<tr><th>No.</th><th>Serial No.</th><th>Purpose</th><th>Calibration Date</th><th>Calibration interval</th></tr>
<tr><td>1</td><td>HY69531500532</td><td>To monitor supply water temperature of 1#FHC heat exchange system</td><td>1. 2021-10-14
2. 2022-10-14</td><td>12 months</td></tr>
<tr><td>2</td><td>B20110586</td><td>To monitor supply water temperature of 2#FHC heat exchange system</td><td>1. 2021-10-14
2. 2022-10-14</td><td>12 months</td></tr>
<tr><td>3</td><td>18101366</td><td>To monitor supply water temperature of 3#FHC heat exchange system</td><td>1. 2021-10-14
2. 2022-10-14</td><td>12 months</td></tr>
<tr><td>4</td><td>2105340</td><td>To monitor supply water temperature of 3#FHC heat exchange system</td><td>1. 2021-10-14
2. 2022-10-14</td><td>12 months</td></tr>
</table></td></tr>
</table>

5	416240455	To monitor supply water temperature of 1#GYSF heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
6	80306	To monitor supply water temperature of 1# GYSF heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
7	HY69531500710	To monitor supply water temperature of 1#DFYJ heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
8	HY69531108854	To monitor supply water temperature of 2#DFYJ heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
9	HY68561104083	To monitor supply water temperature of 2#DFYJ heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
10	18101350	To monitor supply water temperature of 3#DFYJ heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
11	416240531	To monitor supply water temperature of 1#DHYY heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
12	HY68602808589	To monitor supply water temperature of 1#QHY heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
13	7060-8	To monitor supply water temperature of 1#XXHT heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
14	1020-8	To monitor supply water temperature of 1#XXHT heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
15	4070-6	To monitor supply water temperature of 1#HLC heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months

16	7060-6	To monitor supply water temperature of 1#HLC heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
17	220615480	To monitor supply water temperature of 1#JHY heat exchange system	1. 2022-12-14	12 months
18	220911372	To monitor supply water temperature of 1#JHY heat exchange system	1. 2022-12-14	12 months
19	4006-8	To monitor supply water temperature of 1#QXZY heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
20	A1901987	To monitor supply water temperature of 1#QXZY heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
21	220911388	To monitor supply water temperature of 1#YHWH heat exchange system	1. 2022-12-14	12 months
22	220911347	To monitor supply water temperature of 1#YHWH heat exchange system	1. 2022-12-14	12 months
23	HY69531599065	To monitor return water temperature of 1#FHC heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
24	HY69531501405	To monitor return water temperature of 2#FHC heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
25	18101760	To monitor return water temperature of 3#FHC heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
26	HY69531508387	To monitor return water temperature of 3#FHC heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months

	27	416240435	To monitor return water temperature of 1#GYSF heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	28	416240485	To monitor return water temperature of 1# GYSF heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	29	18101362	To monitor return water temperature of 1#DFYJ heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	30	HY68561105862	To monitor return water temperature of 2#DFYJ heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	31	HY68603106637	To monitor return water temperature of 2#DFYJ heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	32	18101335	To monitor return water temperature of 3#DFYJ heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	33	416240487	To monitor return water temperature of 1#DHYY heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	34	HY68603107913	To monitor return water temperature of 1#QHY heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	35	2060-8	To monitor return water temperature of 1#XXHT heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	36	2060-6	To monitor return water temperature of 1#XXHT heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	37	1070-8	To monitor return water temperature of 1#HLC heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months

	38	7050-8	To monitor return water temperature of 1#HLC heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	39	220730009	To monitor return water temperature of 1#JHY heat exchange system	1. 2022-12-14	12 months
	40	220730019	To monitor return water temperature of 1#JHY heat exchange system	1. 2022-12-14	12 months
	41	4020-6	To monitor return water temperature of 1#QXZY heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	42	A1902001	To monitor return water temperature of 1#QXZY heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	43	220911390	To monitor return water temperature of 1#YHWH heat exchange system	1. 2022-12-14	12 months
	44	220911312	To monitor return water temperature of 1#YHWH heat exchange system	1. 2022-12-14	12 months
Purpose of data?	To calculate baseline emissions				
Comments?	N/A				

$FR_{j,d,y}$	Average flow rate at the downstream of each heat exchanger (upstream of which is connected with water supply from the geothermal well j) in year y.
Title in line with Methodology?	Yes
Data unit correctly expressed?	Yes – Kg/h
Appropriate description?	Yes - Average flow rate at the downstream of each heat exchanger (upstream of which is connected with water supply from the geothermal well j) in year y. Density of the water is 1,000 kg/m^3. Mass flow can be calculated as volume flow rate times density of water.
Monitored Value?	15-November-2021 to 21-March-2022 (actual heating period during monitoring period) Unit: m^3/h

Sub-areas	Heat-Substations	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22
Fenghuangcheng Station	1#FHC	241.99	243.59	243.69	249.19	240.89
	2#FHC	158.45	157.35	159.25	154.85	157.35
	3#FHC	390.44	395.34	392.14	394.04	392.54
	4#FHC	constructing				
Gongyuanshoufu Station	1#GYSF	455.00	452.00	453.60	450.50	454.90
Dongfangyujing Station	1#DFYJ	159.76	158.26	157.66	157.96	158.66
	2#DFYJ	174.86	171.66	178.46	178.56	173.86
	3#DFYJ	330.33	332.63	333.03	333.33	339.23
Donghuyiyuan Station	1#DHYY	constructing	229.51	229.71	228.70	228.70
Qinghuayuan Station	1#QHY	517.22	516.32	512.72	515.72	512.52
Xiangxiehuating Station	1#XXHT	275.16	274.36	271.56	275.56	275.56
Hualancheng Station	1#HLC	211.26	213.56	212.16	215.16	212.66
Jiuhaoyuan Station	1#JHY	constructing				
Jinxiuyuan Station	1#JXY	constructing				
Tianshenggongguan Station	1#TSGG	constructing				
Qianxizhuangyuan Station	1#QXZY	817.63	819.23	816.73	812.73	817.93
Yehaowanghu Station	1#YHWH	constructing				

22-March-2022 to 14-November-2022

The project is not implementing heating for the residential buildings.

15-November-2022 to 18-March-2023 (actual heating period during monitoring period) Unit: m^3/h

Sub-areas	Heat-Substations	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23
Fenghuangcheng Station	1#FHC	243.29	241.99	242.39	245.69	242.39
	2#FHC	154.65	158.45	156.25	158.35	154.55
	3#FHC	449.59	447.99	442.99	447.53	449.29
	4#FHC	constructing				
Gongyuanshoufu Station	1#GYSF	458.46	454.56	456.36	456.36	456.26
Dongfangyujing Station	1#DFYJ	157.86	157.66	159.96	157.26	158.26
	2#DFYJ	177.66	175.46	178.56	176.56	179.26
	3#DFYJ	332.63	333.13	332.13	336.53	333.63
Donghuyiyuan Station	1#DHYY	283.54	286.24	288.64	286.54	288.24
Qinghuayuan Station	1#QHY	575.18	576.18	575.28	573.58	577.38
Xiangxiehuating Station	1#XXHT	316.35	312.15	312.55	317.25	316.25
Hualancheng Station	1#HLC	443.92	448.22	448.22	447.62	452.32
Jiuhaoyuan Station	1#JHY	constructing		216.26	216.26	216.56
Jinxiuyuan Station	1#JXY	constructing				
Tianshenggongguan Station	1#TSGG	constructing				
Qianxizhuangyuan Station	1#QXZY	819.23	816.53	819.33	818.23	819.23
Yehaowanghu Station	1#YHWH	constructing		194.21	196.21	194.81

Correct value provided?	Yes
Source clearly referenced? (appropriate?)	Yes– Electromagnetic Flowmeters
Choice of data correctly justified?	Yes –The measuring and reporting frequency are in line with the monitoring plan and applied methodology.

<table>
<tr><td>Measurement method and procedures correctly described?</td><td>Yes – Readings taken from electromagnetic flowmeters installed at downstream of each heat exchanger. Average flow rate at the downstream of each heat exchanger are monitored by electromagnetic flowmeter.</td></tr>
<tr><td>Calculation method?</td><td>Mass flow can be calculated as volume flow rate times density of water.</td></tr>
<tr><td>Monitoring frequency correctly described?</td><td>Monitored continuously, aggregated at least annually for year x or monthly for month i</td></tr>
<tr><td>Monitoring equipment correctly described?</td><td>The electromagnetic flowmeters can monitor the volume flow rate of each heat exchange system continuously and record it per hour. All the hourly volume flow rate data are exported by the VCS monitoring team to form the monthly record at the beginning of the next month.</td></tr>
<tr><td>QA/QC procedure correctly described?</td><td>Yes – Calibration of the electromagnetic flowmeters is done according to national standard (JJG 257-2007 Verification Regulation of Float Meter) by qualified organizations. All the electromagnetic flowmeters are calibrated before the operation period of the geothermal heating system. Calibration of meters are presented as of following. If the electromagnetic flowmeters can be used normally, re-calibration is not required. The calibration interval is 12 months.
<table>
<tr><th>NO.</th><th>Serial No.</th><th>Purpose</th><th>Calibration Date</th><th>Calibration interval</th></tr>
<tr><td>1</td><td>2011885</td><td>To monitor flow rate of 1#FHC heat exchange system</td><td>1. 2021-10-14
2. 2022-10-14</td><td>12 months</td></tr>
<tr><td>2</td><td>20174847</td><td>To monitor flow rate of 2#FHC heat exchange system</td><td>1. 2021-10-14
2. 2022-10-14</td><td>12 months</td></tr>
<tr><td>3</td><td>20175745</td><td>To monitor flow rate of 3#FHC heat exchange system</td><td>1. 2021-10-14
2. 2022-10-14</td><td>12 months</td></tr>
<tr><td>4</td><td>1511947</td><td>To monitor flow rate of 1#GYSF heat exchange system</td><td>1. 2021-10-14
2. 2022-10-14</td><td>12 months</td></tr>
<tr><td>5</td><td>1513164</td><td>To monitor flow rate of 1#DFYJ heat exchange system</td><td>1. 2021-10-14
2. 2022-10-14</td><td>12 months</td></tr>
<tr><td>6</td><td>1513470</td><td>To monitor flow rate of 2#DFYJ heat exchange system</td><td>1. 2021-10-14
2. 2022-10-14</td><td>12 months</td></tr>
</table></td></tr>
</table>

	7	20172136	To monitor flow rate of 3#DFYJ heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	8	1513565	To monitor flow rate of 1#DHYY heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	9	1513597	To monitor flow rate of 1#QHY heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	10	1513458	To monitor flow rate of 1#XXHT heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	11	1513148	To monitor flow rate of 1#HLC heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	12	1513145	To monitor flow rate of 1#JHY heat exchange system	1. 2022-12-14	12 months
	13	1513165	To monitor flow rate of 1#QXZY heat exchange system	1. 2021-10-14 2. 2022-10-14	12 months
	14	AY202209390	To monitor flow rate of 1#YHWH heat exchange system	1. 2022-12-14	12 months

Purpose of data?	BE, PE calculation
Comments?	The heat exchanger should handle the heat supplied by geothermal well only and not by any other source.

T_j	Hours per heat utilization in well j.
Title in line with Methodology?	Yes
Data unit correctly expressed?	Hours
Appropriate description?	Yes - Hours per hear heat utilization in well j.
Monitored Value?	Yes 15-November-2021 to 21-March-2022 (actual heating period during monitoring period)

Sub-areas	Heat-Substations	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22

Fenghuangcheng Station	1#FHC	360	744	744	672	504
	2#FHC	360	744	744	672	504
	3#FHC	360	720	744	672	504
	4#FHC	constructing				
Gongyuanshoufu Station	1#GYSF	312	720	744	672	504
Dongfangyujing Station	1#DFYJ	336	672	744	672	504
	2#DFYJ	336	672	744	672	504
	3#DFYJ	336	648	744	672	504
Donghuyiyuan Station	1#DHYY	Const ructing	240	744	672	360
Qinghuayuan Station	1#QHY	384	744	672	648	504
Xiangxiehuating Station	1#XXHT	384	744	720	672	480
Hualancheng Station	1#HLC	384	744	744	672	504
Jiuhaoyuan Station	1#JHY	constructing				
Jinxiuyuan Station	1#JXY	constructing				
Tianshenggongguan Station	1#TSGG	constructing				
Qianxizhuangyuan Station	1#QXZY	384	744	744	672	504
Yehaowanghu Station	1#YHWH	constructing				

22-March-2022 to 14-November-2022

The project is not implementing heating for the residential buildings.

15-November-2022 to 18-March-2023 (actual heating period during monitoring period)

Sub-areas	Heat-Substations	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22
Fenghuangcheng Station	1#FHC	384	744	719	672	360
	2#FHC	384	744	719	672	360
	3#FHC	384	744	744	672	360
	4#FHC	constructing				
Gongyuanshoufu Station	1#GYSF	384	744	744	672	360
Dongfangyujing Station	1#DFYJ	384	720	719	648	408
	2#DFYJ	384	720	720	648	408

	3#DFYJ	384	720	720	648	408
Donghuyiyuan Station	1#DHYY	360	744	672	648	384
Qinghuayuan Station	1#QHY	384	744	744	672	432
Xiangxiehuating Station	1#XXHT	384	744	744	672	432
Hualancheng Station	1#HLC	384	744	744	672	432
Jiuhaoyuan Station	1#JHY	constructing		432	672	432
Jinxiuyuan Station	1#JXY	constructing				
Tianshenggongguan Station	1#TSGG	constructing				
Qianxizhuangyuan Station	1#QXZY	384	744	744	672	432
Yehaowanghu Station	1#YHWH	constructing		312	672	432

Correct value provided?	Yes
Source clearly referenced? (appropriate?)	Operation record /30/ of the geothermal based space heating system
Choice of data correctly justified?	Yes. The actual number of heating hours are sourced from the statistical data of the geothermal base space heating system. As per Kaifeng City Central Heating Management Measures /63/ published by Kaifeng City Urban Administration, winter heating season of Kaifeng City is usually from November 15 to March 31 of the next year (120 days). Therefore, T_j can be calculated as 120*24=2,880 h.
Measurement method and procedures correctly described?	Yes
Calculation method?	-
Monitoring frequency correctly described?	Monthly
Monitoring equipment correctly described?	N/A
QA/QC procedure correctly described?	Time given for heating services provided will be measured. The measured data shall be cross-checked against the news published on the portal of the People's Government of Henan Province. /64/

Purpose of data?	BE calculation
Comments?	N/A

A_m	Net heating area for construction type m.
Title in line with Methodology?	Yes
Data unit correctly expressed?	m^2
Appropriate description?	Yes
Monitored Value?	Yes

15-November-2021 to 21-March-2022 (actual heating period during monitoring period)

Sub-areas	Heat-Substations	Residential
Fenghuangcheng Station	1#FHC	73806.45
	2#FHC	48326.53
	3#FHC	119080.78
	4#FHC	constructing
Gongyuanshoufu Station	1#GYSF	138638.65
Dongfangyujing Station	1#DFYJ	48727.06
	2#DFYJ	53330.85
	3#DFYJ	100749.96
Donghuyiyuan Station	1#DHYY	69662.23
Qinghuayuan Station	1#QHY	157747.75
Xiangxiehuating Station	1#XXHT	83921.05
Hualancheng Station	1#HLC	64432.99
Jiuhaoyuan Station	1#JHY	constructing
Jinxiuyuan Station	1#JXY	constructing
Tianshenggongguan Station	1#TSGG	constructing
Qianxizhuangyuan Station	1#QXZY	249371.65
Yehaowanghu Station	1#YHWH	constructing
Total		1,207,795.95

22-March-2022 to 14-November-2022

The project is not implementing heating for the residential buildings.

15-November-2022 to 18-March-2023 (actual heating period during monitoring period)

Sub-areas	Heat-Substations	Residential
Fenghuangcheng Station	1#FHC	73806.45
	2#FHC	48326.53
	3#FHC	136634.33
	4#FHC	constructing
Gongyuanshoufu Station	1#GYSF	138638.65
Dongfangyujing Station	1#DFYJ	48727.06
	2#DFYJ	53330.85
	3#DFYJ	100749.96
Donghuyiyuan Station	1#DHYY	87637.42
Qinghuayuan Station	1#QHY	174664.59
Xiangxiehuating Station	1#XXHT	95477.43
Hualancheng Station	1#HLC	137039.37
Jiuhaoyuan Station	1#JHY	65439.14
Jinxiuyuan Station	1#JXY	constructing
Tianshenggongguan Station	1#TSGG	constructing
Qianxizhuangyuan Station	1#QXZY	249371.65
Yehaowanghu Station	1#YHWH	59661.25
Total		1,469,504.68

Correct value provided?	Yes
Source clearly referenced? (appropriate?)	Yes– Value derived from heating supply contracts/26/.
Choice of data correctly justified?	Yes
Measurement method and procedures	Yes – Yearly measurement. Sum of area of each district for heat supplied.

correctly described?	
Calculation method?	N/A
Monitoring frequency correctly described?	Yearly
Monitoring equipment correctly described?	N/A
QA/QC procedure correctly described?	The data shall be cross-checked with Certificate of Enterprise Investment Project in Henan Province issued by Lankao Development and Reform Commission and the heating supply contracts between the project owner and communities.
Purpose of data?	BE calculation
Comments?	N/A

$EC_{PJ,j,y}$ (EC_y)	Electricity consumption for the year y in operating the geothermal heating system.
Title in line with Methodology?	Yes
Data unit correctly expressed?	Yes – MWh
Appropriate description?	Yes - Electricity consumption for the year *y* in operating the geothermal heating system.
Monitored Value?	Yes 15-November-2021 to 21-March-2022 (actual heating period during monitoring period)

<table>
<tr><th>Sub-areas</th><th>Heat-Substations</th><th>Nov-21</th><th>Dec-21</th><th>Jan-22</th><th>Feb-22</th><th>Mar-22</th></tr>
<tr><td rowspan="4">Fenghuangcheng Station</td><td>1#FHC</td><td rowspan="2">132.60</td><td rowspan="2">234.48</td><td rowspan="2">254.24</td><td rowspan="2">234.36</td><td rowspan="2">155.20</td></tr>
<tr><td>2#FHC</td></tr>
<tr><td>3#FHC</td><td>142.88</td><td>239.06</td><td>279.87</td><td>259.41</td><td>160.05</td></tr>
<tr><td>4#FHC</td><td colspan="5">constructing</td></tr>
<tr><td>Gongyuanshoufu Station</td><td>1#GYSF</td><td>61.83</td><td>125.97</td><td>211.77</td><td>304.77</td><td>103.74</td></tr>
<tr><td>Dongfangyujing Station</td><td>1#DFYJ</td><td>96.69</td><td>190.67</td><td>208.18</td><td>190.93</td><td>76.75</td></tr>
</table>

	2#DFYJ	16.95	22.71	21.75	21.27	14.94
	3#DFYJ	36.09	44.85	52.98	40.11	30.51
Donghuyiyuan Station	1#DHYY	constructing	23.33	72.29	71.09	60.98
Qinghuayuan Station	1#QHY	101.12	162.92	193.42	209.66	129.58
Xiangxiehuating Station	1#XXHT					
Hualancheng Station	1#HLC	31.20	73.04	80.98	72.54	43.40
Jiuhaoyuan Station	1#JHY	constructing				
Jinxiuyuan Station	1#JXY	constructing				
Tianshenggongguan Station	1#TSGG	constructing				
Qianxizhuangyuan Station	1#QXZY	201.81	428.77	470.06	436.00	110.75
Yehaowanghu Station	1#YHWH	constructing				

22-March-2022 to 14-November-2022

The project is not implementing heating for the residential buildings.

15-November-2022 to 18-March-2023 (actual heating period during monitoring period)

Sub-areas	Heat-Substations	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23
Fenghuangcheng Station	1#FHC	69.64	139.68	150.96	125.72	67.84
	2#FHC					
	3#FHC	100.79	320.40	311.81	231.53	57.42
	4#FHC	constructing				
Gongyuanshoufu Station	1#GYSF	95.91	158.52	151.38	134.85	66.93
Dongfangyujing Station	1#DFYJ	115.23	189.53	183.82	152.96	44.38
	2#DFYJ	17.82	22.41	21.75	19.29	11.34

	3#DFYJ	33.27	140.91	259.65	72.60	24.39
Donghuyiyuan Station	1#DHYY	59.62	99.60	111.60	99.17	41.09
Qinghuayuan Station	1#QHY	153.18	542.70	541.16	418.80	124.16
Xiangxiehuating Station	1#XXHT					
Hualancheng Station	1#HLC	61.94	109.58	114.24	104.28	53.96
Jiuhaoyuan Station	1#JHY	constructing		50.02	39.47	23.69
Jinxiuyuan Station	1#JXY	constructing				
Tianshenggongguan Station	1#TSGG	constructing				
Qianxizhuangyuan Station	1#QXZY	258.33	483.85	544.23	393.07	93.44
Yehaowanghu Station	1#YHWH	constructing				

Date	$EC_{PJ,j,y}$ (EC_y)
15/11/2021 – 30/11/2021	821.17
01/12/2021 – 31/12/2021	1,545.79
01/01/2022 – 31/01/2022	1,845.54
01/02/2022 – 28/02/2022	1,840.14
01/03/2022 – 21/03/2022	885.90
15/11/2021 –21/03/2022	**6,977.53**
15/11/2022 – 30/11/2022	965.72
01/12/2022 – 31/12/2022	2,207.18
01/01/2023 – 31/01/2023	2,440.61
01/02/2023 – 28/02/2023	1,791.73
01/03/2023 – 18/03/2023	608.63
15/11/2022 –18/03/2023	**8,013.87**
Total	**14,991.40**

<table>
<tr><td>Correct value provided?</td><td>Yes</td></tr>
<tr><td>Source clearly referenced? (appropriate?)</td><td>Yes– At the end of each heating month, the VCS monitoring team records readings of the electricity meters, which can calculate the electricity consumption of this month by minus last month’s base number of meters. The operation record /30/ of the geothermal heating system during the related heating season were summarized by all the monthly record.</td></tr>
<tr><td>Choice of data correctly justified?</td><td>Yes – Electricity settlement agreement was signed between the state Grid Lankao County Power Supply Company and the Project Owner. At the end of each heating month, the state Grid Lankao County Power Supply Company prepares electricity bill to the project owner for confirmation, which contains the user number, the user’s name, the address of electricity consumption, the total monthly electricity consumption, the total monthly electricity cost and meter reading record.</td></tr>
<tr><td>Measurement method and procedures correctly described?</td><td>Yes –Before test run of the whole geothermal space heating system, base number of the electricity meters are recorded by the staff of the State Grid Lankao County Power Supply Company and VCS monitoring team under the supervision of the representative of each sub-area. At the end of each heating month, the VCS monitoring team records readings of the electricity meters, which can calculate the electricity consumption of this month by minus last month’s base number of meters.</td></tr>
<tr><td>Calculation method?</td><td>Yes –At the end of each heating month, the VCS monitoring team records readings of the electricity meters, which can calculate the electricity consumption of this month by minus last month’s base number of meters.</td></tr>
<tr><td>Monitoring frequency correctly described?</td><td>Measured Hourly/Recording Monthly</td></tr>
<tr><td>Monitoring equipment correctly described?</td><td>Serial No. of the electricity meters are:
<table>
<tr><th>Sub-areas</th><th>Heat-Substations</th><th>User number</th><th>Serial No.</th></tr>
<tr><td rowspan="3">Fenghuangcheng Station</td><td>1#FHC</td><td rowspan="2">5156891478</td><td rowspan="2">41300010000005482419 39</td></tr>
<tr><td>2#FHC</td></tr>
<tr><td>3#FHC</td><td>5171423708</td><td>41300010000005482403 21</td></tr>
<tr><td></td><td>4#FHC</td><td colspan="2">Constructing</td></tr>
</table></td></tr>
</table>

	Gongyuanshoufu Station	1#GYSF	5163472334	41300010000003207919 97
	Dongfangyujing Station	1#DFYJ	5199700090 5222826650	41300010000003194567 53 41300010000004292272 74
		2#DFYJ	-	201291014517
		3#DFYJ	5194569920	41300010000003195025 66
	Donghuyiyuan Station	1#DHYY	5156750289	41300010000005482446 64
	Qinghuayuan Station	1#QHY	5194569597	41300010007000000673 28
	Xiangxiehuating Station	1#XXHT		
	Hualancheng Station	1#HLC	5216416065	41300010000003207949 67
	Jiuhaoyuan Station	1#JHY	5275416639	41300010000001940279 70
	Jinxiuyuan Station	1#JXY	Constructing	
	Tianshenggongguan Station	1#TSGG	Constructing	
	Qianxizhuangyuan Station	1#QXZY	5197228868	41300010000003194894 23
	Yehaowanghu Station	1#YHWH	5223570844	41300010000004615727 76
QA/QC procedure correctly described?	Yes - Calibration of the electricity meters installed at the State Grid Lankao County Power Supply Company is done by the Power Supply Company. State Grid Company is a wholly state-owned company directly managed by the central government. These meters owned by the State Grid Lankao County Power Supply Company are calibrated according to national standard (*JJG596-2012 Verification Regulation of Electrical Meters for Measuring Alternating-current Electrical Energy*)/74/. These electricity meters are calibrated before the operation period of the geothermal heating system. The calibration records of these meters are provided by the State Grid Lankao County Power Supply Company and have been checked, the calibration information is shown in the following table. If the meters can be used normally, re-calibration is not required. The validity is 5 years.			

Calibration of the three-phase four-wire electricity meter installed at the 2#DFYJ heat substation is done by the project owner.

The three-phase four-wire electricity meter installed at the 2#DFYJ heat substation is checked regularly for potentially performance-reducing anomalies by the VCS monitoring team. The accuracy level of the electricity meter is 2.0.

Calibration of the three-phase four-wire electricity meter is done according to national standard *(JJG596-2012 Verification Regulation of Electrical Meters for Measuring Alternating-current Electrical Energy)* by qualified organizations as confirmed through checking the calibration report. The three-phase four-wire electricity meter is calibrated before the operation period of the geothermal heating system. Calibration of the three-phase four-wire electricity meter during the 1st monitoring period is shown as the following table. If the three-phase four-wire electricity meter can be used normally, re-calibration is not required. The validity is 12 months.

NO.	Serial No.	Heat-Substations	Calibration Date	Term of Validity
1	41300010000005482419 39	1#FHC/2#FHC heat substation	2021-10-11	2026-10-10
2	41300010000005482403 21	3#FHC heat substation	2021-10-11	2026-10-10
3	41300010000003207919 97	1#GYSF heat substation	2021-10-11	2026-10-10
4	41300010000003194567 53	1#DFYJ heat substation	2021-10-11	2026-10-10
5	41300010000004292272 74		2021-10-11	2026-10-10
6	201291014517	2#DFYJ heat substation	1. 2021-10-14 2. 2022-10-14	1. 2022-10-13 2. 2023-10-13
7	41300010000003195025 66	3#DFYJ heat substation	2021-10-11	2026-10-10
8	41300010000005482446 64	1#DHYY heat substation	2021-10-12	2026-10-11
9	41300010007000000673 28	1#QHY/1#XXHT heat substation	2021-10-12	2026-10-11
10	41300010000003207949 67	1#HLC heat substation	2021-10-12	2026-10-11

	11	41300010000001940279 70	1#JHY heat substation	2022-12-12	2027-10-11
	12	41300010000003194894 23	1#QXZY/1#YHWH heat substation	2021-10-12	2026-10-11
	13	41300010000004615727 76		2021-10-12	2026-10-11
Purpose of data?	PE calculation				
Comments?	-				

HI_m	Heating index for construction type m.
Title in line with Methodology?	Yes
Data unit correctly expressed?	W/m^2
Appropriate description?	Yes
Monitored Value?	30 W/m^2 for residential buildings.
Correct value provided?	Yes
Source clearly referenced? (appropriate?)	Yes - The conservative standard index for construction type m as provided by Feasibility Report of the project
Choice of data correctly justified?	Yes
Measurement method and procedures correctly described?	N/A
Calculation method?	N/A
Monitoring frequency correctly described?	N/A
Monitoring equipment correctly described?	N/A
QA/QC procedure correctly described?	Yes - As per feedback from the space heating experts at the project site, heating index of the Lankao geothermal heating system is 30 W/m^2 for residential buildings, which is comply with the requirement of *DBJ411 062 – 2012 Henan Province design standard for energy efficiency of residential buildings (cold zone)* published by Henan Housing and Urban-Rural Construction Development.
Purpose of data?	BE calculation
Comments?	N/A

$EF_{EF,j,y}$	Combined margin emission factor for the grid in year y.
Title in line with Methodology?	Yes
Data unit correctly expressed?	tCO_2/MWh
Appropriate description?	Yes

Monitored Value?	0.5721 (=0.8587*0.5+0.2854*0.5)
Correct value provided?	Yes
Source clearly referenced? (appropriate?)	Yes– Value is derived from "Baseline Emission Factors of China's Regional Power Grid for Emission Reduction Projects" which is relevant to CCPG published by the Ministry of Ecology and Environment of China, which is the DNA of China
Choice of data correctly justified?	Yes - the measuring and reporting frequency are in line with the monitoring plan and applied tool
Measurement method and procedures correctly described?	Yes – value is derived from "2019 Emission Factors of China's Regional Power Grid Baseline for Emission Reduction Projects" published by the Ministry of Ecology and Environment of China latest.
Calculation method?	N/A
Monitoring frequency correctly described?	Value will change once the latest data is published, the value has derived from the published latest data for this monitoring period
Monitoring equipment correctly described?	N/A
QA/QC procedure correctly described?	N/A
Purpose of data?	PE calculation
Comments?	-

$TDL_{j,y}$	Average technical transmission and distribution losses for providing electricity to source j in year y.
Title in line with Methodology?	Yes
Data unit correctly expressed?	%
Appropriate description?	Yes
Monitored Value?	20
Correct value provided?	Yes
Source clearly referenced? (appropriate?)	Yes– Value is derived from Tool 05 "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0)/8/
Choice of data correctly justified?	Yes - the measuring and reporting frequency are in line with the monitoring plan and applied tool/8/
Measurement method and procedures correctly described?	Yes –As per the tool to calculate the Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0)/8/, CTI confirmed that different values applied to different scenarios. For the project, the electricity consumption was derived from the power grid. Hence, scenario A: Electricity consumption from the grid is applied to this situation. For this situation, a default value of 20% is used for $TDL_{j,y}$ in line with the tool/8/ and it is confirmed that this

	value is the maximum value as per Methodology tool 05 Version 03.0 and conservative. Via checking the Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0)/8/, CTI confirmed that the data in MR is correct.
Calculation method?	N/A
Monitoring frequency correctly described?	Changed once the tool is updated.
Monitoring equipment correctly described?	N/A
QA/QC procedure correctly described?	N/A, as the value is derived from tool.
Purpose of data?	PE calculation
Comments?	-

CAR 16 were raised. Refer to Appendix C for detail assessment.

3. Assessment of GHG emission reductions Quantity

Calculation of project GHG emissions or actual net GHG removals by sinks

According to the methodology, the project emissions are calculated using the following formula:

$$PE_y = PE_{FE,y} + PE_{EC,y} + PE_{FF,y}$$

Project emissions are calculated taking into consideration fugitive carbon dioxide and methane released from geothermal vents (PE_{FE}), electricity consumption from the use the pumps to extract the geothermal water (PE_{EC}) and fossil fuel used to operate the geothermal facility (PE_{FF}).

1: As per paragraph 84 of AM0072 (Version 03.0), fugitive emissions from low temperature geothermal system is considered negligible. Therefore, $PE_{FE,y}$=0 tCO_2.

2: As per paragraph 16 of Tool 05 (Version 03.0), project emissions from consumption of electricity are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and a factor to account for transmission losses, as follows:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1+TDL_{j,y})$$

Where:

$PE_{EC,y}$	=	Project emissions from electricity consumption in year y (t CO_2/yr).
$EC_{PJ,j,y}$	=	Quantity of electricity consumed by the project electricity consumption source *j* in year y (MWh/yr).

$EF_{EL,j,y}$ = Emission factor for electricity generation for source *j* in year y (t CO_2/MWh).

$TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source *j* in year *y*.

It was confirmed that $EC_{PJ,j,y}$ for the period of 15/11/2021~14/11/2022 is 6,938.53MWh; while for the period of 15/11/2022~18/03/2023 is 8,013.87 MWh.

3: No fossil fuel was used to operate the geothermal facilities. Therefore, $PE_{FF,y}$=0 tCO_2

So Project Emissions during this monitoring period is calculated as below table.

Date	$PE_{FE,y}$ (tCO_2e)	$PE_{EC,y}$ (tCO_2e)	$PE_{FF,y}$ (tCO_2e)	PE_y (tCO_2e)
15/11/2021~14/11/2022	0	4,766	0	4,766
15/11/2022~18/03/2023	0	5,503	0	5,503
Total (15/11/2021~18/03/2023)	0	10,269.00	0	10,269

Calculation of leakage GHG emissions

According to the methodology and above assessment, no leakage emissions associated the project activity. So, LE_y = 0 tCO_2e.

Summary of calculation of GHG emission reductions or net anthropogenic GHG removals by sinks

The VVB has checked the Joint-PD-MR includes a summary table of the emission reductions calculation.

Summary of emission reductions during the monitoring period,

$ER_y = BE_y – (PE_y + LE_y)$

Hence, the emission reductions during this monitoring period from 2020 to 2022 are summarized in the table below

Parameters / Period	Baseline Emissions BE_y	Project Emissions PE_y	Leakage Emissions LE_y	Net GHG emission reductions or removals ER
	(tCO_2e)	(tCO_2e)	(tCO_2e)	(tCO_2e)
15/11/2021~14/11/2022	35,862	4,766	0	31,096
15/11/2022~18/03/2023	42,044	5,503	0	36,541
Total (15/11/2021~18/03/2023)	**77,906**	**10,269**	**0**	**67,637**

All the figures as per the monitoring report were cross-checked by the VVB against basic monitored data. In conclusion, the calculations of project GHG emissions have been carried out in

accordance with the formulae and methods described in the registered monitoring plan, the applied methodology and, where applicable, the applied standardized project. Any assumptions used in emission calculations have been justified. No errors, miscalculations, omissions, misstatements or incomplete information has been identified. It can be confirmed that the project calculation is overall correct.

4.2 Quality of Evidence to Determine GHG Emission Reductions and Removals

For each reported data, the evidence is provided and verified as sufficient and quality is appropriate. Also, the cross-checks have been performed on the reported data with different source of evidence. The information flow from data generation and aggregation, to recording, calculation and final transposition into the monitoring report has been assessed by VVB in section 4.1 for each parameter and also the calibration have been conducted as per the frequency of monitoring equipment defined in the JPM.

Therefore, it is concluded that the evidence provided are verified as sufficient and quality is appropriate and thus the evidence can be used to determine the GHG emission reductions and removals for this monitoring period.

5 VALIDATION AND VERIFICATION OPINION

CTI has been engaged by Hangzhou Chaoteng Energy Technology Co., Ltd. to perform the validation of Lankao Geothermal Based Space Heating System.

The management of the project proponent is responsible for the preparation of the GHG emissions data and the estimated GHG emissions reductions on the basis set out within the project's Monitoring Plan in the VCS Joint-PD-MR and the approved methodology AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0.

Our Validation approach was based on the requirements as defined under the Kyoto Protocol, Marrakesh accord, as well as those defined by the CDM Executive Board and VERRA. Our approach is risk-based, drawing on an understanding of the risks associated with estimated GHG emissions data and the controls in place to mitigate these.

A risk-based approach has been followed to perform this validation activity. The review of the project description and additional documents related to baseline and monitoring methodology; the subsequent background investigation, follow-up interviews with Project Owner have provided CTI with sufficient evidence for positive validation opinion as per the requirement of VCS Standard Version 4.5.

Based on the reviewing the documented evidence and by an on-site assessment, CTI can confirm that:

➢ the baseline scenario is correctly defined as per the applied methodology and relate tools;

➢ the project is additional;

➢ all data and information used for ex-ante calculation of emission reductions is of projected and/or hypothetical nature;

➢ All assumptions and parameters along with their references and sources used for determine the ex-ante of emission reduction, are listed, and correctly quoted and in the VCS Joint-PD-MR (version 03 dated 22/02/2024) /1/.

➢ All values used for calculating project emission reductions are considered reasonable in the context of the Project activity.

➢ the monitoring plan in the validated VCS Joint-PD-MR is as per the applied baseline and monitoring methodology.

➢ the project has been implemented as per the VCS Joint-PD-MR;

➢ the project complies with the validation criteria for projects set out in VCS Standard Version 4.5;

➢ the project description and other supporting documents provided are complete and verifiable and in accordance with the applicable VCS requirement and AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0;

➢ the monitoring mechanism is in place as per the applied baseline and monitoring methodology AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0;

The estimated GHG emission reductions and removals in the 10-year crediting period (15/11/2021 to 14-11-2031) is validated as the following:

Year	Estimated GHG emission reductions or removals (tCO_2e)
15/11/2021~14/11/2022	78,508
15/11/2022~14/11/2023	78,508
15/11/2023~14/11/2024	78,508
15/11/2024~14/11/2025	78,508
15/11/2025~14/11/2026	78,508
15/11/2026~14/11/2027	78,508
15/11/2027~14/11/2028	78,508
15/11/2028~14/11/2029	78,508
15/11/2029~14/11/2030	78,508
15/11/2030~14/11/2031	78,508
Total estimated ERs	785,080
Total number of crediting years	10
Average annual ERs	78,508

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
15/11/2021~14/11/2022	95,670	17,162	0	78,508
15/11/2022~14/11/2023	95,670	17,162	0	78,508
15/11/2023~14/11/2024	95,670	17,162	0	78,508
15/11/2024~14/11/2025	95,670	17,162	0	78,508
15/11/2025~14/11/2026	95,670	17,162	0	78,508
15/11/2026~14/11/2027	95,670	17,162	0	78,508
15/11/2027~14/11/2028	95,670	17,162	0	78,508
15/11/2028~14/11/2029	95,670	17,162	0	78,508
15/11/2029~14/11/2030	95,670	17,162	0	78,508
15/11/2030~14/11/2031	95,670	17,162	0	78,508
Total	**956,700**	**171,620**	**0**	**785,080**

The estimated GHG emission reductions or removals in the above table are calculated based on the conservative values derived from the supporting documents, applied methodology and VCS requirements, though the reasonableness of assumptions has been adequately justified. The actual GHG emission reductions and removals may vary from the estimated values since the actual monitoring data will be used for the realistic project scenario.

The first monitoring period is from 15/11/2021 to 18/03/2023, including:

1) the heating season 2021-2022 (from 15/11/2021 to 21/03/2022), and

2) non-heating times (from 22/03/2022 to 14/11/2022), and

3) the heating season 2022-2023 (from 15/11/2022 to 18/03/2023)

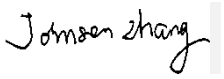
Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
15/11/2021 – 30/11/2021	4,385	564	0	3,821
01/12/2021 – 31/12/2021	8,612	1,062	0	7,550

01/01/2022 – 31/01/2022	9,012	1,267	0	7,745
01/02/2022 – 28/02/2022	7,962	1,264	0	6,698
01/03/2022 – 21/03/2022	5,891	609	0	5,282
22/03/2022 – 14/11/2022	0	0	0	0
15/11/2021 – 14/11/2022	**35,862**	**4,766**	**0**	**31,096**
15/11/2022 – 30/11/2022	5,121	663	0	4,458
01/12/2022 – 31/12/2022	10,259	1,516	0	8,743
01/01/2023 – 31/01/2023	10,441	1,676	0	8,765
01/02/2023 – 28/02/2023	9,775	1,230	0	8,545
01/03/2023 – 18/03/2023	6,448	418	0	6,030
15/11/2022 – 18/03/2023	**42,044**	**5,503**	**0**	**36,541**
15/11/2021 – 18/03/2023	**77,906**	**10,269**	**0**	**67,637**

From the operation start date (15/11/2021) of this project activity to the end of this monitoring period (18/03/2023), the project has achieved cumulative GHG emission reductions of 67,637 tCO_2e.

Year	Ex-ante estimated reductions/ removals	Achieved reductions/ removals	Percent difference	Justification for the difference
15/11/2021– 14/11/2022	78,508	31,096	-60.39%	The actual heating area lost mainly due to influence of

15/11/2022-18/03/2023	78,508	36,541	-53.46%	residential construction period and actual occupancy rate in year y (A_m). Average temperature difference between inlet and outlet temperatures at the downstream of each substation heat exchanger in year y ($\Delta_{tj,d,y}$), average flow rate at the downstream of each heat exchanger in year y ($FR_{j,d,y}$), hours per hear heat utilization in well j (T_j) and electricity consumption for the year y in operating the geothermal heating system($EC_{PJ,j,y}$ (ECy)) monitored have changed.



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26-February-2024

APPENDIX A: <ABBREVIATIONS>

Abbreviation	Full text
CAR	Corrective Action Request
CCPG	Centre China Power Grid
CDM	Clean Development Mechanism
CER	Certified Emission Reduction(s)
CL	Clarification request
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DOE	Designated Operational Entity
DNA	Designated National Authority
EB	Executive Board
EF	Emission Factor
EIA	Environmental Impact Assessment
ER	Emission Reduction
ETN	Electricity Transaction Note
FAR	Forward Action Request
FSR	Feasibility Study Report
GHG	Greenhouse Gas(es)
GS	Gold Standard
IPCC	Intergovernmental Panel on Climate Change
CCPG	Centre China Power Grid
VCS Joint-PD-MR	Project Description and Monitoring Report
PDD	Project Design Document
PP	Project Proponent
QC/QA	Quality Control
UNFCCC	United Nations Framework Convention on Climate Change
VVB	Validation/Verification Body
VVS	Validation and Verification Standard for Project activities
VCS	Verified Carbon Standard
VCU	Verified Carbon Unit

APPENDIX B: <REFERENCES>

Ref no.	Reference Document
/1/	Hangzhou Chaoteng Energy Technology Co., Ltd. VCS Joint-PD-MR, version 01 dated 24/04/2023, version 02 dated 20/10/2023, version 03 dated 22/02/2024
/2/	Hangzhou Chaoteng Energy Technology Co., Ltd. ER calculation spreadsheet, version 02 dated 20/10/2023
/3/	Hangzhou Chaoteng Energy Technology Co., Ltd. Project LCOH calculation spreadsheet version 02 dated 20/10/2023, version 03 dated 22/02/2024
/4/	VERRA, VCS-Joint-Project-Description-Monitoring-Report-Template-v4.2
/5/	CDM Executive Board, AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating version 3.0 dated 31/05/2013
/6/	CDM Executive Board, Tool 02 Combined tool to identify the baseline scenario and demonstrate additionality version 7.0 dated 22/09/2017
/7/	CDM Executive Board, Tool 03 Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion, version 3.0 dated 22/09/2017
/8/	CDM Executive Board, Tool 05 Baseline, Project and/or leakage emissions from electricity consumption and monitoring of electricity generation, version 3.0 dated 22/09/2017
/9/	CDM Executive Board, Tool to calculate the emission factor for an electricity system, version 07.0, dated 31/08/2018
/10/	CDM Executive Board, Common practice version 03.1 dated 28/05/2015
/11/	CDM Executive Board, Standard Applicability of sectoral scopes version 01.0 dated 11/03/2016
/12/	VERRA, VCS standard version 4.5 dated 29/08/2023
/13/	VERRA, VCS Registration and Issuance Process version 4.4 dated 04/10/2023
/14/	VERRA, VCS Program Guide version 4.4 dated 29/08/2023
/15/	VCS Program Definitions, v4.4 dated 29/08/2023

/16/	Chengdu Dexinlong Engineering Consulting Co., Ltd., FSR for Project dated 11/2018
/17/	Lankao DRC (Development and Reform Committee), Project approval dated 27/09/2017
/18/	Henan Zhengde Environmental Protection Technology Co., Ltd., EIA dated Phase I 12/2017, Phase II 05/2019, Phase III 06/2020
/19/	Lankao County Environment Protection Bureau, EIA Approval dated Phase I 05/01/2018, Phase II 09/05/2019, Phase III 29/06/2020
/20/	Lankao Water Resource Department, water extraction permits for 10 sub-areas: 1. Fenghuangcheng Station, dated 02/03/2018 2. Gongyuanshoufu Station, dated 02/03/2018 3. Dongfangyujing Station, dated 02/03/2018 4. Donghuyiyuan Station, dated 02/03/2018 5. Qinghuayuan Station, dated 13/12/2019 6. Xiangxiehuating Station, dated 13/12/2019 7. Hualancheng Station, 13/12/2019 8. Jiuhaoyuan Station, 26/01/2022 9. Qianxizhuangyuan Station, 13/12/2019 10. Yehaowanghu Station, 13/12/2019
/21/	Lankao Green Energy Clean Energy Co., Ltd., Business license dated 09/08/2019 Zhejiang Lute Energy Technology Co., Ltd. Business license dated 24/04/2020
/22/	National Enterprise Credit Information Publicity System http://www.gsxt.gov.cn/
/23/	Lankao Green Energy Clean Energy Co., Ltd. & Zhejiang Lute Energy Technology Co., Ltd., Project construction contract dated 15/08/2020
/24/	Lankao Green Energy Clean Energy Co., Ltd. Diagram of Project Design
/25/	Lankao Green Energy Clean Energy Co., Ltd. Commencement report of the Project dated 25/09/2020

/26/	Lankao Green Energy Clean Energy Co., Ltd. and Lankao County Housing and Urban-Rural Construction Development Bureau, Heating Supply Contract for Project dated 12/09/2017 Lankao Green Energy Clean Energy Co., Ltd. and Communities (End-users), Heating Supply Contracts for Project dated 12/09/2017, 03/2020, 06/2020, 07/2020, 08/2020, 09/08/2020, 10/2020, 11/2020, 20/11/2020, 03/2021, 04/2021, 05/2021, 06/2021, 08/2021, 10/2021, 06/2022, 08/2022
/27/	Lankao Green Energy Clean Energy Co., Ltd. and Polar Bear Energy, Equipment purchase Contracts dated 09/09/2020, 31/08/2021, 25/08/2021
/28/	Lankao Green Energy Clean Energy Co., Ltd. Project completion acceptance dated 14/11/2021
/29/	Technical agreement and Operating Instruction of Geothermal Space Heating System
/30/	Lankao Green Energy Clean Energy Co., Ltd. Operation log and Operation records during this monitoring period
/31/	Monthly electricity consumption bills
/32/	Lankao Green Energy Clean Energy Co., Ltd., Local Stakeholder Consultation Records prior to the project construction (Public Opinion Survey Questionnaire) dated 13/08/2020 – 15/08/2020 Lankao Green Energy Clean Energy Co., Ltd., Local Stakeholder Consultation Records for this monitoring period (Survey Questionnaire on Winter Heating Satisfaction) dated 07/03/2022 – 11/03/2022, 13/03/2023 – 17/03/2023
/33/	Lankao Green Energy Clean Energy Co., Ltd., Name plate of the main equipment
/34/	Lankao Green Energy Clean Energy Co., Ltd., Employee Training Records
/35/	Lankao Green Energy Clean Energy Co., Ltd. Labor contact, roster, payroll
/36/	Lankao Green Energy Clean Energy Co., Ltd. Meters and Calibration certificates
/37/	Lankao Green Energy Clean Energy Co., Ltd. Meters records
/38/	Lankao Green Energy Clean Energy Co., Ltd. Invoice and transaction note
/39/	Henan Zhengde Environmental Protection Techology Co., Ltd., Qualification certificate dated 27/04/2016, 19/05/2019
/40/	Economic Evaluation Method and Parameter of Construction Projects version 03

/41/	Housing and Urban Rural Development Department of Kaifeng City, Research on Heating in Winter of Kaifeng City dated 05/2018
/42/	Website, The plan for clean heating in winter in Northern China (2017-2021) https://www.gov.cn/xinwen/2017-12/20/content_5248855.htm [https://www.gov.cn/xinwen/2017-12/20/5248855/files/7ed7d7cda8984ae39a4e9620a4660c7f.pdf]
/43/	Guidance on Promoting Clean Heating in Northern Areas http://www.chic.org.cn/Home/Index/detail1?id=55
/44/	Catalogue for the Guidance of Industrial Structure Adjustment (2019 version) http://www.gov.cn/xinwen/2019-11/06/5449193/files/26c9d25f713f4ed5b8dc51ae40ef37af.pdf
/45/	Implementation Plan of Air Pollution Prevention and Control in Henan Province in 2018. [https://www.henan.gov.cn/2018/02-23/249520.html]
/46/	Green Industry Guidance Directory (2019 version) [https://kj.jdz.gov.cn/zwzx/gggs/P020210823363389433184.pdf]
/47/	China Energy Statistical Yearbook 2022 http://www.zgtjnj.org/navibooklist-n3023071301-1.html
/48/	Three-Year Action Plan to Strengthen Air Pollution Prevention and Control https://www.gov.cn/zhengce/content/2018-07/03/content_5303158.htm
/49/	Levelized cost of heat (LCOH) https://en.wikipedia.org/wiki/Levelized_cost_of_electricity
/50/	The price index of investment in fixed asset for Henan Province https://www.henan.gov.cn/2021/03-08/2104927.html
/51/	Salary statistics https://www.gszybw.com/gs/shuju/henan/9318.html

/52/	Zozen Boiler: 79% https://www.zhongzhengguolu.cn/product/DZL-ran-mei-zheng-qi.html Xinli Boiler: 75%-85% https://kfxlgl.com/product/youjirezaitilu/ylwmeilu.html#xjzs Henan Hengde Boiler: 85% http://www.hengdeguolu.com/product/172.html
/53/	Xinhua Net: Multiple carbon monoxide poisoning incidents in different regions sound the alarm for winter heating safety http://m.xinhuanet.com/gz/2019-01/10/c_1123971640.htm
/54/	Stated Council: Three-year Action Plan to Win the Blue Sky Defense War https://www.gov.cn/zhengce/content/2018-07/03/content_5303158.htm
/55/	Environmental Protection Law of the People's Republic of China https://www.mee.gov.cn/ywgz/fgbz/fl/201404/t20140425_271040.shtml
/56/	Technical specification for geothermal space heating engineering (CJJ 138-2010) http://cnspc.sinopec.com/cnspc/Resource/Pdf/CJJ%20138-2010.pdf
/57/	YAO Hua, HUANG Yun, XU Jingying, MA Guangyu, WANG Yan, LIU Changpeng, SUN Shoubin. Technology Status and Discussion on Challenges of Clean Heating in Northern China. Bulletin of Chinese Academy of Sciences, 2020, 35(9): 1177-1188
/58/	News: https://www.sohu.com/a/355884111_99999190
/59/	Solar thermal collectors' space heating http://www.cqvip.com/qk/85154x/201718/673315149.html
/60/	Emission Standard for Industrial Enterprise Noise at Boundary (GB12348-2008) https://www.mee.gov.cn/ywgz/fgbz/bz/bzwb/wlhj/hjzspfbz/200809/t20080918_128936.shtml
/61/	2020 Coal Economic Situation Analysis Report dated 01/2021
/62/	Website, 2019 Baseline Emission Factors for Regional Power Grids in China by China DNA https://www.mee.gov.cn/ywgz/ydqhbh/wsqtkz/202012/W020201229610353340851.pdf https://www.mee.gov.cn/ywgz/ydqhbh/wsqtkz/202012/W020201229610353816665.pdf https://www.mee.gov.cn/ywgz/ydqhbh/wsqtkz/202012/W020201229610354442145.pdf

/63/	Kaifeng City Urban Administration, Kaifeng City Central Heating Management Measures https://www.kaifeng.gov.cn/sitegroup/root/html/8a28897b41c403ec0141c41c883b00c8/ed8c81d3259842f9952246b306e10121.html
/64/	The People's Government of Henan Province, News related to the time given for heating services https://www.henan.gov.cn/2022/03-15/2414579.html https://www.henan.gov.cn/2023/03-16/2708234.html
/65/	*Mysteel.com*, Price list of coal (5,000 kcal)
/66/	Lankao Green Energy Clean Energy Co., Ltd. Repair Order during this monitoring period
/67/	Problem of oil fired boiler https://www.hbzhan.com/tech_news/detail/637134.html https://yuzhixianedu.com/information/detail/post-796.html https://www.zjgbxny.com/news_Detail_1/10.html
/68/	Chinese Standard for design of boiler plant (GB 50041-2020) http://www.szhvac.org/news_details.html?newsid=329034
/69/	China Solar Thermal Alliance, Status and Trends of Clean Heating and Thermal Storage Technologies http://www.cnste.org/html/jishu/2020/0604/6438.html
/70/	National Development and Reform Commission, Notice on Further Improving the Coal Market Price Formation Mechanism https://www.ndrc.gov.cn/xwdt/tzgg/202202/t20220225_1317006_ext.html
/71/	KML file of the project activity
/72/	Public information on the ten facilities (or projects) that provide the same output as the proposed project activity 1) Heating project of 40ton coal-fired boiler for a heat power company in Henan Province https://www.ydglzg.com/cases/61.html 2) Henan Thermal Power Company 40 tonne coal-fired boiler

	http://www.hnydgl.com/case/hangye/gongnuan/145.html 3) Coal-fired Boiler Heating Project in Zhengzhou City, Henan Province https://www.zzboiler.com/prltgl/109.html 4) Henan University 2*7MW (10 tonnes) Coal-fired Boiler Heating Project in Henan Province https://www.zzboiler.com/prltgl/80.html 5) Dongfang Thermal Power 2×75t/h coal-fired boiler heating project in Henan Province https://www.zzboiler.com/prltgl/219.html 6) Coal-fired Boiler Project for Winter Heating in Yan'an Drug Rehabilitation Centre, Shanxi Province https://www.ccgp.gov.cn/cggg/dfgg/zbgg/202401/t20240125_21474277.htm 7) Dunhua Heating Company 46MW (65 tons/hour) coal-fired boiler heating project in Jilin Province https://www.zzboiler.com/prltgl/58.html 8) 35t Coal-fired Boiler Heating Project in Tongxiang City, Zhejiang Province https://www.zzboiler.com/prltgl/243.html 9) Heating project of Coal-fired boiler for 900,000 m2 in Beijing https://www.youqiguolu.com/news/8184.html 10) Coal-fired heating boilers in Wuwei City https://www.youqiguolu.com/news/23037.html
/73/	POWER DEMAND SIDE MANAGEMENT (ISSN 1009-1831), Power demand response capability calculation and reserve objective optimized decomposition of Henan province http://sgdsm.cnjournals.com/ch/reader/view_abstract.aspx?file_no=20210315
/74/	JJG596-2012 Verification Regulation of Electrical Meters for Measuring Alternating-current Electrical Energy
/75/	State Grid Lankao County Power Supply Company: Calibration records for grid owned electricity meters
/76/	Electricity settlement agreement signed between the State Grid Lankao County Power Supply Company and the PP
/77/	Emission Standard of Environment Noise for Boundary of Construction Site (GB12532-2011)

	https://www.mee.gov.cn/ywgz/fgbz/bz/bzwb/wlhj/hjzspfbz/201112/t20111222_221680.shtml
/78/	The People's Government of Lankao County: Reply to Proposal No. 121 of the Sixth Session of the 15th County People's Congress: http://www.lankao.gov.cn/sitesources/lkxrmzf/page_pc/ztzl/jyta/xrddbzdjy/article4bdba844db7f4b09a9e1ace042459b52.html
/79/	The difference between municipal central heating system and distributed central heating https://b2b.baidu.com/q/aland?q=7E1F7B75037470600C661A2275661F1970600C667C0D0E317839&id=qidbcd8d62d6950778416f5c2e5374a3a89&answer=17614859976909480140&utype=2 https://www.163.com/dy/article/ID0K300005562F0W.html
/80/	The People's Government of Henan Province: Notice on Issuing the 13th Five Year Plan for Energy Development in Henan Province: https://m.henan.gov.cn/2017/01-25/248661.html
/81/	Zhejiang University: XU Haizhou: Research on Investment Decisionmaking of Geothermal Energy Heating Projects Based on the Theory of Real Options

APPENDIX C: <RESOLUTION OF CLARIFICATION REQUEST AND CORRECTIVE ACTION REQUESTS AND FORWARD ACTION REQUESTS>

Table 1. CL from this joint validation and verification

CL ID	CL 1	**Section no.**	-	**Date:** 01/09/2023
Description of CL				
The 112.08MW, clarification is requested for 112.08MW capacity.				
Project proponent response				**Date:** 11/09/2023
The related content has been supplemented. Please refer to footnote 3 in the /Joint PD & MR Report/ (version 02). The total heating load (112.08MW) is also stated in the /Feasibility Study Report/ of the project.				
Documentation provided by project proponent				
/Joint PD & MR Report/ - version 02 /Feasibility Study Report/				
VVB assessment				**Date:** 25/09/2023
By reviewing Joint PD & MR Report total heating load (112.08MW) is sourced from FSR. CL 1 was closed.				

CL ID	CL 2	**Section no.**	3.4	**Date:** 01/09/2023
Description of CL				
Pre-screening of alternative scenarios, PP excludes several options for the implementation of a new geothermal facility, but doesn't provide the information source for the justification. 1. the demonstration of alternative "2(i) Introduction of a district heating system" is not clear. Clarification is requested. 2. the demonstration of alternative of "3(iii) Oil fired boilers in boiler houses, supplying several buildings through a heat distribution network" is not clear. Clarification is requested.				

Project proponent response	Date: 11/09/2023
1. The related content has been supplemented, please refer to this part in Section 3.4 of the /Joint PD & MR Report/ (version 02). 2. The related content has been supplemented with a website link ((footnote 18) for support. Please refer to this part in Section 3.4 of the /Joint PD & MR Report/ (version 02).	
Documentation provided by project proponent	
/Joint PD & MR Report/ - version 02 /Feasibility Study Report/	
VVB assessment	**Date:** 25/09/2023
By reviewing Joint PD & MR Report, references for exclusion or keeping of alternative scenarios are clear. CL 2 was closed.	

CL ID	CL 3	Section no.	Investment analysis	Date: 01/09/2023
Description of CL				
Clarification for the appropriateness of the parameters on the investment analysis are requested, such as Total space heating area, Annual heat supply hours, Heating supply fee for residential building, Heating supply fee for commercial building, Investment, Annual operational and maintenance costs (O&M costs), Long-term interest rate, income tax rate, other cost, material cost etc.				
Project proponent response				**Date:** 11/09/2023
● The data of ***Total space heating area*** is from the /Feasibility Study Report/ of the project. The data is cross-checked with /Project Approval/ and the /Heating supply contracts/. The related content has been stated, please refer to the Joint PD & MR Report (version 02). ● The data of ***Annual heat supply hours*** is sourced from *Kaifeng City Central Heating Management Measures* published by Kaifeng City Urban Administration. The data is cross-checked against the news published on the portal of the People's Government of Henan Province to ensure that the number of annual heating hours used for the investment analysis is appropriate. The related content has been stated, please refer to Footnote 4, 49, 50 in the Joint PD & MR Report (version 02). ● The data of ***Heating supply fee for residential building*** is from the /Feasibility Study Report/. The data is determined in the /heating supply contracts/. According to the *Measures for the Administration of Centralized Heat Supply in Urban Areas of Lankao County* issued by the Office of the People's Government of Lankao County, the heat supply operating enterprise shall sign a heat supply contract with the heat users, and the content of the heat supply contract shall include the area of heat supply, time of heat supply, heating load, price of heat supply, time limit for payment, rights and obligations of both sides of heat supply and use. (http://lankao.gov.cn/info/2249/47811.htm) Therefore, the *Heating supply fee for residential*				

building reflected in the heat supply contract is appropriate to be utilized on investment analysis.

- The data of ***Heating supply fee for commercial building*** is not needed to be clarified. Because the project does not supply geothermal heating for commercial building.
- The data of ***Investment*** is from the /Feasibility Study Report/. The data is also cross-checked with /Project Approval/ and the /Construction Contract/ to ensure the investment data is appropriate.
- The data of ***Annual operational and maintenance costs (O&M costs)*** is from the /Feasibility Study Report/, containing:
  - Office management expenses = salaries + management fee
  - Operation fee = electricity + maintenance costs
- The data of ***Income tax rate*** is 25%, which is from the Enterprise Income Tax Law of the People's Republic of China issued by the President of the People's Republic of China on 16/03/2007 (http://czt.hebei.gov.cn/root17/yshj/202303/P020230303502331214647.pdf)
- The data of ***Long-term interest rate*** is not clarified. Because no bank loans are involved in this project.
- The parameters utilized on investment analysis for calculating the LCOH of the baseline scenario are from the /Feasibility Study Report/, including ***investment*** in boiler house per heating area, ***O&M costs*** and ***material cost*** (coal cost). The source of these data in the /Feasibility Study Report/ is the *Research on Heating in Winter of Kaifeng City* published by the Housing and Urban Rural Development Department of Kaifeng City, which are appropriate.

Documentation provided by project proponent

/Joint PD & MR Report/ - version 02

/Feasibility Study Report/

/Project Approval/

/Heating supply contracts/

/Construction Contract/

VVB assessment	**Date:** 25/09/2023

By reviewing evidences provided, Total space heating area, Annual heat supply hours, Heating supply fee for residential building, Heating supply fee for commercial building, Investment, Annual operational and maintenance costs (O&M costs), Long-term interest rate, income tax rate, other cost, material cost etc. are provided.

CL 3 was closed.

CL ID	CL 4	**Section no.**	1.15.2	**Date:** 01/09/2023

Description of CL

Via checking the Joint PD & MR Report (version 01, 24/04/2023), if the project rejected by Other GHG Programs is not clarified in section 1.15.2.

Project proponent response	Date: 11/09/2023
The related content has been supplemented. Please refer to the /Joint PD & MR Report/ (version 02).	
Documentation provided by project proponent	
/Joint PD & MR Report/ - version 02	
VVB assessment	**Date:** 25/09/2023
CL 4 was closed.	

CL ID	CL 5	Section no.	6.1	Date: 01/09/2023
Description of CL				
For parameter $EF_{CO2,i,}$ the PD is requested to clarify why the fuel type used in the boiler only include coking coal.				
Project proponent response				**Date:** 11/09/2023
Based on the comment, the related content has been modified. Please refer to this part in the /Joint PD & MR Report/ (version 02).				
Documentation provided by project proponent				
/Joint PD & MR Report/ - version 02 /Feasibility Study Report/				
VVB assessment				**Date:** 25/09/2023
By reviewing evidences provided, it was confirmed that coking coal is only fuel type in baseline scenario. CL 5 was closed.				

Table 2.CAR from this joint validation and verification

CAR ID	CAR 1	Section no.	-	Date: 01/09/2023
Description of CAR				
Via checking the Joint PD & MR Report (version 01, 24/04/2023), the version of the VCS standard (version 4.2) on which the report was based is not the latest version, thus CAR 02 is raised. PP is requested to update it.				

Project proponent response	Date: 11/09/2023
The latest version of VCS Standard (version 4.5) has been utilized for the /Joint PD & MR Report/ (version 02). The related content has been modified.	
Documentation provided by project proponent	
/Joint PD & MR Report/ - version 02	
VVB assessment	**Date:** 25/09/2023
VCS standard is per current now, CAR 1 was closed.	

CAR ID	CAR 2	Section no.	1.11	Date: 01/09/2023
Description of CAR				
Through the on-site visit, it was found that the parameters of some equipments in the heat substation differed slightly from those disclosed in the Joint PD & MR Report (version 01, 24/04/2023). Thus, CAR 2 is raised.				
Project proponent response				**Date:** 11/09/2023
The key equipment parameters disclosed in the Joint PD & MR Report (Version 01, 24/04/2023) were taken from the earliest project design proposal. After several revisions and improvements conducted by the project team, the main equipment parameters in the latest project design are consistent with those of the actual equipment installed on the project site. The latest and actual key equipment parameters are also stated in the /Feasibility Study Report/ of the project. The related content has been modified, please refer to Section 1.11 of the /Joint PD & MR Report/ (version 02).				
Documentation provided by project proponent				
/Joint PD & MR Report/ - version 02 / Feasibility Study Report /				
VVB assessment				**Date:** 25/09/2023
CAR was closed.				

CAR ID	CAR 3	Section no.	1.12	Date: 01/09/2023
Description of CAR				

Via checking the Joint PD & MR Report (version 01, 24/04/2023), in Table 1-3, only the total number of production wells is totaled, the total number of injection wells was missing.
Project proponent response **Date:** 11/09/2023
The total number of injection wells is 24. The related content has been modified, please refer to Section 1.12 of the /Joint PD & MR Report/ (version 02).
Documentation provided by project proponent
/Joint PD & MR Report/ - version 02
VVB assessment **Date:** 25/09/2023
Detailed wells are provided. CAR was closed.

CAR ID	CAR 4	**Section no.**	1.14	**Date:** 01/09/2023
Description of CAR				
Via checking the /EIA approval/ and the Joint PD & MR Report (version 01, 24/04/2023), the name of the governmental authority responsible for approving the project's EIA report is incorrect.				
Project proponent response **Date:** 11/09/2023				
The right name is Lankao Environment Protection Bureau. The related content has been modified, please refer to Section 1.14 of the /Joint PD & MR Report/ (version 02).				
Documentation provided by project proponent				
/Joint PD & MR Report/ - version 02 / EIA approval /				
VVB assessment **Date:** 25/09/2023				
Governmental authority responsible for approving the project's EIA report is correct, CAR was closed.				

CAR ID	CAR 5	**Section no.**	1.16.3	**Date:** 01/09/2023
Description of CAR				

Via checking the Joint PD & MR Report (version 01, 24/04/2023), how the project makes a statement about supply chain emission is not specified in detail.
Project proponent response **Date:** 11/09/2023
According to update 23# of the August 2023 Overview of VCS Program Updates and Effective Dates (PDF), only a public statement from project proponents and authorized representatives who are buyers or sellers of a product in a supply chain is requested after 1-March-2024". As this monitoring period covers 15-11-2021 to 18-3-2023 and this document is submitted prior to 1-March-2024, the section 1.16.3 of the /Joint PD & MR Report/ (version 02) is not discussed based on VCS Standard (version 4.5).
Documentation provided by project proponent
/Joint PD & MR Report/ - version 02
VVB assessment **Date:** 25/09/2023
Supply chain emission was illustrated. CAR was closed.

CAR ID	CAR 6	**Section no.**	1.17.2	**Date:** 01/09/2023
Description of CAR				
Via checking the Joint PD & MR Report (version 01, 24/04/2023), the section 1.17.2 Sustainable Development Contributions Activity Monitoring is not described.				
Project proponent response **Date:** 11/09/2023				
The related content has been modified, please refer to Section 1.17.2 of the /Joint PD & MR Report/ (version 02).				
Documentation provided by project proponent				
/Joint PD & MR Report/ - version 02				
VVB assessment **Date:** 25/09/2023				
Sustainable Development Contributions Activity Monitoring was described. CAR was closed.				

CAR ID	CAR 7	**Section no.**	1.17.2	**Date:** 01/09/2023
Description of CAR				

Via checking the Joint PD & MR Report (version 01, 24/04/2023), the cumulative contributions over the project lifetime is documented in the "Current Project Contributions" column in the Table 1-4, which shall be documented in the "Contributions Over Project Lifetime" column.	
Project proponent response	**Date:** 11/09/2023
The related content has been modified, please refer to Table 1 in the Section 1.17.2 of the /Joint PD & MR Report/ (version 02).	
Documentation provided by project proponent	
/Joint PD & MR Report/ - version 02	
VVB assessment	**Date:** 25/09/2023
CAR was closed.	

CAR ID	CAR 8	**Section no.**	3.3	**Date:** 01/09/2023
Description of CAR				
Via checking the Joint PD & MR Report (version 01, 24/04/2023), the number of substations stated under (b) in the Project Boundary section is not consistent with that in Figure 3-1.				
Project proponent response				**Date:** 11/09/2023
The number of substations is 17, which is also stated in the /Feasibility Study Report/ of the project. The related content has been modified, please refer to Section 3.3 of the /Joint PD & MR Report/ (version 02).				
Documentation provided by project proponent				
/Joint PD & MR Report/ - version 02 / Feasibility Study Report /				
VVB assessment				**Date:** 25/09/2023
Number of substations stated under (b) in the Project Boundary section is consistent. CAR was closed.				

CAR ID	CAR 9	**Section no.**	3.4	**Date:** 01/09/2023

Description of CAR	
Via checking the Joint PD & MR Report (version 01, 24/04/2023), 1. for demonstration the alternative scenarios, the link referenced in pre-screening (footnote 14) is not valid when excluding "3(ii) Natural gas fired boilers in boiler houses, supplying several buildings through a heat distribution network". 2. for demonstration the alternative scenarios, the reason for the exclusion of "3(v) Renewable energy sources, such as biomass or solar thermal collectors, connected to a heat distribution network." in pre-screening lacks support. 3. for demonstration the alternative scenarios, the reason for the exclusion of "4(ii) Coal fired stoves for individual apartments." in pre-screening lacks support. 4. for demonstration the alternative scenarios, the reason for the exclusion of "4(iv) Natural gas fired stoves for individual apartments." in pre-screening lacks support. 5. for step 1b, how the remaining alternatives consistent with mandatory laws and regulations is not specified. 6. for step 2, how to identify barriers that would prevent the implementation of alternative scenarios is not specified.	
Project proponent response	**Date:** 11/09/2023
1. The link is updated, please refer to footnote 17 of the /Joint PD & MR Report/ (version 02). 2. A website link (footnote 20) is provided for support. 3. A website link (footnote 22) is provided for support. 4. A website link (footnote 24) is provided for support and the related content has been supplemented. 5. The related content has been supplemented, please refer to this part in Section 3.4 of the /Joint PD & MR Report/ (version 02). 6. The related content has been supplemented, please refer to this part in Section 3.4 of the /Joint PD & MR Report/ (version 02).	
Documentation provided by project proponent	
/Joint PD & MR Report/ - version 02 / Feasibility Study Report /	
VVB assessment	**Date:** 25/09/2023
The reason for the exclusion of cases were provided. CAR was closed.	

CAR ID	CAR 10	**Section no.**	3.5	**Date:** 01/09/2023
Description of CAR				
Via checking the Joint PD & MR Report (version 01, 24/04/2023), for "Step 2: identify similar projects", the start date shall be based on the "Glossary CDM terms" as the "Tool 24 Common practice (Version 03.1) is a CDM Tool"				
Project proponent response				**Date:** 11/09/2023
The related content has been modified, please refer to this part of the /Joint PD & MR Report/				

(version 02).
Documentation provided by project proponent
/Joint PD & MR Report/ - version 02 /Tool 24/
VVB assessment | **Date:** 25/09/2023
CAR 11 was closed.

CAR ID	CAR 11	**Section no.**	5.1	**Date:** 01/09/2023
Description of CAR				
Via checking the Joint PD & MR Report (version 01, 24/04/2023), 1. for "Step 1: Determine the baseline ex ante parameters of the project", the website links for Xinli Boiler and Henan Hengde Boiler (Footnote 39) are not valid. 2. for Equation (7), the explanation of the parameter "$\Delta t_{j,d,y}$" is incorrect.				
Project proponent response | **Date:** 11/09/2023				
1. The link is updated and the related content has been modified, please refer to footnote 42 of the /Joint PD & MR Report/ (version 02). 2. The related content has been modified, please refer to this part of the /Joint PD & MR Report/ (version 02).				
Documentation provided by project proponent				
/Joint PD & MR Report/ - version 02 /Methodology AM0072/				
VVB assessment | **Date:** 25/09/2023				
CAR 11 was closed.				

CAR ID	CAR 12	**Section no.**	5.4	**Date:** 01/09/2023
Description of CAR				
Via checking the Joint PD & MR Report (version 01, 24/04/2023), the ex-ante calculation of ER value is not correct due to the values of HS_y, are not correctly calculated, revision is requested.				
Project proponent response | **Date:** 11/09/2023				
The estimated ER value is re-calculated in the /ER Calculation/ sheet, please refer to the /ER				

Calculation/ sheet (version 02) for more details. The related content has been modified as well, please refer to the /Joint PD & MR Report/ (version 02).
Documentation provided by project proponent
/Joint PD & MR Report/ - version 02 / ER Calculation / - version 02
VVB assessment **Date:** 25/09/2023
Values of HS_y, are correctly calculated. CAR 12 was closed.

CAR ID	CAR 13	**Section no.**	6.1	**Date:** 01/09/2023
Description of CAR				
Via checking the Joint PD & MR Report (version 01, 24/04/2023), it is incorrect to list the parameters $EF_{EL,j,y}$ ($EF_{grid,CM,y}$) and $TDL_{j,y}$ in section 6.1 "Data and Parameters Available at Validation".				
Project proponent response				**Date:** 11/09/2023
The related content has been modified and supplemented. The parameters $EF_{EL,j,y}$ ($EF_{grid,CM,y}$) and $TDL_{j,y}$ have been listed in section "6.2 Data and Parameters Monitored" and the descriptions of these two parameters have been added in section "6.3 Monitoring Plan". Please refer to the /Joint PD & MR Report/ (version 02).				
Documentation provided by project proponent				
/Joint PD & MR Report/ - version 02				
VVB assessment				**Date:** 25/09/2023
CAR 13 was closed.				

CAR ID	CAR 14	**Section no.**	6.2	**Date:** 01/09/2023
Description of CAR				
Via checking the Joint PD & MR Report (version 01, 24/04/2023), 1. for describing the data "$\Delta t_{j,d,y}$", "$FR_{j,d,y}$" and "$EC_{PJ,j,y}$ (EC_y)" the serial numbers of the applied equipment are not listed and the QA/QC procedures for the applied equipment are not specified in detail. 2. for describing the QA/QC procedures for the data "T_j", the information used for cross-checking lacks support.				

3. for describing the data "HI_m" and "A_m", he QA/QC procedures are not specified in detail.	
Project proponent response	**Date:** 11/09/2023
1. The serial numbers of the applied bimetallic thermometers and Electromagnetic Flowmeters have been listed and the QA/QC procedures for the applied bimetallic thermometers and Electromagnetic Flowmeters have been refined by adding the detailed description of the calibration procedure and calibration report information. 2. The QA/QC procedures for the data "T_j" has been updated, new information used for cross-checking has been provided with two website links for support. 3. The related content has been supplemented. Please refer to the /Joint PD & MR Report/ (version 02).	
Documentation provided by project proponent	
/Joint PD & MR Report/ - version 02 / Calibration report /	
VVB assessment	**Date:** 25/09/2023
CAR 14 was closed.	

CAR ID	CAR 15	**Section no.**	6.3	**Date:** 01/09/2023
Description of CAR				
Via checking the Joint PD & MR Report (version 01, 24/04/2023), in Figure 6-2, the installation positions of BT Inlet and BT Outlet are reversed				
Project proponent response				**Date:** 11/09/2023
The related content has been modified, please refer to Figure 6-2 in the /Joint PD & MR Report/ (version 02).				
Documentation provided by project proponent				
/Joint PD & MR Report/ - version 02				
VVB assessment				**Date:** 25/09/2023
CAR 15 was closed.				

CAR ID	CAR16	**Section no.**	7.1	**Date:** 01/09/2023
Description of CAR				

Via checking the Joint PD & MR Report (version 01, 24/04/2023),

1. for describing the data "$\Delta t_{j,d,y}$", the values applied on March 2022 are not consistent with the those values in the ER Calculation-MR.
2. for describing the data "$FR_{j,d,y}$", the unit of the values listed in the "Value applied" column is not "kg/h".
3. for describing the data "$EC_{PJ,j,y}$ (EC_y)", the two values applied are not consistent with the those values in the electricity bills. These two values are the Electricity consumption data of
   a) Heat Substation 1#GYSF in February 2022,
   b) Heat Substation 1#QXZY in January 2022, respectively.

Project proponent response	**Date:** 11/09/2023

1. The "$\Delta t_{j,d,y}$" values applied on March 2022 have been modified, which are consistent with those values in the /ER Calculation-MR/.
2. The unit of the values listed in the "Value applied" column is "m^3/h". In order to be consistent with the unit stated in the "Data unit" column, related content about water density has been added.
3. These two values have been modified to be consistent with the /electricity bills/. The related content has been modified, including the /ER Calculation-MR/ sheet, the Calculation results of project emissions and Net GHG Emission Reductions and Removals.

Please refer to the /Joint PD & MR Report/ (version 02) and the /ER Calculation-MR/ (version 02).

Documentation provided by project proponent

/Joint PD & MR Report/ - version 02

/ER Calculation-MR/ - version 02

/Electricity bills/

VVB assessment	**Date:** 25/09/2023

1. The "$\Delta t_{j,d,y}$" values applied on March 2022 have been modified, which are consistent with those values in the /ER Calculation-MR/.
2. The unit of the values listed in the "Value applied" column is "m^3/h". In order to be consistent with the unit stated in the "Data unit" column, related content about water density has been added.
3. These two values have been modified to be consistent with the /electricity bills/. The related content has been modified, including the /ER Calculation-MR/ sheet, the Calculation results of project emissions and Net GHG Emission Reductions and Removals.

The above was confirmed to be correct, CAR was closed.

CAR ID	CAR17	**Section no.**	7.2, 7.3	**Date:** 01/09/2023

Description of CAR

Via checking the ER Calculation-MR sheet, the results of "Baseline emissions" and "Project emissions" are not calculated using RUNDDOWN and RUNDUP functions, respectively.

Project proponent response	Date: 11/09/2023
The results of “Baseline emissions” and “Project emissions” have been re-calculated using RUNDDOWN and RUNDUP functions, respectively. The related content has been modified, including the /ER Calculation-MR/ sheet, the Calculation results of baseline emissions, project emissions and Net GHG Emission Reductions and Removals.	
Documentation provided by project proponent	
/Joint PD & MR Report/ - version 02 /ER Calculation-MR/ - version 02	
VVB assessment	**Date:** 25/09/2023
RUNDDOWN and RUNDUP functions are activated. CAR was closed.	

Table 3.FAR from this joint validation and verification

FAR ID	01	Section no.	3.1	Date: 20/01/2024
Description of FAR				
There are two emaining Sub-areas (Jinxiuyuan Station and Tianshenggongguan Station), corresponding to 2 production wells have not been put into operation yet which have not obtained the Water Extraction Permit, thus, this FAR was raised to check the Water Extraction Permit for the two remaining Sub-areas during the next monitoring period.				
Project proponent response				**Date:** 22/02/2024
The Water Extraction Permit for the two remaining Sub-areas will be obtained before commissioning.				
Documentation provided by project proponent				
-				
VVB assessment				**Date:** 26/02/2024
The Water Extraction Permit for the two remaining Sub-areas will be checked during the next monitoring period and the FAR remains OPEN				