WUCHENG GEOTHERMAL BASED SPACE HEATING SYSTEM

大庆油田设计院有限公司
DAQING OILFIELD DESIGN INSTITUTE CO., LTD.

Document Prepared by Daqing Oilfield Design Institute Co., LTD.

Project Title	Wu Cheng Geothermal Based Space Heating System
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1 PROJECT DETAILS

1.1 Summary Description of the Project

The Project is planned and designed to introduce the geothermal energy-based space heating system to realize heat supply to a series of new buildings and old buildings in Wucheng County, Dezhou City, Shandong Province over the heating season, which will displace heat supply from coal-fired boilers as a business-as-usual scenario in the project area.

The project was put into operation on 8-November-2021.

The project owner is Tangshan Jidong Oilfield New Energy Development Co., LTD. Wucheng Branch[1]. It can supply geothermal heat to 1469.2 thousand m^2 of existing buildings and 766 thousand m^2 of new buildings with a total heating load of 81.42 MW. The scenario prior to the implementation of the proposed project activity is that heat supplied to the building areas in winter would be provided by isolated coal-fired boilers.

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 62054 tCO_2e, and total GHG emission reductions for the 10-years crediting period are 620536 tCO_2e.The date of crediting period is 08- November-2021 to 07-November-2031.

The actual Emission reductions achieved for the 1st monitoring period was 59185 tCO_2e. The date of 1st monitoring period is 08-November-2021 to 15-March-2023.

Audit Type	Period	Program	VVB Name	Number of years
Validation/ Verification	/	Verified Carbon Standard	China Classification Society Certification Co. LTD. (CCSC)	10

1.2 Sectoral Scope and Project Type

The Project is not a grouped project, sectoral scope and methodologies are as follows:

Sectoral Scope 01: Energy industries (renewable - / non-renewable sources)

Project Methodology: AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating (Version 03.0)

[1] Tangshan Jidong Oilfield New Energy Development Co., LTD. Wucheng Branch is a wholly-owned subsidiary of Tangshan Jidong Oilfield New Energy Development Co., LTD.

1.3 Project Eligibility

The scope of the VCS Program includes:

1) The seven Kyoto Protocol greenhouse gases: The project only considers the reduction of Carbon Dioxide (CO_2) Emissions for VCS Standard crediting. Refer to section 3.3 of the PD&MR for more details.

2) Ozone-depleting substances: NA.

3) Project activities supported by a methodology approved under the VCS Program through the methodology approval process: NA.

4) Project activities supported by a methodology approved under a VCS approved GHG program unless explicitly excluded under the terms of Verra approval: The methodology AM0072 (Version 03.0) of the project utilized is a methodology approved under CDM Program, which is a VCS approved GHG program.

5) Jurisdictional REDD+ programs and nested REDD+ projects as set out in the VCS Program document Jurisdictional and Nested REDD+ (JNR) Requirements: NA.

Meanwhile, the project is not belonged to the projects excluded in Table 1 of VCS Standard 4.4.

Thus, the project is eligible under the scope of VCS program.

Eligibility of the project under VCS Standard:

The proposed project falls under section 3.1 General Requirements of VCS Standard with the following eligibility criteria:

Eligibility Criteria	Justification
Section 3.1.1 of VCS Standard (Version 4.4) Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document. Projects shall be guided by the principles set out in Section 2.2.1.	The project meets all applicable rules and requirements as set out under the VCS Program.
Section 3.1.2 of VCS Standard (Version 4.4) Projects shall apply methodologies eligible under the VCS Program. Methodologies shall be applied in full, including the full application of any tools or modules referred to by a methodology, noting the exception set out in Section 3.14.1. The list of methodologies and their validity periods is	The project applies CDM approved methodology AM0072 (version 03.0) which is an eligible VCS methodology along with tool or modules as applicable. Refer to section 3.1 and 3.2 of the PD&MR below for more details.

available on the Verra website.	
Section 3.1.3 of VCS Standard (Version 4.4) Projects shall apply the latest version of the applicable methodology in all cases unless a grace period applies to the project as set out in 3.21 below. Projects must update to the latest version of the methodology when reassessing the baseline and renewing a crediting period.	Projects are following the latest version of the applicable methodology.
Section 3.1.4 of VCS Standard (Version 4.4) Projects and the implementation of project activities shall not lead to the violation of any applicable law, regardless of whether or not the law is enforced.	Projects are following currently applicable laws. According to Environmental Impact Registration Form for Construction Projects , the project complies with all Chinese relevant laws and regulations. Refer to section 1.14 of the PD&MR below for more details.
Section 3.1.5 of VCS Standard (Version 4.4) Where projects apply methodologies that permit the project proponent its own choice of model (see the VCS Program document VCS Program Definitions for the definition of model), the model shall meet the requirements set out in the VCS Program document VCS Methodology Requirements, and it shall be demonstrated at validation that the model is appropriate to the project circumstances (i.e., use of the model will lead to an appropriate quantification of GHG emission reductions or removals).	Not applicable. There is no model needs to be chosen by the project proponent as per the applied methodology AM0072 (version 03.0).
Section 3.1.6 of VCS Standard (Version 4.4) Where projects apply methodologies that permit the project proponent to choose a third-party default factor or standard to ascertain GHG emission data and any supporting data for establishing baseline scenarios and demonstrating additionality, such default factor or standard shall meet the requirements set out in the VCS Program document VCS Methodology Requirements.	Not applicable. There is no third-party default factor or standard need to be chosen by the project proponent as per the applied methodology AM0072 (version 03.0).

Section 3.1.7 of VCS Standard (Version 4.4) Where the rules and requirements under an approved GHG program conflict with the rules and requirements of the VCS Program, the rules and requirements of the VCS Program shall take precedence.	Not applicable.
Section 3.1.8 of VCS Standard (Version 4.4) Where projects apply methodologies from approved GHG programs, they shall conform with any specified capacity limits (see the VCS Program document VCS Program Definitions for the definition of capacity limit) and any other relevant requirements set out with respect to the application of the methodology and/or tools referenced by the methodology under those programs.	Not applicable. There is no specified capacity limits and any other relevant requirements set out as per the applied methodology and tools.
Section 3.1.9 of VCS Standard (Version 4.4) Where Verra issues new VCS Program rules, the effective dates of these requirements are set out in Appendix 3 Document History and Effective Dates or equivalent for other program documents, and are listed in a companion Summary of Effective Dates document which corresponds with each update.	This is the first crediting period of the project, and it has fellow all the latest requirements of Verra.

1.4 Project Design

☐ The project includes a single location or installation only

☒ The project includes multiple locations or project activity instances, but is not being developed as a grouped project

☐ The project is a grouped project

The project is designed to introduce geothermal energy-based space heating system to realize heat supply to a series of new buildings and old buildings in Wucheng County over winter season.

Eligibility Criteria

The project is not a grouped project. So, it's not applicable.

1.5 Project Proponent

Organization name	Tangshan Jidong Oilfield New Energy Development Co., LTD.Wucheng Branch
Contact person	Ming Ding
Title	Chief of Financial Assets Department
Address	No. 66 Liting Road, Wucheng County, Dezhou City, Shandong Province
Telephone	13363153601
Email	gjf@petrochina.com.cn

Organization name	Tangshan Jidong Oilfield New Energy Development Co., LTD.
Contact person	Bing Han
Title	General Manager
Address	Area A, No. 51 Xinhua West Road, Lubei District, Tangshan City
Telephone	13784141312
Email	gjf@petrochina.com.cn

1.6 Other Entities Involved in the Project

Organization name	Daqing Oilfield Design Institute Co., LTD.[2]
Role in the project	VCS Consultant
Contact person	Jian Yao
Title	Project Director
Address	No. 42 Xiyuan Street, Ranghulu District, Daqing City
Telephone	0459-5903947
Email	yaojian@petrochina.com.cn

[2] Project Proponent who assists in project management, including monitoring & execution.

1.7 Ownership

The owner of the project is Tangshan Jidong Oilfield New Energy Development Co., LTD. Wucheng Branch. The approval of Environmental Impact Registration Form for Construction Projects, the approval of the project, Feasibility Study Report (FSR), and the business license of the project owner are evidence for legislative right. The equipment purchase contract, construction contract, the heat supply contract of the project also prove that the project is invested and operated by Tangshan Jidong Oilfield New Energy Development Co., LTD. Wucheng Branch.

Tangshan Jidong Oilfield New Energy Development Co., LTD. Wucheng Branch is a wholly-owned subsidiary of Tangshan Jidong Oilfield New Energy Development Co., LTD. According to the entrustment agreement signed between Tangshan Jidong Oilfield New Energy Development Co., LTD. and Daqing Oilfield Design Institute Co., LTD, Tangshan Jidong Oilfield New Energy Development Co., LTD. entrusted Daqing Oilfield Design Institute Co., LTD. for the project development and implementation. The emission reductions income shall be owned by the Geothermal right owners .

The responsibilities of each project proponent are as follows:

Tangshan Jidong Oilfield New Energy Development Co., LTD.: supervise the operation of the project in the later stage, including monitoring and regular patrolling activities.

Daqing Oilfield Design Institute Co., LTD: Responsible for the project development and overall management including: registration, issuance, management of VCS accounts, preparing PD and MRs, distribution of emission reduction benefits, and communication with relevant stakeholders. In the early development of the project, and assist the Tangshan Jidong Oilfield New Energy Development Co., LTD. in the monitoring and management of the project in the later period.

1.8 Project Start Date

As per section 3.7 of VCS Standard (Version 4.4), the project start date of a non-AFOLU project is the date on which the project began generating GHG emission reductions or removals. The project has been designed to include multiple project activity instance. The project activity and the date the project started fully commissioning on 8-November-2021. Thus, the project start date is 8-November-2021.

1.9 Project Crediting Period

This project adopts fixed crediting periods of 10 years. The crediting period is 10 years from

8/11/2021 to 7/11/2031 (both days included).

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

The estimated annual GHG emission reductions/removals of the project are:

☐ <20,000 tCO_2e/year

☒ 20,000 – 100,000 tCO_2e/year

☐ 100,001 – 1,000,000 tCO_2e/year

☐ >1,000,000 tCO_2e/year

The project annual average CO_2 emission reductions are estimated as 62054 tCO_2e, which is smaller than 300,000 tCO_2e. As per Section 3.1.9 of VCS Standard (Version 4.2), it is a project.

Project Scale	
Project	×
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
2021	28958
2022	62054
2023	62054
2024	62054
2025	62054
2026	62054
2027	62054
2028	62054
2029	62054
2030	62054

2031	33095
Total estimated ERs	620536
Total number of crediting years	10
Average annual ERs	62054

1.11 Description of the Project Activity

The project uses geothermal resources in cascade levels. The high-temperature water can be used to supply heat directly through plate heat exchangers, and the low-temperature water enters the geothermal heat pumps after the heat exchange. Through the secondary heat exchange of the geothermal heat pumps, the temperature of the feed water can be increased to meet the requirements of the terminal heating design parameters.

A total of 31 geothermal wells were constructed, of which the 14 production wells with an average flow rate of 120 m^3/h will supply the feed geothermal water at temperature of 62°C to 1 heat substations through primary heating network. The 17 re-injection wells will receive the return water at temperature of 21.8°C after secondary heat exchange. The heat substations will supply the feed water at temperature of 55°C to the project buildings and receive the return water at temperature of 38°C from them. In terms of terminal devices of heating configuration of users, floor radiation and radiator will be used as per Feasibility Study Report of the project. Technologies and measures employed by the project activity are shown in Figure 1-1 below.

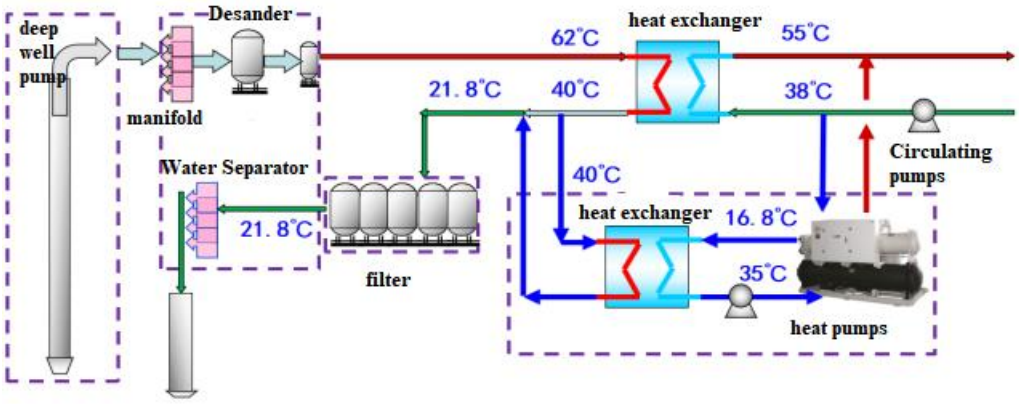

Figure 1-1 Technologies and Measures Employed by the Project Activity

The heat substations was constructed to enable the heat exchange between geothermal water transported by the primary heating network and the clean circulation water transported by the secondary network. In addition to water source geothermal heat pumps, the main equipment of the heat substations also includes deep well pumps, desander, plate heat exchangers, circulating pumps, make-up pumps,and water-softening facilities. All the geothermal wells, heat substations and related facilities were newly constructed.

The project has put into operation on 08-November-2021. Operation start date and test run period are the same and start on 08- November-2021. It can supply geothermal heat to 2235.2 thousand m^2 of buildings with a total heating load of 81.42 MW. It is affected by the actual occupancy rate. The buildings where the project is located is oldly and newly built and the occupancy rate is changing, which leads to the actual heating area and load in the first monitoring period being smaller than the design value. For the monitoring period from 08-November-2021 to 22-March-2022, the heating area is 1083946.152 m^2, ,from 11-November-2022 to 15-March-2023, the heating area is 1213478.615 m^2. The heating load is calculated based on the heating area. The main parameters of the heat substation is shown in Table 1-1 below.

Table 1-1: Main Equipment of Each Heat Substation

Equipment Name	Models and Specifications	Unit	Quantity	Remarks
Deep-well pump	Q=150m^3/h, Head=185 m	Unit	27	
desander	Treatment capacity: 600 m^3/h	Unit	3	
Primary plate heat exchangers	Primary heat exchange temperature of supply water and return water: 62/40°C; Secondary heat exchange temperature of supply water and return water:55/38 °C	Unit	3	
Secondary plate heat exchangers	Primary heat exchange temperature of supply water and return water: 40/21.8 °C; Secondary heat exchange temperature of supply water and return water:16.8/35 °C	Unit	2	
Secondary network Circulating pumps	Q=2400 m^3/h, Head=80 m	Unit	3	
Heating network circulating pump Circulating pumps	Q=900 m^3/h, Head=35 m	Unit	3	
Make-up pumps	Q=87 m^3/h, Head=38 m	Unit	2	
Tanks	Effective volume: 100 m^3			
Water softening facilities	Treatment capacity: 60 m^3/h	Unit	1	

There are new and old buildings in the project area. For new buildings, there was no existing heating system prior to the project activity, in baseline scenario, heating supply in winter for the building areas will be provided by newly built coal-fired boilers in boiler house. For old buildings, as established for the baseline in Section 3.4, Wucheng County People's Government Planning and Design Institute had implemented a plan to replace current small-scale heating boilers with coal-fired district heating boilers. Therefore, in the baseline scenario the current heating equipment(s) would not continue to be used. In baseline scenario, heating supply in winter for the building areas will be provided by newly built coal-fired boilers in boiler house.

1.12 Project Location

The Project is in Wucheng County, Dezhou City, Shandong Province of China. The geographical coordinates of the Project is 115°51' to 116°17'Eand 37°03 'to 37°23'N. The detailed coordinates of the 31 geothermal Wells are provided in Table 1-2 below.

Table 1-2: Coordinates of 31 Geothermal Wells

No.	Geothermal Wells		Coordinate（N）	Coordinate（E）
1	WRXK1	Production Well	37°13'45.282"	116°3'4.583"
2	WRXK2	Production Well	37°13'45.234"	116°3'1.04"
3	WRBK1	Production Well	37°13'45.261"	116°3'1.585"
4	WRJK1	Production Well	37°13'50.206"	116°3'48.655"
5	WRJK2	Production Well	37°13'50.435"	116°3'56"
6	WRGK1	Production Well	37°13'50.436"	116°3'56.547"
7	WRGK2	Production Well	37°13'50.434"	116°3'55.818"
8	WRDK1	Production Well	37°13'50.437"	116°3'56.363"
9	WRFK1	Production Well	37°13'49.006"	116°4'30.507"
10	WRFK2	Production Well	37°13'49.301"	116°4'27.321"
11	WRBY1	Production Well	37°13'49.787"	116°3'46.455"
12	WRBY2	Production Well	37°13'50.384"	116°3'47.697"
13	WRBY3	Production Well	37°13'50.386"	116°3'47.885"
14	WRBY4	Production Well	37°13'45.604"	116°3'5.328"
15	WRHG1	Injection Well	37°13'45.243"	116°3'1.221"
16	WRHG2	Injection Well	37°13'45.254"	116°3'1.404"
17	WRHG3	Injection Well	37°13'45.262"	116°3'4.217"
18	WRHG4	Injection Well	37°13'45.274"	116°3'4.4"
19	WRHG5	Injection Well	37°13'50.204"	116°3'48.47"
20	WRHG6	Injection Well	37°13'50.434"	116°3'55.638"
21	WRHG7	Injection Well	37°13'50.435"	116°3'56.18"
22	WRHG8	Injection Well	37°13'50.436"	116°3'56.725"
23	WRHG9	Injection Well	37°13'50.204"	116°3'48.287"
24	WRHG10	Injection Well	37°13'48.978"	116°4'30.884"
25	WRHG11	Injection Well	37°13'48.993"	116°4'30.699"
26	WRHG12	Injection Well	37°13'49.275"	116°4'27.668"
27	WRHG13	Injection Well	37°13'49.288"	116°4'27.495"
28	WRHG14	Injection Well	37°13'49.306"	116°4'27.148"
29	WRBY5	Injection Well	37°13'45.603"	116°3'5.145"
30	WRBY6	Injection Well	37°13'45.597"	116°3'4.396"
31	WRBY7	Injection Well	37°3'45.595"	116°3'4.212"

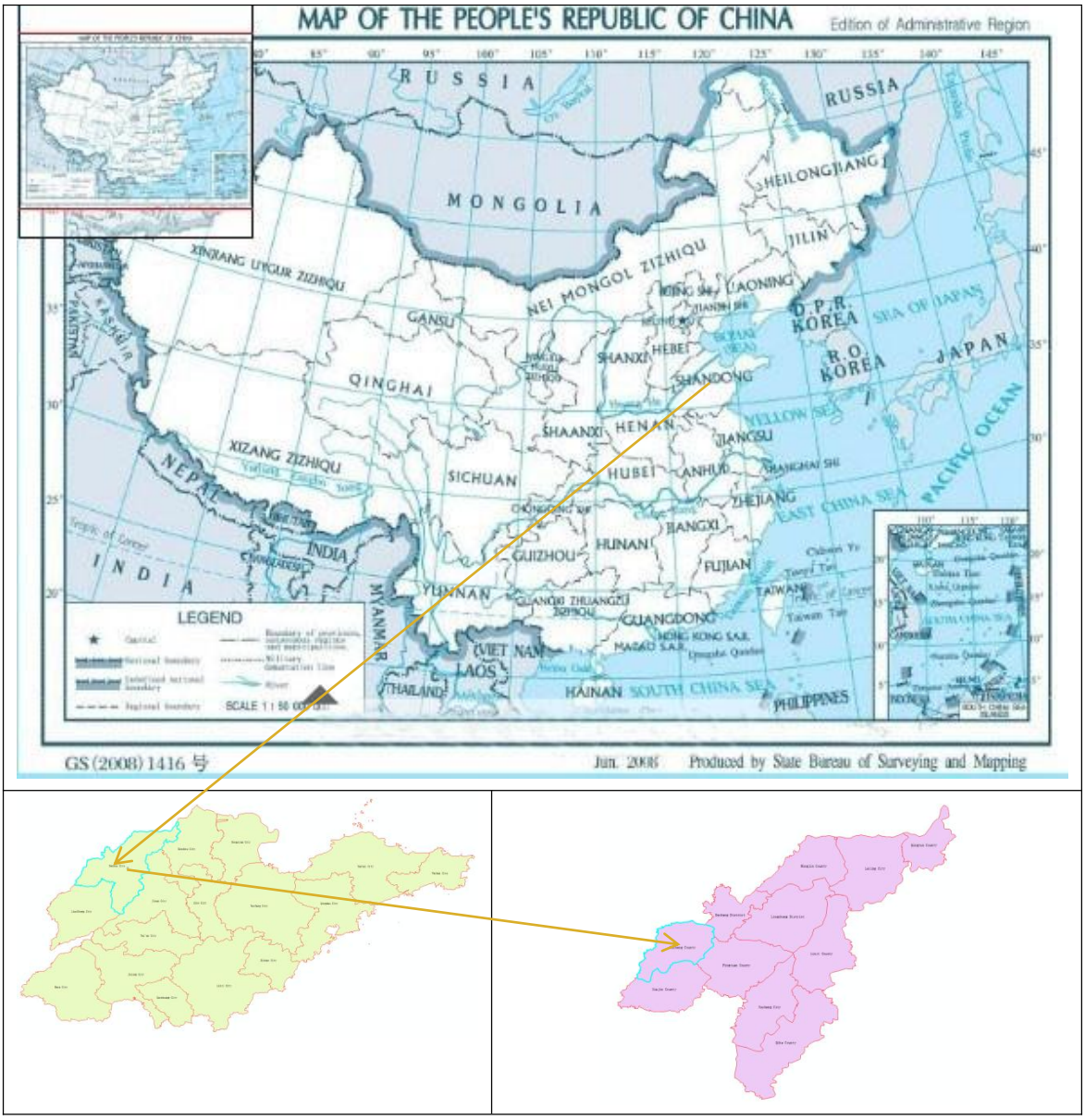

Figure 1-2 Location of the Project

1.13 Conditions Prior to Project Initiation

The project activity instances involve geothermal space heating system. For old buildings that were planned to be constructed as coal-fired boilers before project activities,The government department requires the dismantling of small coal-fired boilers before October 2021[3]. For new

[3] http://www.dezhou.gov.cn/n1403/n38391604/n59392514/n66398575/c67381092/content.html

buildings there are no project activities at the project sites before the construction of the proposed 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.

1.14 Compliance with 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) (Development and Reform of Energy resources (2017) No. 2100)[4]

2. Catalogue for the Guidance of Industrial Structure Adjustment (Amendment 2021).

Water drawing permit from governmental authorities: Wucheng County Administrative Service Approval Bureau. The approval well demonstrate that local government permits the construction of the project. Consequently, the project is compliance with laws, status, and other regulatory frameworks.

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The project has neither been registered nor seeking registration under any other GHG programs. The project is seeking registration only in VCS program.

1.15.2 Projects Rejected by Other GHG Programs

The Project has not been rejected by any GHG programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

Does the project reduce GHG emissions from activities that are included in an emissions trading program or any other mechanism that includes GHG allowance trading?

☐ Yes ☒ No

The project proponent is not part of any emission trading program. The net GHG emission reductions from the project will not be used for compliance with emission trading programs or to meet binding limits on GHG emissions. The project activity has not participated under any other GHG programs.There is a cap & trade scheme in China. However, the project activity is not

[4] https://www.gov.cn/xinwen/2017-12/20/5248855/files/7ed7d7cda8984ae39a4e9620a4660c7f.pdf

included the mandatory emission control scheme since the scheme only cover the high-emission industries, such as power generation sector that emitted at least 26,000 tons of CO_2e/year. There is no emission cap enforced for the project owner. In addition, the heating system of the heat substation can be identified through its GPS coordinates and unique identification code, which will prevent the geothermal heating system counted in the project activity to be part of any other voluntary market or emission reduction mechanism (CDM, CCER, GS etc.) as well. The project will not apply for emission reduction credits or labels under any other schemes except VCS. In addition, the project owner provided "Declaration of No Double Counting" and "Declaration of not involved in other GHG scheme".

1.16.2 Other Forms of Environmental Credit

Has the project sought or received another form of GHG-related credit, including renewable energy certificates?

☐ Yes ☒ No

The project hasn't sought or received another form of environmental credits.

1.16.3 Supply Chain (Scope 3) Emissions

The project exclude supply chain (Scope 3) emissions.

1.17 Sustainable Development Contributions

1.17.1 Sustainable Development Contributions Activity Description

A summary description of project activities that result in sustainable development (SD) contributions:

The project is planned and designed to introduce geothermal energy-based space heating system to realize heat supply to a series new and old buildings in Wucheng county over winter season, which received heat supply from fossil fuel-based heat supply system as a business-as-usual scenario before, which has positive impact to climate and also provide jobs.

The Project will contribute to sustainable development in the following ways:

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".

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".

This project will increase 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".

1.17.2 Sustainable Development Contributions Activity Monitoring

The project introduce geothermal energy-based space heating system to realize heat supply to a series new and old buildings in Wucheng County over winter season.

The Project contribute to sustainable development in the following ways monitoring period:

Project supply geothermal energy-based heat to the project site. Thus, the project achieve SDG 7 “Ensure access to affordable, reliable, sustainable and modern energy for all”.

The project achieve a GHG emission reduction during the crediting period. Thus, the project achieve SDG 13“ Take urgent action to combat climate change and its impacts”.

This project increase income of local residences and accelerate economy development in rural areas. During the crediting period, direct and indirect employment opportunities generated. Thus, the project achieve SDG 8 “Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all”.

Table 1: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	13.0	SDG 13 "Take urgent action to combat climate change and its impacts"[5]	In 2020, China's energy consumption per unit of GDP was reduced by 24.4% compared with 2012; 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.	No further changes this monitoring period	The project activity is designed to introduce geothermal energy based space heating system to realize heat supply to a series of commercial and residential buildings (off grid solutions for targeted users and/or applications) 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.

[5] https://sdgs.un.org/goals/goal13

2)	7.0	SDG 7: "Ensure access to affordable, reliable, sustainable and modern energy for all[6]	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.	Heating fees will be charged according to local normal levels	The project activity is designed to introduce geothermal energy based space heating system to realize heat supply to a series of old and new buildings (off grid solutions for targeted users and/or applications) 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.

[6] https://sdgs.un.org/goals/goal7

3)	8.0	SDG 8 "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all" [7].	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 and 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.	Provides job opportunities for all locals during project implementation and monitoring activities irrespective of gender or any other status.	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.

[7] https://sdgs.un.org/goals/goal8

1.18 Additional Information Relevant to the Project

Leakage Management

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

Refer to section 5.3 of the Joint-PD-MR for more details.

Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the project description.

Further Information

No additional relevant legislative, technical, economic, sectoral, social, environmental, geographic, site-specific and/or temporal information that may have a bearing on the eligibility of the project, the net GHG emission reductions or removals, or the quantification of the project's net GHG emission reductions or removals.

2 SAFEGUARDS

2.1 No Net Harm

Socio-economic impacts

The Environmental Impact Registration Form for Construction Projects was compliled by Tangshan Jidong Oilfield New Energy Development Co., LTD., Wucheng Branch. The environmental impact registration form of the project has been completed, and the record number is 202137142800000090. During the construction and operation of this project, the project provides employment opportunities for local residents. Therefore, the project plays an important role in the local social and economic development.

In conclusion, the project has no negative impacts on local environment. No net harm on local environment and social community has been detected for the project.

2.2 Local Stakeholder Consultation

The Project Owner collected comments by local stakeholders on the project activity. Survey questionnaires were distributed to local residents and government officials by the Project owner on 08/2021 for the Project. The survey questionnaire was designed to assess the project impacts on the local environment and social economic development. The structure of the survey respondents is listed in Table 2-1 below.

Table 2-1: Structure of stakeholder survey for the Project

Item \ Distribution		Quantity	Percentage
Number of stakeholders surveyed	Male	28	56.00%
	Female	22	44.00%
Age	＜25	10	20.00%
	25-45	20	40.00%
	45-55	15	30.00%
	＞55	5	10.00%
Occupation	Worker	15	30.00%
	Peasant	20	40.00%
	Management personnel	5	10.00%
	Civil servant	5	10.00%
	Unspecified	5	10.00%

Forty questionnaires were distributed to local stakeholders for each project, and all questionnaires have been recollected. Comments from these questionnaires are summarized in Table 2-2 below:

Table 2-2: Summary of stakeholders' comments

No.	Questions	Attitude or Opinion	Amount	Percentage
1	Do you know about the project activity?	Very much	40	80.00%
		Heard of	10	20.00%
		Nothing	0	0.00%
2	Do you think the project will improve the current situation of heating system?	Yes	35	70.00%
		No	0	0
		Don't know	15	30.00%
3	Do you think the project will improve the local employment situation?	Yes	35	70.00%
		No	5	10.00%
		Don't know	10	20.00%
4	Do you think the project will improve the local social community?	Yes	40	80.00%
		No	0	0.00%

		Don't know	10	20.00%
5	What impact do you think will the project bring to your family?	Positive impact	30	60.00%
		No impact	20	40.00%
		Negative impact	0	0.00%
6	What is the most probable environmental impact do you think the project will cause after the construction finish? (multiple choice)	None	40	80.00%
		Air pollution	0	0.00%
		Water pollution	0	0.00%
		Noise pollution	0	0.00%
		Harm to land	0	0.00%
		Don't know	10	20.00%
7	What do you think will be the project's impact on the local community? (Multiple choices)?	Promote economic development	5	10.00%
		Improve heat supply condition	40	80.00%
		No great impact	5	10.00%
8	What is your attitude to the project activity?	Support	45	90.00%
		Against	0	0.00%
		Indifferent	5	10.00%

In general, local stakeholders are supportive of the project construction. The survey shows that a majority of local stakeholders think the Project will help improve the life of local people without much adverse environmental impact. The survey shows that almost the stakeholders are supportive to the proposed project, believing that the Project will provide more employment opportunities and improve the local air quality by reducing the fossil fuel use. Therefore, the implementation of the Project is regarded as beneficial by most of the local stakeholders.

Local Stakeholder Consultation during the project implementation stage:

Procedure followed to invite stakeholder comments

Public hearing for local stakeholders:

Invitation procedure

The stakeholder consultation was conducted by Tangshan Jidong Oilfield New Energy Development Co., LTD., Wucheng Branch. with assistance from Daqing Oilfield Design Institute Co., LTD. Stakeholder groups were identified, and they were informed through oral and written means about the meeting. The invitation letter was sent by email to participants. This invitation email was done 2 weeks before the meeting date.

Place and date of the meeting

The stakeholder consultation was held from 9:00 a.m. to 11:30 a.m. on 5-August-2021 at

Conference room, 3/F, No. 66 Liting Road, Wucheng County, Dezhou City, Shandong Province.

Meeting Participants

The meeting was attended by local residents and representatives from the following stakeholder categories:

1.Local residents/farmers

2.Local government representatives

3.Representative of the project owner

There were 50 participants who accepted the invitation, attended the meeting and returned the

questionnaire.

Opening of the meeting

Hua Guo from Tangshan Jidong Oilfield New Energy Development Co., LTD., Wucheng Branch.. introduced the project activity and its social and environmental impacts.

The project activity is designed to introduce geothermal energy-based space heating system to realize heat supply to a series of new and old buildings in Wucheng County 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 using geothermal energy instead of the combustion of fossil fuel for space heating.

Question and answer session about the project

After the description of the project, all participants have the opportunity to express their questions and comments. The representative of project owner provided answers to the questions and comments raised by the stakeholders.

Ownership of the issued carbon credits was also discussed during this session. All the end users who attended the meeting were notified that the project owner has the legal ownership of the carbon credits generated by the project activity.

Discuss any potential risks and positive impacts of the project

Afterwards, the meeting continued with the discussion of the Awareness training and project risk assessment activity. The Awareness training make participants aware of the contribution to the environment and the social, such as this project create jobs opportunities for locals, especially women's groups or other marginalized groups. During the project risk assessment, participants discussed the difficulties and risks that may be encountered in the process of project development.

Discuss the monitoring plan for environmental impacts

Regarding the monitoring plan, it mainly discusses the practicability and rationality of related

parameter monitoring to ensure that it can be successfully registered and issued in VCS. During the stakeholder consultancy meeting, some stakeholders worried that the project would bring noise, land occupying and pollution on employees and local residents' living. For these issues, the project owner offer some measures: i.e., installation of soundproof devices and plating of green isolation belts are used for mitigating noise; the area the project built not occupy life area of local residents. So, the effect of the noise from the plant is little to local residents; at the project site, waste recycling carried out to reduce emit of waste. All attendances to the meeting were satisfied to the measures. The impacts of construction of the project are basically positive. All stakeholders were pleased with the development of the project.

Discussion of Continuous input & Grievance Mechanism

After discussions of the impacts and monitoring plan, the host then explained about the Continuous input & Grievance Mechanism which entails how the stakeholders can reach out to the project implementer during the project's crediting period in case of any questions, comments or suggestions. Also, the contact methods are provided to the attendees to see if the methods are appropriate and easy to access.

In a word, the impacts of construction of the project are basically positive. All stakeholders were pleased with the development of the project. The VCS project would actually facilitate the development of the local economy and increase the income of local residents.

Communications with Local stakeholders are being carried out 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. There are no negative comments received for the project. In line with VCS requirements all the processes have been implemented to receive comments from local stakeholders as well as communicate with them at periodic intervals.

2.3 Environmental Impact

The Environmental Impact Registration Form has been completed for filing for the Project . The environmental impacts of the project are summarized as follows.

1. Construction Phase

1.1 Air pollution

Construction dust is generated during excavation, pigging and backfilling. The discharge of dust is proportional to the area of the construction site and the frequency of construction activities. At the same time, construction machinery and welding process back to produce a small amount of smoke. During the construction period, closed construction, sprinkling dust suppression, speed limit and other measures can reduce dust pollution to the atmosphere; Construction machinery exhaust through the selection of low energy consumption, low pollution emissions of

construction machinery and vehicles, strengthen the management and maintenance of machinery and vehicles; Welding dust is discharged after being treated by mobile dust purifier.

The above measures can effectively reduce the impact of waste gas on the surrounding environment during construction period and have little impact on the ambient air.

1.2 Wastewater

The waste water during the construction period is mainly pipe pressure test waste water and a small amount of domestic sewage produced by the construction personnel.

The pressure test medium of the pipeline is tap water, and the main pollutant is SS, which belongs to clean water and can be discharged to the municipal sewage pipe network after precipitation.

During the construction period, the construction personnel live on the existing living facilities of the community, and the domestic sewage is processed by the septic tank and then sent to the municipal sewage pipe network.

1.3 Noise

Construction noise mainly comes from construction machinery noise and transportation vehicle noise.

In view of noise during construction, the construction party took the following measures:

-Construction units should choose construction machines and tools and transport vehicles in line with the relevant national standards, choose low-noise construction machinery and technology, and the machinery exceeding the national standards should be prohibited from entering the construction. Fixed mechanical equipment with large vibration should be equipped with vibration damping frame, and all kinds of construction equipment should be strengthened to maintain and maintain their normal operation, so as to fundamentally reduce the noise source.

-Reasonable arrangement of construction time, strictly prohibited in 22:00~6:00 period of construction.

-In the transportation of construction materials, a reasonable choice of transportation route, and try to transport in the day, to reduce the impact on the rest of residents on both sides of the transportation road at night. For the situation that night transportation must be carried out, the prohibition and speed limit sign should be set, and the speed of vehicles should be less than 20km/h when passing at night. In addition, drivers should slow down and stop honking when passing through existing towns, schools and hospitals.
-The construction unit requires the construction unit to post notices and complaints on the site, the construction unit in time to contact the local environmental protection department after receiving complaints, in order to deal with various environmental disputes in a timely. .

The Wucheng Geothermal Based Space Heating System conforms to the national industrial policy; After taking the corresponding environmental protection measures, the pollutants generated during the construction period and operation period can be discharged up to the standard or reasonably placed, with little impact on the environment. Therefore, the project is feasible from the perspective of environmental protection.

2.4 Public Comments

The project will be open for public comment on the verra website.

2.5 AFOLU-Specific Safeguards

NA.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Approved baseline and monitoring methodology:

AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating (Version 03.0).

Tool applied:

Tool 02 Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0)

Tool 03 Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (Version 03.0)

Tool 05 Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0)

Tool 07 Tool to calculate the emission factor for an electricity system (Version 07.0)

Tool 24 Common practice (Version 03.1)[8]

For more detail information about the methodology and tools, please reference to the following link:

https://cdm.unfccc.int/methodologies/DB/TMGAEU1XHW6BFN1CDFCTWV9VUGVI19

https://cdm.unfccc.int/Reference/tools/index.html

[8] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-24-v1.pdf

3.2 Applicability of Methodology

Justification for the choice of the selected methodology is shown in the following table:

Table 3-1: Applicability of AM0072

AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating (Version 03.0)	
Eligibility Criteria	**Justification for the Project Activity**
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.	Applicable. The project activity is designed to introduce geothermal energy-based space heating system to realize heat supply to a series of new and old buildings in Wucheng County over winter season. All the facilities related to the geothermal heating system including new and old buildings. And the project activity didn't involve any capacity expansion through the addition of extra geothermal wells.
The methodology is applicable under the following conditions: (a) The geographical extent of the 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;	Applicable. The geographical extent of the project boundary includes the 31 geothermal wells, and the primary networks and secondary network. And the Project supplies heat to the residential buildings and the public buildings. No existing facilities were involved.
(b) Project will use geothermal resources for centralized space-heating system of residential areas, commercial areas and/or industrial areas;	Applicable. As per Feasibility Study Report, the project activity is designed to introduce geothermal energy-based space heating system to realize heat supply to a total of new and old residential buildings and public buildings in Wucheng County. It can supply geothermal heat to 2235.2 thousand m^2 of existing buildings and new buildings.
(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	Applicable. As per Feasibility Study Report, the project involves installation of new geothermal based centralized space heating systems in existing buildings and new buildings of the project, which will replace the use of isolated coal-fired boilers in baseline scenario

of existing facilities the methodology is applicable to expanding the existing geothermal heating system;	completely.
(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;	Applicable. As per Feasibility Study Report, Central heating section: the calculated capacity of the original system is 54.61MW, due to the increase of new buildings and the active installation capacity of the project is 85MW, with the capacity increased by more than 10%.a new baseline scenario has to be determined for the new capacity.
(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;	Applicable. As per Feasibility Study Report, only the existing buildings and new buildings were supplied by the fossil fuel heat-only boilers used in the baseline. No industrial processes were involved.
(f) The use of GHG emitting refrigerants is not permitted under this methodology.	No GHG emitting refrigerants is used.
In addition, the applicability conditions included in the tools referred to below apply.	Justification for the choice of the selected tools is shown in the following tables.

Table 3-2: Applicability of applied tools

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, interalia, 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.	Applicable. The project activity is designed to introduce geothermal energy-based space heating system to realize heat supply to a series of new and old buildings in WuCheng County. Alternative scenarios, barrier analysis, investment analysis and common practice analysis will be carried out based on Tool 02.
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	Applicable. The project activity will use electricity from grid (the Project is connected to the North China Power Grid (NCPG), which falls under scenario A of Tool 05 (Version 03.0). Therefore, emissions related to

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 (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.	electricity consumption need to be calculated. Electricity bill and invoice with the power grid company were provided as evidence.
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.	Not applicable. This methodological tool is applied for calculating for emission by electricity consumption in 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	Not relevant. The project will install geothermal based space heating system to displace fossil fuel consumption.

baseline scenario or to sources of leakage. The tool only accounts for CO_2 emissions.	No captive renewable power generation technologies will be installed to provide electricity in the project activity. Tool 05 is used for calculating project emissions of CO_2. 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 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).	Not relevant. In baseline scenario, heating supply in winter for the building areas were provided by coal-fired boilers in boiler house. No electricity will be used, 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.	Applicable. The project activity uses electricity from NCPG only. Electricity bill and contract with the power grid company were provided as evidence. Emission factor for the project electricity system will be calculated for grid power plants only as per Tool 07.
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.	Applicable. The project electricity system is located totally in Shandong Province of China, which is not an Annex I country.
Under this tool, the value applied to the CO_2 emission factor of biofuels is zero.	Not relevant.

	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 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.	Applicable. The project applies the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality" for the demonstration of additionality.
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.	Applicable. It is consistent of Tool 24 (Version 03.1) and AM0072 (Version 03.0) on approaches for the conduction of the common practice test.

3.3 Project Boundary

The greenhouse gases included or excluded from the project boundary are summarized in Table. 3-3 below.

Table 3-3: Emission Sources Included in or Excluded from the Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Fossil fuel used for space heating	CO_2	Yes	Main emission source
		CH_4	No	Minor source. Neglected for simplicity and conservativeness
		N_2O	No	Minor source. Neglected for simplicity and conservativeness
Project	Electricity used for geothermal extraction /operations	CO_2	Yes	Can be a significant emission source
		CH_4	No	Minor source
		N_2O	No	Minor source
	Fuel used	CO_2	Yes	Can be a significant emission source

Source		Gas	Included?	Justification/Explanation
	for geothermal extraction /operations	CH_4	No	Minor source
		N_2O	No	Minor source
	Fugitive emissions from geothermal resource extraction	CO_2	No	Minor source
		CH_4	No	Minor source
		N_2O	No	Minor source

As per AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating (Version 03.0), the spatial extent of the project boundary includes:
(a) The site of geothermal heat extraction including, geothermal wells, re-injection wells, pumps, geothermal water storage tanks etc.
The Central heating section project includes 14 production wells and 17 re-injection wells as shown in Figure 3-1.

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

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

The floor radiation and radiator system was installed in buildings connected to the substations. There is no decentralized heating equipment involved in the project boundary.

Figure 3-1 shows the project boundary in which the geothermal based space heating system is operated. Ground water extracted from geothermal production well j is pumped and transmitted, through primary heating network, to substation k where water at the downstream side of substation k will receive heat through heat exchangers and be subsequently supplied to endusers of construction type m through secondary heating network. Substation k (heat exchangers) is the primary point of measurement for monitoring parameters. The geothermal water returned from the exchangers will be re-injected into the re-injection well.

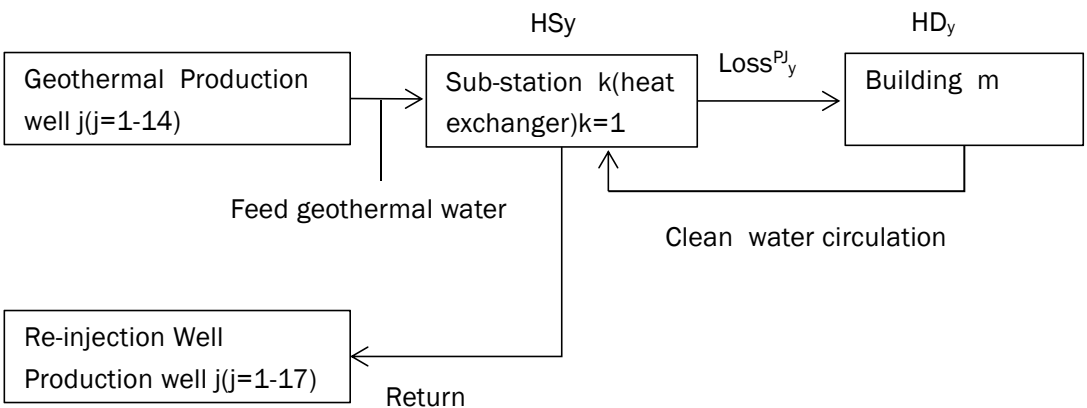

Figure 3-1: Project Boundary

3.4 Baseline Scenario

As per section 5.2 of AM0072 Fossil Fuel Displacement by Geothermal Resources for Space Heating (Version 03.0), the most plausible baseline scenario shall be determined with Tool 02 Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0) by the application of the following steps:

Step 1 Identification of alternative scenarios

This Step serves to identify all alternative scenarios to the proposed project activity that can be the baseline scenario through the following Sub-steps:

Step 1a: Define alternative scenarios to the proposed project activity.

Identify all alternative scenarios that are available to the project participants and that provide outputs or services (i.e. heat supply) with comparable quality as the project activity. For the purpose of identifying relevant alternative scenarios, provide an overview of other technologies or practices used for generation of heat that have been implemented prior to the start of the project activity or are currently underway in the relevant geographical area.The realistic and credible alternative(s) may include:

Table 3-4: The realistic and credible alternative(s)

No	Alternative scenarios	Pre-screening
1	a) Implementation of the project activity without the benefits;	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 - Both in the case of (i) new buildings and in the case of (ii) existing buildings: The location of the project is not in the central heating area. District heating is not provided in the project area.

	(ii) The replacement of the heat-only boilers in the existing network(s) by new heat-only boilers.	Excluded – There are no existing integrated district heating systems installed in any of the Project Areas. Both in the case of (i) new buildings and in the case of (ii) existing buildings, this option is not applicable to the Project Activity.
	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 -For new buildings , It is normal practice establishment of a new district heating network of Coal fired boilers in boiler houses, supplying several buildings through a heat distribution network in Wucheng county for new buildings of the project area . For existing buildings one of the main types of heating system is described under c(i): coal-fired district heating system. The local government has a policy to replace existing small coal-fired boilers — i.e. coal-fired district heating boilers[9]. Accordingly , the baseline for existing buildings with the baseline c(i) can be considered the same as for new buildings, as described above.
	(ii) Natural gas fired boilers in boiler houses, supplying several buildings through a heat distribution network;	Excluded - The laying of natural gas pipeline is relatively complicated, and the cost is high.Meanwhile, local policies do not allow the construction of new gas boilers[10].

[9] http://www.dezhou.gov.cn/n1403/n38391604/n59392514/n66398575/c67381092/content.html

[10] http://www.dezhou.gov.cn/n1403/n38391604/n59392514/n66398575/c67381092/content.html

	(iii) Oil fired boilers in boiler houses, supplying several buildings through a heat distribution network;	Excluded - Oil fired boilers are more expensive than gas-fired boilers in order to produce the same volume of heat. According to "China Energy Statistical Yearbook 2020[11] , Coal-fired heating is still the mainstream method in Shandong province.
	(iv) Decentralized cogeneration plants;	Excluded – Decentralized cogeneration plants do not cover the project area.
	(v) Renewable energy sources, such as biomass or solar thermal collectors, connected to a heat distribution network.	Excluded - Due to the limit on biomass reserves and 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[12]. Therefore, this option is not a realistic and credible alternative scenario.
	d) Continued use or introduction of individual heat supply solutions:	
	(i) Coal fired boilers for individual buildings;	Excluded - As per "Three-Year Action Plan to Strengthen Air Pollution Prevention and Control[13] ", coal fired boilers for individual buildings should be eliminated gradually. New coal fired boilers built for individual buildings are forbidden by local government.
	(ii) Coal fired stoves for individual apartments;	Excluded - 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[14], it sounds the

[11] https://www.yearbookchina.com/navibooklist-n3020013309-1.html

[12] http://www.gov.cn/zhengce/2022-06/08/content_5694539.htm

[13] http://www.gov.cn/zhengce/content/2018-07/03/content_5303158.htm

[14] http://www.xinhuanet.com/legal/2019-01/09/c_1210034051.htm

		alarm on safety of home heating in winter. New coal fired stoves built for individual apartments are forbidden by local government[15].
	(iii) Natural gas fired boilers for individual buildings	Excluded – as per demonstration of 3 (ii) above, the area where the project is located is temporarily not covered by natural gas pipe network[16].
	(iv) Natural gas fired stoves for individual apartments	Excluded – Natural gas fired stoves for individual apartments is dangerous and expensive. Heating with natural gas costs 2.27 times as much as heating with coal[17].
	(v) Oil fired boilers for individual buildings	Excluded - Oil-fired boilers generally use light oil and heavy oil as fuel, in which diesel oil is most used. The hourly fuel cost of a one-ton diesel boiler is about nearly two times than that of natural gas fired boilers[18].
	(vi) Oil fired stoves for individual apartments	Excluded - Oil fired stoves are mainly used in the industrial field. It is not yet completely mature for using in apartments[19].
	(vii) Electricity (e.g. off-peak storage heating)	Excluded - Electricity-based heating technologies are more costly and thus not comparable with other alternatives in terms of cost-effectiveness. The operating costs of electricity boilers are about four times than that of coal-fired

[15] http://www.gov.cn/zhengce/content/2018-07/03/content_5303158.htm

[16] http://www.bulletin.cas.cn/publish_article/2020/9/20200914.pdf

[17] http://www.bulletin.cas.cn/publish_article/2019/4/20190405.htm

[18] https://www.guolujiage.cn/news/news1/512.html

[19] https://www.sohu.com/a/355884111_99999190

		boilers[20].
	(viii) Individual heating devises using renewable energy sources, e.g. solar thermal collectors	Excluded - 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 that are air and water. The efficiency of the air heating solar system is low and the water heating solar system is easy to ruin by freezing. There are no stable individual space heating devices using solar thermal collectors[21].
	(ix) Individual heating devises using nonrenewable biomass	Excluded - As illustration of 3 (v) above, there is no sufficient biomass in the project area. Technical barriers for the commercialization of household biomass heating devices are still existing.

There is no existing geothermal based heat supply system, so it is not necessary to analysis the options for expansion of a geothermal heat supply system.

In summary, 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;

Step 1b: Consistency with mandatory laws and regulations

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) (Development and Reform of Energy resources (2017) No. 2100)[22]

2. Catalogue for the Guidance of Industrial Structure Adjustment (Amendment 2021).

[20] https://www.zzboiler.com/baike/explanation/3750.html

[21] https://www.ixueshu.com/h5/document/10a911bfed7419ce82f3a2eb1bb17fed318947a18e7f9386.html

[22] https://www.gov.cn/xinwen/2017-12/20/5248855/files/7ed7d7cda8984ae39a4e9620a4660c7f.pdf

The Project has obtained the project approval and EIA approval from local government authorities:

The approvals well demonstrate that local government permits the construction of the project. Consequently, the project is compliance with laws, status and other regulatory frameworks.

Thus, the option 1(a) complies with all relevant law and regulations.

According to the "the Plan for Clean Heating in Winter in Northern China (2017-2021) (Development and Reform of Energy resources (2017) No. 2100)", coal-fired boiler heating is the mainstream situation, which is in line with Chinese laws or regulations.

Thus, option 3(i) complies with all relevant law and regulations.

Step 2: Barrier analysis

There are no technology barriers, acceptability barriers and financial barriers that may prevent these two alternative scenarios to occur. As per Tool 02 Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0), go to Step 3 investment analysis.

Step 3: Investment analysis

The comparison of economic attractiveness is carried out by applying Step 3 Investment analysis of Tool 02 Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0).According to Methodological tool 27 Investment analysis: For the baseline scenario of centralized heating with coal-fired boilers, the project owner is responsible for Companies mainly producing geothermal energy will not invest in coal-fired boiler central heating projects and cannot directly control the baseline Scenario, therefore, this project chooses benchmark analysis method for investment analysis.

The benchmark return rate set by the group company is 8%.

(1) Basic parameters for calculating financial indicators

Based on the feasibility study report of this project, the basic financial indicators calculated are as follows:

Table 3-5: Basic financial indicators

No	Project	Unit	Data	Data source
General description				
1	Heating area	m^2	2235200	FSR
2	Heating fee for civil construction (excluding tax)	RMB/m^2	20.7	FSR

No	Project	Unit	Data	Data source
3	Heating fees for public buildings (excluding tax)	RMB/m^2	25.7	FSR
4	Annual heating hours	Hour	2,880	FSR
5	New building interface fee	RMB/ m^2	70.0	FSR
6	New building area	m^2	766,000	FSR
7	Static total investment	10^4 RMB	29,886.62	FSR
Financing				
8	Loan ratio	/	45%	FSR
9	Repayment period (excluding construction period)	Year	10	FSR
10	Working capital	10^4 RMB	214	FSR
11	Working capital loans	10^4 RMB	150	FSR
12	Working capital loan ratio	/	70%	FSR
13	Long term loan interest rate	/	4.185%	FSR
14	Working capital loan interest rate	/	3.470%	FSR
Tax				
15	urban maintenance and construction tax	Proportion to value-added tax	5%	FSR
16	Education surtax	Proportion to value-added tax	5%	FSR
17	income tax rate	/	25%	FSR
18	Period of depreciation	Year	15	FSR
19	Value added tax rate: interface fee and heating fee	/	9%	FSR
20	Value added tax rate: electricity fee	/	13%	FSR
21	Value added tax rate: water fee	/	9%	FSR
22	Value added tax rate: Equipment	/	13%	FSR
Cost				
23	Residual value rate	/	3%	FSR
24	Number of employees (regular employees)	person	5	FSR
25	Number of employees (temporary workers)		20	FSR
26	Annual average salary	10^4 RMB/y	110	FSR

No	Project	Unit	Data	Data source
27	Ground maintenance rate	Original value of fixed assets occupying the ground	1.5%	FSR
28	Drilling maintenance costs	10^4 RMB/y	150	FSR
29	Pipeline maintenance cost	10^4 RMB/y	20	FSR
30	Office building rental fee	10^4 RMB/y	15.5	FSR
31	Public network fee	10^4 RMB/y	1.6	FSR
32	Period fee	10^4 RMB/y	19	FSR
32.1	Other manufacturing costs	10^4 RMB/y	5	FSR
32.2	Other management rates	10^4 RMB/y	14	FSR
33	Water fee (excluding tax)	RMB/t	4.01	Refer to the urban tap water price table in Wucheng County
34	water consumption	10^4 t/y	12.384	FSR
35	Electricity fee (excluding tax)	RMB/kwh	0.484	Lufagai Price [2020] No. 1352
36	Power consumption	10^4 kwh/y	1495.89	FSR
37	Capacity charge	10^4 RMB/y	70.56	FSR
38	Carbon benefits	10^4 RMB/y	341.30	count
39	carbon price	RMB/tCO_2	55.00	reference price
40	Emission reduction	tCO_2	62054	See the calculation table for emission reduction

(2) Compare the internal rate of return of the project with the financial benchmark

Based on the benchmark analysis (Option III), the project is not considered financially attractive if the financial indicator (such as the IRR) is lower than the benchmark.

Table 3-6 shows the situation of the IRR of this project with emission reduction benefits and no emission reduction benefits. There is no emission reduction benefit, and the full investment IRR is below the 8% benchmark. Therefore, this project is not financially attractive. With the support of emission reduction benefits, the full investment IRR of this project has significantly improved and exceeded the benchmark. Therefore, this project will be considered attractive to investors after receiving emission reduction benefits.

Table 3-6: Financial indicators of this item

	IRR (%) (after income tax)
Excluding revenue from voluntary emissions reduction transactions	6.66
Consider revenue from voluntary emissions-reduction	8.07

transactions	

Sensitivity analysis

The sensitive parameters will vary by 10%:

1) Static total investment

2) Average annual operation and maintenance fee

3) Heating fee

4) Heating area

Table 3-7: Sensitivity Analysis

Sensitivity Analysis					
	-10%	-5%	0	5%	10%
Static total investment	8.21%	7.40%	6.66%	5.99%	5.36%
O&M costs	7.45%	7.06%	6.66%	6.26%	5.85%
Heating fee	4.81%	5.76%	6.66%	7.54%	8.39%
heating area	4.58%	5.64%	6.66%	7.66%	8.64%

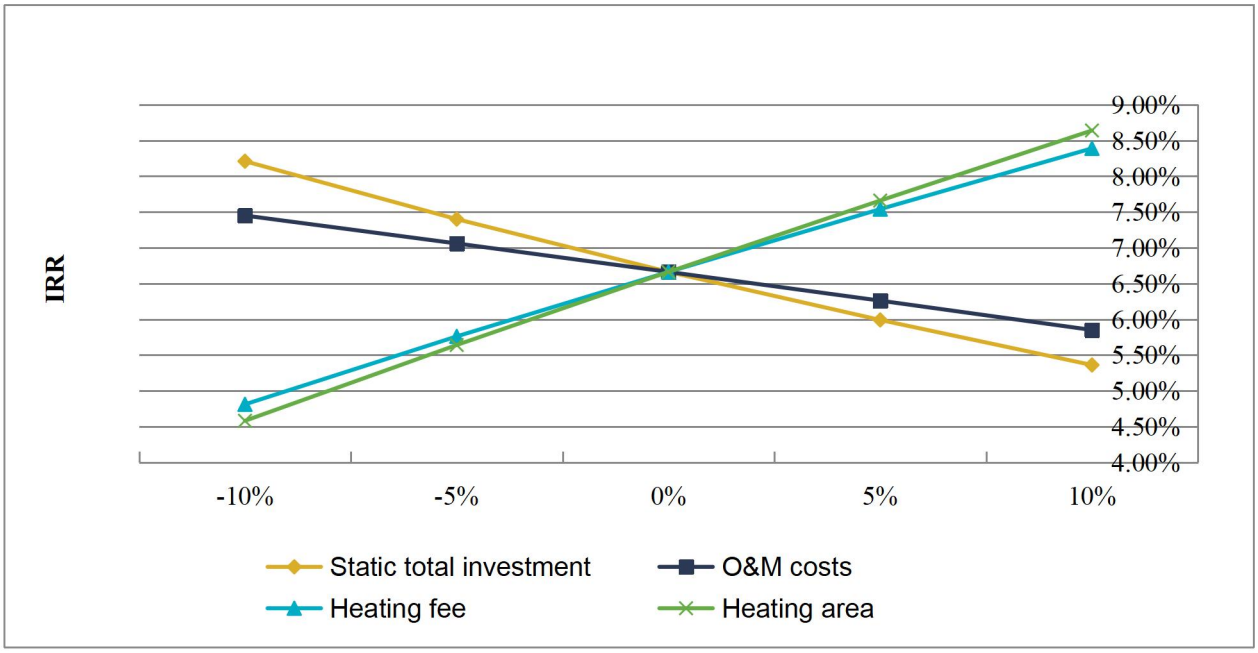

Figure 3-2: Sensitivity Analysis

Table 3-8: Change in IRR at 8% baseline

IRR value	6.66%	IRR value	Change in IRR at 8% baseline

Static total investment	100.00%	Static total investment	-8.75%
O&M costs	100.00%	O&M costs	-17.10%
Heating fee	100.00%	Heating fee	7.70%
heating area	100.00%	heating area	6.70%

Static total investment

The project is financially attractive when the static total investment decreases by 8.75%. According to the statistical data of the National Bureau of Statistics, the fixed asset investment price index, increased from 2017 to 2019, which is an upward trend. Therefore, it is impossible for static total investment to decrease by 8.75%.

Year（Last year=100）	2017	2018	2019	2020	Average
Fixed asset investment price index [23]	105.8	105.4	102.6	/	104.6

So, a significant reduction of 8.75% in the level of investment is unlikely.

Annual operation and maintenance fee

The project is financially viable when the average annual operation and maintenance fee drops by 17.10%. The average annual operation and maintenance fee includes personnel salary, water and electricity fee, maintenance fee, management fee, material fee, etc. According to the statistics of the National Bureau of Statistics 11, from 2017 to 2021, the average salary of urban employees and the purchase price index of fuel and power producers have been increasing every year since 2017, so the operation and maintenance costs are unlikely to decrease by 17.10%.

Year（Last year=100）	2017	2018	2019	2020	2021	Average
Producer purchase price index of fuel and power industries [24]	113.0	107.1	98.2	91.6	120.5	106.08
Average monetary wage index of urban unit employees [25]	110.0	110.9	109.8	107.6	109.7	109.6

[23] https://data.stats.gov.cn/easyquery.htm?cn=C01&zb=A0901&sj=2020

[24] https://data.stats.gov.cn/easyquery.htm?cn=C01&zb=A090E&sj=2019

[25] https://data.stats.gov.cn/easyquery.htm?cn=C01&zb=A040F&sj=2019

Year（Last year=100）	2017	2018	2019	2020	2021	Average
Producer purchase price index of building materials industry [26]	108.6	110.5	104.2	100.5	105.5	105.95
Labor cost price index [27]	103.9	104.4	/[28]	/[29]	/[30]	104.15

It is not likely for annual O&M to decrease by as much as 17.10%, making the Project IRR exceed benchmark.

Heating fee

The project is financially attractive when heating prices increase by 7.70%. The price of geothermal heating is the same as that of coal-fired heating, according to the Wucheng County People's Government[31], The price is valid for five years starting from 2018, shandong province price bureau not released price guidance for central heating, thus, central heating prices will not appear significant growth in the future, so heating prices increase by 7.70% is impossible.

Heating area

The project is financially attractive when the heating area increases by 6.70%. However, according to the feasibility study report, the boundary of the project and the designed capacity are fixed. The project does not include capacity expansion, nor does it include other heating areas, so it is impossible to increase the heating area by 6.70%.

The analysis is that the project is not financially attractive in the absence of carbon emission benefits.

[26] https://data.stats.gov.cn/easyquery.htm?cn=C01&zb=A090E&sj=2019

[27] https://data.stats.gov.cn/easyquery.htm?cn=B01&zb=A0603&sj=2020D

[28] The datas of year 2019 have not been released yet

[29] The datas fo year 2020 have not been released yet

[30] The datas fo year 2020 have not been released yet

[31] http://www.wucheng.gov.cn/n37855206/n38016159/n43501800/n43501737/n43534889/c44744476/content.html

3.5 Additionality

Additionality for the project activity is demonstrated using Tool 02 Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0). Step 1-3 were already done in section 3.4 of this Report for selection of alternative 1 (a) and 3 (i).

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.

The installed capacity of this project is 85MW.

As above, power projects with the heating load between between 42.5 MW~127.5 MW for the Project are included in the range of similar projects.

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

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

Shandong 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 Shandong 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 power generation projects vary from province to province, including the tariff rates, the cost of labor and services, and the types of loan that can be obtained. These all vary between provinces.

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

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

Geothermal based space heating system should be used.

(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 exchangers 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 42.5 MW~127.5MW .

(f) The projects started commercial operation before the PD 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 espective dates." Therefore, the start date of the Project is 8/11/2021, which is the signing time of heat supply contract. which is the earliest contract signed for the project.

Therefore, the geothermal heating project with installed capacity 42.5 MW~127.5MW, have started commercial operation before 8/11/2021 in Shandong province are chosen for this analysis. According to the available information, there are no geothermal heating projects with 42.5 MW~127.5 MW which have started commercial operation before 8/11/2021 in Shandong 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. 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 Ndiff In summary, N_{all}=N_{diff}=0.

Step 5: calculate factor F=1-N_{diff}/N_{all} representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the easure/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}=1-1=0<3

As per paragraph 18 of Tool 24 Common practice (Version 03.1), the proposed project activity is not a "common practice" within a sector in the applicable geographical area. As per paragraph 40 of Tool 02 Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0), the project activity is additional.

3.6 Methodology Deviations

There is no methodology deviation for the project.

4 IMPLEMENTATION STATUS

4.1 Implementation Status of the Project Activity

The project activities operate normally during the monitoring period and are heated according to government requirements. The specific heating time is adjusted according to government requirements.

5 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

As per section 5.1 of this Report, the project reduces CO_2 emissions using geothermal heat to replace heat generated from the coal-fired isolated 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 proposed 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 BE_y in a year y are calculated as:

$$BE_y = \sum_i \left(HS^{BL}_{i,y}\right) \times EF_{CO2,i} / \eta_{BL,i} \quad (2)$$

Where:

BE_y	=	The baseline emissions from heat displaced by the project activity during the year y (t CO_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 (tCO_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 technology i 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:

$$HS_y - Loss^{PJ}{}_y = \sum_i HS^{BL}_{i,y} - LOSS^{BL}{}_y \quad (3)$$

Where:

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).

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

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

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 (Version 03.0), 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) HS_y;

(b) $Loss^{PJ}_y$.

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 VVB 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 Wucheng County were old boilers, but the boilers used in the baseline of the proposed 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.

Two manufacturers of coal-fired boiler were checked, and the efficiencies of their products were 83% and 82.8%[32].

(d) Use the default values from Table 3-1 of AM0072 (Version 03.0)

As per Table 3-1 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.

According to the conservative principle, take 85%.In summary, the efficiency of 85% is applied for the proposed 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 3-2 Data source for fossil fuel emission factors for each identified technology of AM0072 (Version 03.0), Data source (a) and (b) are unavailable. As discussed in section 4.1 of the Report, the boilers are not actually existing and there is no fuel supplier for the baseline coalfired 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%

[32] https://www.zozen.com/products/ranmeiguolu/dhl-rmzqgl.html?5xyFrom=baidu-bd,https://www.ranmeiguolu.net/LianTiaoLuPaiGuoLu/46.html

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 ($Loss^{BL}i,y$) 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 eothermal well to be considered by the project activity.

$$HS_y = min\{H_{CAP}, HS_{y,estimate}\} \quad (5)$$

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

$$HS_{y,estimate} = \sum_j (Q_{j,d,y} \times T_j \times CF) \quad (6)$$

Where:

$HS_{y,estimated}$	=	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 exchangers (upstream of which is connected with water supply from the geothermal well j) (GW). It can be calculated as formula (7).
T_j	=	Number of hours per year heat utilization at well j.
CF	=	Conversion factor from GWh to TJ (3.6).

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

Where:

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

$$H_{CAP} = (\sum_m A_m \times HI_m \times T_j) \times CF + LOSS^{BL}_y - H_{ff} \quad (8)$$

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. No fossil fuel boiler is utilized in the project activity and Hff 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.

$$LOSS^{BL}_y = HS_y - HD_y \quad (9)$$

Where:

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

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 option (a) 10% design heat losses provided by the engineering specifications of the manufacturer of the heat network.

$$LOSS^{PJ}_y = \sum_m 10\% \times A_m \times HI_m \times T_j \times CF \times 10^{-9} \quad (10)$$

Step 3: Calculate baseline emissions from heat produced

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

$$BE_y = \sum_i (HS^{BL}_{i,y} \times EF_{CO2} / \eta_{BL,i}) \quad (11)$$

5.2 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}).

$$PE_y = PE_{FE,y} + PE_{EC,y} + PE_{FF,y} \quad (12)$$

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 62°C, which is a low-temperature system. As per paragraph 84 of AM0072 (Version 03.0), 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 EC_y.

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:

$$PE_{EC,y} = \sum_j EC_{pJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y}) \quad (13)$$

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.

Average technical transmission and distribution losses for providing electricity to source j in year y. The electricity consumed by facilities of the geothermal system is sourced from local power grid connected to North China Power Grid (NCPG). 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). $EF_{EL,j,y}=EF_{grid,CM,y}$.

The tool determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the "combined margin" emission factor (CM) of the electricity system. The CM is the result of a weighted average of two emission factors pertaining to the electricity system: the "operating margin" (OM) and the "building margin" (BM). The operating margin is the emission factor that refers to the group of existing power plants whose current electricity generation would be affected by the proposed project activity. The build margin is the emission factor that refers to the group of power plants whose construction and future operation would be affected by the proposed project activity.

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times EF_{grid,BM,y} \times \omega_{BM} \quad (14)$$

Where:

$EF_{grid,CM,y}$ = Operating margin CO_2 emission factor in year y, tCO_2/MWh. As per 2019 China regional power grid carbon dioxide baseline emission factor OM calculation instructions published by Ministry of Ecology and Environment of the People's Republic of China[33], $EF_{grid,OM,y}$= of NCPG is 0.9419 tCO_2/MWh.

$EF_{grid,BM,y}$ = Building margin CO_2 emission factor in year y, tCO_2/MWh. As per 2019 China regional power grid carbon dioxide baseline emission factor BM calculation instructions published by Ministry of Ecology and Environment of the People's Republic of China[34], $EF_{grid,BM,y}$= of NCPG is 0.4819 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 (14), $EF_{grid,CM,y}$ can be calculated as 0.9419 tCO_2/MWh *0.5+0.4819 tCO_2/MWh *0.5=0.7119 tCO_2/MWh.

[33] http://www.mee.gov.cn/ywgz/ydqhbh/wsqtkz/202012/W020201229610353816665.pdf

[34] http://www.mee.gov.cn/ywgz/ydqhbh/wsqtkz/202012/W020201229610354442145.pdf

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.

5.3 Leakage

No leakage emissions have been identified for the project activity. Therefore, LEy=0 tCO_2.

5.4 Estimated Net GHG Emission Reductions and Removals

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad (15)$$

Where:

ER_y	=	Emission reductions in year y (t CO_2e/yr).
BE_y	=	Baseline emissions in year y (t CO_2e/yr).
PE_y	=	Project emissions in year y (t CO_2/yr).
LE_y	=	Leakage emissions in year y (t CO_2/yr)

Baseline emissions

As per section 4.1 of the Report, Baseline emissions can be calculated as follows:

$$BE_y = \sum_i (HS^{BL}_{i,y}) \times EF_{CO2} / \eta_{BL,i} \quad (16)$$

Where:

$EF_{CO2,i}$	=	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. 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.
$\eta_{BL,i}$	=	The net thermal efficiency of the heating technology i using fossil fuel that would have been used in the absence of the project activity. The highest efficiency of coal-fired boilers provided by Zozen Boilers (83%), Zhengzhou Boiler Co., LTD. (82.8%). As per Table 3-1 Default baseline efficiency for different boilers of AM0072 (Version 03.0), the highest value of 85% for new coalfired boiler is applicable for the proposed project. In summary, the efficiency of 85% is applied for the proposed project.

Relationship between the baseline scenario and the project activity

$$BE_y = \sum_i (HS^{BL}_{i,y} \times EF_{CO2} / \eta_{BL,i}) \quad (17)$$

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

$$HS^{BL}_{i,y} = W_i \times (HS_y - LOSS^{PJ}{}_y + LOSS^{BL}{}_y) \quad (18)$$

(Where:

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. all the heating in winter of residential and public buildings were supplied by coal fired boilers. As per paragraph 51(a)(ii) option 2 Assign weights based on available historical records of AM0072 (Version 03.0), wi is equal to 1.

$Loss^{BL}y$ = The net distribution losses of the heat supply system, in the absence of project activity, during the year y (TJ/yr). Option 1 A conservative value of 0% of loss is used as historic information is not available.

Estimate net quantity of heat supplied by the geothermal heat resource in the project activity

$$HS_y = min\{H_{CAP}, HS_{y,estimate}\} \quad (19)$$

$$HS_{y,estimate} = \sum_j (Q_{j,d,y} \times T_j \times CF) \quad (20)$$

$$Q_{j,d,y} = \frac{FR_{j,d,y} \times \Delta t_{j,d,y} \times 4.18}{3.6} \times 10^{-9} \quad (21)$$

Where:

T_j = Number of hours per year heat utilization at well j. As per Research on Heating in Winter of Wucheng county published by Wucheng county Municipal Amenities Authority, winter heating season of Wucheng county is usually from November 15 to March 15 of the next year (120 days). Therefore, Tj can be calculated as 120*24=2880 h.

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

Average temperature difference between inlet and outlet temperatures at the downstream of substation heat exchangers ($\Delta t_{j,d,y}$) and average flow rate at the downstream of heat exchangers ($FR_{j,d,y}$) are unavailable. For ex ante estimation, average temperature difference between inlet and outlet temperatures, and average flow rate at upstream of heat exchangers (water supply from the geothermal well j) will be 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)[35]. The 14 production wells will supply the feed geothermal water at temperature of 62 °C to 1 heat substations through primary heating network. The 17 re-injection wells will receive the return water at temperature of 21.8°C after secondary heat exchange. Therefore, average temperature difference between inlet and outlet temperatures of the geothermal wells can be calculated as 62°C-21.8°C=40.2°C. For ex ante estimation, $HS_{y,estimated}$ can be calculated as follows:

$$HS_{y,estimate} = (120000kg/h * 40.2℃ * 4.18/3.6*10^{-9} * 2880h * 3.6 * 14) = 813TJ$$

$$H_{CAP} = (\sum_m A_m \times HI_m \times T_j) \times CF + LOSS^{BL}{}_y - H_{ff} \quad (22)$$

$$LOSS^{PJ}{}_y = \sum_m 10\% \times A_m \times HI_m \times T_j \times CF \times 10^{-9} \quad (23)$$

Where:

A_m = Net heating area for construction type m (m^2). Heating area of buildings is 2235.2 thousand m^2:

Community classification	A_m(m^2)
Energy saving building in new community - floor heating	766,000
Energy saving buildings in the sub new area - floor heating	899,900
Non energy-saving buildings in old areas - floor heating	468,700
Non energy saving buildings in old residential quarters - radiator	81,900
Non energy saving building of public buildings - radiator	18,700

HI_m = Heating index for construction type m (GW/m^2). As per Feasibility Report of the project:

$HI_{m,New\ community}$	35	W/m^2
$HI_{m,Secondary\ Senior\ Management}$	35	W/m^2
$HI_{m,Old\ District}$	40	W/m^2
$HI_{m,Old\ residential\ area}$	43	W/m^2
$HI_{m,public\ buildings}$	45	W/m^2

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

[35] The density of water is 1,000 kg/m^3

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Heating in Winter of Wucheng county published by Wucheng county Municipal Amenities Authority, winter heating season of Wucheng county is usually from November 15 to March 15 of the next year (120 days). Therefore, T_j can be calculated as 120*24=2880 h.

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

H_{ff} = Heat supplied by fossil fuel boiler; in case a boiler is used to meet the heat demand of network. There are no fossil fuel boilers used to meet the heat demand of the project heating network. Therefore, H_{ff}=0 TJ.

The results of HS_y can be summarized as the following table. Refer to the ER calculation sheet for more details.

Name of Subproject	Am (m^2)		$Loss^{PJ}y$ (TJ)	Am*HIm*Tj *CF(TJ)	H_{CAP} (TJ)	$HS_{y,estimated}$ (TJ)	HSy (TJ)
	Residential and public	Public					
Energy saving building in new community - floor heating	766,000	-/	27.80	277.97	305.76	/	/
Energy saving buildings in the sub new area - floor heating	899,900	/	32.66	326.56	359.21	/	/
Non energy-saving buildings in old areas - floor heating	468,700	/	19.44	194.38	213.82	/	/
Non energy saving buildings in old residential quarters - radiator	81,900	/	3.65	36.51	40.16	/	/
Non energy saving building of public buildings - radiator	/	18,700	0.87	8.72	9.60	/	/
Total	2,216,500	18,700	84	844	929	813	813

Calculate baseline emissions from heat produced

Baseline emissions can be summarized as the following table. Refer to the ER calculation sheet for more details.

Year	8/11/2021-31/12/2021	1/1/2022-31/12/2022	1/1/2023-31/12/2023	1/1/2024-31/12/2024	1/1/2025-31/12/2025	1/1/2026-31/12/2026	1/1/2027-31/12/2027	1/1/2028-31/12/2028	1/1/2029-31/12/2029	1/1/2030-31/12/2030	1/1/2031-7/11/2031
HS_y (TJ)	379.41	813.03	813.03	813.03	813.03	813.03	813.03	813.03	813.03	813.03	433.61
Loss PJ_y (TJ)	39.39	84.41	84.41	84.41	84.41	84.41	84.41	84.41	84.41	84.41	45.02

$Loss_{BL_y}$ (TJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$HS^{BL}_{i,y}$ (TJ)	340.02	728.61	728.61	728.61	728.61	728.61	728.61	728.61	728.61	728.61	388.59
BE_y (tCO_2e/yr)	34,922	74,833	74,833	74,833	74,833	74,833	74,833	74,833	74,833	74,833	39,911

Project emissions

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

Where:

$PE_{FE,y}$ = Project emissions from fugitive emissions resulting from non-condensable gases from the geothermal vents during the year y (tCO_2). The geothermal system of the proposed project is designed to operate by extracting geothermal water at approximately 62°C, which is considered to be a low temperature system. As per paragraph 84 of AM0072 (Version 03.0), fugitive emissions from low temperature geothermal systems is considered negligible. Therefore, $PE_{FE,y}$=0 tCO_2.

$PE_{FF,y}$ = 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.

So here is obtained：PE_y= $PE_{EC,y}$.

Calculate project emissions from additional electricity consumption as a result of the project activity

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

Where:

$EF_{EL,j,y}$	=	Emission factor for electricity generation for source j in year y (t CO_2/MWh). $EF_{EL,j,y}$=$EF_{grid,CM,y}$= 0.7119 tCO_2/MWh.
$TDL_{j,y}$	=	Average technical transmission and distribution losses for providing electricity to source j in year y. The electricity consumed by facilities of the geothermal system is sourced from local power grid connected to central China Power Grid (CCPG). Scenario A: Electricity consumption from the grid is applied to the proposed project. For project electricity consumption sources, a default value of 20% is used for $TD_{Lj,y}$.

Estimated quantity of electricity consumed by the project electricity consumption source j in year y ($EC_{PJ,j,y}$)

As per Feasibility Study Report of the project, estimate of annual electricity consumption is 14958.900 MWh. The actual values will be monitored.

Project emissions can be summarized as the following table. Refer to the ER calculation sheet

Year	8/11/2021-31/12/2021	1/1/2022-31/12/2022	1/1/2023-31/12/2023	1/1/2024-31/12/2024	1/1/2025-31/12/2025	1/1/2026-31/12/2026	1/1/2027-31/12/2027	1/1/2028-31/12/2028	1/1/2029-31/12/2029	1/1/2030-31/12/2030	1/1/2031-7/11/2031
$EC_{PJ,j,y}$ (kWh)	6,980,820	14,958,900	14,958,900	14,958,900	14,958,900	14,958,900	14,958,900	14,958,900	14,958,900	14,958,900	7978080
$EC_{PJ,j,y}$ (MWh)	6,980.820	14,958.900	14,958.900	14,958.900	14,958.900	14,958.900	14,958.900	14,958.900	14,958.900	14,958.900	7978.080
$EF_{EL,j,y}$ (tCO_2/MWh)	0.7119	0.7119	0.7119	0.7119	0.7119	0.7119	0.7119	0.7119	0.7119	0.7119	0.7119
$(1+TD_{Lj,y})$	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
$PE_{EC,y}$ (tCO_2e/yr)	5,964	12,779	12,779	12,779	12,779	12,779	12,779	12,779	12,779	12,779	6816

Leakage

As described in section 5.3, the leakage is not considered.

Emission reductions

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)
2021（8-11-2021-31-12-2022）	34,922	5,964	0	28,958
2022（1-1-2022-31-12-2023）	74,833	12,779	0	62,054
2023（1-1-2023-31-12-	74,833	12,779	0	62,054

2024）				
2024（1-1-2024-31-12-2025）	74,833	12,779	0	62,054
2025（1-1-2025-31-12-2026）	74,833	12,779	0	62,054
2026（1-1-2026-31-12-2027）	74,833	12,779	0	62,054
2027（1-1-2027-31-12-2028）	74,833	12,779	0	62,054
2028（1-1-2028-31-12-2029）	74,833	12,779	0	62,054
2029（1-1-2029-31-12-2030）	74,833	12,779	0	62,054
2030（1-1-2030-31-12-2031）	74,833	12,779	0	62,054
2031（1-1-2030-7-11-2031）	39,911	7,987	0	33,095
Total	748,327	127,791	0	620,536

The project:

$ER_y=BE_y-PE_y-LE_y$= (748327-127791)/10 tCO_2e/yr = 62054 tCO_2e/yr (average)

6 MONITORING

6.1 Data and Parameters Available at Validation

Data / Parameter	$EF_{CO2,i}$
Data unit	tCO_2/TJ
Description	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.
Source of data	Option (d) 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 is used as per Table 5 of the applied methodology AM0072 (Version 03.0).
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.

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 (Version 03.0).
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 (83%), Zheng zhou Boiler co.LTD. (82.8%). 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 (Version 03.0).
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 (Version 03.0).
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	Feasibility Study Report of the proposed project
Value applied:	Coal fired boilers in boiler houses, supplying several buildings through a heat distribution network.
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 03.0), the most plausible aseline scenario shall be determined through the use of Tool 02 Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0). Heat supply system using coal-fired boilers is identified as the baseline scenario of the proposed project activity. Refer to section 3.4 of the Report for more details.
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 31.
Justification of choice of data or description of measurement methods and procedures applied	There are a total of 31 geothermal wells including 14 production wells and 17 re-injection wells in the boundary of the proposed project activity as 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	Feasibility Study Report of the proposed project
Value applied:	Residential、Public
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
Justification of choice of data or description of measurement methods and procedures applied	There is 1 sub-stations in the boundary of the proposed project activity, which can be identified through unique identification code and GPS coordinates.
Purpose of Data	To calculate baseline emissions
Comments	Includes a heat exchangers as part of the sub-station.

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	$Loss^{PJ}_{y}=\sum 10\%\times A_m\times HI_m\times T_j\times CF\times 10^{-9}$ 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

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	As per section 4.1 of this Report, the baseline scenario of the project is 3(i) " per section 4.1 of this Re houses, supplying several buildings through a heat distribution network". 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:	There are no fossil fuel boilers used to meet the heat demand of the project heating network. Therefore, H_{ff}=0 TJ.
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

6.2 Data and Parameters Monitored

Data / Parameter	$\Delta t_{j,d,y}$
Data unit	°C
Description	Average temperature difference between inlet and outlet temperatures at the downstream of each heat exchangers in year y.
Source of data	Temperature transmitters installed at downstream inlet and outlet points of each heat exchangers.
Description of measurement methods and procedures applied	Temperatures to be monitored at inlet and outlet points at downstream of each heat exchangers j. Inlet and outlet temperatures at the downstream of each heat exchanger are monitored by the temperature transmitters. There are 14 production wells and 17 re-injection wells. There are totally 1 set of heat exchange system. 2 temperature transmitters 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 temperature transmitters. Serial No. of the temperature transmitters are TT-5201,TT-5202 separately. The temperature transmitters can monitor the inlet and outlet temperature of the heat exchange system continuously and record the temperature data per hour. All the hourly temperature data were 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 were calculated based on the 24-hourly temperature data separately. The average monthly inlet and outlet temperature were calculated based on all the daily inlet and outlet temperature of this month. Finally, the operation record of the geothermal heating system during the related heating season were summarized by all the monthly record.
Frequency of monitoring/recording	Measured Hourly/Recording Monthly
Value applied:	Average temperature difference between inlet and outlet temperatures at the downstream of substation heat exchangers is unavailable. For ex

<table>
<tr><td></td><td>ante estimation, average temperature difference between inlet and outlet temperatures was used. As per Feasibility Study Report of the

project, the 14 production wells will supply the feed geothermal water at temperature of 62°C to heat substations through primary heating network. The 17 re-injection wells will receive the return water at temperature of 21.8°C after secondary heat exchange. Therefore, average temperature difference between inlet and outlet temperatures of the geothermal wells can be calculated as 62°C-21.8°C=40.2°C</td></tr>
<tr><td>Monitoring equipment</td><td>Temperature transmitters</td></tr>
<tr><td>QA/QC procedures applied</td><td>Temperature transmitters have been checked regularly for potentially performance-reducing anomalies by the vcs monitoring team. The temperature measurement range of the ultrasonic calorimeters are 1°C to 100°C with an accuracy of 1°C.

The temperature transmitters are calibrated based on JJF 1183-2007 Verification Regulation of Heat Meters. All the 2 temperature transmitters were calibrated before the operation period of the geothermal heating system. Calibration of the 2 temperature transmitters is shown as the following table. If the temperature transmitters can be used normally, recalibration is not required. The validity is 1 year.

<table>
<tr><th>NO.</th><th>Serial No.</th><th>Purpose</th><th colspan="2">Calibration Date</th><th>Term of Validity</th></tr>
<tr><td>1</td><td>TT-5201</td><td>To monitor supply water temperature of the heat exchange system</td><td>04-November-2021</td><td>02-November-2022</td><td>01-November-2023</td></tr>
<tr><td>2</td><td>TT-5202</td><td>To monitor return water temperature of the heat exchange system</td><td>04-November-2021</td><td>02-November-2022</td><td>01-November-2023</td></tr>
</table>

There were no missing data or damaged data during the 1st monitoring period. The average temperature change of the heat exchange system of the 2021-2023 heating season (9.42°C) were cross checked by the design temperature difference of the end-user (17°C). As per feedback from the space heating experts at the project site, average temperature change of the heat exchange system of the Wucheng geothermal heating system is about 9°C.</td></tr>
</table>

Purpose of data	To calculate baseline emissions
Calculation method	-
Comments	The heat exchangers should handle the heat supplied by geothermal well only and not by any other source. The temperature readings should be taken at immediate inlet and outlet point of heat exchangers.

Data / Parameter	$FR_{j,d,y}$
Data unit	kg/h
Description	Average flow rate at the downstream of each heat exchangers (upstream of which is connected with water supply from the geothermal well j) in year y.
Source of data	Electromagnetic flowmeter
Description of measurement methods and procedures applied	Readings taken from electromagnetic flowmeter installed at downstream of each heat exchangers is monitored by the electromagnetic flowmeter. Refer to Figure 6-2 of the Joint-PD-MR for more details on installation and configuration of the electromagnetic flowmeter. No. of the electromagnetic flowmeter is 14210938369. The electromagnetic flowmeter can monitor the volume flow rate of each heat exchange system continuously and record it per hour. All the hourly volume flow rate data were exported by the VCS monitoring team to form the monthly record at the beginning of the next month. The average daily volume flow rate was calculated based on the 24-hourly data. The average monthly volume flow rate was calculated based on all the daily data of this month. Finally, the operation record of the geothermal heating system during the related heating season were summarized by all the monthly record. Density of the water is 1,000 kg/m^3. Mass flow can be calculated as volume flow rate times density of water.
Frequency of monitoring/recording	Measured Hourly/Recording Monthly
Value applied:	Average flow rate at the downstream of heat exchangers is unavailable. For ex ante estimation, average flow rate at upstream of heat exchangers (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)

<table>
<tr><td>Monitoring equipment</td><td>electromagnetic flowmeter</td></tr>
<tr><td>QA/QC procedures applied</td><td>Electromagnetic flowmeter have been checked regularly for potentially performance-reducing anomalies by the VCS monitoring team. The highest measurement flow rate range of the electromagnetic flowmeter is 5,000 m^3/h with an accuracy of 1%.
The electromagnetic flowmeter is calibrated based on JJF 84-2010 Verification Regulation of flowmeter. The electromagnetic flowmeter is calibrated before the operation period of the geothermal heating system. Calibration of the electromagnetic flowmeter is shown as the following table. If the ultrasonic calorimeters can be used normally, recalibration is not required. The validity is 1 year.
<table>
<tr><th>NO.</th><th>Serial No.</th><th>Purpose</th><th colspan="2">Calibration Date</th><th>Term of Validity</th></tr>
<tr><td>1</td><td>14210938369</td><td>To monitor flow rate of the heat exchange system</td><td>04-November-2021</td><td>01-November-2022</td><td>31-October-2023</td></tr>
</table>
There were no missing data or damaged data during the 1st monitoring period. The average volume flow rate of the heat exchange system of the 2021-2023 heating season (3700.32 m^3/h) were cross checked by the rated flow of the circulating pumps, refer to Table 1-1 of the for more details. The average volume flow rate of the heat exchange system of the 2021-2023 heating season were lower than the least rated flow of the circulating pumps (2400*2=4800 m^3/h).</td></tr>
<tr><td>Purpose of data</td><td>To calculate baseline emissions</td></tr>
<tr><td>Calculation method</td><td>-</td></tr>
<tr><td>Comments</td><td>The heat exchangers should handle the heat supplied by geothermal well only and not by any other source.</td></tr>
</table>

Data / Parameter	T_j

Data unit	Hours
Description	Hours per hear heat utilization in well j.
Source of data	Data logged in the Geothermal plant
Description of measurement methods and procedures applied	The actual number of heating hours are sourced from the statistical data of the geothermal base space heating system. As per Research on Heating in Winter of Dezhou City published by Dezhou City Municipal Amenities Authority, winter heating season of Dezhou City is usually from November 15 to March 15 of the next year (120 days).
Frequency of monitoring/recording	Monthly
Value applied:	Estimates and actual project feasibility study data are the same. 2880h (120 days*24h)
Monitoring equipment	-
QA/QC procedures applied	Time given for heating services provided will be measured. The measured data shall be cross-checked against applicable local policy and regulation on heat supply.
Purpose of data	To calculate baseline emissions
Calculation method	-
Comments	The heat exchangers should handle the heat supplied by geothermal well only and not by any other source.

Data / Parameter	HI_m
Data unit	W/m^2
Description	Heating index for construction type m.
Source of data	The conservative standard index for construction type m as provided by Feasibility Report of the project
Description of measurement methods and procedures applied	-

Frequency of monitoring/recording	-
Value applied:	Estimates and actual project feasibility study data:

$HI_{m,New\ community}$	35	W/m^2
$HI_{m,Secondary\ Senior\ Management}$	35	W/m^2
$HI_{m,Old\ District}$	40	W/m^2
$HI_{m,Old\ residential\ area}$	43	W/m^2
$HI_{m,public\ buildings}$	45	W/m^2

Monitoring equipment	-
QA/QC procedures applied	Data to be validated by space heating experts at the project site.
Purpose of data	To calculate baseline emissions
Calculation method	-
Comments	N/A

Data / Parameter	$EC_{PJ,j,y}$ (EC_y)
Data unit	MWh
Description	Electricity consumption for the year y in operating the geothermal heating system.
Source of data	Electricity meters.
Description of measurement methods and procedures applied	Electricity meter will be installed at the geothermal well and substation. Readings will be done monthly.Serial No. of the electricity meters are 2103523579000003,2010137684000036,2010137684000041 Before test run of the whole geothermal space heating system, base number of all the 3 electricity meters were recorded by the VCS monitoring team under the supervision of the representative of each sub-area. At the end of each heating month, the VCS monitoring team recorded readings of the 3 electricity meters, which can calculate the electricity consumption of this month by minus last month's base number of meters. The operation record of the geothermal heating system during the related heating season were summarized by all the

<table>
<tr><td></td><td>monthly record.

Electricity consumption of the geothermal space heating system are only part of the power consumption in public area of each sub-area.

All the electricity costs during the heating season were settled by the community property service company of each sub-area and local power grid company, which includes the electricity consumption of the geothermal heating system.

Electricity settlement agreement was signed between the project owner and the community property service company of each sub-area. At the end of each winter heating season, the project owner prepares electricity bill to the related community property service company for confirmation, which contains name of the community property service company, period of the electricity consumption, related electricity consumption (test run period included), information of the electricity meters (location, serial number, accuracy, highest range and stop number of this heating season) and the related charges. The project owner would pay the bill and payment receipt would be provided by the related community property service company.</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>Hourly</td></tr>
<tr><td>Value applied:</td><td>14958.900MWh. For ex ante estimation, the data is from Feasibility Study Report of the project. The actual electricity consumption will be monitored.</td></tr>
<tr><td>Monitoring equipment</td><td>Electricity meters.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. The accuracy of the electricity meters is 0.2S.</td></tr>
<tr><td>QA/QC procedures applied</td><td>The electricity meters are calibrated based on JJG 780-1992 Electrical Meters for Measuring Alternating-current Electrical Energy. All the 3 electricity meters were calibrated before the operation period of the geothermal heating system. Calibration of the 3 electricity meters is shown as the following table. If the electricity meters can be used normally, recalibration is not required. The validity is 1 years.
<table>
<tr><td>NO.</td><td>Serial No.</td><td>Location</td><td>Calibration Date</td><td>Term of Validity</td></tr>
</table>
</td></tr>
</table>

	1	2103523579000003	To monitor Electricity consumption for the year y in operating the geothermal heating system.	02-November-2021	29-October-2022	28-October-2023
	2	2010137684000036	To monitor Electricity consumption for the year y in operating the geothermal heating system.	02-November-2021	29-October-2022	28-October-2023
	3	2010137684000041	To monitor Electricity consumption for the year y in operating the geothermal heating system.	02-November-2021	29-October-2022	28-October-2023
	There were no missing data or damaged data during the 1st monitoring period. All the electricity consumption data was cross checked with the electricity bill confirmed by each community property service company and payment receipt of the geothermal heating system.					
Purpose of data	To calculate baseline emissions					
Calculation method	-					
Comments	N/A					

Data / Parameter	$EF_{EL,j,y}$ ($EF_{grid,CM,y}$)
Data unit	tCO_2/MWh
Description	Combined margin emission factor for the grid in year y.
Source of data	Calculate the combined margin emission factor, using the procedures in Tool 07 Tool to calculate the emission factor for an electricity system

	(Version 07.0). The data of $EF_{grid,OM,y}$ and $EF_{grid,BM,y}$ are from Baseline emission factors of China's regional power grid for emission reduction projects in 2019 published by Ministry of Ecology and Environment of the People's Republic of China.
Description of measurement methods and procedures applied	As per Tool 07 Tool to calculate the emission factor for an electricity system (Version 07.0).
Frequency of monitoring/recording	Once each monitoring period
Value applied:	0.7119 (0.9419*0.5+0.4819*0.5)
Monitoring equipment	Electricity meters.
QA/QC procedures applied	The latest version of Baseline emission factors of China's regional power grid for emission reduction projects published by Ministry of Ecology and Environment of the People's Republic of China were used for the 1st monitoring period. It calculated $EF_{grid,OM,y}$ and $EF_{grid,BM,y}$ based on the latest version of Tool 07 (Version 07.0).
Purpose of data	To calculate project emissions
Calculation method	-
Comments	N/A

Data / Parameter	$TDL_{j,y}$
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j in year y.
Source of data	In case of scenario B and scenario C, case C.II, assume TDLj,y=0 as a simplification. In case of other scenarios (scenario A and scenario C, cases C.I and C.III), choose one of the following options: 1. Use annual average value based on the most recent data available within the host country. 2. Use as default values of 20% for: (a) project or leakage electricity consumption sources; (b) baseline electricity consumption sources if the electricity consumption by all

	project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is larger than the electricity consumption of all baseline electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies. 3. Use as default values of 3% for: (a) baseline electricity consumption sources. (b) project and leakage electricity consumption sources if the electricity consumption by all project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is smaller than the electricity consumption of all baseline electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies.
Description of measurement methods and procedures applied	Scenario A: Electricity consumption from the grid is applied to the proposed project. For project electricity consumption sources, a default value of 20% is used for $TDL_{j,y}$.
Frequency of monitoring/recording	Annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
Value applied:	20%
Monitoring equipment	-
QA/QC procedures applied	-
Purpose of data	To calculate project emissions
Calculation method	-
Comments	For (a): $TDL_{j,y}$ should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed project activity is connected to. The technical distribution losses should not contain other types of grid losses (e.g.,commercial losses/theft). The distribution losses can either be calculated by the project participants or be based on references from utilities, network operators or other official documentation.

Data / Parameter	A_m
Data unit	m^2
Description	Net heating area for construction type m.

<table>
<tr><td>Source of data</td><td>For ex ante estimation, the data is from Feasibility Study Report of the project. Actual measurements may also be available from heating supply contracts.</td></tr>
<tr><td>Description of measurement methods and procedures applied</td><td>Yearly measurement.</td></tr>
<tr><td>Frequency of monitoring/recording</td><td>Yearly</td></tr>
<tr><td>Value applied:</td><td>2235.2 thousand m^2 for new and old buildings
<table>
<tr><th rowspan="2">Name of Subproject</th><th colspan="2">A_m (m^2)</th></tr>
<tr><th>Residential and Public</th><th>Public</th></tr>
<tr><td>Energy saving building in new community - floor heating</td><td>766,000</td><td>-</td></tr>
<tr><td>Energy saving buildings in the sub new area - floor heating</td><td>899,900</td><td>-</td></tr>
<tr><td>Non energy-saving buildings in old areas - floor heating</td><td>468,700</td><td>-</td></tr>
<tr><td>Non energy saving buildings in old residential quarters - radiator</td><td>81,900</td><td>-</td></tr>
<tr><td>Non energy saving building of public buildings - radiator</td><td>-</td><td>18,700</td></tr>
</table></td></tr>
<tr><td>Monitoring equipment</td><td>Feasibility Study Report or heating supply contracts</td></tr>
<tr><td>QA/QC procedures applied</td><td>The data shall be cross-checked with local development plan and operational data of the project geothermal heating system.</td></tr>
<tr><td>Purpose of data</td><td>To calculate project emissions</td></tr>
<tr><td>Calculation method</td><td>-</td></tr>
<tr><td>Comments</td><td>N/A</td></tr>
</table>

6.3 Monitoring Plan

The monitoring plan presented in this Joint-PD-MR assures that real, measurable, long term GHG emission reductions can be monitored, recorded, and reported. It is a crucial procedure to identify the final VCUs of the project. This monitoring plan will be implemented by the project owner during the project operation. The details of the monitoring plan are specified as follows:

Parameters to be monitored

The monitoring requirements for this methodology include the monitoring of parameters for both baseline and project emissions calculations. All provisions in the methodology and relevant tools shall apply, as described for each parameter in section 6.2 of the Report.

For the parameters of A_m, net heating area for construction type m (Am) will be determined based on heating supply contracts.

Heating index for construction type m (HI_m) is sourced from the conservative standard index as provided by the standards institute of China (CJJ 34-2010 Design Code for City Heating Network published by Ministry of Housing and Urban-Rural Development of the People's Republic of China). The values should be updated according to the latest national and local standards. Local standards take precedence over national standards.

Average technical transmission and distribution losses for providing electricity to source j in year y ($TD_{Lj,y}$) shall be determined using the latest version of Tool 05.

Hours per hear heat utilization in well j (Tj) will be sourced from data logged in the Geothermal plant. The winter heating season is fixed by local regulations, which is usually from November 15 to March 15 of the next year (120 days).

Combined margin emission factor for the grid in year y ($EF_{EL,j,y}$ ($EF_{grid,CM,y}$)) is calculated using the procedures in the latest version of Tool 07. It shall be determined as per the latest Baseline emission factors of China's regional power grid for emission reduction projects published by Ministry of Ecology and Environment of the People's Republic of China.

Above all, 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).

Monitoring framework

Above all, 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). Figure 6-1 below outlines the organization structure of the monitoring system for the related three parameters. The project owner will be responsible for the whole monitoring work. 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.

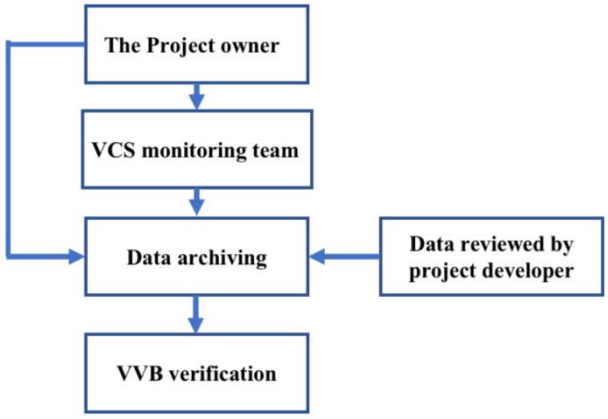

Figure 6-1: Organization Structure of the Monitoring Team

Principle of Monitoring

All heat supplied to end-users shall be 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 should be measured continuously.

Meters shall be installed in a manner that 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 exchangers 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.

Monitoring equipment and installation

Installation and configuration of meters are shown as Figure 6-2. 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.

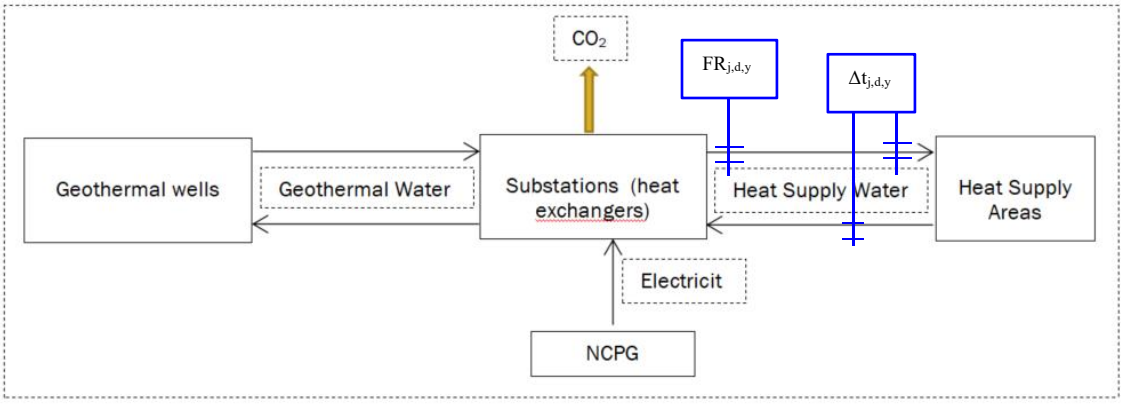

Figure 6-2: Project monitoring diagram

(B) Management Structure

The Project owner organizes a specific VCS team in the project development department to be responsible for data collection, supervision, and witness the whole process of data measuring and recording. A VCS manager is appointed to take full responsibility for the overall monitoring of the project. The monitoring and measurement are to be carried out by designated monitoring officers. In addition, the project developer appoints internal verifiers who are responsible for internal check of the measurement, collection of relevant receipts and invoices, and the calculation of the emission reductions. A monitoring and management manual of the project that identifies detailed duties and responsibilities of the relevant parties is developed and served as the basis of the project monitoring. Figure 6-3 shows the operation and management structure of the Project.

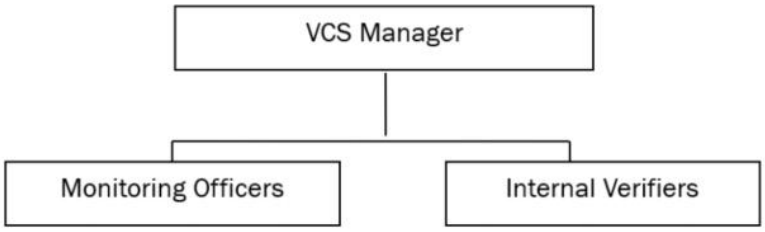

Figure 6-3: Operation and management structure of the project

(C) Data collection

Monitoring officers are responsible for data collection. Designated teams will read and collect the monitored data regularly. The monitored data will serve as the main data source for emission reductions calculation. All data files, relevant flow rate and temperature records will be collected by a designated monitoring officer, who will prepare backup in time and archive all documents properly.

(D) Quality assurance

All metering equipment for monitoring will be chosen in accordance with VCS requirements and

will be calibrated regularly for accuracy by qualified party according to the national regulations. To assist in future verifications, the Project owner will preserve the calibration records, along with the data files of project monitoring.

Error check routines will be established on site and at the point of data storage to detect data measuring/transmission failures as well as malfunctions. In the case of malfunction of the meters, the meter supplier will provide technical support to engage the problem promptly and emission reductions during the corresponding period will be calculated conservatively.

The installation of flow meters and electricity meters will fulfill the national standard and the installation of temperature meter will fulfill the national standard. All the meters will be checked and maintained periodically.

(E) Data file management

All monitoring data will be electronically filed by the end of each month and the electronic data

files will be archived in both disk copy and printed hard copy. Other documents in paper e.g. maps, forms and environment assessment reports will be preserved as well. All data collected as part of monitoring will be archived electronically and be kept at least for 2 years after the end of the crediting period. The Project owner will provide original records and documents if necessary.

7 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

7.1 Data and Parameters Monitored

Data / Parameter	$\Delta t_{j,d,y}$
Data unit	°C
Description	Average temperature difference between inlet and outlet temperatures at the downstream of each heat exchangers in year y.
Value applied:	

Year	November	December	January	February	March
2021	8.05	9.93	/	/	/
2022	8.03	11.75	11.76	11.03	6.99

	2023 / / 11.23 9.16 6.27
Comments	The heat exchangers should handle the heat supplied by geothermal well only and not by any other source. The temperature readings should be taken at immediate inlet and outlet point of heat exchangers.

Data / Parameter	$FR_{j,d,y}$
Data unit	kg/h
Description	Average flow rate at the downstream of each heat exchangers (upstream of which is connected with water supply from the geothermal well j) in year y.
Value applied:	Year: November: December: January: February: March 2021: 3910: 3810: /: /: / 2022: 3421: 3708: 3743: 3700: 3585 2023: /: /: 3744: 3811: 3609
Comments	The heat exchangers should handle the heat supplied by geothermal well only and not by any other source.

Data / Parameter	T_j
Data unit	Hours
Description	Hours per hear heat utilization in well j.
Value applied:	Year: November: December: January: February: March 2021: 552: 744: /: /: / 2022: 480: 744: 744: 672: 522 2023: /: /: 744: 672: 344
Comments	N/A

Data / Parameter	HI_m		
Data unit	W/m^2		
Description	Heating index for construction type m.		
Value applied:	$HI_{m,New\ community}$	35	W/m^2
	$HI_{m,Secondary\ Senior\ Management}$	35	W/m^2
	$HI_{m,Old\ District}$	40	W/m^2
	$HI_{m,Old\ residential\ area}$	43	W/m^2
	$HI_{m,public\ buildings}$	45	W/m^2
Comments	N/A		

Data / Parameter	$EC_{PJ,j,y}$ (EC_y)	
Data unit	MWh	
Description	Electricity consumption for the year y in operating the geothermal heating system.	
Value applied:	Date	$EC_{PJ,j,y}$ (EC_y)
	08-November-2021-30-November-2021	2,082.216
	01-December-2021-31-December-2021	4,092.900
	01-January-2022-31-January-2022	5,451.553
	01-February-2022-28-February-2022	3,921.184
	01-March-2022-22-March-2022	1,300.649
	23-March-2022-10-November-2022[36]	0.000
	11-November-2022-30-November-2022	1,108.874

[36] Winter heating season of Wucheng County is usually from November 15 to March 15 of the next year. So, the electricity consumption in operating the geothermal heating system from 23-April-2021 to 11-November-2021 is 0.

	01-December-2022-31-December-2022	3,929.742
	01-January-2023-31-January-2023	4,232.169
	01-February-2023-28-February-2023	2,770.836
	01-March-2023-15-March-2023	762.791
	08-November-2021-31-December-2021	6,175.116
	01-January-2022-22-March-2022	10,673.386
	15-November-2022-31-December-2022	5,038.616
	1-January-2023-15-March-2023	7,765.796
	01-January-2021-15-March-2023	29,652.914
Comments	N/A	

Data / Parameter	$EF_{EL,j,y}$ ($EF_{grid,CM,y}$)
Data unit	tCO_2/MWh
Description	Combined margin emission factor for the grid in year y.
Value applied:	0.7119 (0.9419*0.5+0.4819*0.5)
Comments	N/A

Data / Parameter	$TDL_{j,y}$
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j in year y.
Value applied:	20%
Comments	For (a): TDLj,y should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection

	where the proposed project activity is connected to. The technical distribution losses should not contain other types of grid losses (e.g., commercial losses/theft). The distribution losses can either be calculated by the project participants or be based on references from utilities, network operators or other official documentation.

Data / Parameter	A_m
Data unit	m^2
Description	Net heating area for construction type m.
Value applied:	

Year	8-November-2021-22-March-2022	23-March-2022-10-November-2022	11-November-2022-15-March-2023
$A_{m,New\ community}$	149595.010	0	267636.400
$A_{m,Secondary\ Senior\ Management}$	540567.619	0	577003.165
$A_{m,Old\ District}$	274747.050	0	278636.415
$A_{m,Old\ residential\ area}$	67477.310	0	61801.639
$A_{m,public\ buildings}$	51559.163	0	28400.996
$A_{m,Total}$	1083946.152	0	1213478.615

Comments	N/A

7.2 Baseline Emissions

The baseline emissions in year y (BE_y) can be calculated as follows,

$$BE_y = \sum_i \left(HS^{BL}_{i,y}\right) \times EF_{CO2,i} / \eta_{BL,i} \quad (24)$$

Where:

BE_y = The baseline emissions from heat displaced by the project activity during the year y (t CO_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. 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.

$\eta_{BL,i}$ = The net thermal efficiency of the heating technology i using fossil fuel that would have been used in the absence of the project activity. The highest
efficiency of coal-fired boilers provided by Zozen Boilers (83%), Zhengzhou Boiler Co., LTD. (82.8%). As per Table 3-1 Default baseline efficiency for different boilers of AM0072 (Version 03.0), the highest value of 85% for new coalfired boiler is applicable for the proposed project. In summary, the efficiency of 85% is applied for the proposed project.

$HS^{BL}_{i,y}$ = 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)

$HS^{BL}_{i,y}$ can be calculated as follows,

$$HS^{BL}_{i,y} = W_i \times (HS_y - Loss^{PJ}_y + LOSS^{BL}_y) \quad (25)$$

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 6.1 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 (Version 03.0), 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 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.

$$HS_y = min\{H_{CAP}, HS_{y,estimate}\}$$

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

$$HS_{y,estimate} = \sum_j (Q_{j,d,y} \times T_j \times CF) \quad (26)$$

Where:

$HS_{y,estimated}$ = 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 exchangers (upstream of which is connected with water supply from the geothermal well j) (GW).It can be calculated as formula (7).

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

CF = Conversion factor from GWh to TJ (3.6)

$$Q_{j,d,y} = \frac{FR_{j,d,y} \times \Delta t_{j,d,y} \times 4.18}{3.6} \times 10^{-9} \quad (27)$$

Where:

$FR_{j,d,y}$ = Average flow rate at the downstream of heat exchangers (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 exchangers (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.

$$H_{CAP} = (\sum_m A_m \times HI_m \times T_j) \times CF + LOSS^{BL}_y - H_{ff} \quad (28)$$

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).As per Feasibility Report of the project:

$HI_{m,New\ community}$	35	W/m^2
$HI_{m,Secondary\ Senior\ Management}$	35	W/m^2
$HI_{m,Old\ District}$	40	W/m^2
$HI_{m,Old\ residential\ area}$	43	W/m^2
$HI_{m,public\ buildings}$	45	W/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.No fossil fuel boiler is utilized in the project activity and Hff is 0 TJ.

Based on the results of monitored parameters, heat supplied by the geothermal based heating system (each heat exchangers) is summarized as Table 7-1 and Table 7-2:

Table 7-1： Net quantity of heat supplied by the geothermal heat resources

Date	$Loss^{PJ}_{y}$ (TJ)	$A_m*HI_m*T_j*CF$	H_{CAP} (TJ)
08-November-2021-30-November-2021	8.02	80.22	88.24
01-December-2021-31-December-2021	10.81	108.12	118.93
01-January-2022-31-January-2022	10.81	108.12	118.93
01-February-2022-28-February-2022	9.77	97.66	107.42
01-March-2022-22-March-2022	7.59	75.86	83.44
23-March-2022-10-November-2022[37]	0.00	0.00	0.00
11-November-2022-30-November-2022	7.71	77.14	84.86
01-December-2022-31-December-2022	11.96	119.57	131.53
01-January-2023-31-January-2023	11.96	119.57	131.53
01-February-2023-28-February-2023	10.80	108.00	118.80
01-March-2023-15-March-2023	5.53	55.29	60.81

Table 7-2： Estimated quantity of heat supplied by the geothermal heat resources

	$FRj_{,d,y}$ (kg/hr)	Δtj,d,y (°C)	Qj,d,y (GW)	Tj (h)	HSy,estimated (TJ)
08-November-2021-30-November-2021	3910	8.05	0.037	552	72.63
01-December-2021-31-December-2021	3810	9.93	0.044	744	117.65
01-January-2022-31-January-2022	3743	11.76	0.051	744	136.89

[37] This period is not a heating period, so the data is 0.

01-February-2022-28-February-2022	3700	11.03	0.047	672	114.64
01-March-2022-22-March-2022	3550	6.87	0.029	522	53.22
23-March-2022-10-November-2022[38]	0	0	0	0	0.00
11-November-2022-30-November-2022	3421	8.03	0.032	480	55.12
01-December-2022-31-December-2022	3708	11.75	0.051	744	135.48
01-January-2023-31-January-2023	3744	11.23	0.049	744	130.76
01-February-2023-28-February-2023	3811	9.16	0.041	672	98.06
01-March-2023-15-March-2023	3609	6.27	0.026	344	32.53

Table 7-3: Calculation results of baseline emissions

Date	H_{CAP} (TJ)	$HS_{y,estimated}$ (TJ)	HS_y (TJ)	$Loss^{BL}_y$ (TJ)	$HS^{BL}_{i,y}$ (TJ)	$EF_{CO2,i}$ (t CO_2/TJ)	$\eta_{BL,i}$ (%)	BE_y (tCO_2e/yr)
	A	B	C	D	E	F	G	H=E*F/G
08-November-2021-30-November-2021	88.24	72.63	72.63	0	64.61	87.3	85%	6,636
01-December-2021-31-December-2021	118.93	117.65	117.65	0	106.84			10,973
01-January-2022-31-January-	118.93	136.89	118.93	0	108.12			11,105

[38] This period is not a heating period, so the data is 0.

2022								
01-February-2022-28-February-2022	107.42	114.64	107.42	0	97.66			10,030
01-March-2022-22-March-2022	83.44	53.22	53.22	0	45.63			4,686
23-March-2022-10-November-2022[39]	0.00	0.00	0.00	0	0.00			0
11-November-2022-30-November-2022	84.86	55.12	55.12	0	47.41			4,869
01-December-2022-31-December-2022	131.53	135.48	131.53	0	119.57			12,281
01-January-2023-31-January-2023	131.53	130.76	130.76	0	118.80			12,202
01-February-2023-28-February-2023	118.80	98.06	98.06	0	87.26			8,962
01-March-2023-15-March-2023	60.81	32.53	32.53	0	27.01			2,774
08-November-2021-31-December-2021	207.17	190.28	190.28	0	171.45			17,609
01-January-2022-22-March-2022	309.79	304.74	279.57	0	251.41			25,821
15-November-2022-31-December-2022	216.39	190.61	186.65	0	166.98			17,150
01-January-2023-15-March-	311.14	261.35	261.35	0	233.07			23,938

[39] This period is not a heating period, so the data is 0.

2023								
08-November-2021-15-March-2023	1044.49	946.98	917.85	0	822.90			84,517

Baseline emissions was 17609 tCO_2e from 08- November -2021 to 31- December -2021, 25821 tCO_2e from 01- January -2022 to 22- March -2022， 17150 tCO_2e from 15- November -2022 to 31- December -2022, and 23938 tCO_2e from 01- January -2023 to 15- March -2023. Total baseline emissions of the 1st monitoring period (08- November -2021-15- March -2023) was 84517 tCO_2e.

7.3 Project Emissions

As per the signed heating contract, heating areas (2021-2023 heating season) are summarized as the Table 7-4.

Table 7-4: Heating areas (2021-2023 heating season)

Year	8-November-2021-22-March-2022	23-March-2022-10-November-2022	11-November-2022-15-March-2023
$A_{m,New\ community}$	149595.010	0	267636.400
$A_{m,Secondary\ Senior\ Management}$	540567.619	0	577003.165
$A_{m,Old\ District}$	274747.050	0	278636.415
$A_{m,Old\ residential\ area}$	67477.310	0	61801.639
$A_{m,public\ buildings}$	51559.163	0	28400.996
$A_{m,Total}$	1083946.152	0	1213478.615

From 08-November-2021 to 22-March-2022, 1083946.152m^2 buildings can access to geothermal energy-based space heating system in winter season.

From 11-November-2022 to 15-March-2023, 1213478.615m^2 buildings can access to geothermal energy-based space heating system in winter season.

For the 1st monitoring period from 08-November-2021 to 22-March-2022, 1083946.152m^2 of buildings can access to geothermal energy-based space heating system in winter season from 11-November-2022 to 15-March-2023, 1213478.615m^2 of buildings can access to geothermal energy-based space heating system in winter season.

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}).

$$PE_y = PE_{FE,y} + PE_{EC,y} + PE_{FF,y} \quad (29)$$

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 62°C, which is a low-temperature system. As per paragraph 84 of AM0072 (Version 03.0), 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 (PEEC) 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 EC_y.

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:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y}) \quad (30)$$

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.

The electricity consumed by facilities of the geothermal system is sourced from local power grid connected to North China Power Grid (NCPG). Scenario A: Electricity consumption from the grid

is applied to the proposed project. For project electricity consumption sources, a default value of 20% is used for $TDL_{j,y}$.

Calculation results of project emissions during the year y (PE_y) are summarized as Table 7-5,

Table 7-5: Calculation results of project emissions

Date	$EC_{PJ,j,y}$ (kWh)	$EC_{PJ,j,y}$ (MWh)	$EF_{EL,j,y}$ (tCO_2/MWh)	$(1+TDL_{j,y})$	$PE_{EC,y}$ (tCO_2e/yr)
08-November-2021-30-November-2021	2,082,216	2,082.216	0.7119	1.2	1,779
01-December-2021-31-December-2021	4,092,900	4,092.900	0.7119	1.2	3,496
01-January-2022-31-January-2022	5,451,553	5,451.553	0.7119	1.2	4,657
01-February-2022-28-February-2022	3,921,184	3,921.184	0.7119	1.2	3,350
01-March-2022-22-March-2022	1,300,649	1,300.649	0.7119	1.2	1,111
23-March-2022-10-November-2022	0	0	0.7119	1.2	0
11-November-2022-30-November-2022	1,108,874	1,108.874	0.7119	1.2	947
01-December-2022-31-December-2022	3,929,742	3,929.742	0.7119	1.2	3,357
01-January-2023-31-January-2023	4,232,169	4,232.169	0.7119	1.2	3,615
01-February-2023-28-February-2023	2,770,836	2,770.836	0.7119	1.2	2,367
01-March-2023-15-March-2023	762,791	762.791	0.7119	1.2	652
Year 2021(08-November-2021--31-December-2021)	6,175,116	6,175.116	0.7119	1.2	5,275
Year 2022(01-January-2022--31-December-2022)	15,712,002	15,712.002	0.7119	1.2	13,422
Year 2023(01-March-2023--15-March-2023)	7,765,796	7,765.796	0.7119	1.2	6,634
Total	29,652,914	29,652.914	0.7119	1.2	25,332

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

Therefore, for the 1st monitoring period, $PE_y=PE_{EC,y}$.

In summary, project emissions was 5275 tCO_2e from 08-November-2021 to 31-December-2021, and 13422 tCO_2e from 01-January-2022 to 31-December-2022, and 6634 tCO_2e from 01-January-2021 to 15-March-2023. Total project emissions of the 1st monitoring period (08-November-2021-15-March-2023) was 25332 tCO_2e.

7.4 Leakage

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

7.5 Net GHG Emission Reductions and Removals

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)
Year 2021(08-11-2021--31-12-2021)	17609	5275	0	12333
Year 2022(01-01-2022--31-12-2022)	42970	13422	0	29548
Year 2023(01-01-2023--15-3-2023)	23938	6634	0	17303
Total	84517	25332	0	59185

Ex-ante emissions reductions /removals	Achieved emissions reductions /removals	Percent difference	Justification for the difference
124108	59185	-52.31%	The actual heating area of 2021~2022 is 48.49% of the design value.The actual heating area of 2022~2023 is

			54.29% of the design value.

The estimated outcomes for the 1st monitoring period (08/11/2021-15/03/2023) is 124108 tCO_2e. The actual heating area of 2021~2022 is 48.49% of the design value.The actual heating area of 2022~2023 is 54.29% of the design value. Average temperature difference between inlet and outlet temperatures at the downstream of each substation heat exchanger in year y ($\Delta t_{j,d,y}$), 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 (Tj) and electricity consumption for the year y in operating the geothermal heating system($EC_{PJ,j,y}$ (EC_y)) should be monitored. Emission reductions for the 1st monitoring period was 59185 tCO_2e. Net heating area for construction, and the changes of the five parameters lead to the difference between the estimated value and actual value for emission reductions.

APPENDIX X: <TITLE OF APPENDIX>

Use appendices for supporting information. Delete this appendix (title and instructions) where no appendix is required.