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Update of Geothermal Development of Mongolia

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ABSTRACT

A first large scale detailed geophysical exploration work in Arkhangai province (a largest geothermal active zone) is done between 2019 and 2020. Based on the result of this geophysical exploration work a combined geothermal district heating and power production plant will be built in Arkhangai province in the coming few years. Ground source heat pump application is broadly introduced in the country using ground water and soil heating system.

1. INTRODUCTION

The energy system of Mongolia is consists of a traditional coal fired combined heat and power plants, wind farms, solar PV power plants and imports from Russia and China. Currently, the renewable energy share in the installed capacity is about 20 percent at the 2020. There are no geothermal power plants existing but some space heating and sanatorium applications are active.

Beside these heating and sanatorium application the ground source heat pumps using ground water and soil heating developed well due to the cold winter and air pollution.

The Institutes of Geophysics and Astronomy of Mongolian Academy of Sciences of Mongolia and the Geothermal Energy & Geofluids of Switzerland are done the detailed magnetotelluric (MT) and TT measurement in a selected are of Arkhangai province.

2. GEOTHERMAL EXPLORATION IN HANGAI AREA

The existence of numerous hot springs in Mongolia's Hangai mountain area is indicative for large geothermal energy resources, which are remnants of the region's volcanic geological history. Previous studies have shown that a combined, geothermal heat and power plant could provide cheap and clean energy for the Arkhangai province center Tsetserleg (Dorj, 2005 and 2015). Several exploration wells were drilled in the past decades to detect the geothermal reservoir that feeds the hot springs of Tsenkher and Shivert. However, until none of the wells was successful and could tap the proposed geothermal reservoir.

A new collaborative project of ETH Zurich, Switzerland, and the Mongolian Academy of Sciences aims to introduce the missing geophysical component of the so far conducted geothermal exploration program in the Hangai area. The project is funded by the Swiss Programme for Research on Global Issues for Development (r4d programme) – a joint funding initiative by the Swiss Agency for Development and Cooperation (SDC) and the Swiss National Science Foundation (SNSF).

With this project, the Institute of Astronomy and Geophysics in Ulaanbaatar is equipped with modern geophysical measurement stations. Together the project partners establish the scientific methods to image the geothermal reservoir near Tsetserleg, which feeds the hot springs in Tsenkher and Shivert. The result will be of great importance for promoting the construction of geothermal power plant.

On focus of the project are magnetotelluric investigations, a method which is widely used in geothermal exploration (e.g. Munoz, 2014). A first field survey was conducted during May to July in 2019 in the hot spring area south of Tsetserleg. The study area covers of about 20*30km and encompasses the hot springs of Tsenkher, Bortal and Gyalgar. During the survey a total of 184 magnetotelluric stations were measured (Fig. 1). This data set will serve as a base to image the distribution of fluids in the subsurface and to construct the first conceptual reservoir model of study region.

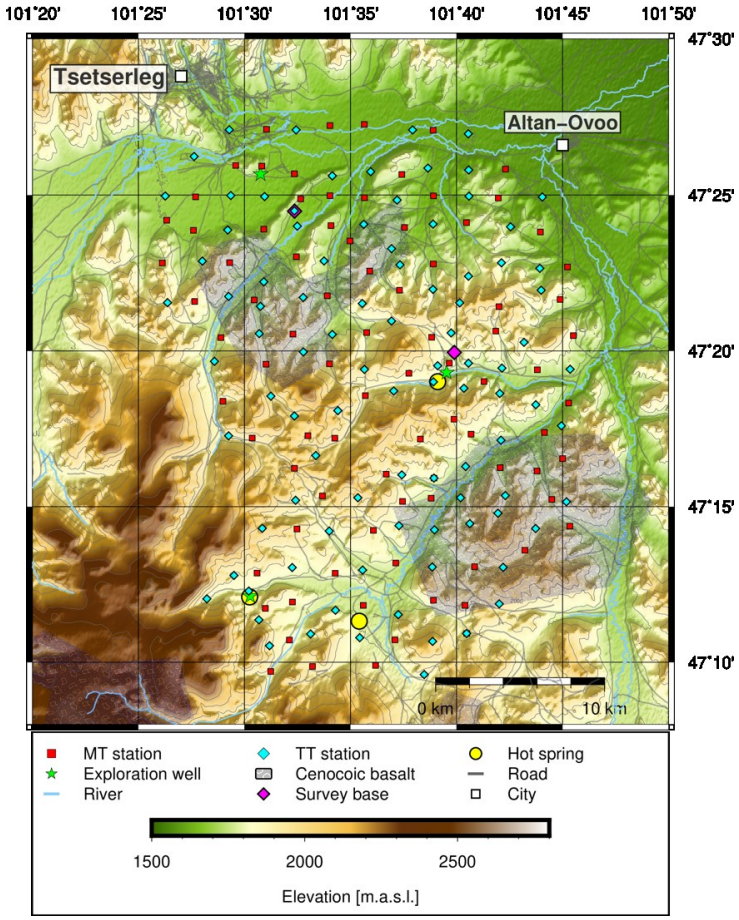

Figure 1: Map of the hot spring region south of Tsetserleg, with the hot springs of Tsenkher, Bortal and Gyalgar. Red squares show magnetotelluric (MT) measurement stations, blue diamond's show telluric stations.

3. GEOTHERMAL DEVELOPMENT BETWEEN 2015 AND 2020

In this section we illustrated geothermal activities in Mongolia. Please see the following tables.

Table 1: Present and planned production of electricity

	Geothermal		Fossil Fuels		Hydro		Nuclear		Solar and wind		Total	
	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr
In operation in December 2019			1180.8	6176.5	28	89.1			215	184.5	1423.8	6450.2
Under construction in December 2019			200						71		271	
Funds committed, but not yet under construction in December 2019												
Estimated total projected use by 2020			1380.8	6176.5	28				286		1694.8	6450.2

Table 2: Utilization of geothermal energy for direct heat as of 31 December 2019 (other than heat pumps)

			Maximum Utilization					Capacity	Annual Utilization		
Locality		Type	Flow Rate	Temperature (°C)		Enthalpy (kJ/kg)			Ave. Flow	Energy	Capacity
			(kg/s)	Inlet	Outlet	Inlet	Outlet	(MWt)	(kg/s)	(TJ/yr)	Factor[5)]
1	Sharlgaljuut	Heat and Bath	3.15	92	40			0.685	3.1	21.3	0.99
2	Ikh Onon	Bath	11	88	30			2.669	5.5	42.1	0.50
3	Saikhan khulj	Bath	2.3	55	30			0.241	1.15	3.8	0.50
4	Khujirt	Bath	16	55	30			1.674	8	26.4	0.50
5	Khuremt	Bath	5	55	30			0.523	2.5	8.2	0.50
6	Mogoit	Bath	7	72	30			1.230	3.5	19.4	0.50
7	Taats	Bath	2.5	55	30			0.262	1.25	4.1	0.50
8	Shargaljuut	Bath	25	92	30			6.485	12.5	102.2	0.50
9	Uheg	Bath	5	57	30			0.565	2.5	8.9	0.50
10	Tsenkher	Heat and Bath	10	86	30			2.343	5	36.9	0.50
11	Tsagaan Sum	Bath	8	69	30			1.305	4	20.6	0.50
12	Shivert	Heat and Bath	4	55	30			0.418	2	6.6	0.50
13	Chuluut	Bath	1.2	45	30			0.075	0.6	1.2	0.50
14	Noyon	Bath	6	38	30			0.201	3	3.2	0.50
15	Zaart	Bath	2.8	44	30			0.164	1.4	2.6	0.50
16	Otgontenger	Bath	1.7	56	30			0.185	0.85	2.9	0.50
17	Ulaan khaalga	Bath	0.2	37	30			0.006	0.1	0.1	0.50
18	Salbart	Bath	6	44	30			0.351	3	5.5	0.50
19	Khunjil	Bath	0.1	62	30			0.013	0.05	0.2	0.50
TOTAL								19.4		316.3	

Table 3: Geothermal (ground-source) heat pumps as of 31 December 2019

Locality	Ground or Water Temp.	Typical Heat Pump Rating or Capacity	Number of Units	Type	COP	Heating Equivalent Full Load	Thermal Energy Used
	(°C	(kW)				Hr/Year[4)]	(TJ/yr)
Kindergarten in Zuunmod	1.6 to 1.8	90	1	Vertical	2.91	1980	4.6
School in Zuunmod	1.6 to 1.8	90	1	Vertical	2.91	1980	4.6
School in Zuunmod	1.6 to 1.8	76.8	1	Vertical	2.91	1980	2.6
Hospital in Zuunmod	1.6 to 1.8	76.8	1	Vertical	2.91	1980	5.9
Corporate Nukht Hotel in Ulaanbaatar	3	400	1	W (well)	3	1980	10.6
Steppe Solar LLC in Ulaanbaatar	1.6 to 1.8	68.5	3	Vertical	3	1980	0.7
Nar Energy LLC in Ulaanbaatar	1.6 to 1.8	300	1	Vertical	3	1980	13.2
Mongol Tulsh LLC in Ulaanbaatar	3	493.3	4	Water well and O (air)	3	1980	4.6
MCS property LLC and EGO LLC in Ulaanbaatar	2 to 3	1588	55	Water well	3	1980	33.0
Bayasaltugs LLC in Ulaanbaatar	2 to 3	135	3	Water well	3	1980	2.6
TOTAL		3318.4	71				82.4

Table 4: Summary table of geothermal direct heat uses as of 31 December 2019

Items	Installed Capacity[1)]	Annual Energy Use[2)]	Capacity Factor[3)]
	(MWt)	(TJ/yr = 10^{12} J/yr)	
Individual Space Heating	3.45	316.3	0.50
Bathing and Swimming[7)]	18.71	294.9	0.50
Geothermal Heat Pumps	3318.4	82.4	
TOTAL	3340.56	693.6	

Table 5: Allocation of professional personnel to geothermal activities (Restricted to personnel with University degrees)

Year	Government	Universities	Contributed Through Foreign Aid Programs	Private Industry
2015	4	3		4
2016		1		10
2017				2
2018				
2019			4	
Total	4	4	4	16

NOTE: - In total of 12 fellows were graduated the UNUGTP since 2001 and they are actively working in the government, institutes and private industries in Mongolia.

- Two local and two international consultants are working in the scope of the Swiss National Science Foundation funded Project for "Development of a geoscientific framework for geothermal exploration and energy utilization in Mongolia between 2019 and 2020".

- At least 12 people are working in the Nar Energy LLC, Steppe Solar LLC, EGO LLC and Bayasaltugs LLC and Green Solar Energy LLC.

Table 6: Total investments in geothermal in 2019, US$

Period	Research & Development Incl. Surface Explor. & Exploration Drilling	Field Development Including Production Drilling & Surface Equipment	Utilization		Funding Type	
			Direct	Electrical	Private	Public
	Million US$	Million US$	Million US$	Million US$	%	%
1995-1999						
2000-2004						
2005-2009	0.05				100	
2010-2014		1.02				100
2015-2019	0.48					100
2015-2019			8.5		100	

Note: -NewCom LLC has spent 50 thousand US$ for pre-feasibility study of Baga Shargaljuut area in 2006.

- In total of 1.02 million US dollars of the State Budget 2010 spent for a construction of 3 ground source heat pumps in Tuv province.

- In total of 0.48 million US dollars funded by Swiss National Science Foundation for a Project Development of a geoscientific framework for geothermal exploration and energy utilization in Mongolia between 2019 and 2020.

- in total of 8.5 million US dollars invested by private sectors for installation of shallow ground source heat pumps.

CONCLUSIONS

Detailed geophysical exploration work in Arhangai province will reveal underground geothermal reservoir in this area. Based on the estimated geothermal resources a further geothermal application will be designed. Hopefully geothermal power and heating system built in Mongolia.

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