Proceedings World Geothermal Congress 2020+1
Reykjavik, Iceland, April - October 2021

Geothermal Energy Country Update Report from Ukraine, 2020

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Keywords: geothermal energy, direct uses, country update, Ukraine

ABSTRACT

The paper presents the status of geothermal energy development in Ukraine. Regarding reports for World Geothermal Congress, it is the first update on geothermal energy use in Ukraine since the World Geothermal Congress 2005 (Khvorov, 2005). Additionally, in 2016 the update on the status of geothermal energy in Ukraine was given to European Geothermal Congress 2016 and it was followed by the next update for European Geothermal Congress 2019.

This paper analyzes Ukrainian geothermal conditions. The best regions for the development of geothermal energy are usually concerned as the Transcarpathian and the Carpathian depressions, the Black Sea artesian basin (the Crimean steppe and the Black Sea coast) and the Dnipro-Donetsk artesian basin. Substantial low-temperature geothermal resources are also available in Donetsk folded area. These territories correspond with the known territories of oil & gas extraction

Geothermal use for heating purposes in the country was initiated in the 1970s. Since that time there is a steady rise in geothermal energy consumption in Ukraine. The last decade there was an especial rise of the development of geothermal energy resources for balneology and shallow geothermal heat pumps.

Ukraine provides governmental programs of financing research in the field of geothermal energy. Ukraine provides feed-in-tariff for electrical energy produced by geothermal electrical plants and feed-in-tariff can be increased if equipment made in Ukraine is used. Simultaneously, there are reduced taxes for imported geothermal equipment in Ukraine too. However, currently there is no geothermal electrical production in Ukraine.

There is also a government support for conducting geothermal research in Ukraine. Thus, in 2018, an experimental installation for study of heat storage from renewable energy sources in the underground aquifer thermal energy system was created by the Institute of Renewable Energy National Academy of Sciences of Ukraine.

1. INTRODUCTION

The paper presents the status of geothermal development in Ukraine in 2019 since the previous update report at WGC 2005 (Khvorov, 2005). However, in 2016 and 2019 there were similar updates, respectively for European Geothermal Congress 2016 (Morozov, 2016) and European Geothermal Congress 2019 (Morozov, 2019).

2. GEOLOGICAL AND GEOTHERMAL BACKGROUND

The best regions for the development of geothermal energy are usually concerned as the Transcarpathian and the Carpathian depressions, the Black Sea artesian basin (the Crimean steppe and the Black Sea coast) and the Dnipro-Donetsk artesian basin (Gordienko, 2005). Substantial low-temperature geothermal resources are also available in Donetsk folded area. These territories correspond with the known territories of oil & gas extraction (Fig. 1).

3. THE POTENTIAL OF GEOTHERMAL RESOURCES

Institute of Renewable Energy (IRE) of the National Academy of Sciences of Ukraine (NASU) made the estimation of geothermal energy resources in Ukraine. The assessment was made based on the actual data on about 450 oil and gas wells that have revealed thermal water (about 50% of the total number of existing wells). Only those wells were taken into consideration, thermal water temperature of which exceeds 60 °C. Geothermal potential calculations are made volumetrically. The calculations do not take into account the dynamic component resource, i.e. the amount of underground water which may enter the productive horizon of the adjacent horizons or influx of rock mass heat. Geothermal resources of the explored part of Ukraine are estimated to produce up to 50 million TOE per year.

Institute of Geophysics (IGPH) NASU in 2004 year issued "Geothermal Atlas of Ukraine" which shows possible heat output at the depths of 3, 4.5 and 6 km. Heat output was calculated based on average geothermal gradient and thermal properties of rocks of an estimated area. However, the mentioned calculations consider only petrothermal energy sources, while thermal water resource (hydrothermal) are not included.

Based on the calculations made by IGPH NASU the total capacity of geothermal resources of Ukraine at the depth in the interval of (5.5)…(6) km, is 0.56 trillion TOE.

4. GEOTHERMAL USE

Because it is the first Ukrainian geothermal report since 2005, it is important to compare how the state of geothermal energy in Ukraine has changed since that time.

In the Ukrainian geothermal review for WGC 2005 (Khvorov, 2005) there were geothermal 9 facilities, built from from 1978 to 1998. During this stage the main goal of geothermal energy development was about creating experimental geothermal facilities in order to evaluate the commercial potential of geothermal energy. These experimental facilities were using geothermal energy for heating, bathing and swimming (balneotherapy/recreation).

There were 6 geothermal plants used for district heating with the total thermal capacity of 7.4 MWth. Two of the geothermal district heating systems had the total installed electric capacity of 0.16 MWe.

Other 3 geothermal plants at the sport center and sanatoriums were used predominately for bathing and swimming purposes with the total thermal capacity of 3.5 MWth.

However, later there was a decline among these installed facilities. Comparing with data from WGC 2005 (Khvorov, 2005), all of the mentioned district heating facilities were closed after WGC 2005 (Table A). It happened because of out-dated equipment and problems connected to corrosive properties of geothermal water which lead to high repair cost at geothermal stations.

Unlike district geothermal heating systems, currently there is a growing number of facilities using geothermal energy for bathing, swimming and balneology purpose (Table 3) including also some space heating. However, the data on the characteristics of these facilities is rather tentative.

Up to this, there is a steady rise in geothermal ground-source heat pump installations (Table 4). However, the information on geothermal ground-source heat pump installations is also rather tentative.

Table A:The parameters of geothermal systems in Ukraine for the period of 1978 to 1998, based on Khvorov (2005) without including new geothermal object, built after 2000

№	Object (type of consumer)	Type[1)]	Location	Commission date	Thermal (electric) capacity, MWth (MWe)	Status
1	Sport center “Zakarpattia” (heating supply and balneology)	H+B	Berehovo BerehovoRaion, Zakarpattia Oblast	1978	2.1	Under reconstruction
2	Sanatorium “Kosyno” (heating supply and balneology)	H+B	Koson, Berehovo Raion, Zakarpattia Oblast	1998	1.2	Active
3	Sanatorium “Latorytsia” (heating supply and balneology)	H+B	Mukachevo Mukachevo Raion, Zakarpattia Oblast	1985	0.2	Active
4	Geothermal district heating system of the village Yantarne	D	Yantarne, Qurman Raion, Autonomous Republic of Crimea	1991	4.6	Closed
5	Geothermal district heating system of the village Chonhar (public buildings only)	D	Chonhar, Henichesk Raion, Kherson Oblast,	1998	1.0 (0.1)	Closed
6	Geothermal district heating system of the village Medvedivka (public buildings and a kindergarten)	D	Medvedivka, Dzhankoy Raion, Autonomous Republic of Crimea	2002	0.8 (0.06)	Closed
7	Geothermal district heating system of the village Zernove	D	Zernove, Saky Raion, Autonomous Republic of Crimea	1997	0.4	Closed
8	Geothermal district heating system of the village Piatykhatka (public buildings only)	D	Piatykhatka, Qurman Raion, Autonomous Republic of Crimea	1996	0.3	Closed
9	Geothermal district heating system of the village Nyzynne	D	Nyzynne, Qurman Raion, Autonomous Republic of Crimea	1998	0.3	Closed

[1)] B = Bathing and swimming (including balneology); D = District heating; H = Individual space heating (other than heat pumps).

5. LEGAL FRAMEWORK GEOTHERMAL ENERGY OF UKRAINE

In recent years, there was an improvement of the legal basis in Ukraine regarding the field of conservation, management, environmental protection and development of alternative and renewable energy sources, in particular geothermal waters. Among

adopted legal documents there were: “On Subsoil” (from 27.07.94, number 132/94-VR), “Water Code” (from 06.06.95, number 213/95-VR), “On alternative energy sources” (from 20.02. 03, № 555-IV) etc.

The procedure for the development of geothermal fields, providing requirements for special permits (licenses) is based on the Cabinet of Ministers of Ukraine № 615 of May 30, 2011 “On approval of special permits for subsoil use”.

Ukraine provides feed-in-tariff for electrical energy produced by geothermal electrical plants and feed-in-tariff can be increased if equipment made in Ukraine is used. Simultaneously, there are reduced taxes for imported geothermal equipment in Ukraine too. However, currently there is no geothermal electrical production in Ukraine.

Besides that, IRE NASU has developed the three-state national standards in the field of geothermal energy: “Geothermal energy. Terms and definitions”, “Geothermal energy. Geothermal heat stations” and “Geothermal energy. Geothermal power stations”. These standards define the basic terms and concepts, as well as technical requirements for electrical and thermal geothermal stations.

In 2018, because of government support, an experimental installation for study of heat storage from renewable energy sources in the underground aquifer thermal energy system was created by the IRE NASU. The investments in the research of geothermal sector in 2019 consist of 4 million UAH (0.16 million USD).

CONCLUSION

Currently, the number of geothermal facilities in Ukraine is increasing. The current trend is linked to commercial use of geothermal heat pumps and direct use of geothermal energy for heating and balneology purposes. The most developed geothermal region in Ukraine is Zakarpattia Oblast.

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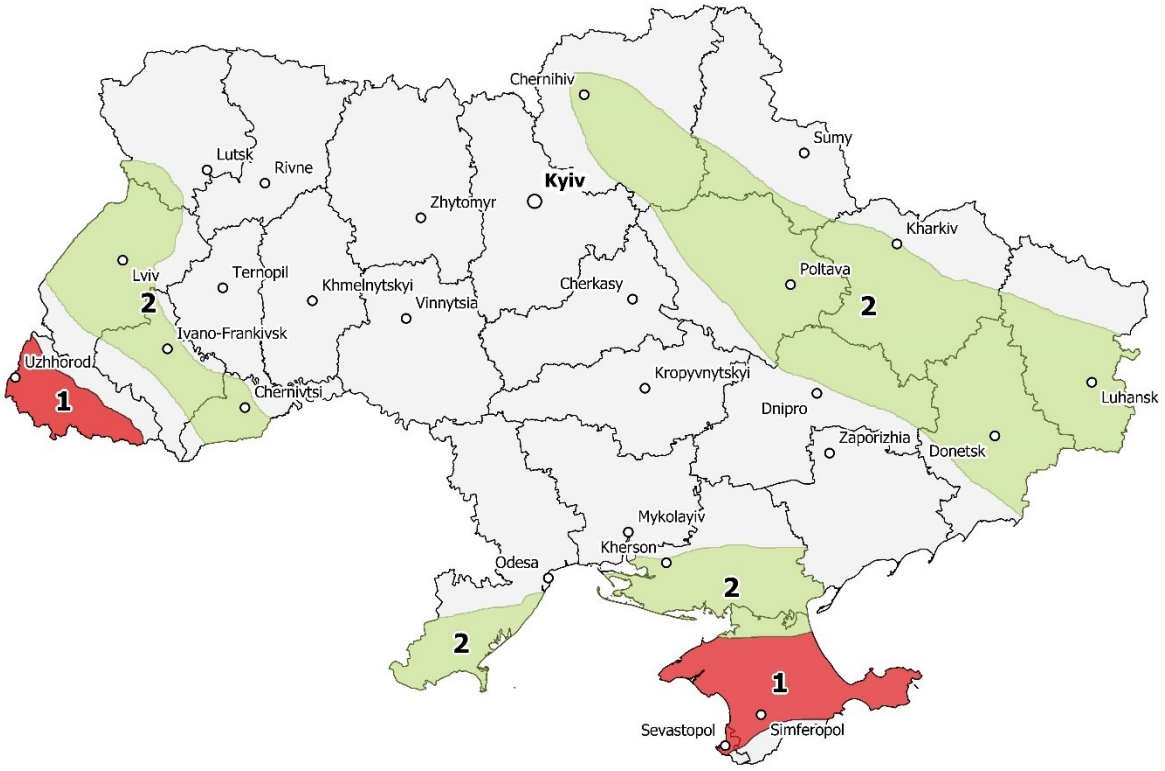

Figure 1: Ukrainian geothermal map zones based on their geothermal potential, 2019:

1 – the best zones to extract geothermal energy;

2 – the other zones to extract geothermal energy.

TABLE 1. PRESENT AND PLANNED PRODUCTION OF ELECTRICITY, UKRAINE

There is no geothermal electric power generation in Ukraine thus there is no need to show that table.

TABLE 2. UTILIZATION OF GEOTHERMAL ENERGY FOR ELECTRIC POWER GENERATION AS OF 31 DECEMBER 2019, UKRAINE

No geothermal electric power generation in Ukraine.

TABLE 3. UTILIZATION OF GEOTHERMAL ENERGY FOR DIRECT HEAT AS OF 31 DECEMBER 2019, UKRAINE (other than heat pumps)

Name	Location	Type	Maximum Utilization			Capacity	Annual Utilization		
			Flow Rate	Temperature (°C)			Ave. Flow	Energy	Capacity
			(kg/s)	Inlet	Outlet	(MWt)	(kg/s)	(TJ/yr)	Factor
Borzhava	Dovhe, Irshava Raion, Zakarpattia Oblast	H+B	7.2	50	40	0.30	3.37	4.45	0.47
Derenivska Kupil	Nyzhnie Solotvyno, Uzhhorod Raion, Zakarpattia Oblast	H+B	8.6	45	35	0.36	5.68	7.49	0.66
Hariache Dzherelo	Henicheska Hirka, Henichensk Raion, Kherson Oblast	H+B	21.5	60	50	0.90	7.96	10.50	0,37
Kosyno	Koson, Berehovo Raion, Zakarpattia Oblast	H+B	28.7	45	35	1.20	14.92	19.68	0.52
Latorytsia	Mukachevo, Mukachevo Raion, Zakarpattia Oblast	H+B	6.7	50	40	0.20	1.77	2.33	0.37
Tepli Vody	Veliatyno, Khust Raion, Zakarpattia Oblast	H+B	14.3	45	35	0.60	6.17	8.14	0.43
Teplytsia	Vynohradiv, Vynohradiv Raion, Zakarpattia Oblast	H+B	6.9	50	35	0.43	4.11	8.14	0.60
Termal Star	Nyzhnie Solotvyno, Uzhhorod Raion, Zakarpattia Oblast	H+B	13.6	45	35	0.57	5.59	7.37	0.41
Zhavoronok	Berehovo, Berehovo Raion, Zakarpattia Oblast	H+B	10.8	45	35	0.45	5.92	7.81	0.55
Zolota Hora	Barvinok, Uzhhorod Raion, Zakarpattia Oblast	H+B	13.1	50	40	0.55	6.97	9.19	0.53
Small facilities in Kherson Oblast		H+B	9.6	50	40	0.40	4.49	5.93	0.30
Small facilities in Zakarpattia Oblast		H+B	16.7	50	40	0.70	11.05	14.57	0.30
Small facilities in other regions of Ukraine		H+B	7.2	50	40	0.30	0.70	22.09	0.30
TOTAL			**162.9**			**6.96**	**71.05**	**95.95**	

*Rough calculations.

[1)] B = Bathing and swimming (including balneology); D = District heating; H = Individual space heating (other than heat pumps)

[2)] The shown temperature for small facilities are of average value.

TABLE 4. GEOTHERMAL (GROUND-SOURCE) HEAT PUMPS AS OF 31 DECEMBER 2019, UKRAINE

Locality	Ground or Water Temp. (ºC)	Typical Heat Pump Rating or Capacity (kW)		Number of Units	Type[1)]	COP	Heating Equivalent Full Load Hr/Year	Thermal Energy Used (TJ/yr)	Cooling Energy (TJ/yr)
Ukraine	(-7)…(-25)	5…20	1 600 000	ca. 110 000	V, H, W	av. 3.2	1260	4990	20…30 % devices are used for cooling; exact data is not known

[1)] V – vertical ground coupled; H – horizontal ground coupled; W – water source (well or lake water)

TABLE 5. GEOTHERMAL (GROUND-SOURCE) HEAT PUMPS AS OF 31 DECEMBER 2019, UKRAINE

Use	Installed Capacity (MWt)	Annual Energy Use (TJ/yr = 10^{12} J/yr)	Capacity Factor
Individual Space Heating	-	-	-
District Heating	-	-	-
Air Conditioning (Cooling)	-	-	-
Greenhouse Heating	-	-	-
Fish Farming	-	-	-
Animal Farming	-	-	-
Agricultural Drying	-	-	-
Industrial Process Heat	-	-	-
Snow Melting	-	-	-
Bathing and Swimming (Balneology)[1)]	6,96	95,95	0,44
Other Uses	-	-	-
Subtotal	6,96	95,95	0,44
Geothermal Heat Pumps	1600	4990	0,10
TOTAL	1606,96	5085,95	0,10

[1)] The same facilities may use geothermal energy for heating purpose but in found data on these facilities geothermal consumption for space heating is not divided form balneology consumption. Thus, both types of consumption are shown together as for 'bathing and swimming' purpose.

TABLE 6. WELLS DRILLED FOR ELECTRICAL, DIRECT AND COMBINED USE OF GEOTHERMAL RESOURCES FROM JANUARY 1, 2015 TO DECEMBER 31, 2019, UKRAINE (excluding heat pump wells)

No data about that in Ukraine.

TABLE 7. ALLOCATION OF PROFESSIONAL PERSONNEL TO GEOTHERMAL ACTIVITIES, UKRAINE (Restricted to personnel with University degrees)

(1) Government
(2) Public Utilities
(3) Universities
(4) Paid Foreign Consultants
(5) Contributed Through Foreign Aid Programs
(6) Private Industry

Year	Professional Person-Years of Effort					
	(1)	(2)	(3)	(4)	(5)	(6)
2019	10	90	30	n.d.	n.d.	60

Rough calculations.
n.d. – no data

TABLE 8. TOTAL INVESTMENTS IN GEOTHERMAL IN (2019) US$, UKRAINE

Period	Research & Development Incl. Surface Explor. & Exploration Drilling Million US$	Field Development Including Production Drilling & Surface Equipment Million US$	Utilization		Funding Type	
			Direct Million US$	Electrical Million US$	Private %	Public %
2015-2019	0.61	n.d.	n.d.	n.d.	n.d.	100

Rough calculations.
n.d. – no data