Geothermal Energy Use, Country Update for Ukraine

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Keywords: thermal waters, geothermal installation, heating, balneology.

ABSTRACT

In this report, the analysis of Ukrainian geothermal conditions is given and thus the regions (or territories) which are perspective for the formation of geothermal deposits are distinguished. These are the Transcarpathian and the Carpathian depressions, the Black Sea artesian basin (Steppe Crimea and Black Sea Coast) and the Dnieper-Donetsk artesian basin. Low-temperature geothermal resources are also available in Donetsk folded area. The geothermal field mainly is confined to the oil and gas provinces.

There are more than 12,000 wells in Ukraine. Mentioned wells include oil wells, gas wells as well as wells drilled for other purposes. Based on the information got from construction of these wells, most thermal aquifer depths in Ukraine are placed in the range from 900 to 7020 m. The formation temperature of the thermal water varies from 35 to 210 °C. The well flow rates change from a few to 30 dm^3/s. Some of those perspective geothermal sites are shown in Figure 1. Forecast capacity of geothermal resources of the explored part of Ukraine is 50 million TOE.

The utilization of geothermal resources in Ukraine started in 1986. Total 8 geothermal plants have been built. Within 3-10 years, they have been used for heating of social buildings and sanatoriums. The total installed capacity of these plants is 11.2 MW. Currently, there are only two geothermal plants with a total installed capacity of 0.9 MW.

In recent years, rapidly growing using of geothermal resources for the balneological and recreational aims (swimming pools and procedures). Geothermal recreation centers have been built in the Zakarpattia and Kherson oblasts. The total installed capacity of geothermal balneological plants is about 3 MW. There are reports on new geothermal recreation centers to be built in 2019.

1. GEOTHERMAL CONDITIONS

Ukraine is among the countries with average conditions for the formation of geothermal fields. The youngest geologically structures are the Carpathian mountain folds and the Crimean Mountains. These structures are formed in the Cimmerian and Alpine orogeny era and are characterized by heightened heat flow (from 60 to 90 mW/m^2 and more), active seismicity, tectonic dissection. However, geothermal gradients for these areas are low (less than 2 °C / 100 m). This is explained by the fact that the structures are regional feed for aquifers. Cold precipitations filters from the deeper layers along faults. Thus, the Carpathian mountain folding and Crimean Mountains are the source of heat to the surrounding areas, but they cannot be regarded as promising for the formation of geothermal fields.

Adjacent areas, namely Transcarpathia and Carpathian depressions, Black Sea depression, characterized by intermediate values of heat fluxes (from 50 to 80 mW/m^2), but the heat is much higher than background. The highest geothermal gradients (up to 7-8.4 °C/100 m) are observed in the Transcarpathian basin, in the central part of the Crimean Peninsula on the coast and the Black Sea (Kherson and Odessa administrative region). Aquifers are presented Cenozoic and Mesozoic sedimentary and volcanic rocks.

Promising areas as concerns the central part of the Dnieper-Donets Basin (that includes the following administrative regions: Chernihiv, Poltava, Kharkiv, Dnipro, Sumy). Heat flows in this area vary from 70 to 90 mW/m^2, and geothermal gradients do not exceed 3-3.5 °C/100 m. Of the Dnieper-Donets Basin is a graben with a depth of 12 to 20 km, filled with sedimentary Mesozoic rocks. As aquifers are found at great depths, so this area is favorable for the formation of geothermal fields.

2. THE POTENTIAL OF GEOTHERMAL RESOURCES

Institute of Renewable Energy (IRE) of the National Academy of Sciences of Ukraine (NASU) estimates the predictive potential 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). We took into account only those wells, thermal water temperature of which exceeds 60 °C. 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, also not taken into account the influx of heat from the rock mass. Forecast potential geothermal resources explored part of Ukraine corresponds to 50 million TOE in year.

Institute of Geophysics (IGPH) NASU in 2004 year issued "Geothermal Atlas of Ukraine", in which were made estimates of geothermal resources of territory according to the depth of 3, 4.5 and 6 km. In a basis of calculations were placed average geothermal gradient and thermal properties of rocks, which defined by the actual data and specific to certain calculation areas.

Note that defined IGPH NASU resources reflecting actual petrothermal energy sources, while thermal water resource (hydrothermal) in this assessment are not included. The total value of geothermal resources of Ukraine in the depth at interval 5.5- 6 km according to calculations of IGPH NASU was 0.56 trillion TOE

3. THE USE OF GEOTHERMAL ENERGY FOR HEATING

The first in Ukraine and the Soviet Union geothermal circulation system was created in 1986 at Illinka (Saky Raion, Autonomous Republic of Crimea). Overall, from 1986 to 2002 year on the peninsula of Crimea six similar plants were built with a total installed capacity of 11 MW. Geothermal energy is used for heating of social buildings (schools, hospitals, kindergartens, office buildings). In addition, two geothermal plants with installed capacity of 0.2 MW each were built with. Kosino and Mukachevo, Zakarpattia oblast.

During the period of the dissolution of the Soviet Union almost all installations were dismantled. Currently, there are two geothermal: in the village of Medvedivka at Autonomous Republic of Crimea (0.7 MW), and the village of Kosino at Zakarpattia oblast (0.2 MW).

4. THE USE OF GEOTHERMAL RESOURCES IN BALNEOLOGY AND FOR RECREATIONAL PURPOSES

Thermal water with healing properties is available in many regions of Ukraine. Most are common in the Zakarpattia and Kherson oblast, and also in the Autonomous Republic of Crimea. Currently, in the Autonomous oblast, there are more than 50 thermal springs. Thermal recreational center built in Shoreline, Borzhava, Velyatin, Dovge, Koson, Mukachevo. Thermal water is extracted from wells. The temperature of the thermal water at the wellhead varies from 35 to 60 °C. The total installed capacity of geothermal installations balneological about 3 MW.

5. FORECAST OF DEVELOPMENT OF GEOTHERMAL POWER

State Agency on Energy Efficiency and Energy Saving of Ukraine has developed the “Road map of geothermal energy and the energy of the environment for the period up to 2020”. This document, which was approved by the Cabinet of Ministers, determines the basic parameters of development of geothermal energy in Ukraine.

It is planned that the installed capacity of geothermal power plants in 2020 will amount to 64 MW of geothermal heating plants -120 MW, geothermal heat pumps - 120 MW.

6. PRECEDENCE DEVELOPMENT OF GEOTHERMAL RESOURCES OF UKRAINE

Priority objects are defined based on the analysis of hydro-geological exploration data indicators, and assessing their performance. Table 1 presents the geothermal facilities, which are the most studied. The data can be used as a priority objects after the tests and determine the technological parameters, as well as estimates of reserves of geothermal fields.

Table 1. Priority geothermal objects

№	Name of geothermal object	Placement by region	Bed tempera-ture, °C	Depth of productive horizon, m
1	Russkie Komarovtsy	Zakarpattia	89	1350
2	Henichesk	Kherson	89	2620-2651
3	Monasty-ryshche	Chernigiv	96-98	3374-3384
4	Spivakov-skaya	Kharkiv	98	2780
5	Gadyach	Poltava	119-120	4950
6	Mostyska	Lviv	90-95	3160
7	Hlinsko-Rozbyshe-vskoe	Poltava	127	5060

The data can be used as a priority objects after the tests and determine the technological parameters, as well as estimates of reserves of geothermal fields.

7. LEGAL FRAMEWORK GEOTHERMAL ENERGY OF UKRAINE

In recent years, the legal basis of Ukraine has done much for the regulation of legal relations in the field of conservation, scientifically proven, natural resource management, environmental protection, development of alternative and renewable energy sources, including, geothermal waters. There were adopted the Code “On Subsoil” (from 27.07.94, number 132/94-VR), “Water Code” (from 06.06.95, number 213/95-VR), the law “On alternative energy sources” (from 20.02. 03, № 555-IV) and others.

Powered with international standards for classification of reserves of geothermal waters approved provisions for the training of geothermal deposits to commercial operation, a procedure for conducting geological - exploration of geothermal fields to set technical requirements for safe, reliable and economic operation of heating sources

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”.

Requirements for scrutiny of geothermal fields to calculate their reserves and state records set on the basis of the “Instruction on the application of the Classification of reserves and mineral resources the state fund of mineral resources fields of cogeneration groundwater”, which was approved by the Cabinet of Ministers of Ukraine dated 21.06.07, №707 / 13971).

In the field of standardization national standards adopted by the State Ukraine: "Geothermal energy. Terms and definitions", "Geothermal energy. Geothermal heat stations" and "Geothermal energy. Geothermal power stations". These standards were developed by IRE.

IRE has developed the three-state national standards in the field of geothermal energy. 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 Institute of Renewable Energy National Academy of Sciences of Ukraine.

8. CONCLUSIONS

At present the research potential of geothermal energy resources in Ukraine are at the initial stage of development: The map of heat flow, geothermal gradients and temperatures for different intervals subsoil depths found main thermal anomaly zones.

Ukraine is among the countries with medium level geothermal gradient. On the territory of the existing areas with anomalously high heat flow values (Carpathian region and the Black Sea basin) and insulating layers that contribute to the conservation of heat deep within the Earth's interior.

In Ukraine there are two types of geothermal deposits, deposit formation types, artesian basins intermountain and foothill basins (Carpathian region and Crimea) and deposit formation type in the Great Artesian Basin platform type (Black Sea and Dnieper-Donetsk artesian basin). Thermal water horizons first type deposits occur at depths of 900-1500 m or more, for the second - 2000-2500 m and more.

Analysis of evidence indicates that the most favorable conditions for the formation of geothermal resources are characterized by gas, gas condensate and some oil fields. This applies particularly to depleted gas fields that are filled up with water during operation.

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Tables A-G

Table A: Present and planned geothermal power plants, total numbers

Geothermal power plants are not available in the country.

Table B: Existing geothermal power plants, individual sites

Geothermal power plants are not available in the country.

Table C: Present and planned geothermal district heating (DH) plants and other direct uses, total numbers

	Geothermal DH plants		Geothermal heat in agriculture and industry		Geothermal heat for individual buildings		Geothermal heat in balneology and other	
	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)
In operation end of 2018	0.9	-	-	-	-	-	3	-
Under construction end 2018	?	-	-	-	-	-	-	-
Total projected by 2020*	120	-	-	-	-	-	?	-
Total expected by 2025	?	-	-	-	-	-	?	-

* The numbers from the "Road map of geothermal energy and the energy of the environment for the period up to 2020".

Table D1: Existing geothermal district heating (DH) plants, individual sites

Locality	Plant Name	Year commissioned	CHP	Cooling	Geoth. capacity installed (MW_{th})	Total capacity installed (MW_{th})	2015 production (GW_{th}/y)	Geoth. share in total prod. (%)
Zakarpattia Oblast	Plant at Kosino Thermal Complex				0.2			
Autonomous Republic of Crimea	Plant at the village of Medvedivka, Dzhankoy Raion				0.7			
total					0.9			

Table D2: Existing geothermal direct use other than DH, individual sites

No data.

Table E: Shallow geothermal energy, ground source heat pumps (GSHP)

	Geothermal Heat Pumps (GSHP), total			New (additional) GSHP in 2018		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2018	1550	?	-	-	-	-
Projected total by 2020	?	?	-			

Table F: Investment and Employment in geothermal energy

	in 2018		Expected in 2020	
	Expenditures (million €)	Personnel (number)	Expenditures (million €)	Personnel (number)
Geothermal electric power	-	-	-	-
Geothermal direct uses	-	-	-	-
Shallow geothermal	-	-	-	-
total	**-**	***est.* 21***	**-**	**?**

* The total number of scientific workers of Institute for Renewable Energy of the National Academy of Sciences of Ukraine and Institute of Geophysics of the National Academy of Sciences of Ukraine

Table G: Incentives, Information, Education

	Geothermal el. power	Geothermal direct uses	Shallow geothermal
Financial Incentives – R&D	Yes	Yes	Yes
Financial Incentives – Investment	-	Yes	Yes
Financial Incentives – Operation/Production	Yes	-	-
Information activities – promotion for the public	Yes	Yes	Yes
Information activities – geological information	Yes	Yes	Yes
Education/Training – Academic	Yes	Yes	Yes
Education/Training – Vocational	-	Yes	Yes

Key for financial incentives:					
DIS	Direct investment support	FIT	Feed-in tariff	-A	Add to FIT or FIP on case the amount is determined by auctioning
LIL	Low-interest loans	FIP	Feed-in premium		
RC	Risk coverage	REQ	Renewable Energy Quota	O	Other (please explain)