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The Geothermal Energy is in the Stavropol Territory

Elizabeth Anatolyevna Matveeva, JuliaVladimirovna Litvinova, Natalia Dementyevna Komarova and Tatiana Nikolaevna Iljina

[1]North Caucasian Branch of the Federal State Budget Educational Institution of Higher Professional Education "Belgorod State Technological University VG Shukhov " Russia, 357202, Stavropol Territory, Mineralnye Vody, Street. Zheleznovodskaya 24
[2]Federal state budget educational institution of higher professional education "Belgorod State Technological University afterV.G. Shukhov " 46 Kostyukova Street , Main Building, Architectural and Civil Engineering Institute, BSTU after V.G. Shukhov, Rm. 401 , Belgorod, 308012, Russia.

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This paper is devoted to the prospects of the development of alternative energy sources in Stavropol region, projects based on the use of environmentally friendly and saving-resource energy sources, particularly the hydrothermal power. Currently the percentage of its application in the energy balance of the Russia is definitely small, which requires soon development of geothermal designs. It should be noted that the use of alternative energy sources is becoming world-wide; the scale of their usage has increased by several times for the last decade. This direction is developing most rapidly in comparison with other branch of energy industry.

Key words: geothermal system, alternative energy sources, hydrothermal deposits, environmental safety, heating.

The use of geothermal sources

Perhaps the time of cheap conventional energy is winding down; the main trend in this area is an inevitable rise in prices for all kinds of power sources because of a fading out of world reserves.

Source of geothermal energy is the natural heat of the earth. Geothermal resources are divided into: low-temperature (less than 90-100 °C), medium temperature (from 90-100 °C to 150 °C) and high temperature (above 150 ° C). Most high-temperature resources are generally used to produce electricity. Low-and medium-temperature resources can be used directly or with the help of heat pumps. Direct use includes: water heating (without heat pumps and power plants) for technological process, heating of buildings and greenhouses, aquaculture (fish farming) and creating of resorts . Direct use projects typically exploit sources with temperatures from 38 to 149 ° C. Heat pumps use the soil or ground water as a heat source in winter and as a heat sink in summer. Using resources with temperatures of 4-38 ° C, heat pumps transfer heat of the ground to a house in winter and in summer this heat returns to the ground (Lee K.S., 2013).

Large-scale industrial use of geothermal energy is possible in areas where the Earth's natural heat flows touch the surface close enough to bring the steam or hot water out of the ground.

* To whom all correspondence should be addressed.

Most of these places are located at the edges of fundamental crystalline formation , or in fault zones; they are usually characterized by the presence of volcanoes, hot springs and other geothermal phenomena.

The use of renewable energy sources in the world

Geothermal district heating system is basically used in Europe, with France and Spain having the lead. In the USA geothermal heating system is mainly used for individual houses (Glassley William E., 2010).

The example of geothermal heating system creating is the one in Reykjavik, Iceland, which provides about 98% of heat demand, consumes 2400 l /s of geothermal hot water with the temperature of 85...1230 ° C (Pierce V., 2011). The system includes a deaerator, pump station, emergency (reserve) tanks, peak boiler and an extensive network of heat distribution.

By the year 2005 geothermal power plants had operated in 24 countries (see. Fig. 1), and the gross installed capacity of them was 8,910.7 MW . The leaders are: the USA-2544 MW, the Philippines - 1931 MW, Mexico- 953 MW, Indonesia-797 MW, Italy- 790 MW, Japan -535 MW, New Zealand- 435 MW, Iceland -202 MW. Over the past 30 years, the annual increase in capacity was 7%. The world geothermal power plants generation was 56798 GWh in 2004 (Povarov O.A. & Tomarov G.V., 2006, #3 pp. 78-80). According to the forecast the total installed capacity of geothermal power plants in the world can be doubled by 2010 (Poole Ch. & Owens F., 2006).

Russia's energy potential

Exploration of geothermal resources was launched in the Soviet Union in 1957, when the first wells were drilled in the geothermal field of Pauzhetka in Kamchatka. At present, the Russian geothermal potential has been mainly explored; a significant number of thermal fields have been found. The Kamchatka Peninsula and the Kuril Islands are seismically active and have the largest geothermal resources. There are 127 volcanoes in Kamchatka; 22 of them are acting (Battocletti, L., 2000). There are also about 150 groups of thermal springs and 11 high-temperature hydrothermal systems (Kononov V. et al., 2000). Other areas of Russia also have significant geothermal resources with temperatures from 50 to 200 ° C, rested at depths of 200 to 3,000 meters. These areas include the North Caucasus, Dagestan, Central Russia, the West Siberian Plain, the Baikal region, Krasnoyarsk region, Chukotka and Sakhalin (see. Fig. 2). In addition, some of the resources are available within the East European and Siberian platforms, in the Urals, Altai and Sayan Mountains, as well as in the Okhotsk-Chukotka volcanic belt. Intergranular and fracture hydrothermal networks with temperatures of 50-70 rest at a depth of about 3 km in these areas (Korjakin Yu., 2003).

It is estimated by Russian specialists that the potential of geothermal resources rested at depths of about 3 km is 180 million TFOE per year (Yanovsky A. & Bezrukih P., 1999). About 20 million TFOE of this potential are suitable for development. The economic potential of hydrothermal resources and steam-water mixture with the use of geocircular technology is estimated at 115 million TFOE per year. According to Oleg Povarov's estimate, 16.9 billion kWh, or nearly 2% of electricity production in Russia, can be theoretically obtained from geothermal energy (Povarov O. et al., 2000, November).

Problems of development of geothermal energy

In addition to the obvious advantages in the use of hydrothermal heat and there are some problems. It should be noted the most important of them .

The first problem is prospecting of springs and well-drilling. To supply a geothermal power station with a heat conductor of high parameters a hole with diameter of 146 mm is usually drilled to the depth of 2.5 km where the hot water or steam are deposited. There are springs that lie deeper, but to drill wells up to them is not cost-efficient. Well-drilling is expensive. In the Stavropol region, for example, in 2002 the cost of drilling of one meter was 8,000 RUR and the sheet deposit of hot water was at a depth of 1800 m, thus the cost of the well was 14.4 million RUR (Staicovici M-D., 2014). Each well provides a certain flow rate, which is limited by the input resistance of the ground out of a heat conductor and its pressure. There is a proposal to drill deviated wells in the aquifer to collect the heat conductor from a larger area (horizontal bend of pipes is perforated).

The second problem is the environment

In the first, noise, arising from geothermal fluid pressure decrease on "the soil surface", is environmentally harmful. According to Devins

(Britvin O.V. et al., 2001, #2, pp.4-10), the noise sometimes becomes deafening roar. To protect from it , noise limiters are installed, the station are made fully automated, so as the personnel was out of the area of noise.

Another environmental problem is a prohibition of dumping of water at a temperature of more than 300C on the “ground surface” (i.e. ponds and other bodies of water). Hot water has to be diluted with cold, and a more reliable way is to reinject it .

The third problem is the depletion of the geothermal source and the change in geology. Withdrawal of large amounts of water out of aquifers leads to subsidence. At Geothermal Power Plant of Wairaken for the period from 1956 to 1980, there was a subsidence of 4m (Alkhasov A.B., 2001, #2, pp. 11-13). That’s why, water is pumped back into the reservoir at new stations. Pumping water consumes a lot of energy. At Larrderello station ,with total turbines capacity of 122 MW, two turbines, with a total capacity of 18 MW, works to cover their own needs, the main of which is to download the condensate back into the aquifer.

The fourth problem is corrosion of the equipment and scaling. Thermal waters contain dissolved corrosive gases (H2S, CO2, etc..) that causes necessity of selection of appropriate materials for pipes and equipment. Scaling is another trouble to be dealt with. All these factors increase the cost of the resulting energy and creates serious difficulties in the operation.

Tasks to be solved by alternative energy sources

In Russia, which has large reserves of conventional organic energy, the government has not paid serious attention to the development of renewable energy sources (RES) in recent years. Unlike other countries there is no legislative support to the process in Russia; objective indicators on their long term development have not been accepted yet.

Taking into consideration that

- centralized energy supply systems in Russia embraces less than one third of its territory,
- Approximately 20 million people live outside the centralized power systems,
- A significant number of regions are suffering from power shortages and require fuel delivery,
- According to Gazprom, only 52% of localities are gasified (including 59% of cities and 30.6% of rural settlements),

Renewable energy sources in Russia could make a significant contribution to solving urgent energy problems , such as:

1. Improving the reliability of heat supply of buildings and production (especially agriculture) in the areas of centralized heat supply (mainly with power shortage) during emergency and restrictive power cuts;
2. Reduction of harmful emissions from power plants in cities and towns affected by environmental problems, as well as in places of public recreation (Nikolskiy A.I., 2012).

Methods for the development of geothermal energy

Geothermal energy is mostly used in the territories and received the most development in the areas, where there are high-potential resources of the Earth (in the USA-3.1 GW, in Indonesia -1.2 GW, in the Philippines - 1.9 GW, etc.).

In Russia in 2012 geothermal power plants (GPP) generated 81.2 MW: 2 units in Pauzhetka (12 MW), 3 units in Verhne- Mutnovka (12 MW) and 2 units in Mutnovka (50 MW) on the Kamchatka Peninsula, as well as 4 block power plants of 7.2 MW, set by Kaluga Turbine Plant to the Kuril Islands: Iturup and Kunashir. Block stations are equipped with a back pressure turbines and taken to the construction site by wagon type containers at 100th prefabrication (Tomarov G.V. et al, 2009, #11, pp. 2-12). Geothermal electrical units with power of 25 MW produced in Russia for Mutnovka’s GPP with turbines from Kaluga Turbine Plant have the best-in-class technical and economic indicators (specific steam consumption is 6.89 kg / (kWh), gross efficiency of 20.1%). World’s most powerful turbine was installed in Indonesia by the Japanese company. Inlet turbine steam pressure is 1.02 MPa, and the output pressure is 12 kPa (Rybach L., 2002).

Leader in renewable energy and in general “energy conservation” in Europe is relatively small Denmark. This is due to at least two reasons. Firstly, in Denmark natural gas is most expensive in Europe: its price comes to • 1.123 / m 3 (in the Stavropol region it is about 2.8 rubles / m3, i.e. almost 10 times cheaper). Secondly, in Denmark, as in most Western European countries, renewable energy users receive large financial benefits from the government.

Geothermal water is used in two ways

1 For space and greenhouses heating and for balneology purposes. The installed capacity of the deep (using water from a depth of more than 400 m) geothermal heating systems operating in the world was 50.6 GW in 2010 (Amerkhanov R.A. et al., 2012, #11, pp.36-40). In Russia, it is 0.4 GW the most of the systems are in Dagestan and other parts of the North Caucasus, and less of them are in Kamchatka and in the Krasnodar region.

2 For the production of electricity. The total installed capacity of geothermal power plants in the world is about 10.7 GW (Tomarov G.V. et al., 2012, #11, pp.26-35). It is much less than the power of direct heat plants. However, it should be borne in mind that, in the case of geothermal power plant , electric power is generated from the heat with an efficiency of 15 to 20%, while, in direct using, all the heat from the source is taken into account.

RESULTS

The prospect of the development of alternative sources in the Stavropol Territory.

There have been unique hydrothermal springs spouting in the mountains and plains of the Stavropol Territory for centuries. From ancient times, people have used this natural wealth not only to treat diseases, but also in the household (Popel O.S. et al., 2010, 56 pp).

There are about 9 large hot springs in the Stavropol Territory, but their benefit has not been truly appreciated yet.

The deposits are in the locality of human settlements and can be used as a “direct” high-potential source of thermal energy for heating systems, conversion to electricity by means of thermal generator units and also as a low-grade energy sources with modern technologies using a thermal pump.

Balance reserves of Terek-Galogaevskiy, Georgievskiy, Kazminskiy, Suvorovskiy and Nizhne- Zelenchukskiy geothermal deposits are rated at 82 000 mV / day (Alkhasov A.B., 2003, #3, pp..52-54).

Research and development of hydrothermal deposits will make a significant breakthrough in the power industry of the region. In addition to the large deposits there are a number of springs located in small villages, whose coolant volume and thermal potential would allow transferring these administrative entities into offline regime of power delivery.

Prospect of the development of alternative sources in the Stavropol Territory

The committee, headed by Deputy Prime Minister of the Stavropol Territory, the Minister of Industry, Transport and Communications G.Klyushnikov, has considered the prospect of the alternative energy sources development.

One of the main considerations was a reconstruction design of a mini-camp, modernized with the use of geothermal energy. It includes agricultural enterprise with a greenhouse complex and residential area.

Hydrothermal energy industry is a real modern and environmentally friendly type of power engineering, since this technology develops without additional consumption of diesel or oil fuel that is also an indicator of its prospectivity on the background of seismic activity in the region. It should be noted as well that the price of electricity generated by geothermal power plant is much smaller than the one produced by the CHP. Another factor is that geothermal power plant is an environmentally friendly production, excluding carbon and other gases emissions which pollute the environment and contribute to the greenhouse effect. It’s a very important factor because many areas of the Stavropol Territory are recreational and natural reserves.

It is necessary to solve the problem of waste water returning into water bearing layer for making the hydrothermal energy industry widely used. Discharge into open water system is impossible because of the content of various metals salts including toxic (arsenic, lead, boron, zinc, cadmium), as well as ammonia and phenol. These chemicals have a poisonous influence on the ecosystem of natural reservoirs.

Use of the hot spring village Ulyanovka

A driven well located in Ulyanovka village of Mineralovodskiy region in the Stavropol Territory is of great interest. A hot spring in the Ulyanovskaya colony, the original name of

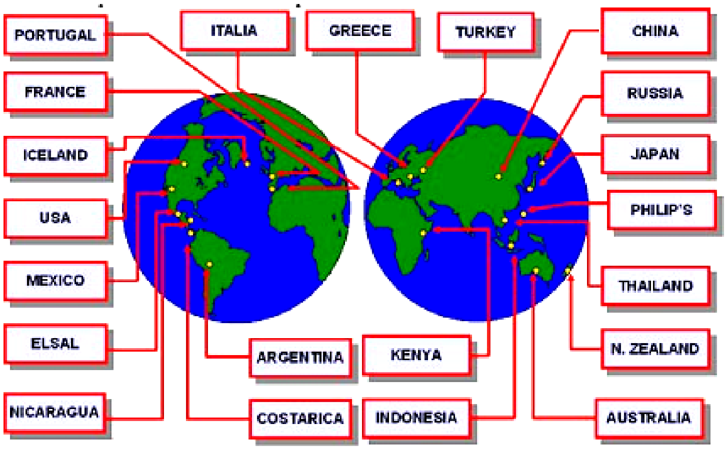

Fig. 1. Countries exploiting geothermal power plants

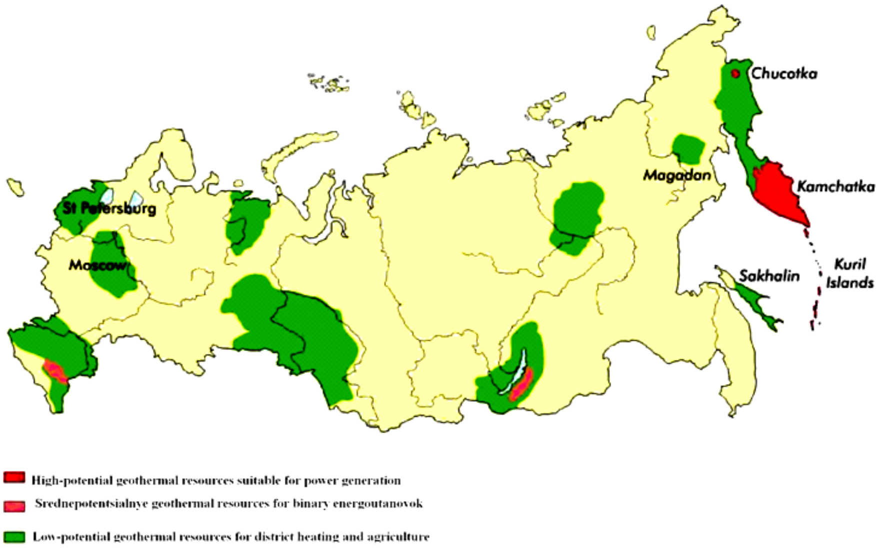

Fig. 2. Geothermal resources

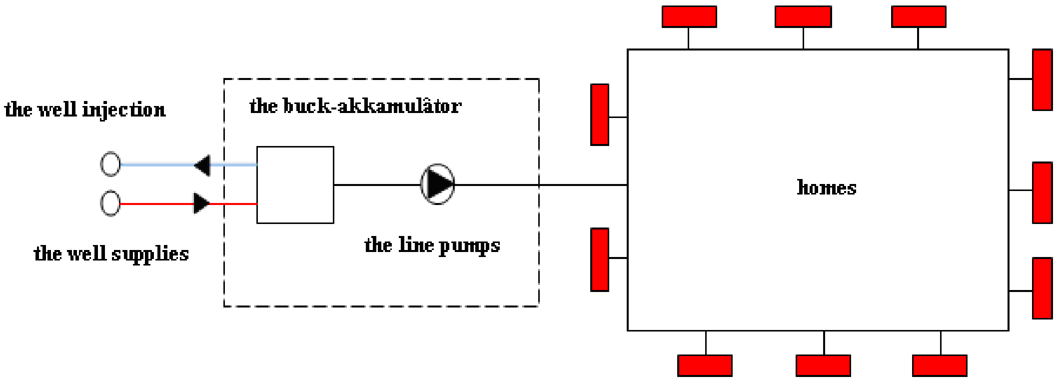

Fig. 3. Schematic diagram of the proposed geothermal heating system of Ulyanovka village council

Ulyanovka village, was first mentioned in 1899 and it was described as the hot water spouting out of the earth near the village. Little attention was paid to developing and use of the hot spring. As time went on the village was growing and needs of its residents were also increasing. In 1962 people living in the hamlet Nicholaevskaya Steppe drilled a well bore on their own, using expedient means; it became the "heart" of the hot water system in the hamlet and village. Residents appreciated that bounty of nature. It was noted that the water from the well healed wounds quickly, the water was also soft and "was soaped" in a strange way. For a decade, pipelines supplying the houses with hot water rotted without repair, and the system was failed.

According to Water Resources Division of the Kuban STB in the Stavropol Territory: a driven well in Ulyanovka village, administrative center of the "Rural settlement Ulyanovsk village council" municipal unity of Mineralovodskiy district in Stavropol Territory, has the following coolant parameters at the wellhead: temperature is 120-138 ° C, flow rate for the 25- year period of monitoring ranged from 460 m3 / d. to 623 m3 / d., static pressure reaches 0.347 MPa, dynamic pressure is up to 0.0128 MPa.

There are a number of similar wells in the Stavropol Territory that allows creating standard designs of heat energy supply of small administrative units or districts of cities. These hydrothermal resources should be used as a direct source of hot water and heating.

Use of geothermal heat for district heating

Direct geothermal heating is hot spring water using to heat houses and businesses, greenhouses and fish farms. Hot water springs with a temperature of 60 to 180æ%C are best suited for this purpose. "The first modern geothermal heating system appeared in the United States, in the western city of Boise, Idaho. Drilling of geothermal wells started in 1890. By the year 1892, houses in Boise had already been heated with the use of natural sources. "(DiPippo R. 2012).

There are two types of systems using ground source energy for heating. The basic one is deep- well pumping and direct water distribution into the heating system. After cooling, water is returned to the underground reservoir. Modern systems have a more complicated process of using geothermal heat transfer agent. Hot water enters heat exchanger comprising the fluid and absorbs heat from the water. The heating fluid, e.g. water, passes through the building within closed- circuit heat-transfer loop . Thermal water and heated liquid are separated in a system using a heat exchanger. This is due to the fact that hydrothermal deposits may contain dissolved salts and minerals that can clog the heating system. The water extracted from the interior of the earth returns into the ground, so as not to deplete the deposit.

Many countries, including in Europe, use geothermal heating systems for the villages, small towns, greenhouses and other consumers. Expenses for their creation depends on the specific conditions and are on different data from 0,2 to 1,2 M □ / MW. The cost of heat energy consumption is estimated at 5 - 45 • / MWh, working time of such systems is 20 - 25 years, the payback period is 7 - 15 years (Boguslavskiy E.I., date accessed: 05.09.2011).

DISCUSSION

Heat supply system of the village Ulyanovka

Ulyanovka village , administrative center of the municipality of "Rural settlement Ulyanovka village council "of Mineralovodskiy district of the Stavropol Territory has a population of 1898 people, including residents of Novogodniy and Nicholaevskaya Steppe hamlets. There are predominantly one-storey buildings and 12 two-storey blocks of flats in the village. Analyzing this information and using the experience of utilized projects hydrothermal deposits of the village can be developed for heating and hot water supply. It should be also noted that the year-round constant temperature of wellhead water will give a chance to increase energy and economic efficiency significantly through the use of hydrothermal heat for electricity generation in non-heating season.

According to the "Guidelines for the formation of consumption standards for housing and communal services developed by the Institute of Economics of Housing and Communal Services in collaboration with the Office of Socio-Economic Development of the Ministry of Economy of the Russian Federation, designed for the development of minimum social standards for consumption of housing services for a particular region or municipality based on local conditions " by Bychkovski I.V., Mintz I.G. and edited by Loktionov V.M, the standard heat consumption for heating and hot water for one person living in the Stavropol Territory, the third climate zone, is 4.3 Gcal. Based on the population of 1866 people of Ulyanovka village and Nicholaevskaya Steppe hamlet located in the proximity of hydrothermal well, we can determine that the annual demand for hot water and heating is 1.07 MW.

According to the results of monitoring studies of OJSC "Kavminkurortresursy", the unified hydrogeological service on mode and operation of water deposits, hydrothermal well in Ulyanovka village has thermal power of 1.78 MW, indicating the possibility of creating an alternative thermal energy system based on hydrothermal water masses (Povarov O. et al., 2002).

Though use of geothermal heat has a great effect in new construction primarily, it can be also used for heating of old buildings. Regulatory operation of a constant temperature of geothermal water coming from a driven well requires additional heat control devices.

A schematic diagram of a heat supply

Principle schema of parallel feed (from a driven well) of geothermal water is suitable for the system of hot -water and heat supply of the village (see. Fig. 3). After it the spent coolant is pumped directly into the reservoir. Heat exchange regulation in the system is produced by mixing the waste water with the use of pumps. Flow of geothermal water in this scheme is the sum of the costs of heating and hot water. This scheme is appropriate for use in areas with large amounts of geothermal waters with limited amount of consumers. Storage tank is used for load shading and leveling of uneven consumption of hot water during the day. There is the difficulty of controlling the temperature in the hydrothermal heating. Stable temperature in the room is provided by electric heaters, controlled automatically by the temperature sensors. When there is an abnormality of a given thermal regime, these devices either enact electric heating system or disconnect it from the network.

Undoubtedly, the installation of thermo-control instruments and electrical resistance heaters increases the cost of the system; geothermal-electric scheme is currently one of the fastest developing forms of buildings heating. Its use reduces the energy consumption on heating and is environmentally safe.

Effective using of geothermal water with modern technical equipment and technologies in construction of the hydrothermal system of the central hot water and heating of residential areas in Ulyanovka village council will improve the living conditions of residents and will contribute to the further economic development of the region. To achieve the goal it is necessary to solve the problem of estimating the resource base of thermal water withdrawal in the Stavropol Territory. Another task is to develop serial production of equipment for central heating hydrothermal systems based on optimal energy efficiency-price ratio for the domestic market .

CONCLUSION

In recent years, there has been a significant technological advance in the development of small hydropower units, including Russia. Designed equipment meets high technical requirements. Its advantages are:

- Opportunity for settings to work, both offline and on the local supply;
- Full automation and absence of necessity of permanent attendance;
- A high service life (up to 40 years, with time between overhauls up to 5 year) (Butuzov V.A. et al., 2010).

Given the above, we can draw the following conclusions:

- In the Stavropol region, there are significant hydrothermal resources for heating systems and some experience in their construction and operation.
- Russian design standards of geothermal heating is advisable to improve using technical solutions and equipment tested with the world practice.
- Economic principles, governed by the rules need to be reviewed in a market economy. Sections on schemes, equipment, heating systems and regulation are based on outdated approaches and technical solutions.
- Resolution of issues of hydrothermal base, preparation of proposals for licensing is the basis of long-term development of

hydrothermal deposits, geological exploration, research activities in the field of environmental management;

- The integrated use and involvement in economic turnover of natural factors accompanying the production of hydrothermal water masses - spontaneous gases and other minerals - will increase the economic benefits from the use of hydrothermal energy by improvement of waste-free production.

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