GEOTHERMAL RESOUCES OF RUSSIA, SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL PROBLEMS DECISION

Svalova V.[1]

[1]*Institute of Environmental Geoscience RAS, Ulansky per., 13, Moscow, Russia, inter@geoenv.ru*

KEY WORDS

Geothermal energy, Russia, sustainable development, environmental parks

ABSTRACT

Geothermal energy use is the perspective way to clean sustainable development of the world. Russia has rich high and low temperature geothermal resources and makes good steps in this direction. The concept of environmental parks could help to demonstrate the advantages of renewable alternative energy utilization.

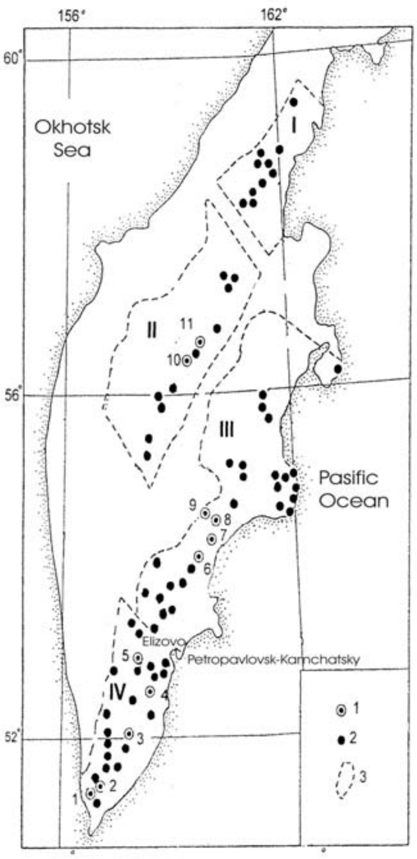
1. INTRODUCTION

In Russia the geothermal researches are carried out by 53 scientific centers and higher educational institutions located in different cities and inherings to different offices: Academy of sciences, Ministries of education, natural resources, fuel and energy. They can be conditionally joint in some regional centres of science, such as Moscow, St.-Petersburg, Northern (Archangelsk and Apatites), North-Caucasian (Makhachkala, Gelendgik, Groznij (before 1993)), Volga region (Yaroslavl, Kazan, Samara), Ural (Ufa, Ekaterinburg, Perm, Orenburg), Siberian (Novosibirsk, Tyumen, Tomsk, Irkutsk, Yakutsk), Far East (Khabarovsk, Vladivostok, South-Sakhalinsk, Petropavlovsk-on-Kamchatka). In such centers consisting usually of several institutes, the next directions of geothermal researches are conducted: theoretical, applied, regional, creation of special instrumentation.

2. GEOTHERMAL ENERGY USE

In Russia the geothermal resources are used predominantly for heat supply both heating of several cities and settlements on Northern Caucasus and Kamchatka with a total number of the population 500000. Besides in some regions of country the deep heat is used for greenhouses of common area 465000 m^2. Most active the hydrothermal resources are used in Krasnodar territory, Dagestan and on Kamchatka. (Fig. 1, Fig.2) [1,2]. The approximately half of extracted resources is applied for heat supply of habitation and industrial puttings, third - to a heating of greenhouses, and about 13 % - for industrial processes. Besides the thermal waters are used approximately on 150 health resorts and 40 factories on bottling mineral water. Quantity of electrical energy developed by geothermal stations of Russia, per 1999 almost twice has increased as contrasted to by former level. Nevertheless, it remains extremely minor, making some 0,01 of percent from common development of the electric power in the country.
The most perspective direction of usage of low temperature geothermal resources is the use of heat pumps. This way is optimal for many regions of Russia - in its European part, on Ural and others. While the first steps are made in this direction only.

The electricity is generated by some geothermal power plants (GeoPP) only in the Kamchatka Peninsula and Kuril Islands. At present three stations work in Kamchatka: Pauzhetka GeoPP (11MW $_e$ installed capacity) and two Severo-Mutnovka GeoPP (12 and 50 MW_e). Moreover, another GeoPP of 100 MV_e is now in project in the same place. Two small GeoPP are in operation in Kuril's Kunashir Isl, and Iturup Isl, with installed capacity of 2,6 MW_e and 6 MW_e, respectively.



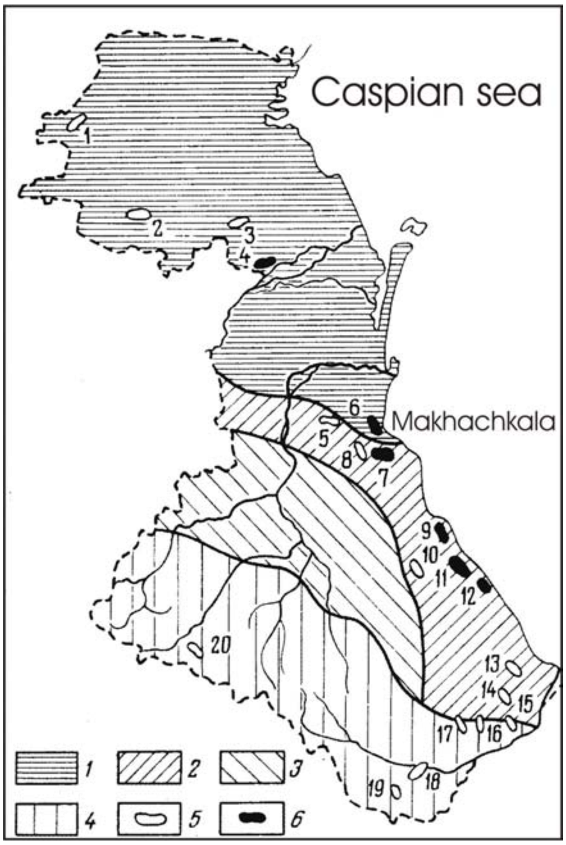


Figure 1. Geothermal resources of Kamchatka

1 – geothermal deposits (1 – Pauzhetskoje, 2 – Nizhne-Koshelevskoje, 3 – Khodutkinskoje, 4 – North-Mutnovskoje, 5 – Big-Bannoje, 6 – Karimskoje, 7 – Semjachinskoje, 8 – Geysers Valley, 9 – Uzonskoje, 10 – Apapelskoje, 11 – Kireunskoje);
2 – groups of thermal springs;
3 – hydrogeothermal provinces (I – North, II – Middle, III – Easten, IV – South).

Figure 2. Map of hydrogeothermal deposits and perspective areas of Dagestan

1-4 – measure (1 – Quaternary,
2 – Neogene,
3 – Cretaceous, 4 – Jurassic);
5 – perspective areas;
6 - hydrogeothermal deposits;
fingers on the map – thermal anomalies (1 – Bazhigan, 2 – Terekly-Mekteb,
3 – Tarumovka,4 – Kizljar, 5 – Istisu,
6 – Makhachkala, 7 – Talgi,
8 – Zauzanbash, 9 – Izberbash,
10 – Salgabak, 11 – Kajakent,
12 – Berikej, 13 – Belidzhy,
14 – Choshmenzin, 15 – Giljar,
16 - Adzhinaur, 17 – Richalsu,
18 – Akhty, 19 – Khnov, 20 – Khzanor.

3. PLACE OF RUSSIA AMONG OTHER COUNTRIES ON GEOTHERMAL ENERGY USE

Russia has considerable geothermal resources and the available capacity is far larger than the current application. This resource is far from adequately developed in the country. In the former Soviet Union, geological exploration was well supported for minerals and oil and gas. Such expansive activities did not aim to discover geothermal reservoirs even in a corollary manner; geothermal waters were not considered among energy resources. Still, the results of drilling thousands of "dry wells" (in oil industry parlance), bring a secondary benefit to geothermal research. These are the abandoned wells themselves, and the data on the subsurface geology, water-bearing horizons, temperature profiles, etc., that were collected during exploration. Not all currently operating companies are willing to disclose their well data, still, in face of the cost of maintaining shut-in wells, it is cheaper to turn them over to others for new purposes.
The next Table 1and figures 3,4 show the geothermal resources use in the world and in Russia in dynamics [3]. They illustrate particularly fast advances taken place in Russia.

Table 1. Direct uses

Country	1995 Power MWt	1995 Energy TJ/year	2000 Power MWt	2000 Energy TJ/year
Algeria	100	1657	100	1586
Argentina			25.7	449
Armenia			1	15
Australia			34.4	351
Austria	21.1	200	255.3	1609
Belgium	3.9	101.6	3.9	107
Bulgaria	133.1	778.5	107.2	1637
Canada	1.68	47	377.6	1023
Caribbean Islands			0.1	1
Chile			0.4	7
China	1915	16981	2282	37908
Colombia			13.3	266
Croatia			113.9	555
Czech Republic			12.5	128
Denmark	3.5	45	7.4	75
Egypt			1	15
Finland			80.5	484
France	599	7350	326	4895
Georgia	245	7685	250	6307
Germany	32	303	397	1568
Greece	22.6	135	57.1	385
Guatemala	2.64	83	4.2	117
Honduras			0.7	17
Hungary	340	5861	472.7	4086
Iceland	1443	21158	1469	20170
India			80	2517
Indonesia			2.3	43
Israel	44.2	1196	63.3	1713
Italy	307	3629	325.8	3774
Japan	319	6942	1167	26933
Jordan			153.3	1540
Kenya			1.3	10
Korea			35.8	753
Lithuania			21	599
F.Y.R. of Macedonia	69.5	509.6	81.2	510
Mexico			164.2	3919
Nepal			1.1	22
Netherlands			10.8	57
New Zealand	264	6614	307.9	7081

Norway			6	32
Peru			2.4	49
Philippines			1	25
Poland	63	740	68.5	275
Portugal			5.5	35
Romania	137	2753	152.4	2871
Russia	**210**	**2422**	**308.2**	**6144**
Slovak Republic	99.7	1808	132.3	2118
Slovenia	37	761	42	705
Sweden	47	960	377	4128
Switzerland	110	3470	547.3	2386
Thailand			0.7	15
Tunisia			23.1	201
Turkey	140	1987	820	15756
United Kingdom			2.9	21
USA	1874	13890	3766	20302
Venezuela			0.7	14
Yemen			1	15
Yugoslavia	80	2375	80	2375
Total	**8604**	**112441**	**15145**	**190699**

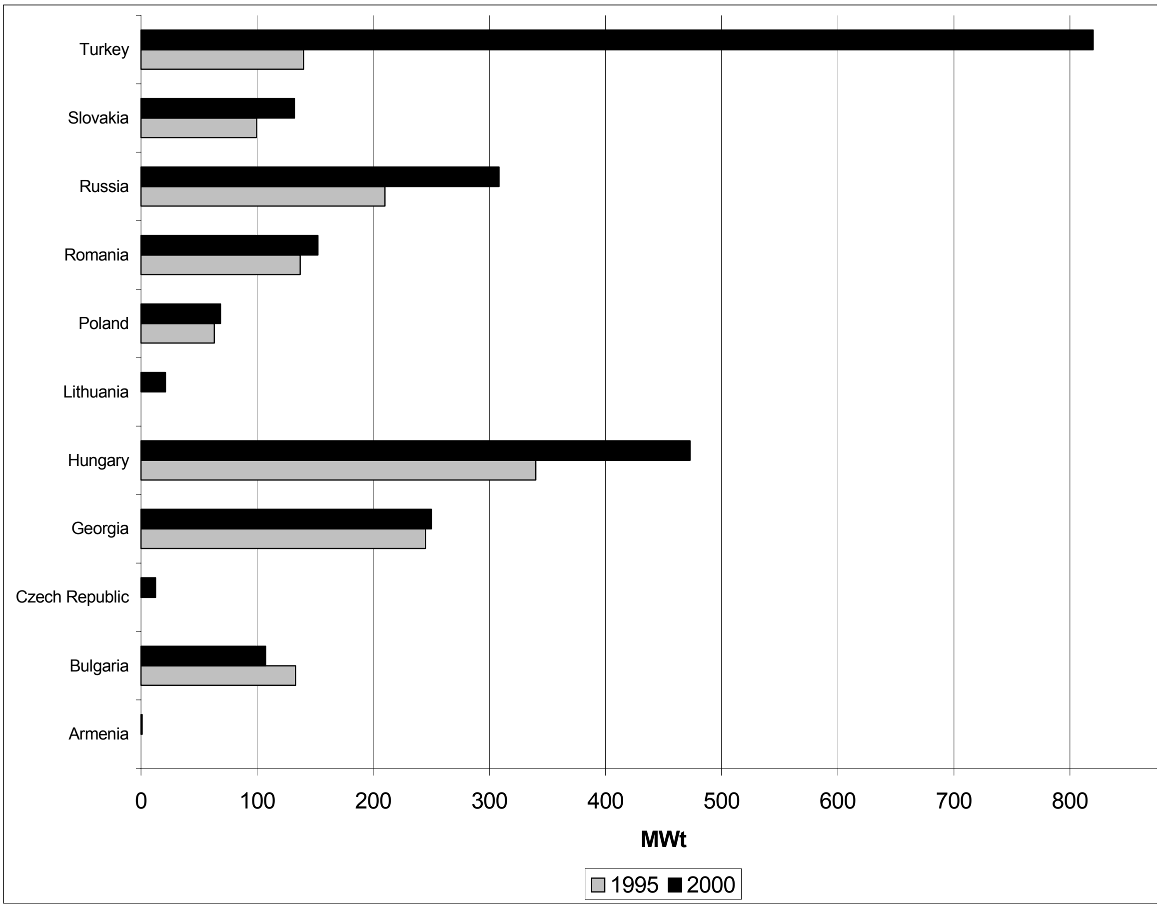


Figure 3. Geothermal energy capacity changes from 1995 to 2000.

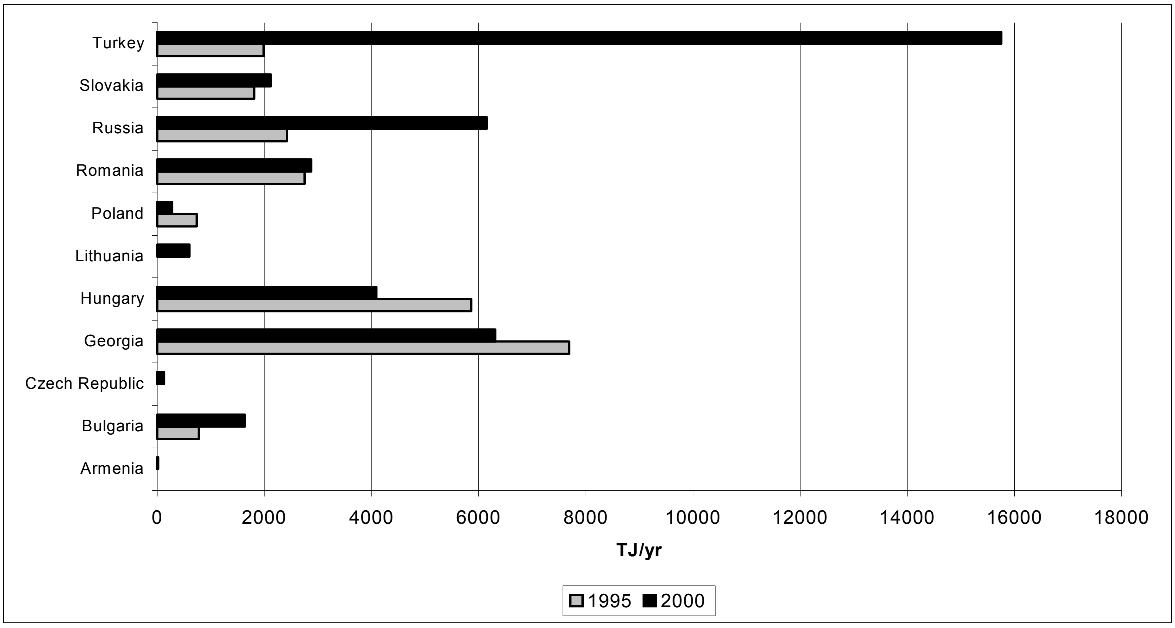


Fig. 4. Geothermal energy utilization changes 1995-2000

4. ADVANTAGES AND PROBLEMS OF GEOTHERMAL RESOURCES USE

The environmental benefits of the use of renewable energy resources such as geothermal is recognized by few decision makers. Moreover, there are major barriers to the development of renewable resources which tend to discourage those few. Detailed geological investigations and expensive drilling of geothermal wells represent a major financial commitment with considerable geological and technical risks.
The use of renewable energy, including geothermal resources, denote benefits. First, use of indigenous energy resources can reduce some of the import dependence or part of the need to build new generating capacity for either supply of heat and industrial or residential hot water supply. Secondly, replacement of conventional fuels with clean energy induces major improvements in environmental conditions and public health and associated savings. Thirdly, a measure of energy savings an efficiency is involved. As district heating systems are common in urban centers of Russia and are in need of modernization, switching to renewable energy resources could take advantage of these benefits. This is particularly important from the economic perspective also; the antiquated district heating systems are not fuel efficient and the engineering life time of most have already expired.

Geothermal energy, much as hydropower, is "clean" compared to any fossil-fuel generated energy. Because of international conventions on climate change and European Community programs to promote renewable energy sources, interest in Russia in identifying these indigenous resources has enjoyed much attention. Policy support has also been generated, although overall, specific legislation for exploring for and producing geothermal waters is absent in all countries. This is partly due to the fact that waters are regulated under water resources laws, minerals under mining laws, energy under energy laws. Geothermal energy transcends all such legislation and makes it difficult to address the varying exploitation methods and uses of geothermal energy under one heading.
There are several types of barriers to geothermal energy development, some generic and some specific to individual countries.

5. GEOTHERMAL ENERGY AND SUSTAINABLE DEVELOPMENT

The industrial evolution over the last two centuries brought plenty of innovations for the human civilisation, but enabled certain nations also to conduct the most disastrous wars in history and to exploit the natural resources at a frightening pace. Since the Seventies of the 20th Century serious warnings about the "limits to growth" went around the world with little effect: the resource exploitation, arms races and wasteful consumption habits squandered these resources at an accelerated pace, along with the exponential growth of world population. All this frenzy needed increasing amounts of energy.

The most wasteful and - in retrospect - irresponsible human habit was the combustion of the finite and rapidly dwindling energy resources coal, petroleum and "natural" i.e. mineral gas. This irresponsible activity is burning the feed-stocks of the chemical industry for the production of plastics, synthetic fibres, building materials, paints, varnishes, pharmaceutical and cosmetic products, pesticides and many other products of the organic chemistry for our descendants, who need these resources for Centuries to come.

But the most catastrophic effect of the fossil fuel age is the unbalancing of the biosphere and climate to a degree that is irreversibly affecting our life base: growing deserts and acid rains spoiling fertile lands, the poisoning of rivers, lakes and ground waters, spoiling the so badly needed drinkable water for the growing world population - and the worst of all - more frequent weather disasters, retracting glaciers, ruined ski resorts, melting ice caps, land slides, more violent storms, flooding of highly populated coastal areas and islands, thus endangering people and rare species, causing migrations, loss of fertile land and cultural heritages – all due to the incessantly growing fossil fuel emissions, causing global warming.

The way to the Clean, Sustainable Energy Age by conserving resources and bringing the biosphere and climate back into a natural balance is connected with renewable energy use.

This way is well illustrated in the Figure 5, where the top line represents estimate of the future world-wide energy demand over the next 50 years. Fossil fuel producers are fully aware of the bottom curve showing the expected mineral energy resources depletion over the next 50 years and the need to reduce fossil fuel combustion beyond the Kyoto Protocol targets in order to slow down global warming of the Earth atmosphere. The middle curve reflects the geothermal energy use future.

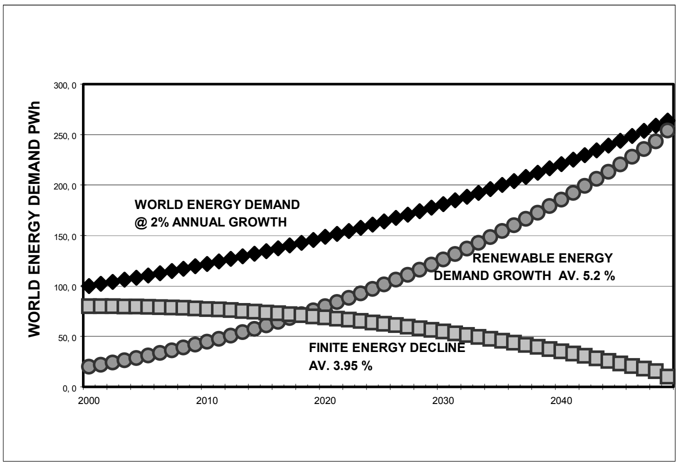


Figure 5. World energy scenario 2000-2050.

6. SUSTAINABLE DEVELOPMENT AND MEGAPOLICES

The development of the present-day world is impossible without large cities. Cities appeared on the Earth almost five millennia ago and gradually became centers of development of the Earth civilization. At present, urbanization has become a truly global process whose rates and scales increase catastrophically. Hardly more than 3% of the Earth's population lived in cities in 1830, 34% of the population lived in cities in 1966, and it is expected that the urban population will account for more than 57% in 2020. Cities-megapolices grow rapidly against a general background of urbanization. Recent megapolices have no historical precedent with respect to the

number of population and the density of the infrastructure. It is expected that the total area of cities in the world will increase by 2.6 million km^2 and will be about 4% of the land area in 2020. The gigantic concentration of people results in a multiple increase in the supplies of water, energy, and food to cities, which, along with an increased production and service, is responsible for the accumulation of a huge amount of polluted water and industrial and domestic waste in the city areas. This causes an aggravation of social, environmental, and economic problems in large cities. Under these conditions the problems of urbanization and municipal engineering take on an absolutely different social significance – they become part and parcel of the global problem of sustained development of the modern society.
In this connection two important aspects could be considered: clean alternative renewable energy use and organization of environmental parks as demonstration of preferences and advantages of such energetic supply, which are very close. The concept of environmental parks on the territories of big towns (some aspects) is presented below. Similar concept can be used for reserved territories arrangement.

7. THE CONCEPT OF NATURE-FRIENDLY ENERGY SUPPORT SYSTEM FOR ENVIRONMENTAL PARK/AQUAPARK

Choice of the optimal system of nature-friendly energy support is based on use of the deep-thermal energy and other ecologically pure sources, depending on concrete conditions of the environmental park/aquapark, and takes into account all the environmental, economical and social factors. As a result the environmental passport of territories can be created.
The main directions of investigation are:
Geological and geothermal assessment of the Park's territory, taking into account the possibility to use the deep thermal sources for energy supply.
Hydrogeothermal and hydrogeochemical assessment of the territory (hot springs, thermal and mineral waters).
Geographical assessment of the territory from the point of possibility to use the non-traditional renewable energy sources (solar, wind, tidal energy and energy of small rivers).
Assessment of the possibility to use other specific energy sources of concrete area (waste utilization, biomasses, etc.).
Creation of criteria for choice of system of energy supply (depending on conditions of area).
Planning of energy supply for concrete area using both thermal sources (heat pumps) and other nature-friendly energy sources.
Optimisation on the system of energy supply on the base of environmental, social and economical factors.
Choice of concrete type of heat pump (types of design and thermal energy extraction) depending on concrete geological,environmental, economical, historical and social conditions of the Park's area.

REFERENCES

1. Gadzhiev A.G.,. Kurbanov M.K., Suetnov V.V., et al.. The problems of geothermal energy in Dagestan. M., Nedra, 1980, pp.208

2. Kononov V.I., Polyak B.G., Kozlow.B.M. Geothermal development in Russia: Country update report 1995-1999. Proceed. of the World Geothermal Congress 2000, pp. 201 – 206, (2000)

3. Lund J.W.and Freeston D.H. World-wide direct uses of geothermal energy 2000. Proceed. of the World Geothermal Congress 2000, Vol. 1, pp. 1-21, (2000)