5.
GEOTHERMAL RESOURCES OF RUSSIA AND ENVIRONMENT

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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 their use.

In Russia the geothermal resources are used predominantly for heat supply both heating of several cities and settlements on Northern Caucasus and Kamchatka. Besides in some regions of country the deep heat is used for greenhouses. Most active the hydrothermal resources are used in Krasnodar territory, Dagestan and on Kamchatka.

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.

The electricity is generated by some geothermal power plants only in the Kamchatka Peninsula and Kuril Islands.

At present, urbanization has become a truly global process. The gigantic concentration of people results in a multiple increase in the supplies of water, energy, and food to cities, which is responsible for the accumulation of a huge amount of polluted water and industrial and domestic waste in the city areas. Under these conditions the problems of urbanization and municipal engineering become part of the global problem of sustainable development of the modern society.

In this connection two important aspects are considered: clean alternative renewable energy use and organization of environmental parks as demonstration of preferences and advantages of such energetic supply. The concept of environmental parks on the territories of big towns and reserved territories is elaborated.

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, and takes into account all the environmental, economical and social factors. As a result the environmental passport of territories can be created.

The concept of environmental parks could help to demonstrate the advantages of renewable alternative energy utilisation.

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 m2. Most active the hydrothermal resources are used in Krasnodar territory, Dagestan and on Kamchatka. (Fig. 1, Fig.2). Gadzhiev *et al*. (1980), Kononov *et al.* (2000) The ap-

proximately 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 Western Siberian plate is another promising region for direct use applications. The aquifers located down to 3 km in this region have a high hydrostatic pressure, temperatures of up to 75°C, and are capable of producing about180 m^3/s. These waters are used to heat dwellings in some small settlements and, on a small scale, assist in the recovery of oil, the extraction of iodine and bromide, and for fish farming. The region is rich in natural gas, which has limited geothermal development.

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.

Heat pumps are at an early stage of development in Russia. An experimental facility was set up in early 1999 in the Philippovo settlement of Yaroslavl district. The source supplies 5-6°C to eight heat pumps that heat the water to 60°C for a 160-pupil school building.(Fig.3,4) There are some buildings with supply of heated water, using heat pumps, in Moscow (Fig. 5-8).

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 under preparation in the same place. Two small GeoPP are in operation in Kuril's Kunashir Isl, and Iturup Isl, with installed capacity of 2,_ MW_e and 6 MW_e respectively.

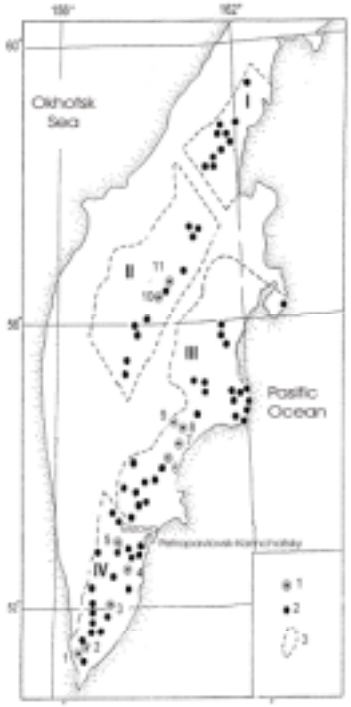

Figure 1. Geothermal resources of Kamchatka
1 – geothermal deposits (1 – Pauzhetskoje, 2 – Nizhne-Koshelevskoje, 3 – Khodutkinskoje, 4 – North-Mutnovskoje, 5 – Big-Bannoje, 6 – Karimskoje, 7 – Semjachinskoje, 8 – Geysers Valley, 9 – Uzonskoje, 10 – Apapelskoje, 11 – Kireunskoje);
2 – groups of thermal 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 – Quarternary, 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.

Figure 3. Filippovo village. Heat supply system.

Figure 4. School in Filippovo.

Figure 5. House in Moscow with heat pumps.

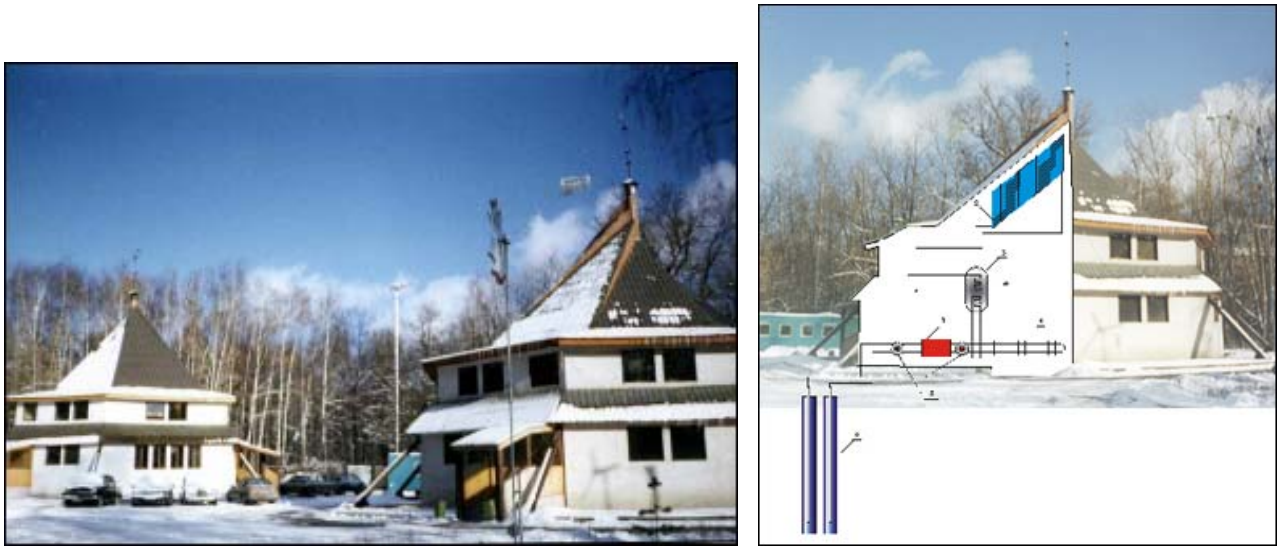

Figure 6. Demonstration center in Moscow with heat pumps.

Figure 7. Heat pump supply system in Fili Moscow

Figure 8. Aquapark in Moscow with heat pumps supply system. (Under construction)

3. PLACE OF RUSSIA AMONG OTHER COUNTRIES

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 Figures 9,10 (Lund .and Freeston ,. 2000) show the geothermal resources use in some countries and in Russia in dynamics. They illustrate particularly fast advances taken place in Russia.

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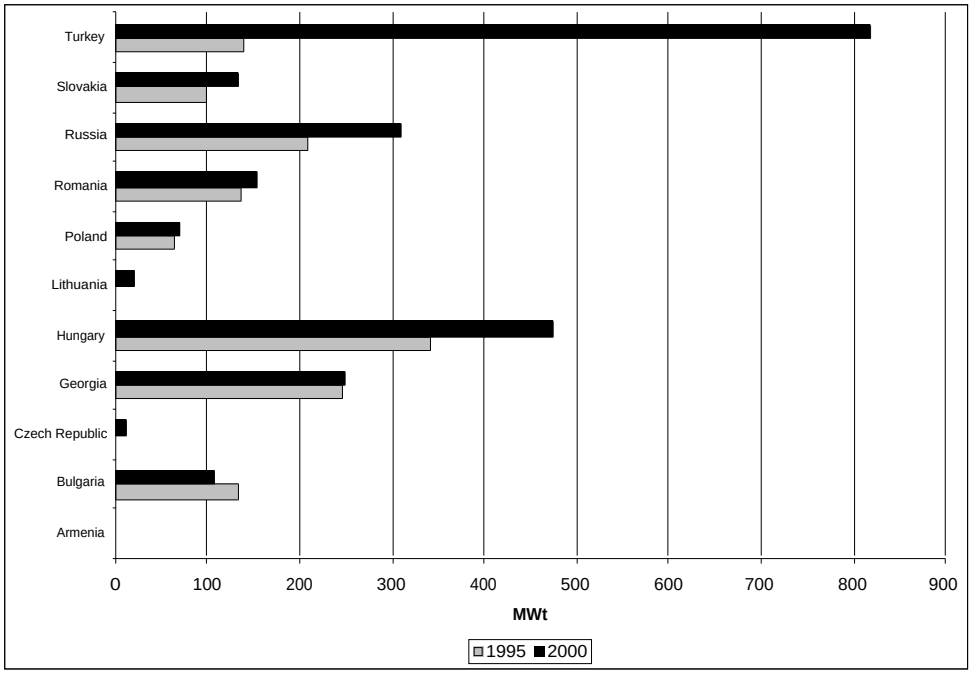

Figure 9. Geothermal energy capacity changes from 1995 to 2000.

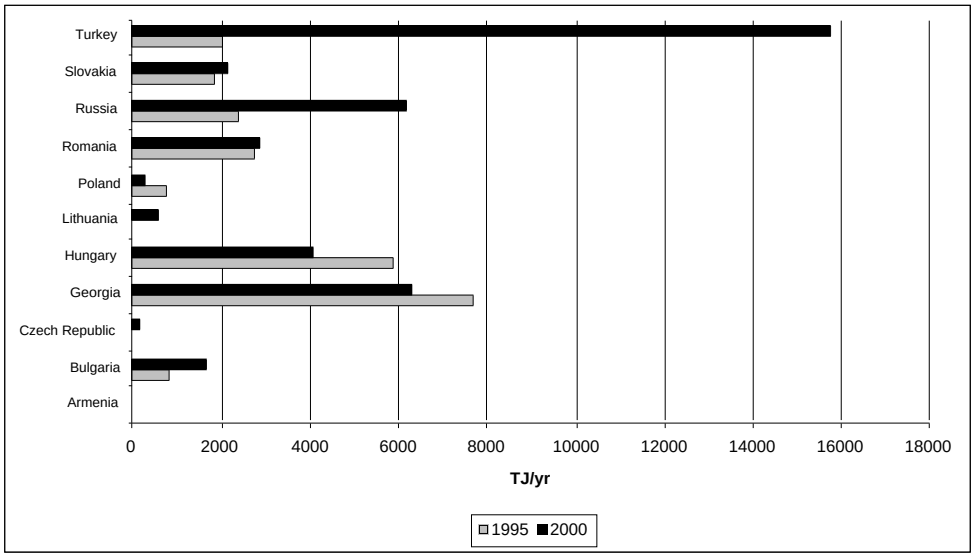

Fig. 10. Geothermal energy utilization changes 1995-2000

4. ADVANTAGES AND PROBLEMS OF GEOTHERMAL ENERGY 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.

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 11, 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.

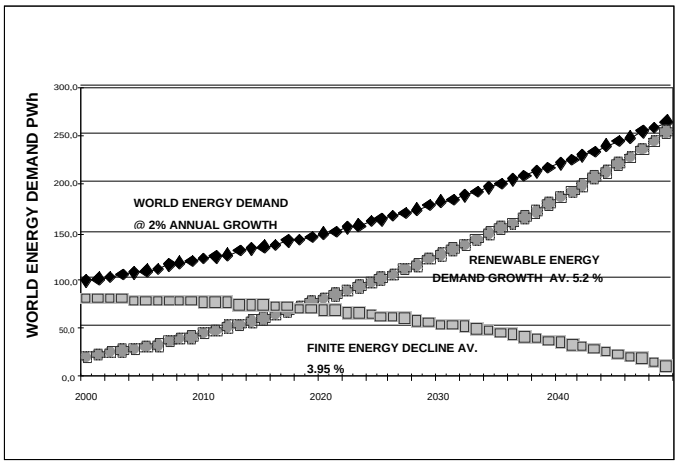

Figure 11. World energy scenario 2000-2050.

6. THE CONCEPT OF NATURE-FRIENDLY ENERGY SUPPORT SYSTEM FOR ENVIRONMENTAL PARK

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.

CONCLUSIONS

Geothermal energy use in Russia develops well and has good perspectives. Especial success is reached in Kamchatka area.

The problems of renewable energy use are connected very close with problems of sustainable development and environment. For research of these problems the concept of ecological parks is developed.

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