Proceedings 24th NZ Geothermal Workshop 2002

GEOTHERMAL ENERGY USE IN RUSSIA AND SUSTAINABLE DEVELOPMENT

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SUMMARY -Geothermal energy provides a clean, sustainable energy source for the world. Russia is rich in both high and low temperature geothermal resources and is progressing with their development. The concept of environmental parks could help to demonstrate the advantages of using renewable alternative energy sources.

1. INTRODUCTION

In Russia, geothermal research is carried out by 53 scientific centres and higher education institutions located in different cities and attached to different offices, such as the Academy of Sciences, and the Ministries of Education, Natural Resources, Fuel and Energy. Regional science centres include those at 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), and Far East (Khabarovsk, Vladivostok, South-Sakhalinsk, Petropavlovsk-on-Kamchatka). These regional science centres usually consist of several institutes. They conduct various aspects of geothermal research including theoretical, applied, regional, and the creation of specialized instrumentation.

2. GEOTHERMAL ENERGY USE

In Russia, the geothermal resources are used predominantly for heat supply. Several cities and settlements on Northern Caucasus and Kamchatka, with a population of 500,000, are heated in this way. In addition, some regions of country utilize the heat for greenhouses that have an average area 465,000 m^2. Hydrothermal resources are most widely used in the Krasnodar territory, Dagestan and Kamchatka (Figures 1 and 2). (Gadzhiev *et al.*, 1980, Kononov *et al.*, 2000).

Approximately half of the extracted resource is used for heating domestic and industrial buildings, about one third for horticulture (greenhouses), and about 13 % is used for industrial processes. The thermal waters are also used by approximately 150 health resorts, and by 40 factories that bottle mineral water. The output of electrical energy produced by geothermal stations in Russia has increased almost twice since 1999. Nevertheless, it is remains an extremely minor contributor producing only 0.01% of the total electric power.

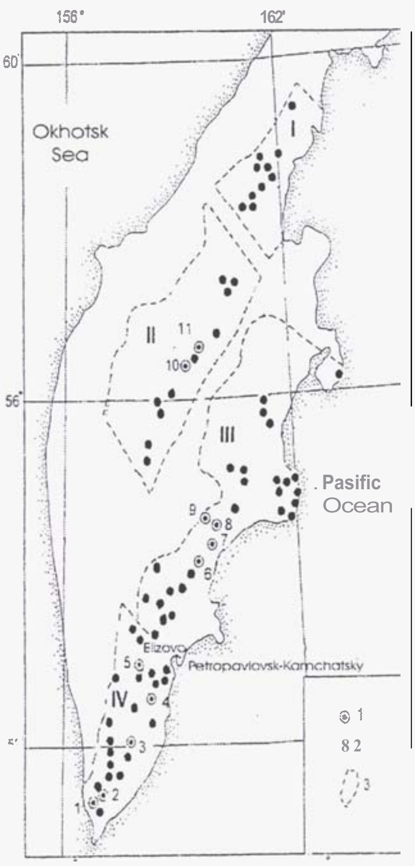

Figure 1 - Geothermal Resources of Kamchatka
KEY
1 Geothermal deposits (1 – Pauzhetskoje, 2 – Nizhne-Koshelevskoje, 3 – Khodutkinskoje, 4 – North-Mutnovskoje, 5 – Big-Bannoje, 6 – Karimskoje, 7 – Semjachinskoje, 8 – Geysers Valley, 9 – Uzonskoje, 10 – Apapelskoje, 11 – Kireunskoje)
2 Groups of Thermal Springs
3 Hydrogeothermal provinces (I – North, II – Middle, III – Eastern, IV – South)

The Western Siberian plate is a promising region for the direct use of geothermal energy. In this region the aquifers, located down to 3 **km,** have a high hydrostatic pressure, temperatures of up to 75°C, and are capable of producing about 180 m^3/s. These waters are already 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 with fish farming. The region is rich in natural gas, which has limited geothermal development.

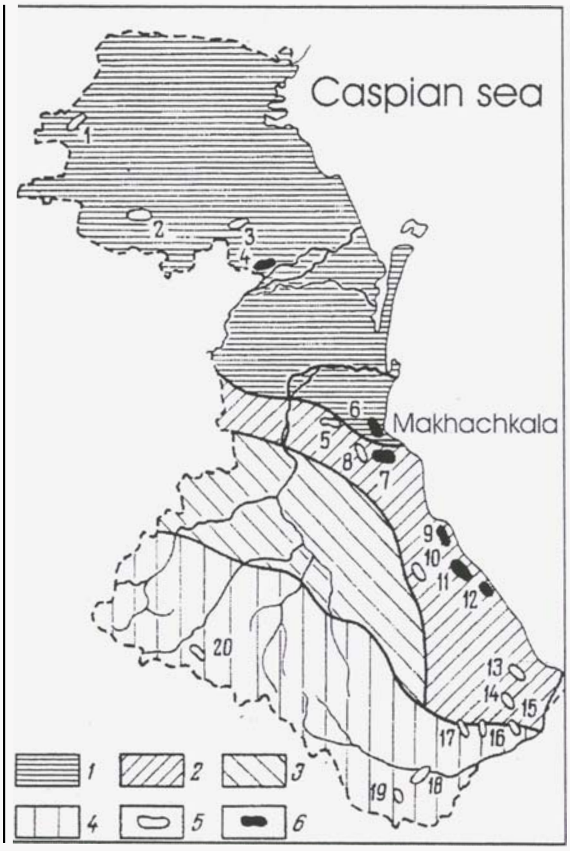

Figure 2 - Map of Hydrogeothermal Deposits and Prospective areas of Dagestan
KEY
1 Quaternary, 2 Neogene, **3** Cretaceous, **4** Jurassic, 5 Prospective areas,
6 Hydrogeothermal deposits.

Numbers show 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.)

Heat pumps provide the most advantageous use of the low temperature geothermal resources. This method is optimal for many regions of Russia including its European part, the Urals, 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. This facility supplies water at 5-6°C to eight heat pumps that heat the water to **60°C** for a 160-pupil school building. There are plans in Moscow to develop an aquatic park and supply heated water, using heat pumps.

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,). Another GeoPP of 100 MV_e is now in planned in the same place. Two small GeoPP are in operation in Kuril's Kunashir Islands, and Iturup Island, with an installed capacity of 2.6 MW_e and 6 MW_e respectively.

3. RUSSIA IN COMPARISON TO OTHER COUNTRIES

Russia has considerable geothermal resources and the available capacity is far larger than the current utilization. This resource is not adequately developed in the country. In the former Soviet Union, geological exploration for minerals, oil, and gas was well supported. Such extensive exploration did not aim to discover geothermal reservoirs, even in a corollary manner, because geothermal waters were not considered as an energy resource. Even so, the drilling of thousands of *"dry* wells" (in oil industry parlance), brought secondary benefits to geothermal research. These benefits are the abandoned wells themselves, and also the data on the subsurface geology, water-bearing horizons, temperature profiles, etc., that were collected during exploration. Not all of the currently operating companies are willing to disclose their well data; nevertheless, compared to the cost of maintaining shut-in wells, it is cheaper to turn them over to others for new purposes.

Figures **3** and **4** (Lund .and Freeston, 2000) show the geothermal resources used in some countries and in Russia. They illustrate the particularly fast advances taking place in Russia.

4. ADVANTAGES AND PROBLEMS OF GEOTHERMAL ENERGY USE

The environmental benefits of the use of renewable energy resources such as geothermal energy is recognized by only a few decision makers.

Moreover, there are major barriers to the development of renewable resources which tend to discourage those decision makers. Detailed geological investigations and expensive drilling of geothermal wells represent a major financial commitment with considerable geological and technical risks.

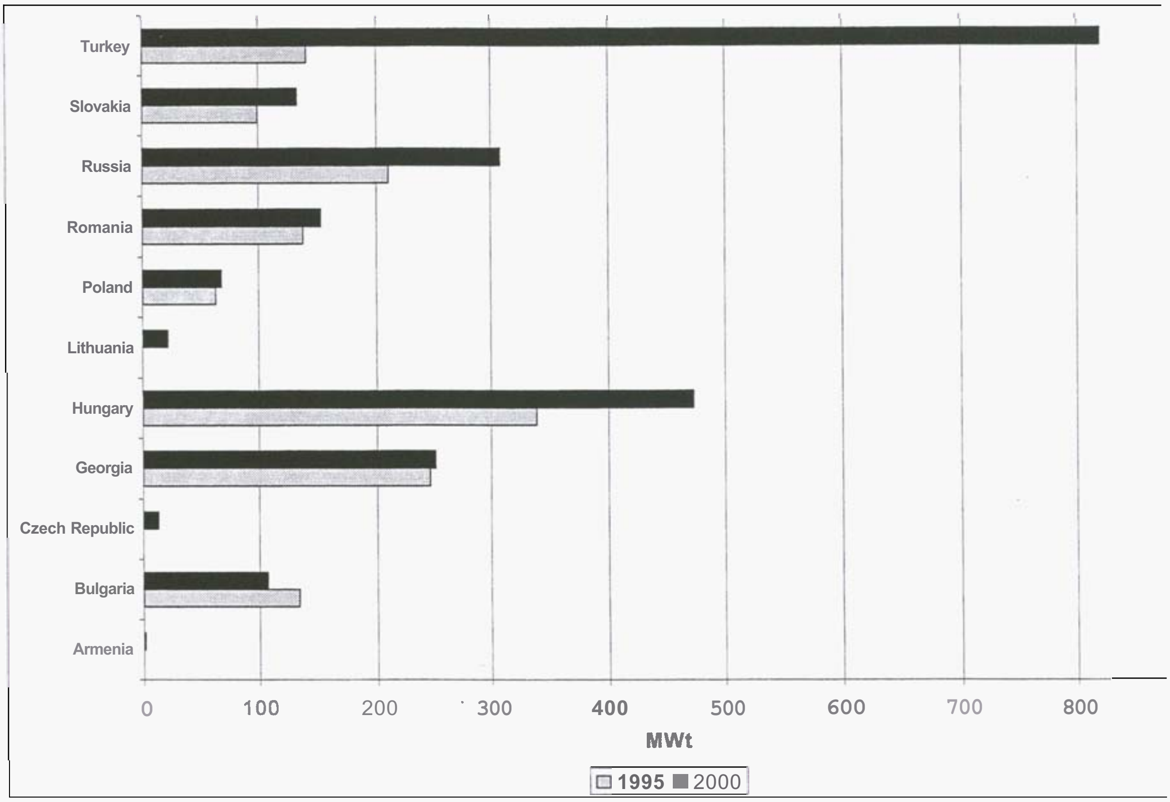

Figure 3 - Geothermal energy capacity changes from 1995 to 2000.

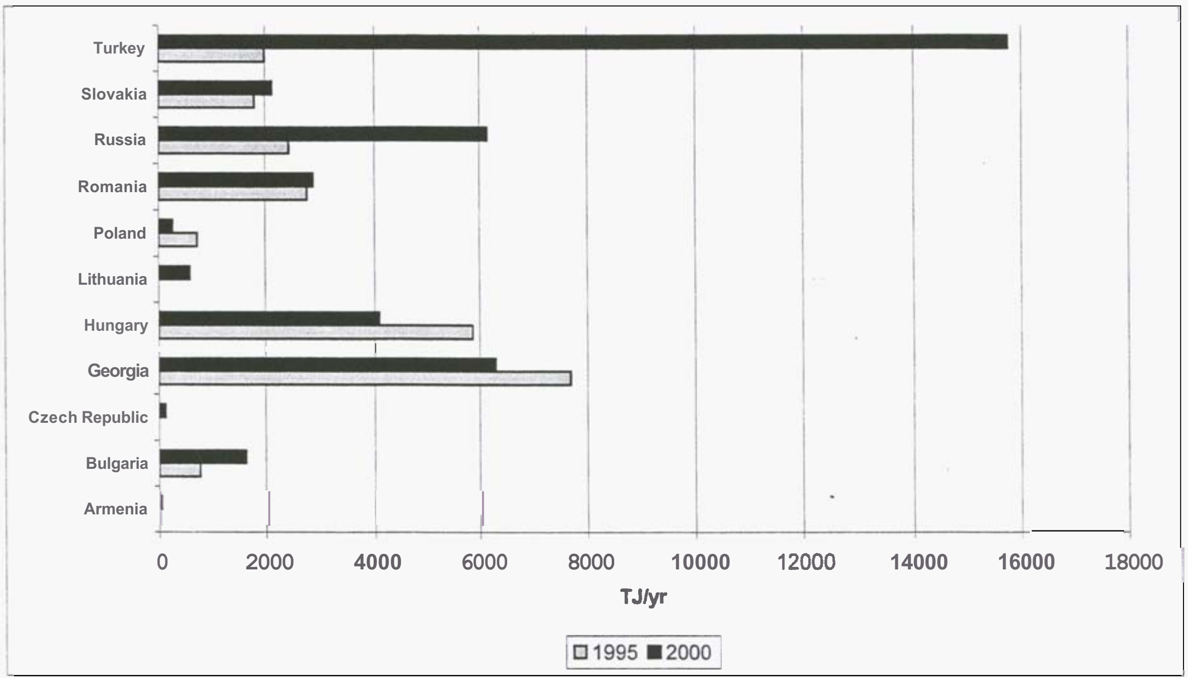

Figure 4 - Geothermal energy utilization changes 1995-2000

However, the use of renewable energy, including geothermal resources has great benefits. Firstly, the use of indigenous energy resources can reduce import dependence, and the need to build new generating capacity for the supply of either heat and industrial or residential hot water. Secondly, replacing conventional fuels with clean energy induces major improvements in environmental conditions and public health, with their associated savings. Thirdly, improvements in energy savings and efficiency are available: district heating systems are common in urban centers of Russia and are in need of modernization, so a switch to renewable energy sources could confer these benefits. This is particularly important fiom the economic perspective, since the antiquated district heating systems are not fuel efficient and the engineering lifetime of most have already expired.

Geothermal energy, like hydropower, is "clean" compared to the energy generated by fossil-fuels. Because of international conventions on climate change and European Union programs to promote renewable energy sources, Russian is interested in identifying these indigenous resources- Policy support has also been generated, although overall, specific legislation for exploring and utilizing geothermal waters is absent in all countries. This is partly due to the fact that geothermal waters are regulated under water resource laws, minerals under mining laws, and energy under energy laws. Geothermal energy transcends all such legislation and it is difficult to address the varying exploitation methods and uses of geothermal energy under one heading.

5. GEOTHERMAL ENERGY AND SUSTAINABLE DEVELOPMENT

The industrial revolution over the last two centuries brought plenty of innovations for human civilisation. It also enabled certain nations to conduct the most disastrous wars in history, and to exploit natural resources at a frightening pace. Since the 1970s serious warnings about the "limits to growth" went around the world with little effect: resource exploitation, arms races and wasteful consumption habits squandered these natural resources at an accelerated pace, along with the exponential growth of world population. All this activity required increasing amounts of energy.

The most wasteful and - in retrospect - irresponsible action was the combustion of the finite and rapidly dwindling energy resources of coal, petroleum and "natural" i.e. mineral gas. This irresponsible activity is burning the fuel stocks required by the chemical industry for the production of plastics, synthetic fibres, building materials, paints, varnishes, pharmaceutical and cosmetic products, pesticides and many other products. Our descendants need these resources for centuries to come.

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: the growth of deserts and acid rain spoiling fertile lands, the poisoning of rivers, lakes and groundwaters, spoiling the badly needed drinkable water for the growing world population - and the worst of all - more frequent weather disasters leading to the retraction of glaciers, ruined ski resorts, melting ice caps, landslides, more violent storms, and flooding of highly populated coastal areas and islands, thus endangering people and rare species, and causing migrations, loss of fertile land and cultural heritages – all due to the incessantly growing fossil fuel emissions that cause global warming.

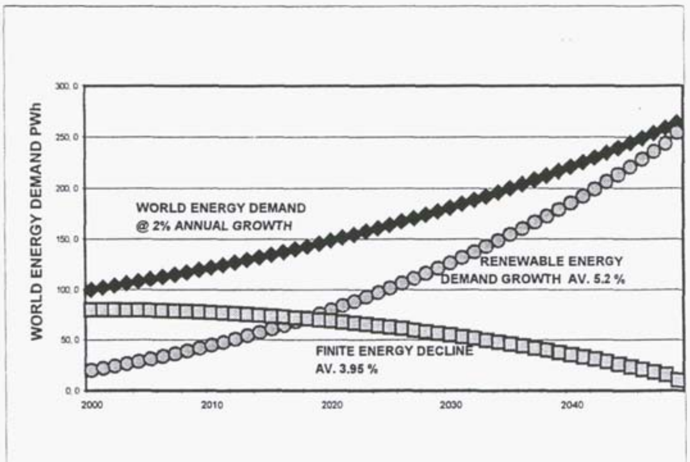

Figure 5 - World energy scenario 2000-2050.

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 the use of renewable energy sources.

This is well illustrated in the Figure 5, where the top line represents estimates 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's atmosphere. The middle curve reflects the future use of geothermal energy.

6. SUSTAINABLE DEVELOPMENT AND CITY POLICIES

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 for human civilization. At present, urbanization has become a truly global process whose rates and scales are increasing catastrophically. In **1830,** about **3%** of the Earth's population lived in cities, by 1966 34% of the population lived in cities, and it is expected that the urban population will account for more than 57% in 2020. City policies develop rapidly against a general background of urbanization. Recent city policies have no historical precedent - with respect to the number of population and the density of the infrastructure. It is expected that the total land 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 in cities results in an increased requirement for the supply of water, energy, and food, which, along with an increase in 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 a different social significance – they become part and parcel of the global problem of sustained development of the modem society.

In this connection, two important aspects need to be considered: clean, alternative, renewable energy use and the creation of environmental parks to demonstrate the advantages of such energy supplies, which are close by. Some aspects of the concept of environmental parks in the districts of big towns is presented below. Similar concepts can be used for reserved territories arrangement.

7. THE CONCEPT OF A NATURE-FRIENDLY ENERGY SUPPORT SYSTEM FOR ENVIRONMENTAL PARKS

The choice of the optimal system of ecologically-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 or 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, including the possibility of using the deep thermal sources for energy supply.

Hydrogeothermal and hydrogeochemical assessment of the Park's territory, for hot springs, thermal and mineral waters.

Assessment of the geographical suitability of the Park's territory for utilization of non-traditional renewable energy sources (solar, wind, tidal, and small rivers).

Assessment of the possibility of using other specific energy sources of concrete areas (waste utilization, biomasses, etc.).

The creation of criteria for choosing the energy supply system (depending on conditions of area).

Planning the energy supply for concrete areas using both thermal sources (heat pumps) and other nature-friendly energy sources.

Optimisation of the energy supply system, based on environmental, social and economical factors.

Choosing the type of heat pump (types of design and thermal energy extraction) depending on the geological, environmental, economical, historical and social conditions of the Park's area.

8. REFERENCES

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