



# INTERNATIONAL SUMMER SCHOOL on Direct Application of Geothermal Energy

Under the auspice of the  
Division of Earth Sciences



## Elizovo – City of XXI century. Total Heat and Power supply of Elizovo Region based on geothermal resources

Dr. Alexander I. Nikolski, Eng. Maxim B. Sapozhnikov, Eng. Konstantin O. Povarov.  
"Nauka" SC – MPEI, Moscow, Russia.

### ABSTRACT.

Geothermal Power Plants (GeoPP) construction at Mutnovsky geothermal field (Kamchatka) has laid the foundation for organization of large-scale heat-power supply demonstration project. It is called "Total Heat and Power supply of Elizovo Region based on geothermal resources".

Almost all methods of Earth heat conversion are widely used to provide the electricity and heat. Heat pumps will be used for direct heat supply (houses, swimming pools, greenhouses).

### INTRODUCTION.

The Elizovsky Region is one of the most developed and populated regions of the Kamchatka peninsula. It hosts most of the settlements in this region. The largest of these is the regional center, Elizovo City.

The main Kamchatka highways cross the territory of the region. From here by

car you can get to the Paratunka valley, to the Mutnovskaya volcano, and to the Okhotsk coast of Kamchatka. Crossing the peninsula from Petropavlovsk to Ust-Bolsheretsk, you can drive along the Kamchatka river valley from Milkovo to the largest volcano of Eurasia, Klyuchevskaya volcano. Highways open access to the attractive nature, and what is especially important, allow reduced transportation expenses for the organization of visitor tours.

Some of the great assets in Elizovsky Region are deposits of thermal and mineral waters. There are 90 therapeutic thermal springs. The most famous of them are Paratunsky, Khodutkinsky, Mutnovsky, Vilyuchinsky, Timonovsky, Malkinsky, and many, many others. Siliceous thermal springs are typical for the region and are the most valuable in a therapeutic sense. They have a wide variety of therapeutic benefits, but only a few of them are developed.

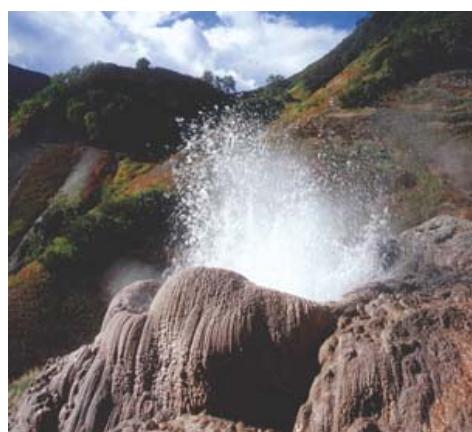


Fig.1. Mineral and thermal springs of Kamchatka.

## BRIEF DESCRIPTION.

At present, the heat supply of Elizovo consumers is provided mostly from 25 boiler-houses of 150 Gcal/hour total heat capacity and 95 / 70 °C temperature schedule. Mazut and Sakhalin coal are the fuel for these heat producers. Heat capacity of mazut boilers comes to 100 Gcal/hour.

Nowadays the price of 1Gcal/hour of heat in Elizovo town is 45 USD. The usage of geothermal heat supply with heat pumps would make possible to reduce the tariff up to 15 USD.

In order to convert the Elizovo heat supply to local geothermal resources it is proposed to create an environmentally friendly geothermal heating system with heat-pumping station (three heat pumps placed in series), providing net water warming during the heating maximum to 95 °C and maximum geothermal fluid utilization.

Supply of Elizovo region with electrical power, including feeding of the heat pumps compressors, will be performed using the Mutnovsky reservoir geothermal resources.

## PROJECT OBJECTIVES.

1. The main goal is to improve living standards and socio-economic conditions of population of Elizovo.
2. To provide fully (100%) supply with electrical power from Mutnovsky Geothermal Power Plants to the population, industrial facilities and agricultural sector of Elizovo region. At the same time, the cost of electricity generated at the geothermal plants is 2 –3 times lower than that supplied by the local power company "Kamchatskenergo" using Heavy Fuel Oil (mazut). The implementation of project will result in creation of a sustainable and self-sufficient energy supply to the region, utili-

zing environmentally friendly and renewable resources of energy.

3. To build a state-of-the-art heat supply system for the population, industrial and agricultural facilities based on local geothermal resources, ensuring at the same time, that the heat will be delivered at a cost of 15 USD per Gcal (i.e. 2,5 times less than the cost of heat generated in the existing boiler houses).

4. To ensure a year-round supply of all local hot water demands utilizing geothermal heat.

5. To considerably improve the environmental conditions of the region by introducing new environmentally safe technologies, utilizing geothermal heat, which will result in significant (by more than 100 times) reduction of CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>x</sub> emissions. The reduced emissions and the reduced risk of oil spills will help the protection of the fragile ecosystems of the region and reduce the environmental pressure on the protected areas and species.

6. Alongside the complete Elizovo power/heat supply, some new communal-general facilities could be constructed, utilizing geothermal energy:

- greenhouses to grow flowers, fruit and vegetables - total area could stretch to 20 hectares;

- to reconstruct balneological complex (spa) in Ketkino, which will allow treatment of up to 5000 people per year (with the developed network of mud baths and swimming pools);

- to build a new hotel of «Novotel» type in the vicinity of "Elizovo" airport making arrangements for saunas, thermal pools and an aqua park;

- to supply "Elizovo" Airport with heat and electricity produced at Mutnovsky Geothermal Power Plant;

- to build several thermal water pools.



TECHNICAL DATA OF ELIZOVO GEOTHERMAL HEAT SUPPLY SYSTEM.

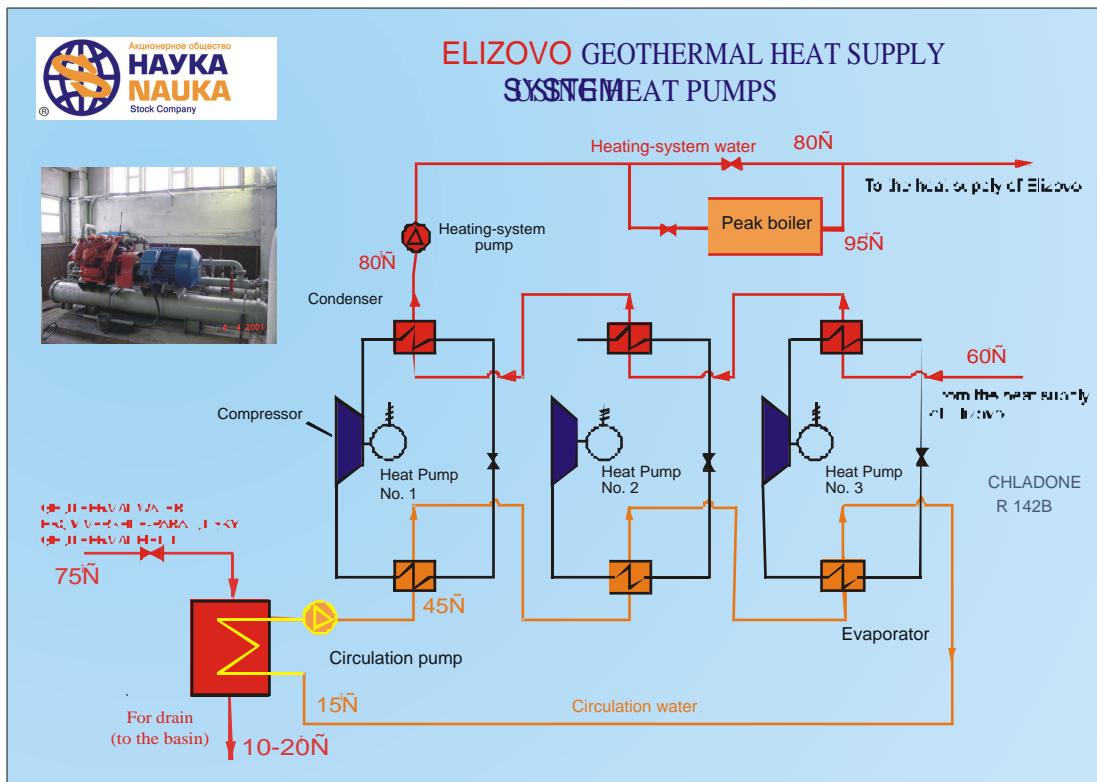


Fig.2. Functional diagram of Heat Supply System.

Fluid consumption	300 l/s
Temperature of water:	
at reservoir	79,8 °
heat pump input	75,0 °
heat pump output	10 – 20 °
Available heat of geothermal water	59,4 - 70,2 Gcal/h
Heat pump outlet heating system water temperature	60 – 80 °
Heat pump heat demand	102 Gcal/h
Power consumption	37MW(e)
Coefficient of performance (COP)	3,2 – 3,6
Heat pumps total annual heat generation	~600*10 <sup>3</sup> Gcal
Elizovo heat demand provided by heat pumps	92%
Fuel consumption replacement due to heat pump use.	125600 tones of equivalent fuel
Cost of heat	US\$ 14/ Gcal

## GEOTHERMAL HEAT SUPPLY USING HEAT PUMPS COVERS 92% OF ELIZOVO HEATING NEED

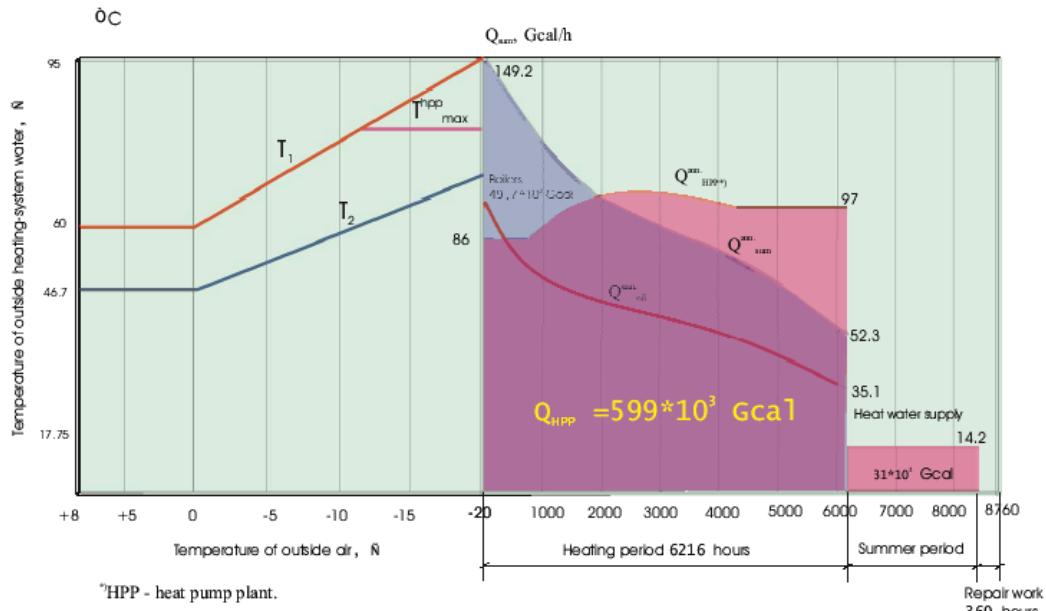


Fig.3. Heat demand schedule of Elizovo heat supply.

### PROJECT INVESTMENT ATTRACTION.

1. Very high tariffs for power and heat in Kamchatka Russia (in recent years electricity prices has reached 10-20 cent/KWh) which makes the conversion and operation of the Elizovo heating system to geothermal highly profitable and will provide quick repayment of investments (average payback in 3-5 years). Now the average electricity tariff in "Kamchatsk-energo" SC is 10 cent/kWh(e). "Geotherm" SC is ready to supply electricity for heating system of Elizovo town at 3 cent/kWh(e).
2. Large and developing regional market for application of geothermal heating pumps (GHP) which is estimated in hundreds of GHP.
3. Geothermal resources are explored and brought to surface in Kamchatka and Sakhalin regions, at Chukotka as well as in other regions of Russia and abroad.
4. Long and successful experience of Russian companies "Geotherm" SC, "Nauka" SC and others in geothermal power project implementation and in attracting loans and funds from EBRD and investments from RAO "UES of Russia". Equipment and services are purchased on international tenders and the companies

operate and are audited in accordance with international accounting standards.

5. Environmental cleanliness of the geothermal heating system technology that decreases harmful discharges of Carbon and other substances that accompany traditional power technologies.
6. Support of the Government of Russia (state budget, Administration of Kamchatka).
7. Approval and support of the Project by the Russian Academy of Sciences, Ministry of Energy of Russia and other official Russian organizations.

### REFERENCES.

1. Britvin O.V., Povarov O.A., et.al. (2001). *The Mutnovsky Geothermal Power Complex in Kamchatka*. Thermal Engineering, Vol.48, No.2, pp. 89-95.
2. John W. Lund. *Geothermal Heat Pumps - an overview*. GHC Bulletin, MARCH 2001. pp. 1-2.
3. Ken Ikeuchi, Shinji Takasugi, Shin-ichi Miyazaki. *Hot water supply test using geothermal heat pump systems at Petropavlovsk-Kamchatski, the capital of Kamchatka, Russia*. GHC Bulletin, MARCH 2001. pp. 9-12.