INTERNATIONAL SUMMER SCHOOL
on Direct Application of Geothermal Energy

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Division of Earth Sciences

STATE-OF-THE-ART OF GEOTHERMAL ENERGY USE IN BULGARIA

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Summary:

Consumption of primary energy resources, the efficiency of energy consumption, as well as short and long - term prospects for the use of traditional and renewable sources in Bulgaria are analyzed in this work. Special attention is paid to the Bulgarian geothermal resources and its use in Agriculture. The results show increase of the potential role of renewable resources for heat and electricity generating. Governmental incentives for initiating national action programs for energy efficiency, new renewable sources and the environment as well as ediucational activities are particularly important.

Key words: Primary energy resources, geothermal energy

Introduction

The energy sector, as any other sector of the national economy, is currently undergoing considerable changes on its way to market relations, primarily connected to determining the role of the state as well as the forth of ownership.

The state energy policy is based on a long - term energy strategy complying with the natural conditions of the country, the expected macro - economic development, the geopolitical situation and regional development of energy cooperation with neighboring and closely situated countries.

Limited reserves of fossil fuels, increased local and global environmental risks and recent technological achievements have straightened the global importance of renewable sources of thermal and electric energy. This is even more relevant for Bulgaria, whose small fossil fuel reserves (mainly lignite) are nearly exhausted and the environment notably polluted.

Conceming local renewable sources of thermal energy and electricity, it is necessary to re --estimate their strategic role, to complete the input data for the resources, also to establish national programs supported by research and educational activities and intemational cooperation.

1. Consumption of Primary Energy Resources

There are two main objectives for the increasing interest in renewable resources in our country - the limited fossil fuels reserves and the environmental concern. The consumption of primary energy resources in Bulgaria has followed the development of the economics and is given in Table 1. The maximum consuinption of energy resources amounts to 47,82 million tons of coal equivalent (tce) and in time coincides with the maximum economic activities in the country - 1988 (1).

Figure 1 shows the forecasts of primary energy resources and their structure till 2.010. All these are only forecasts and their accurate realizafion is not of major importance. Far more important is the planning role of the state energy committee, especially regarding regional security of energy supply and stimulation of energy savings in Bulgaria, which has limited reserves of organic fuels, and till 1.990 the annual energy consumption per head was twice over the average consumption in the world. The discrepancy between reserves of fuel and consumption led to a drastic dependence on import of fuels and energy, whose share in the energy balance of the country is more than 75 % (1).

The introduction of purely market principles in planning and developing the energy sector is not only a new but to a great extend an unique objective and the economic prosperity of our country depends on its successful implementation.

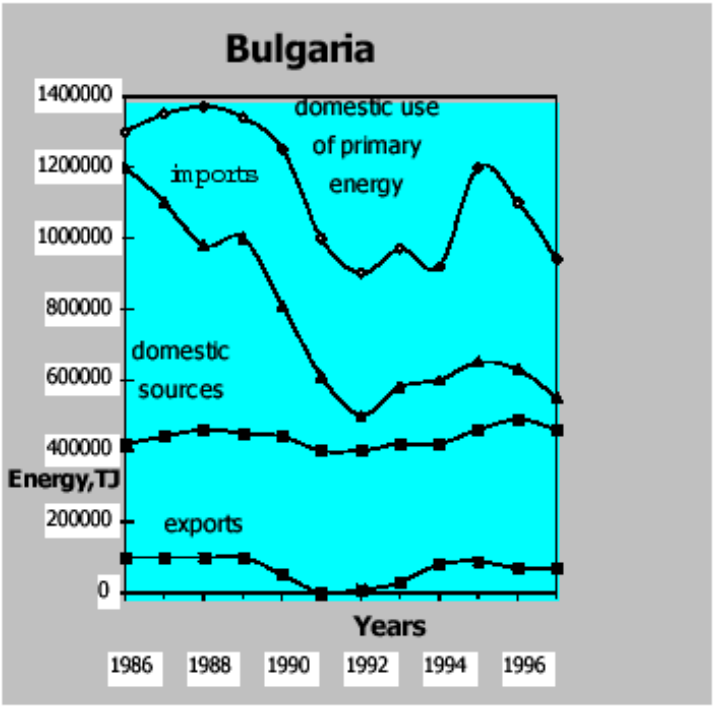

Fig.1. Total consumption of primary energy resources in Bulgaria (Bojadjieva, 2000)

2. Bulgarian Geothermal Resources

The geothermal resources are distributed all over the territory of Bulgaria, Figure 2 (2). About 200 thermal water sources with 3.100 l/s total flow have been established. In accordance with the hydrogeological data obtained the future
thermal water total flow expected including closed water systems (comprised of hot and overheated salty waters of ancient marine origins) still not developed could reach the amount of 13.800 l/s, i.e. five times more than the already discovered.

The thermal waters discovered are about 50°C, the highest percentage (32,92 % [3]) of the waters being at temperature varying between 42 and 50°C. The water mineralization varies from 0,1 up to 50 g/l and in the vicinity of Mirovo village - Varna region reaching up to 324,44 g/l. The highest percentage of low alkaline waters with pH 7,2 - 8,5 is 54,72 % of the total flow.

Until 1980, the thermal waters discovered in Bulgaria were used mainly for medical treatment procedures, swimming pools supply, domestic purposes and greenhouses heating. Only some of the springs, such as Kyustendil, Sapareva Bania and Momin Prohod, were used partially for heating purposes of the buildings and domestic needs. Approximately about 71 of the springs are still not exploited, their flow rate amounting to 36,21 % of the total one [3].

As the geothermal waters used for balneotherapy have to be 40°C and the major part of the springs are at higher temperatures which leads to high losses of heat energy. The total heat capacity of the free flowing away geothermal waters in Bulgaria has been evaluated to about 488 MW, 1/3 of which could be utilized by heat - exchanger apparatuses while the remaining 2/3 by the heat pumps. Thus about 70 tones of fuel equivalent multiplied by the annual work hours of all the facilities will be highly efficient for our national industry.

From the investigations and evaluations of geothermal reservoirs made is obvious that efforts should be directed to generating systems for complex utilization of geothermal waters in hotels, rest houses, medical treatment centres and other places with high consumption of hot water and annual regime of exploitafion. For example the geothermal water in the region of Sapareva Bania is the hottest in Bulgaria, its temperature reaching 101°C and its flow is 13 l/s. The high temperature of this geothermal water provides possibilities by means of low investment to supply a part of the existing conventional heating installations in some places. The studies show [3] that the construction of a geothermal heating station with standard boilers will result in high technical - economical parameters.

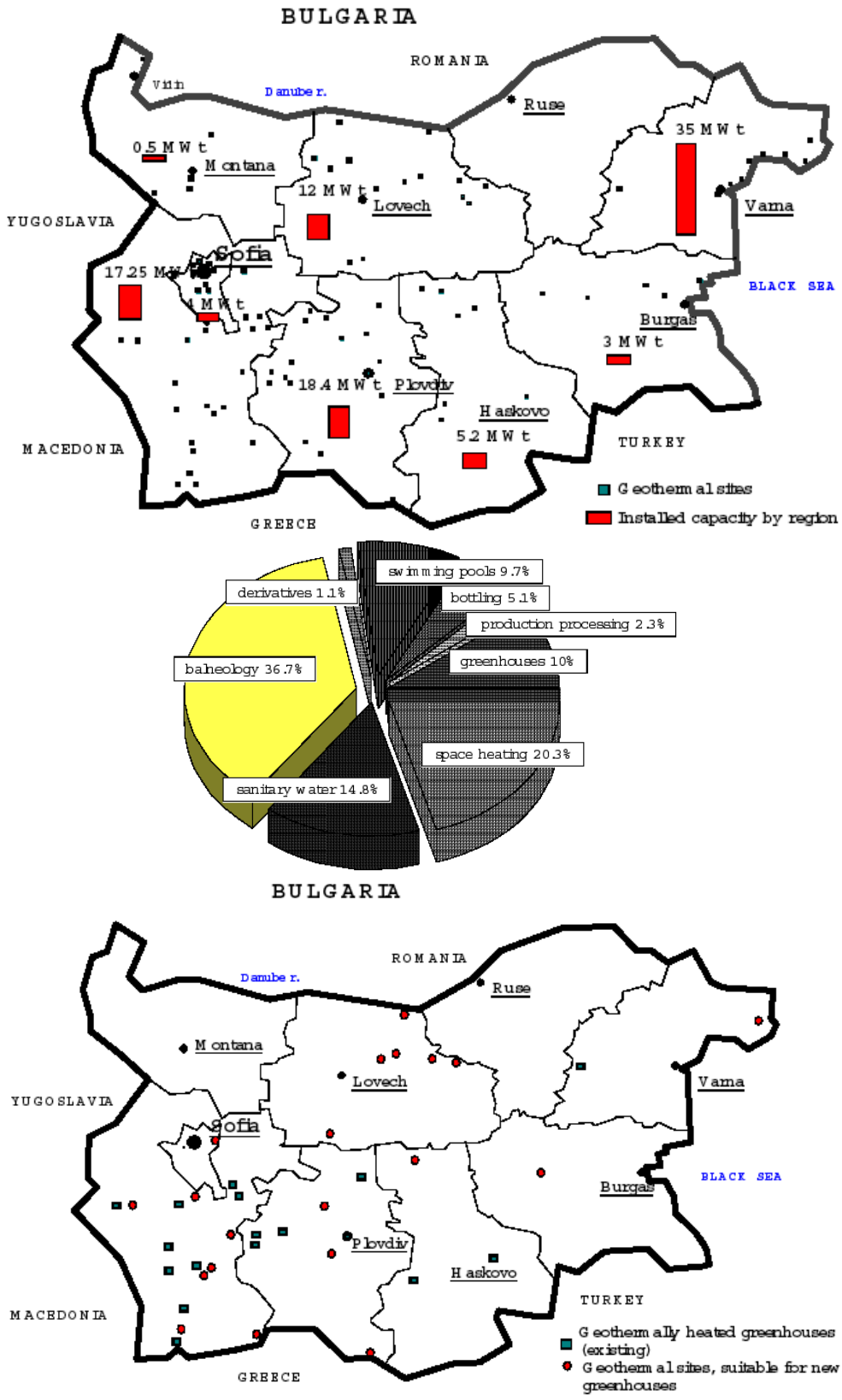

Fig.2. Geohydrthermal map of Bulgaria (Bojadjieva, 2000)

3. Agricultural Applications of Geothermal Fluids in Bulgaria

There are different possibilities for different Bulgarian regions to use geotilermal energy in Agriculture.

The geographical dislocation and the climatic conditions of Bulgaria, especially those in its South - Westem part, have determined preferences for an open mass cultivation of microalgal biomass.

In the locality Roupite (Petrich region) an experimental centre for cultivation and production of green alga and bluegreen alga (*Chlorella vulgaris, Spirulina platensis*, etc), has been established. Roupite has a hydrothermal spring, which releases free CO_2 in the atmosphere. The installation has a total area of 2600 m^2 and is of the sheetlike type [4]. Photoautotrophic algal cultivation is carried out with mineral nutrition media containing both macro and micro elements.

The quality of the water used to prepare the nutrition medium is extremely important for achieving an optimal algal cell growth and for the chemical composition of the obtained algal biomass. Regardless to the individual differences between the various algal species, temperature requirements for algal growth have shown that a raise of the cultivation temperature up to 26°C intensifies considerably the synthesis of algal biomass.Open mass algal cultivation is connected with great day-and-night, as well as season, all changes of temperature and sunny radiation. Suspension warming up by just 4 - 5°C guarantees a good daily growth of the algal culture especially so with blue-green algae. This possibility has been proven through heating systems (warm mineral water is used to warm up the algal suspension) constructed on 6 m^2 and 255 m^2 installations. The optimization of temperature in growing algal cells shortened the inoculation term on whole installation to 10 - 15 days. This is very important especially where re-inoculation is necessary because of parasite infections.

The availability of CO_2 dellited in water and freely released from the Roupite hydrothermal sources, has been a major factor for choosing of this location for setting up a microalgal cultivation centre. A special facility has been created for degassing mineral water and for gas compression in receivers. The utilization of this natural CO_2 in the Roupite centre has been giving very

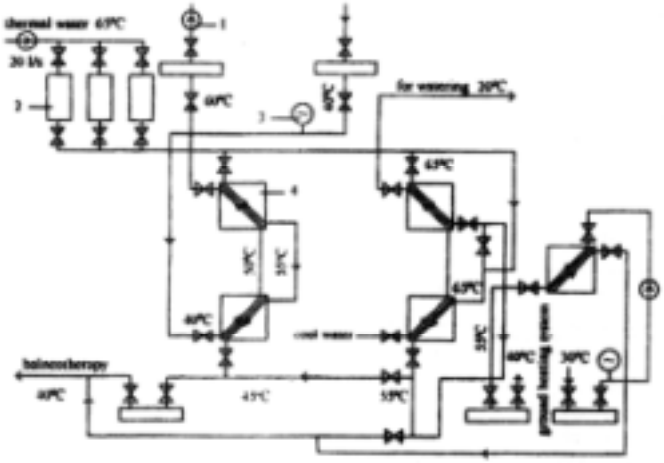

Fig.3. Geothermal plant schematic diagram of the heating system for greenhouses near the town of Shoumen, 1-pumps, 2-balance tanks, 3. expansion vessels, 4- heat exchanger

good results for 25 years. The CO_2 is not purified and it guarantees good algal growth.

It is preferable to use Roupite mineral hot water to cultivate *Spirulina* because high temperature guarantees a bigger algobacterial purity and rich mineral composition helps for a good growth under lower consumption of salts. The utilization of a geothermal source and free $C0_2$ in Roupite has brought about creation of a new and successful biotechnology of production of algal biomass and algal biomass products.

There is certain tradition in Bulgaria about direct uses of thermal waters for greenhouses hearing. Tomatoes, cucumbers, peppers and flowers are grown in greenhouses by means of geothermal heat in the regions of Levunovo, Sandanski, Simitli, Blagoevgrad, etc. [5]. The total area amounts to 16,04 ha (Table 2). The improvements of installations for more effective utilization are planned.

Location	Total areas, ha	Cultures, ha			
		tomatoes	cucumbers	peppers	flowers
1. Petrich (Levunovo)	0,7	-	0,7	-	-
2. Sandanski	2,9	-	-	1,5	1,4
3. Simitli	2,3	2,0	0,3	-	-
4. Blagoevgrad (Bania)	3,14	-	-	-	3,14
5. Kyustendil	0,8	0,4	-	-	0,4
6. Sapareva bania	1,95	-	-	-	1,95
7. Velingrad	1,8	0,84	0,8	0,16	-
8. Haskovski bani	1,0	0,75	-	-	0,25
9. Pazardjik	0,8	-	-	0,8	-
10. Shoumen	0,65	-	-	-	0,65
Total:	16,04				

Table 2. Larger glasshouses, using geothermal waters in Bulgaria

The Petrich - Sandanski region (South - Westem Bulgaria) has been chosen for production of hybrid seeds, because of the high water temperature (inore than 75°C) and number of sunny days through the winter season.

About Velingrad region (Chepino, Draginovo, Ludzhene, etc.) studying the possibilities of further development and modernization of the greenhouses in Chepino is considered to be a realistic task for the near future. The possibilities of setting up a modern greenhouse complex in Draginovo and using the Draginovo geothermal water as heat medium in the already existing greenhouses is considered to be another perspective task. It is recocommended [6] to investigate any other possibility of using geothermal sources in the Velingrad region, e.g. in mushroom growing, fish breeding, aquaculture, etc.

A scheme for heating of a greenhouse complex (0,65 ha) near the Shoumen is shown on Figure 3 [3]. A geothermal well is used as a source with 65°C temperature and 20 l/s flow rate. The scheme includes a heat pipeline ftom the well to the three balance tanks of 50 m^3 capacity each, the water proceeds further to the heat exchanger station. The total geothermal system heat capacity is 1,7 MW. In relation to geothermal water quality and its sedimentation over the equipment and transportation systems there is a special preliminary treatment of the water in relation to the salt depositing into the tree reservoirs.

The entire system is controlled by a microprocessor system, the latter regulating all the parameters of microclimate within the greenhouse complex. The geothermal water output from the geothermal system is used for balneotherapy. This scheme allows further extension of the greenhouse complex and addional supply of heat energy to the ground heating within the polyethylene greenhouses with the purpose of more efficient utilization of the heat potential of geothermal waters. The technical - economical analyses proved the project parameters. The payback of prmary investments vary within the range of 3 - 8 years.

4. Conclusion

The renewable resources in Bulgaria are in fact a real and prospective factor in energy savings.

Limited domestic resources, environmental risks and worldwide developments suggest reestimation of the potential role of renewables as a source of heat and electric energy in most of the South East European countries including Bulgaria [7]. In strategies for development of power sector along with other options detailed examinations of the possible share of renewables (mainly solar and geothermal energy) combined with other energy sources should be performed.

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