Country Update for Bulgaria (2007- 2012)

Klara Bojadgieva[1], Aleksey Benderev[1], Adriana Berova[2], Ivanka Apostolova[2]

[1] Geological Institute, Bulgarian Academy of Sciences, Acad. G.Bonchev bl.24, 1113 Sofia, Bulgaria

[2] Ministry of Environment and Water, 22 Marie Louise, 1000 Sofia, Bulgaria

Keywords: renewable energy, thermal water application

ABSTRACT

A slow trend of increase of the total primary energy production and of the share of renewable energy in the gross final energy consumption has been observed in the past several years in Bulgaria.

Thermal water application by category is compared for the periods (2001-2006) and (2007-2012) and the main legislative and financial factors controlling this activity are discussed. Currently, the balneology and thermal water supply for the regions with no alternative water sources are the leading applications. Bottling of mineral water remained almost constant for the two periods. The share of space heating and greenhouses is rather small for both periods. Oldest and out of date direct heating systems have been gradually closed and only several small demonstration projects were built. According to the information published in the Internet sites of Bulgarian companies involved in geothermal business many systems assisted by ground source heat pumps have been constructed. At present, no summary for their total installed capacity is officially available.

1. INTRODUCTION

Bulgaria is situated on the eastern part of the Balkan Peninsula and has limited energy resources.

The main local sources are coal and nuclear energy. They account for 87% of the produced primary energy. A trend of primary energy increase is observed during the period 2007 – 2011, Fig.2 (Energy balances, 2012). This is related to the increased coal production by approximately 6.3% in the discussed period as well as to the growing share of renewable sources. According to the latest published data on the Internet site of the National Statistical Institute the share of renewable energy in the gross final energy consumption has run up from 9.3% (2007) to 13.8 % (2010), Fig.3.

Two sources have a leading role in the renewable energy development – biomass (wood and wood waste) and hydro power (small and large plants), Fig.4. During the discussed period their share slightly decreased, respectively from 70.7% to 67.7% for biomass and from 25.3% to 20.4% - for hydro power. Most substantial rise is observed for wind energy (from 0.4% to 6.0%), followed by solar – up to 1.8% (thermal and photovoltaic) and other liquid fuels – from 0.2% to 1.4%, (http://www.nsi.bg/).

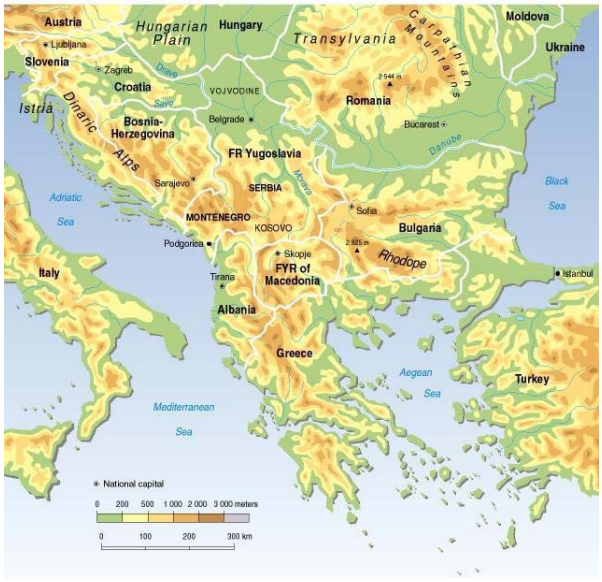


Figure 1: Location map

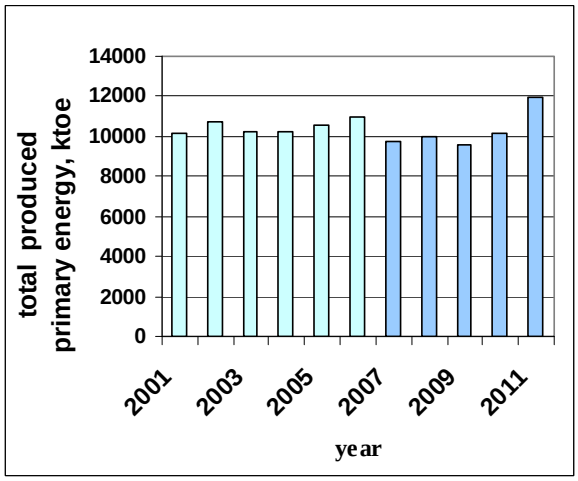


Figure 2: Total primary energy production in Bulgaria (2001-2011)

Geothermal energy share has slightly decreased - from 3.4% in 2007 to 2.7% in 2012. The rapid growth of wind and solar energy application is associated with

the administrative and legislative changes aiming to promote electricity

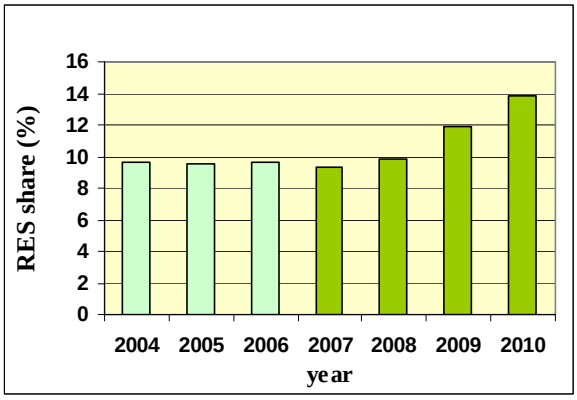


Figure 3: Renewable energy share in the gross final energy consumption in Bulgaria for the period 2004-2010

generation from renewable source (Ministry of Economy, Energy and Tourism, 2011). The most significant of them are as follows:

- Compulsory and priority connection of the producers to the transmission and distribution grid.

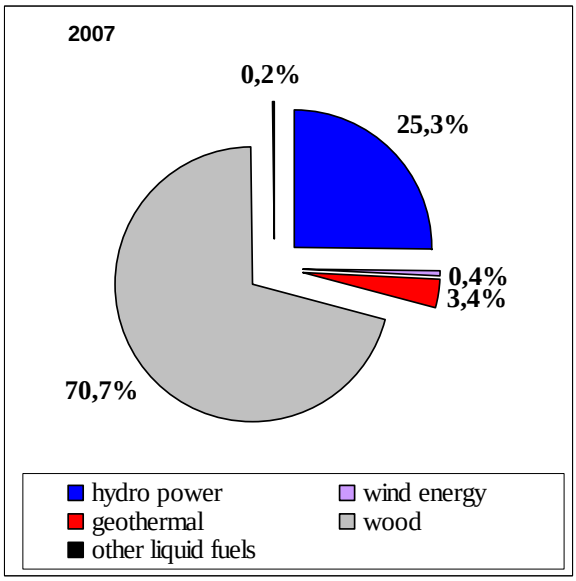
- Feed-in tariffs

With the adoption of the new Renewable Energy Act in 2011 terms for electricity purchase by the grid are: 20 years for energy produced by geothermal, solar and biomass plants; 15 – by hydro plants and 12 years – by wind generators. Hydropower plants with installed capacity greater than 10 MW are excluded. The feed-in tariffs are determined by the State Energy and Water Regulatory Commission.

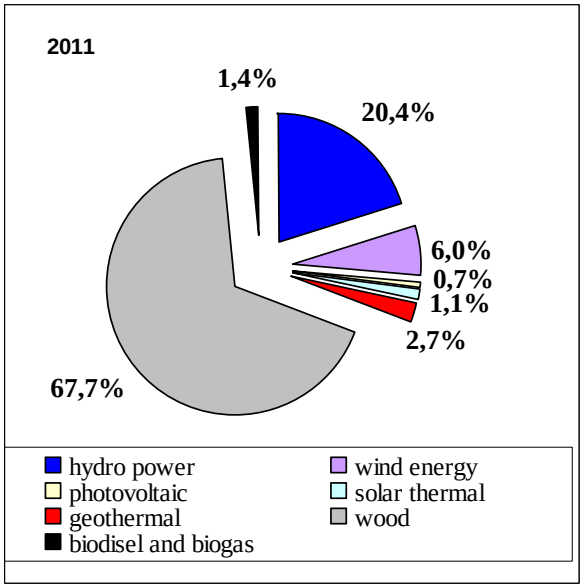
- Licensing regime for producers of electricity from renewable sources with an installed capacity of over 5 MW.

In 2012 the State Energy and Water Regulatory Commission implemented retro active measures for producers of electricity from renewable energy sources, which will significantly hamper any further sector development. All projects with signed preliminary grid connection contracts were postponed to be interconnected after 2016, moratorium on new grid connected RES was declared as well as a decision for unplanned support reduction came into force.

Discovered thermal waters in the country are of temperature below 100°C and not used for electricity generation. The amendments to the Water Act made at the end of 2010 are expected to promote the direct geothermal water application in the near future. Under the new provisions the state-owned geothermal deposits could be granted to the municipalities at the location to meet local needs for a period of 25 years. Thermal waters could be administrated on the spot by legal entities and individuals. In the cases when 51% of a specific state-owned field has been already under exploitation the local Municipality is not entitled to operate with the remaining 49%.



a) 2007



b) 2011

Figure 4: Change in the RES structure during the period 2007 - 2011

According to the Water Act, 102 geothermal fields from all over the country are specified as exclusive state property and 138 - as public municipal property. Currently about 67 state-owned fields have been identified for being granted to the Municipalities.

Another significant change occurred in the period 2007-2012 was the sharp decrease of about 3-4 times of the fees for water use. This measure aimed to provoke the local businesses interest in investing in thermal water application. Up to 50kW thermal energy

can be used free of charge by an owner of a land where a geothermal source is located.

The analysis of geothermal development in the period 2007-2012 is based on the permits issued by the Ministry of Environment and Water for the state-owned geothermal reservoirs and on the concessions approved by the Council of Ministers.

Data on thermal water application in Municipality owned geothermal fields is still not summarized and available for analysis.

2. GEOTHERMAL UTILIZATION

Thermal waters of temperatures up to 98°C are presently discovered in the country. They have direct application in the balneology, water supply, bottling of mineral water and soft drinks and heating of buildings and greenhouses. Higher temperatures of about 150°C are expected for the deeper seated sedimentary water bearing layers of Devonian and Triassic age in the Moesian plate, North Bulgaria. The provided laboratory analyses of water samples taken from them show high total dissolved solids values in the range of 121g/l to 317g/l (Petrov et al., 1998). According to the data obtained from the geochemical thermometers maximum water temperatures of 150°C could be found in Velingrad and Sapareva Banya geothermal fields, South Bulgaria (Hristov, 1993). No drilling data are available for them so far.

Thermal water application has an ancient tradition in Bulgaria but is still not fully utilized. The total amount of exploited thermal water from the state-owned geothermal fields during the period (2007-2012) is varying between 25% and 31% but still remains less compared to the previous period, Fig.5.

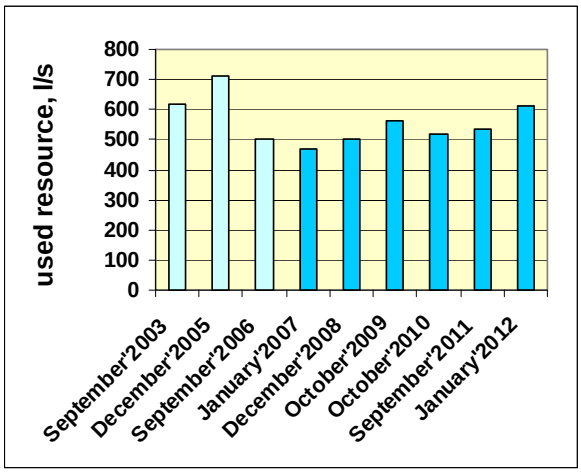


Figure 5: Thermal water quantity used for direct application (state-owned reservoirs)

The structure of thermal water application towards 2006 and 2012 is presented in Fig. 6 and 7.

The information is based on the processing of data available in the issued permits and concessions for the state owned geothermal fields for two periods - (2001-2006) and (2007-2012). The formulated types of application in them are as follows: relaxation, sanitary needs, treatment and rehabilitation, prevention, swimming pools, water for free of charge drinking from public taps, water supply (where no alternative is available), bottling of mineral water, space heating in buildings and greenhouses and some other uses (public laundries, industrial processes, irrigation). Some of the applications, like relaxation, sanitary needs, treatment and rehabilitation, prevention, swimming pools and water drinking from public taps are combined in one category – balneology. These types of uses exist mainly in spa resorts located in the Black sea and mountain regions. About 40% of the sites have two or more types of use provided that balneology is considered as one application.

The fees for water application vary according to the temperature and are the lowest for water supply (0.015 – 0.016) EUR/m^3, followed by treatment and rehabilitation (0.02 - 0.03) EUR/m^3 and (0.08 – 0.26) EUR/m^3 – for all other uses (State Gazette, 2011).

The leading application for the whole period of the past 12 years is balneology, followed by water supply, Fig.6. During the period (2007-2012) a decrease of thermal water use is observed for balneology, while a higher water quantity is provided for water supply. All the other uses have remained almost the same. Concession regime is in force for bottling of potable water and mineral drinks and in rare cases for relaxation and greenhouse heating. Some bottling plants and heating installations have been closed during the discussed period.

A trend of decreased water quantity used for different types of application in balneology is observed for the period 2007-2012, except for water provided for drinking out of public taps, Fig. 7. The highest share in balneology belongs to relaxation and sanitary needs. Permits for relaxation are granted to consumers, which are not registered under the Medical Establishments Act. These are mainly hotels, built in the resorts for the past 10-15 years. Permits for treatment and rehabilitation are issued to the 13 national hospitals and for prevention – to the local medical centers. Water consumption remained almost stable for treatment and rehabilitation and rapidly decreased for prevention due to the lack of funds for maintenance and development of the small private medical centers. Fees paid for prevention are much higher than for treatment and rehabilitation use in the national hospitals.

The observed reduction of thermal water application during the period (2007-2012) could be also a consequence of the terminated licenses due to expired 10 years term of exploitation in many sites. These terminated licenses amount to about 34% of the total number of issued permits during the period 2001-2012.

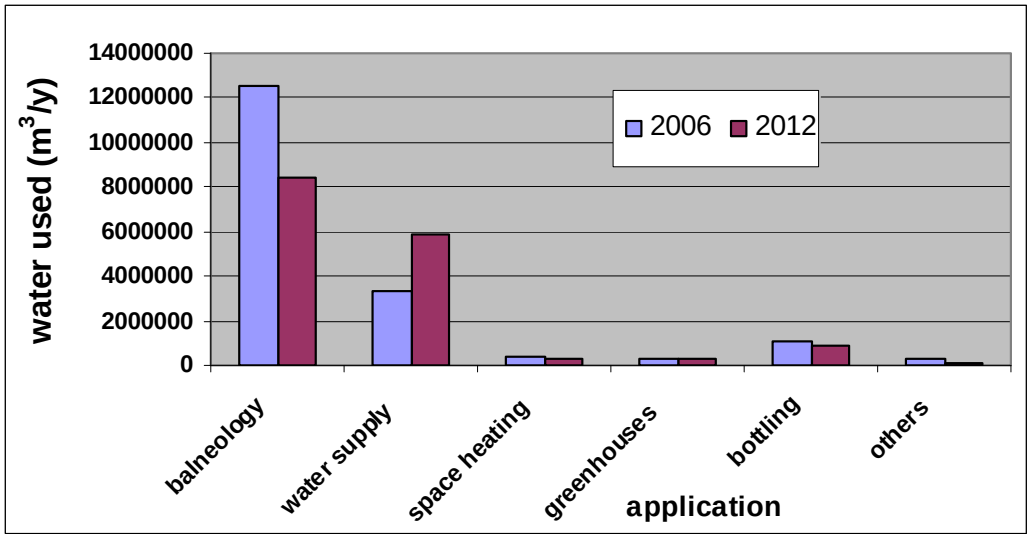


Figure 6: Water use by application

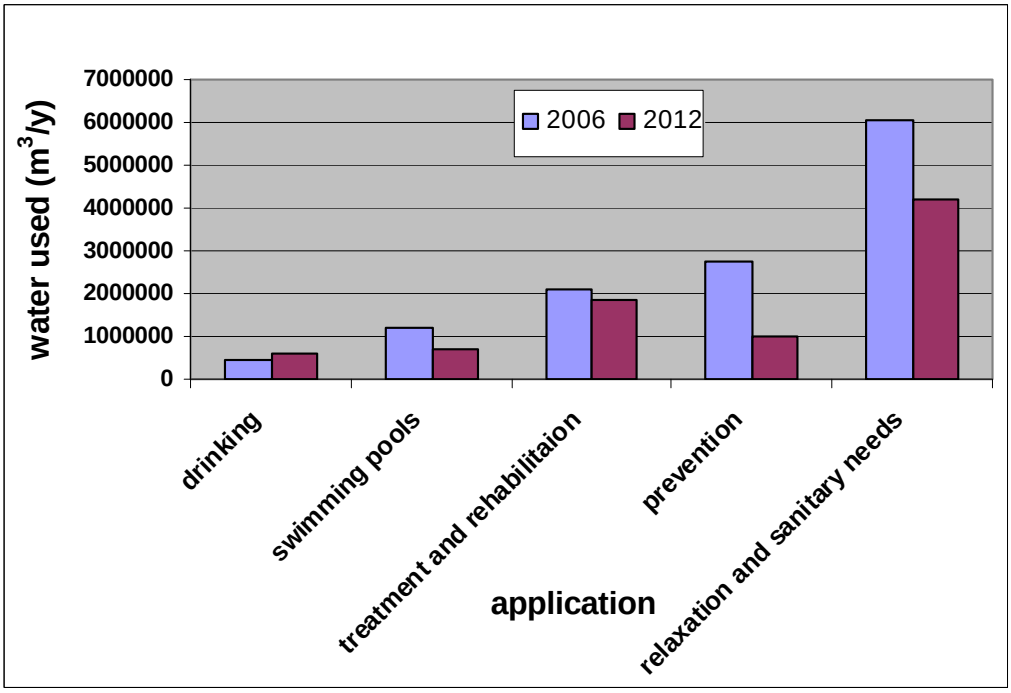


Figure 7: Structure of water use in balneology

Current distribution of thermal water applications on the territory of Bulgaria is presented in Fig.8. Geothermal activity is mainly concentrated in the southern part of the country due to the higher water temperature there and low water salinity (TDS), mostly below 1g/l. The balneology is mostly developed application and the leading sites are: Sandanski, Velingrad, Hisarya, Pavel banya and Varna, Fig.8. The use for relaxation and sanitary needs is most common in balneology and is available in almost all sites.

Water supply is taking place mainly along the north-eastern Black sea coast, Fig. 8.

About 18 bottling enterprises are currently in operation and 5 of them are located in the capital of Sofia and its vicinity. The development of this application is mainly driven by the low TDS (below 1 g/l) typical for more than 90% of the discovered thermal waters in the Southern Bulgaria, although they occur in different geological formations (volcanic, intrusive and metamorphic rocks), (Hristov, 1993).

Geothermal energy in the country is used for individual space heating in 7 sites as 3 of them are located on the Black sea resorts north of Varna city. No geothermal district heating systems

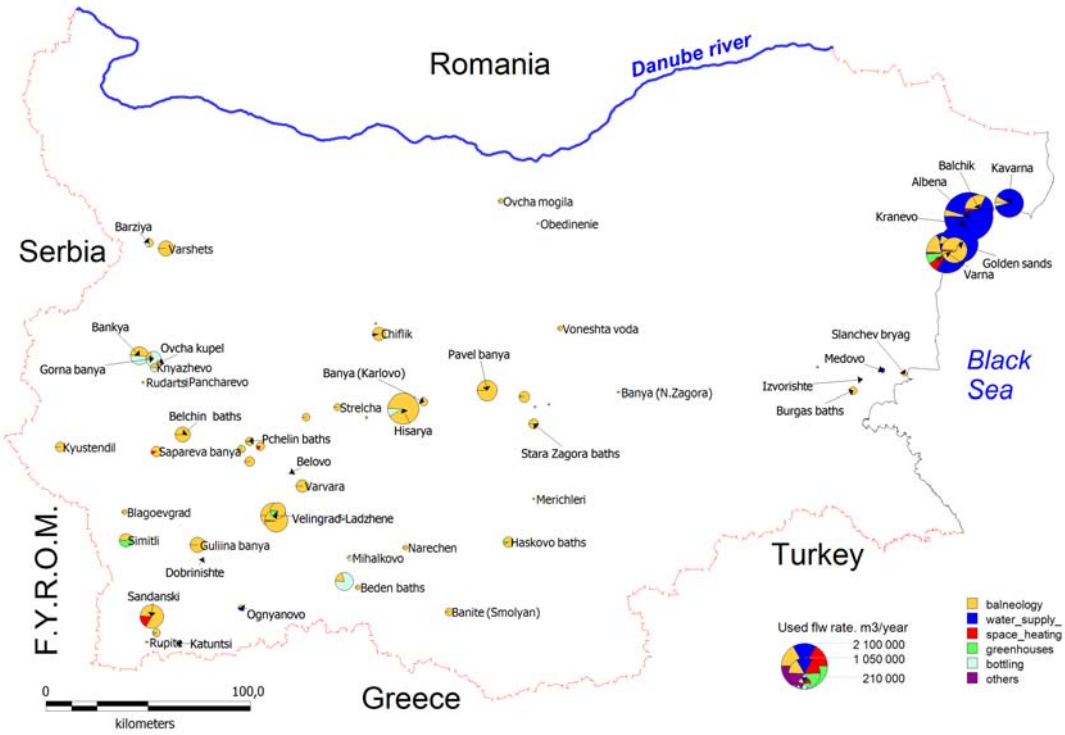


Figure 8. Thermal water application by type on the territory of the country (towards 2012)

are presently available. According to the climate conditions in the country the heating systems are in operation for about 220 days/year. The installations are assisted by plate heat exchangers and additionally prepare domestic hot water.

Greenhouses are located in 7 sites; 6 of them are in SW Bulgaria and only one in the north-eastern part near Varna city. They produce vegetables and flowers for the local market.

The total installed thermal capacity towards 2012 was estimated to about 85.8 MWt (excl. GSHP) and the produced energy to – 2166.4 TJ/yr. The following outflow temperatures have been taken into account for the calculation: 40°C – for greenhouses, 35°C – for individual space heating, 25°C – for balneology and 22°C - for other uses.

Summarized information on the total installed capacity of ground source heat pumps (GSHP) is not currently available. According to the published data in the Internet sites of Bulgarian companies involved in this activity such installations are constructed in family houses, hotels and restaurants, office buildings, sport complexes, auto-services and industrial buildings (Fig.9) in different regions of Bulgaria. The existed GSHP systems provide heating, cooling and domestic hot water. According to the published Internet data their installed capacities vary from 5-6 to 220 kW.

An innovative pilot system using CO_2 earth heat pipe (GECO2) has been recently installed aiming at providing heating to an industrial building located in Branipole village, 5 km south of the town of Plovdiv, S. Bulgaria, Fig.10. A condensed CO_2 is flowing down along the wall of a flexible, corrugated stainless steel pipe (German patent) and as a result of the heat exchange with the surrounding rocks a vaporized CO_2 is moving up the same pipe to a heat pump system, Fig.11. The pipe is fixed in a well of 110m depth. The system is of 3 kW installed capacity and provides only heating. It has been in operation since the beginning of 2012.

Figure 9. Administrative and storage building near Sofia (Energy saved for heating – 75% and for cooling - 80%)

(http://www.rehau.bg)

Figure 10: Shaft with installed heat exchanger

(Branipole village, S. Bulgaria)

Figure 11: Principle scheme

DISCUSSION

Only about 25.3% of the discovered thermal water quantity is presently used in Bulgaria. The majority of the geothermal fields in the country have a water temperature between 20°C and 50°C and a flow rate up to 20 l/s. These parameters combined with the low total dissolved solids (less than 1 g/l) typical for 70% of the discovered mineral water in the country determine the trend of application. The most widespread utilization is for balneology and tourism due to the long term existing tradition and accumulated experience in providing prevention, treatment and rehabilitation.

Thermal waters are widely used for water supply mainly in the region of the north-eastern Bulgaria, due to appropriate mineral composition and the lack of alternative sources there. Both mentioned applications are stimulated by the low fees for water use.

Bottling of mineral water and soft drinks preparation takes third place in terms of the utilized water amount. It has remained relatively constant over the last 12 years and meets the demand of the local market.

Geothermal water for heating and cooling of individual buildings and greenhouses has currently a very limited application. No district heating system has been built in the country so far. In the last 10-12 years, the geothermal energy use has been continuously decreasing due to closure of outdated simple direct heating systems. At the same time, new indirect technological systems have not been built. One of the key obstacles was the high fee paid for the water used for production of geothermal energy. More intensive space heating utilization is expected with the new amendments made in the Water Act. They are associated with a significant fee reduction as well as with granting of state-owned deposits to the local municipalities. Major barriers that emerge at the current stage are the lack of local investments and expertise of the municipalities in managing the geothermal resource. Systems operating on shallow geothermal energy will remained attractive to private consumers and their number will be growing.

REFERENCES

Hristov,V: Application of chemical geothermometers to low temperature fields in Southern Bulgaria, UNU –GTP, *Report 7*, Reykjavik, Iceland. (1993)

Ministry of Economy, Energy and Tourism: *First national progress report of Bulgaria in the promotion and use of renewable energy*,(2011).

National Statistical Institute: *Energy balances'2010: (NSI)*, Sofia, (2012). Available at: http://www.nsi.bg

Petrov,P. et al.: Reassessment of hydrogeothermal resources in Bulgaria, *Report for the Ministry of Environment and Waters*, National Geofund, Sofia, Bulgaria (1998). (in Bulgarian).

State Gazette*: Issue 50*, Decree N 177, p.17, June 24, (2011)

Tables A-G

Table A: Present and planned geothermal power plants, total numbers*

*Geothermal power plants are not available in the country.

Table B: Existing geothermal power plants, individual sites*

*Geothermal power plants are not available in the country.

Table C: Present and planned geothermal district heating (DH) plants and other direct uses, total numbers

	Geothermal DH Plants*		Geothermal heat in agriculture, individual space heating and industry		Geothermal heat in balneology and other	
	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)
In operation end of 2012			3.48	15.70	82.30	586.08

*District heating geothermal plants are not available. The total installed capacity for individual space heating is **1,83MW_{th}** and the produced energy amounts to **8,03 GWh_{th}/y**.

Table D: Existing geothermal district heating (DH) plants, individual sites*

*District heating geothermal plants are not available. The total installed capacity for individual space heating is **1,83MW_{th}** and the produced energy amounts to **8,03 GWh_{th}/y**.

Table E: Shallow geothermal energy, ground source heat pumps (GSHP)*

	Geothermal Heat Pumps (GSHP), total			New GSHP in 2012		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2012	8	5.52	14.746			
Projected by 2015						

* - The data refer only to 8 geothermal projects realised by a loan received under BEERECL. Information for GSHP systems in operation is available in several Bulgarian Internet sites but it is incomplete and not representative for the whole country.

Table F: Investment and Employment in geothermal energy

	in 2012		Expected in 2015	
	Investment (million €)	Personnel (number)	Investment (million €)	Personnel (number)
Geothermal electric power				
Geothermal direct uses				
Shallow geothermal			Available information for 8 geothermal projects completed with requested loan under BEERECL. Total cost - 2,6 million €, loan - 2,2 million €)	
total				

Table G: Incentives, Information, Education

	Geothermal el. power	Geothermal direct uses	Shallow geothermal
Financial Incentives – R&D		Reduction of taxes, paid for thermal water use	
Financial Incentives – Investment			DIS
Financial Incentives – Operation/Production			
Information activities – promotion for the public	No promotion for electricity generation is available	Promotion in the media	Widely promoted by various media – press, radio, TV, Internet sites
Information activities – geological information	Insufficient	Well studied	Well studied
Education/Training – Academic	available	available	available
Education/Training – Vocational	available	available	available

Key for financial incentives:					
DIS	Direct investment support	RC	Risc coverage	FIP	Feed-in premium
LIL	Low-interest loans	FIT	Feed-in tariff	REQ	Renewable Energy Quota