Bulgaria

Country Profile

1. Overview of Electricity Supply

Since the collapse of Bulgaria's socialist government in 1997, the country has observed macroeconomic stabilization and consistent growth fueled by political and economic reforms of the new government. The GDP growth in 2007 was 6 percent, with foreign direct investment rising to $8,164 million. Bulgaria's electricity sector has helped to stabilize and grow the economy throughout the 1990's and 2000's. In January 2007, Bulgaria became a member of the European Union.

The existing generation assets have been sufficient to supply domestic demand and have created a significant export market for electricity. In 2006, Bulgaria generated 43.5 billion kWh, while exporting over 8.9 billion kWh to its neighbors in Southeastern Europe. Despite the current excess of generating capacity, Bulgaria is actively seeking outside investment to expand, as 40 percent of the current generation is scheduled for retirement by 2010.

The Bulgarian government has proceeded more rapidly with restructuring and liberalization of the energy industry than many of its neighbors in Eastern Europe. With the passage of the Energy and Energy Efficiency Act of July 1999, the following changes and goals have been initiated:

- Improving efficiency
- Unbundling monopoly structures
- Promoting privatization
- Attracting foreign investment

- Establishing a State Energy Regulatory Agency

The electricity sector in Bulgaria is managed by the State Energy Regulatory Agency. Under the agency, Nationalna Elektricheska Kompania (NEK) was split into six independent generators, a national transmission system operator, and seven regional distribution system operators. Steps towards the deregulation of the electricity market are underway. As of 2007, the electricity generation companies are mainly state-owned, the electricity distribution companies are privatized, and the district heating companies are still undergoing privatization.

The table below provides summary information about Bulgaria.

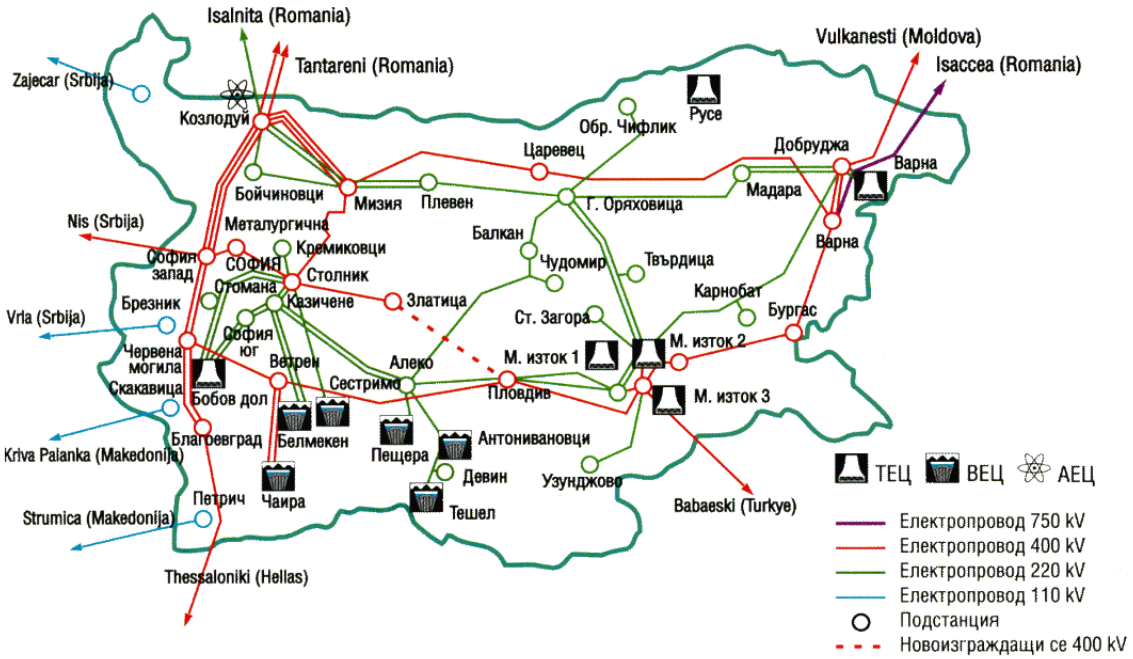
Demographical Information	
Population, millions (2009)	7.20
Land area, thousand sq km (2008)	111.0
Macroeconomic Information (2008)	
GDP, billion US$	93.8
Real GDP growth rate, percent	6.0
Foreign direct investment (net), million US$ (2007)	8,164
Electricity disposition, billion kWh (2006)	
Generation	43.15
Consumption	30.50
Exports	8.88
Imports	1.14
Generation capacity, GW (2005)	
Nuclear	1.91
Thermal	6.68
Hydro	2.57
Other renewables	0.01
Total	11.17

Sources: CIA World Factbook, U.S. Energy Information Administration, United Nations Conference on Trade and Development.

Country Summary Table

The following figure displays the electrical grid of Bulgaria.

Bulgaria's Electrical Grid



(return to top)

2. Renewable Policies and Incentives

As Bulgaria is a member of the European Union, they are held responsible for adhering to the rules and goals set by the EU. Thus, Bulgaria has an energy policy that is very supportive of renewable energy.

"Ordinance on Setting and Applying Prices and Rates of Electric Energy," states that energy generated from renewable energy sources will be given preferential pricing, and that transmission and distribution entities will be required to purchase all renewable energy produced at a fixed rate.

Bulgaria also has a renewable energy target. The European Union Heads of State or Government agreed in March 2007 on binding targets to increase the percentage of renewable energy produced in the European Union. Bulgaria's obligation is to have 16 percent of their total production of electricity be from renewable sources by 2020. In 2005, Bulgaria had 9.4 percent of their total production coming from renewable resources.

Bulgaria is pursuing renewable energy sources in three different directions:

- Electricity - wind, small hydro, solar PV, biomass
- Heating/Cooling - solar thermal, biomass, geothermal
- Transportation - biomass

In order to promote diversifying their energy sources, Bulgaria implemented the Bulgarian Energy Efficiency and Renewable Energy Credit Line. Renewable energy projects are eligible for a 20 percent grant. Loans over 12.8 billion Euros have already been granted.

Biofuels, if not blended with other fuels, have been excise tax exempt since 2005. It should be noted that not all types of bioethanol are included in this exemption.

Feed-in tariffs exist for wind installations (80-90 EUR/MWh) and biomass plants (90-110 EUR/MWh). The feed-in tariffs are applicable for the first 12 years (Nikolaev, 2007)

(return to top)

3. Wind

Bulgaria's wind capacity has grown dramatically in recent years. Currently, the country has a wind power capacity of 86 MW, approximately 25 wind farms. A majority of this capacity was installed in 2008: the 35 MW farm, Kalchevo, and the 32 MW farm, Kavarna East. As of June 2009, 14.5 MW of capacity are under construction: the Bilo (4.5 MW) and Long Man (10 MW) wind farms. Approximately 1,000 MW of capacity are planned for Bulgaria (UDI, June 2009).

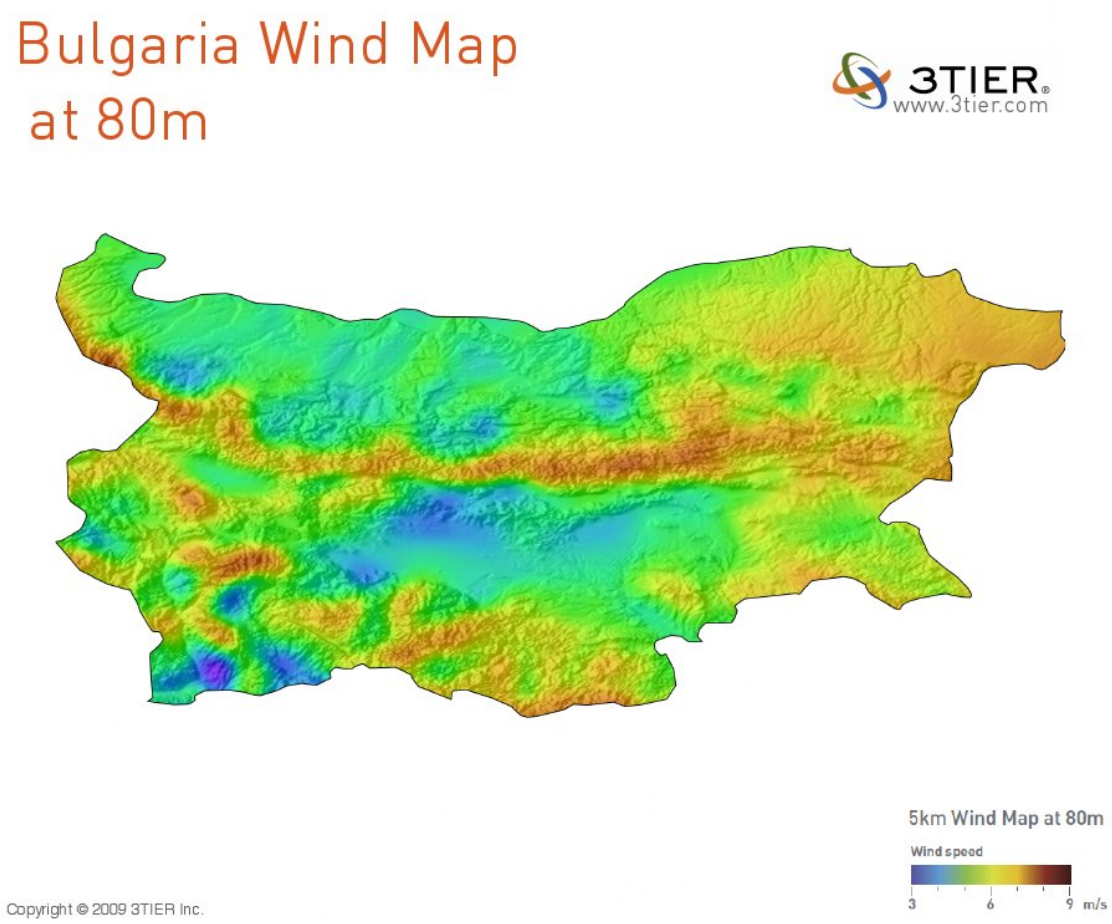
Resource Information

The Bulgarian wind resource is characterized using data from a 1982 study conducted by the Bulgarian Academy of Sciences. This analysis showed several areas with very good wind resource: three areas with wind speeds in excess of 9 m/s, two areas with wind speeds in excess of 7 m/s and several areas with speeds between 4.5 and 7 m/s. This wind speed data originates from 119 meteorological stations (all at 10 m above ground). At the typical turbine height of 50 m, this data would likely imply wind speeds between 5 and 13 m/s. A country wide wind-atlas is available, see figure below.

The most promising sites are in the northern Black Sea Coast, the central mountain range and the Rhodop mountains in the southwest.

The study mentioned above estimated the wind resource potential of Bulgaria to be 2,200 to 3,400 MW. The following figure shows the wind velocities throughout the country at a height of 80 meters.

Bulgaria Wind Resource Map (Source: 3Tier)



(return to top)

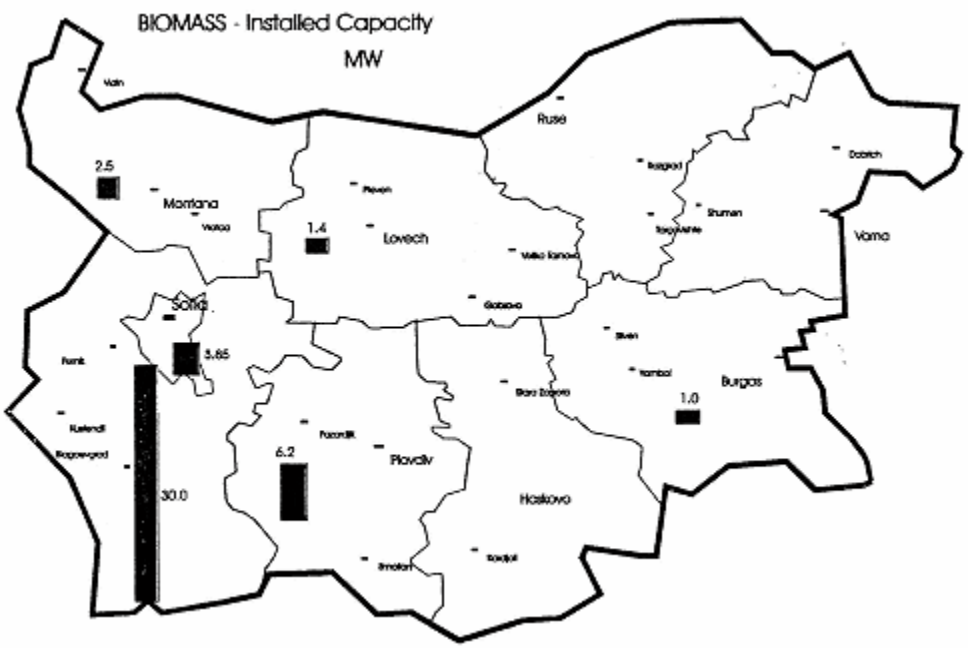
4. Biomass

There is good potential for utilizing biomass as an energy source in Bulgaria. While information regarding the use and potential of biomass has been limited, there have been recent developments through pilot projects and preliminary evaluations that begin to highlight Bulgaria's full potential. In June 2008 the Council of Ministers approved a National Long-term Programme for Encouragement of the Use of Biomass for 2008-2020. This program is a roadmap for the potential use of biomass in Bulgaria.

Bulgaria's first power plant running on biomass was built in Apritsi (north central part of the country) in 2002, and since 2003, wood waste has been used for heating of the Ivan Skenderov Hospital in Southwestern Bulgaria. Also, a plant that manufactures biomass-burning heating units was opened in Haskovo in May 2006 while Bulgaria's largest biomass facility, burning wood waste with an output of 10 MW, was opened in Bansko in December 2006. Many other biomass plants have also been planned for Bulgaria (BTA, July 2009).

Next to the country's hydro resources, biomass accounts for a sizable share of Bulgaria's energy consumption, approximately 10 million kWh in 2007 (EIA, 2007). Due to the lack of reliable nationwide assessments and data, it is estimated that in practice this number is much larger. The majority of the biomass energy consumption exists mainly in the rural areas, where fuelwood, followed by the residential consumption of wood briquettes produced from forestry wastes and sawmill byproducts amount to approximately 2 million m^3 per annum. The figure below identifies those regions where biomass projects have been implemented by industry and that are currently in use.

Installed Biomass Capacity of Bulgaria
(Source: Energy and Ecology Ltd)



Bulgaria has sizeable timber, paper and pulp industries, although utilizing the associated residues as an energy resource has yet to be fully exploited. It is not uncommon for residues generated to accumulate in adjacent areas where degradation and environmental damage occurs. One pilot study funded by the World Bank under the Prototype Carbon Fund of the UNFCCC has evaluated the use of wood wastes generated by a pulp, cellulose, and rayon plant, and concluded that such a project would be feasible.

Wastes generated from agriculture and farming activities are produced in large quantities, and could also prove to be a significant source for energy generation. However, the majority of the farms are small and independently owned. Currently, the majority of agricultural waste generated is sent to local landfills. Many organizations and companies, such as Thermoconsult, EE Systems, Energoproekt, and the Bulgarian Biomass Association, are researching the feasibility and full potential of utilization of such wastes.

Bulgaria also has the potential to capitalize on the utilization of landfill gas. The 1997 Law on Reduction of Adverse Environmental Effects of Wastes set mitigation measures for the reduction of methane and other greenhouse gases released by landfills. The National Long Term Program to encourage the use of biomass for the period of 2008-2020 estimates the maximum possible electric generation from landfill gas to be 58 GWh per year.

Resource Information

Bulgaria has a total land area of approximately 110,000 km^2, of which some 6,200,000 ha, or 60 percent of the overall land area, consists of agricultural lands, and 3,903,000 ha, or 30 percent of the overall land area, is forest cover.

A 2005 study of the technical potential of biomass for energy utilization is included on the Ukrainian biofuel portal for Bulgaria. The total biomass potential is 96.2 PJ/year, which includes three components:

- Forest biomass - 44.4 PJ
- Agricultural biomass - 48.2 PJ
- Waste biomass from industry - 3.6 PJ

The following table provides an overview of Bulgaria's biomass resource potential:

Biomass resource type	Total production	Production density
Total land area covered by	(avg. 2006-2007, km²)	(avg. 2006-2007, %)
Arable Land	30,925	28
Permanent Crops	2,005	2
Permanent Meadows and Pastures	18,450	17
Forest Area	37,000	33
Other Land	20,240	18
Inland Water	2,380	2
Primary crop production	(avg. 2006-2007, tonne)	(tonne /100 km²)
Total primary crops (rank among COO)	6,858,118 (18)	6,180 (14)
Top 10 primary crops		
Wheat	2,846,246	25,642
Maize	950,353	8,562
Sunflower seed	880,509	7,933
Barley	483,027	4,352
Grapes	341,918	3,080
Potatoes	338,302	3,048
Tomatoes	173,079	1,559
Chilies and peppers, green	119,214	1,074
Watermelons	106,431	959
Cabbages and other brassicas	86,831	782
Animal units, number	(avg. 2006-2007, number)	(number / 100 km²)
Cattle	625,034	5,631
Poultry	19,811,000	178,477
Pigs	977,824	8,809
Equivalent animal units	1,214,273	10,939
Annual roundwood production	(2006-2007, m³)	(m³ / 100 km²)
Total	5,844,000	5,265
Fuel	2,705,500	2,437
Industrial	3,138,500	2,828
Wood-based panels	710,500	640
	(2006-2007, tonne)	(tonne / 100 km²)
Paper and paperboard	377,500	340
Recovered paper	80,000	72.1

Source: Food and Agriculture Organization of the United Nations

Biomass Potential by Sector

(return to top)

5. Solar

A sizeable portion of Bulgaria's land area receives medium levels of solar radiation. The potential for energy from this resource is greatest for low temperature thermal applications, rather than electric power generation. Warm air solar heating may be utilized in a broad range of agricultural and forestry applications such as for crop dryers and wood dryers. There are some private sector companies interested in solar energy, such as Energoproekt, AMEK,

Energy and Ecology Ltd., and Thermoconsult, that have done preliminary research and/or pilot project implementation.

Solar thermal energy has been utilized in Bulgaria in several applications. From 1977 to 1990, the Bulgarian government developed an energy efficiency program for the utilization of solar collectors, which amounted to the installation of 50,000 m^2 of collectors or about 17 MWth. Additional pilot and educational projects for domestic hot water heating under the PHARE program have yielded successful results, although there has not been a large increase in such projects.

Other than experimental and prototype photovoltaic projects, very little has been done in implementing solar power projects. However, approximately 20 MW of photovoltaic installations have been planned in Bulgaria, and a 1 MW PV system currently produces power in Sofia (UDI, June 2009). The table below displays the solar thermal installations used for hot water heating by region.

Region	Installed Capacity, m^2	Total Percentage of Installed Capacity
Sofia - town	2,200	4%
Burgas	25,100	41%
Varna	9725	16%
Lovetch	1450	2%
Montana	950	2%
Plovdiv	6,300	11%
Russe	950	2%
Sofia - region	6,800	11%
Haskovo	6,300	11%
Total	59,775 m^2	100 %

Total Installed Capacity of Solar Collectors for Hot Water Heating (Source: Sofia Energy Center)

Resource Information

The Sofia Energy Center, under the auspices of the FEMOPET program, estimated the total theoretical potential for solar energy in Bulgaria to be 12.955 x 10^9 toe. They further estimated that the technical potential for photovoltaic panels to be 53,000 toe, active thermal solar systems to be 161,000 toe and passive thermal solar energy systems to be 33,000 toe.

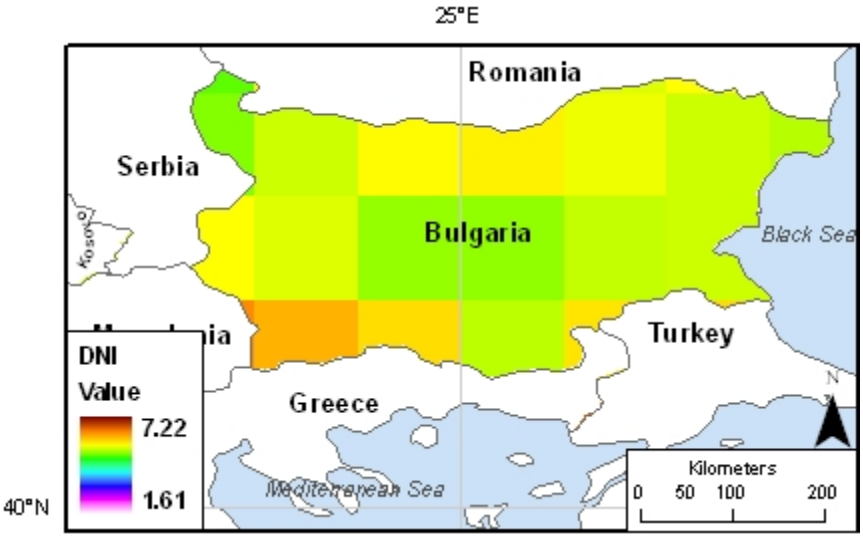
The table below shows the monthly solar radiation for several regions in Bulgaria.

Location	Polianovgra	Sofia Observatory	Sommet Stalin	Tcherni-Vrah	Tchirpan	Varna
Latitude	42.52 N	42.82 N	42.18 N	42.57 N	42.20 N	43.20 N
Longitude	26.85 E	23.38 E	23.58 E	23.28 E	25.33 E	27.92 E
Jan	1.8	1.26	1.27	2.49	1.6	1.55
Feb	3.24	2.67	2.74	4.21	3.28	2.64
Mar	3.65	3.18	4.11	4.81	3.93	3.28
Apr	4.95	3.87	4.58	5.6	4.51	3.88
May	6.42	4.97	4.44	5.83	6.49	4.83
Jun	6.42	5.8	3.96	6.03	6.55	5.47
Jul	6.82	6.45	4.93	7.52	7.22	5.47
Aug	6.06	5.56	4.93	6.66	6.51	5.94
Sep	5.01	3.95	3.95	5.04	4.94	4.49
Oct	3.37	2.63	3.03	4.36	3.52	7.87
Nov	1.98	1.36	2.13	2.78	2.06	1.52
Dec	1.74	1.07	1.53	2.12	1.35	1.26
Avg.	4.28	3.57	3.46	4.79	4.32	4.02

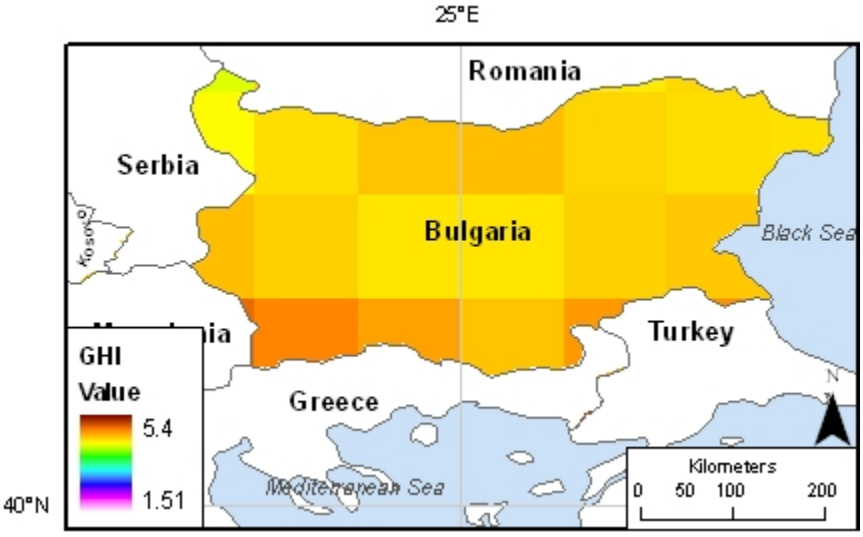
Monthly Solar Irradiation for Select Regions of Bulgaria in kWh/m^2/day (Source: UMASS at Lowell)

The following maps display the direct normal and global horizontal irradiation values for Bulgaria. As shown, Bulgaria has relatively good solar potential throughout the country. The southern border of the country has its best resource.

Direct Normal Irradiation Values



Global Horizontal Irradiation Values



(return to top)

6. Geothermal

Bulgaria has a sizable reserve of geothermal energy and is rich in low enthalpy geothermal waters. The country has been utilizing approximately 37 percent of its total potential, or about 109.6 MWt producing some 1,671.5 TJ of energy per year, for use in space heating and air conditioning, greenhouses, drinking water, and for balneology purposes (IGA, 2004). Starting in 1999 geothermal heat pumps were installed in the capital, and around 50 percent of the pumps were used for cooling. At the present there are no geothermal reserve sites that generate power (IEA, 2007). The different types of applications for geothermal waters can be seen in the figure below.

Applications of State-Owned Hydrothermal Sources (Source: Bojadgieva et al., 2005)

Geothermal development recent years has not made significant progress. The past few years, Bulgaria has been testing and completing new legislation concerning geothermal energy and thermal waters. There are still many barriers that inhibit productive growth of geothermal energy in the country.

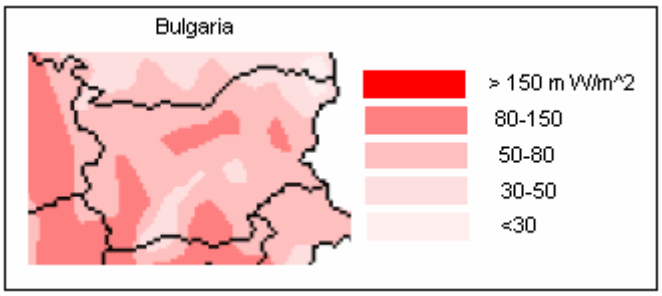
There are a number of state organizations that have performed research into the exploitation of Bulgaria's resources. All activities regarding the use of the reservoirs for energy purposes is channeled through governmental agencies such as the Ministry of Energy and Energy Resources (MEER), State Energy Regulatory Commission (SERC), State Energy Efficiency Agency (SEEA), and the Ministry of Environment and Waters.

Resource Information

There exist approximately 1,000 thermal springs and aquifers in Bulgaria, and generally those identified in the southern regions consist of relatively shallow hot springs, while the northern regions have been developed only through deep well borings. Drill depths for those discovered and evaluated resources in the southern regions range in depth from 100 – 1500 m, while the northern regions range from 100 – 5000 m in depth (Bojadgieva, et. al, 2000). The majority of these deep well borings have been implemented and financed over the years by the government.

The figure below shows the geothermal heat flow of Bulgaria. There are many areas with heat flows between 80-150 mW/m^2.

Heat Flow Contour Map of Bulgaria (m W / m^2)
Source: Energie-Atlas GmbH



Evaluations of the geological structure of Bulgaria and the groupings associated to the varying characteristics have divided the country into five separate geothermal regions: the Moesian Platform and Balkan Foreland reservoirs, the Malm-Valanginian reservoirs, the Triassic (Anisian) reservoirs, the Devonian (Givetian) reservoirs, and the Srednogorie and Rhodopian Massif reservoirs (INEEL, 2001).

In 1998, the Geological Institute of the Bulgarian Academy for Sciences completed a re-assessment of the geothermal resources from 162 known fields. That assessment found a temperature range between 20°C and 100°C, with the majority of the reservoirs in the 20°C - 30°C and 40°C - 60°C ranges.

Further studies have estimated the overall potential in unexploited, proven reserves to be approximately 440 MWt of thermal energy. Additional estimates as to the overall potential of unexploited, probable, and possible resources to be in the neighborhood of 1800 MWt (International Geothermal Association, 2002).

Although at the present Bulgaria does not generate any power from geothermal sources, it has been estimated by the Geothermal Energy Association that the country's estimated power generation potential is 200 MWe.

(return to top)

7. Hydroelectric

Bulgaria has been utilizing its hydrological resources for over two centuries. The country currently has 10,300 MW of installed capacity from large commercial hydroelectric power plants (HPP's). Bulgaria also has approximately 545 MW of installed capacity from small and micro (< 15 MW) HPP's (World Electric Power Plants Database, June 2009). Approximately, 3.6 billion kilowatt-hours were generated by hydroelectric power plants in 2007, so hydroelectric power makes up about 10 percent of the total power generated in Bulgaria (EIA, 2007).

Bulgaria has growth in their hydroelectric power sector. Currently, 105 MW of hydroelectric capacity are being constructed, and 190 MW of capacity have been planned. For the most part, Bulgaria's technical and economic potential for large hydroelectric plants is being fully exploited (Renewable Energy Fact Sheet, European Commission).

The Bulgarian government has placed great emphasis on the development of the country's hydrological sources in an effort to limit the dependence on foreign fuel imports. The 1999

Energy and Energy Efficiency Act targeted privatization of power generation, including hydroelectric. In all, approximately 63 small and micro HPP's are located on the National Energy Company's (NEK) property, all of which are of focus for privatization. According to the World Bank Privatization Database, the Pirinska Bistritsa Energy Company was privatized in 2000, and the Prouchvane i Dobiv na Feft i Gaz Energy Company was privatized in 2003. The Bulgarian government in recent years has also initiated new licensing schemes as part of the project development process.

There are a few private sector companies who are actively involved in the development of small and micro HPP's such as Energoproekt, Hydro Ltd., AMEK, and ESD of Bulgaria. While the country does not have a hydro association, there are several organizations created on a municipal level who have taken an active interest in renewable energy sources. Municipal organizations such as the Plovdiv Energy Agency, as well as the Regional Energy Center's at Lovetch , Russe, and Haskovo - just to name a few.

Resource Information

Bulgaria's geography consists of mountainous terrain combined with valleys and plains. An average altitude of 470 m above sea level and an annual precipitation of 672 mm yield over 526 rivers that are greater than 2.6 km in length. All of these rivers flow into one of three main drainage basins: the Danube Watershed, the Black Sea Basin, and the Aegean Sea Basin. The longest river in Bulgaria is the Iskar, which flows for 368 km and finally discharges into the Danube Watershed.

Total yearly fluvial runoff from the country's inland rivers during a normal year is approximately 20.2 billion m^3, and for a dry year can be as low as 9.3 billion m^3 (Center for Integrated Regional Assessment, 2000).

(return to top)

8. Relevant Links

Please see webpage for relevant links.

(return to top)

9. References

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(return to top)

10. Country Contacts

Contacts made in the preparation of this assessment are gratefully thanked for their contribution to this report. Please see the webpage for the contacts listing.

(return to top)