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 2001 was 4.5 percent, with foreign direct investment rising to $641 million. Bulgaria's electricity sector has helped to stabilize and grow the economy throughout the 1990's. Currently, there is about 12,668 MW of installed capacity including thermal, nuclear, and hydroelectric resources.

The existing generation assets have been sufficient to supply domestic demand and have created a significant export market for electricity. In 2000, Bulgaria generated 38.8 billion kWh, while exporting over 3.2 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

- Establishment of 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.

Country Summary Table (EBRD 2001, EBRD 2002, US DOE 2002).

Demographical Information			
Population, millions		8.10	
Land area, thousand Ha		11,055	
Macroeconomic Information (2001)			
GDP, billion US$		12.1	
Real GDP growth rate, percent		4.5%	
Foreign direct investment (net), million US$		641.00	
EU accession status		EU association agreement signed Mar. 1993	
Electricity sector			
EBRD electric power transition indicator		3+	
Electricity tariff, US¢/kWh (year of data)		2.8 (1999)	
Collection rate, percent (year of data)		112% (1999)	
Load utilization factor, percent (2000)			
Current Feed In / kWh		0.06Euro	
Electricity disposition, billion kWh (2000)			
Generation		38.8	
Consumption		34.4	
Exports		3.2	
Imports		1.5	
Generation capacity mix (2000)	No. of Plants	Capacity (MWe)	Percent of Total
Nuclear	N/A	3,760	31%
Thermal	N/A	6,550	54.1%
Hydro	N/A	1,800	14.9%
Other renewables	--	--	--
Total	N/A	12,110	100%

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2. Renewable Policies and Incentives

- All Renewables – "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.

- All Renewables – achieving the European Union Directive 77/2001 for the promotion of electrical energy produced from renewable sources. Bulgaria is obligated to have 11 percent of gross electricity consumption generated from renewables by 2010.

- All Renewables – Bulgarian government's desire to rely more on country's fuel resources.

- Solar, Geothermal, Hydroelectric – reduction of custom duties for imported items

- Solar, Hydroelectric – reduction in taxes

- Geothermal – free utilization of existing wells
- Geothermal – reduction in Value Added Tax by 2 percent
- Geothermal – Reduction in income tax by 3 percent
- Hydroelectric – creation of employment in areas where there are high levels of unemployment

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3. Wind

Although there are only 30 MW of wind energy power plants in Bulgaria, there country has historical experience with utilizing wind energy for water pumping applications. No current industry association or manufacturer has been identified, although the Technical University of Varna had built a 100 kW turbine in 1990.

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 seems to originate from meteorological station data (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 above mentioned study estimated the wind resource potential of Bulgaria to be 2,200 to 3,400 MW.

Bulgaria Wind Atlas

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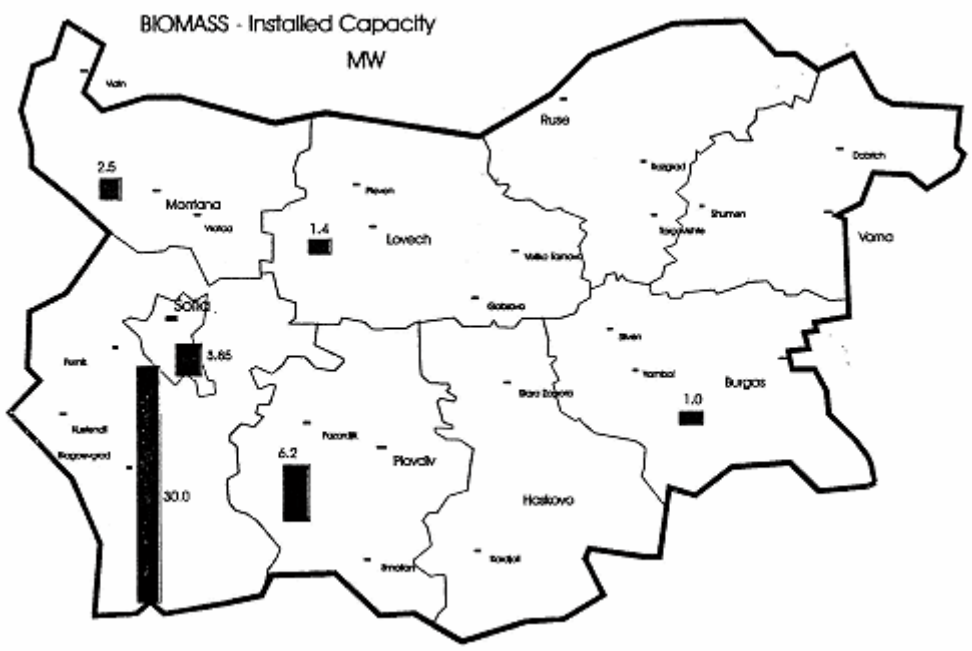
4. Biomass

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. Results have appeared promising, although a lack of project funding has hindered the forward progress of this resource.

Next to the country's hydro resources, biomass accounts for a sizable share of Bulgaria's energy consumption, approximately 3.7 percent or 409,000 toe of the 10,918,000 toe total consumption (Sofia Energy Center, 2002). 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 m3 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 (Energy and Ecology Ltd, 1998 National Energy Efficiency Program).

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 the project is feasible. As of 2003, the planning and construction of a 13 MW power plant at that facility was underway.

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. 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. While as of 2002 there has not been significant research performed on the use of landfill gas as an energy source, there has been initial research performed on 44 landfills with regard to the reduction of GHG's (US Department of Energy). Currently, the majority of agricultural waste generated is sent to local landfills.

Resource Information

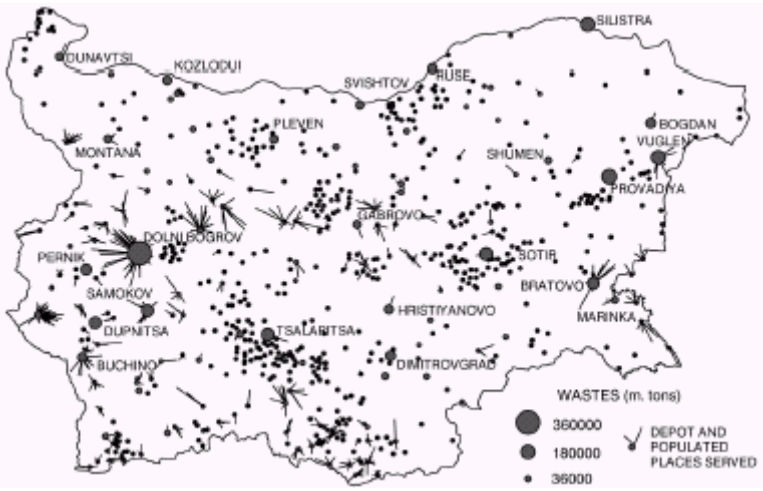
Bulgaria has a total land area of approximately 110,000 km2, of which some 6,200,000 ha, or 60 percent of the overall land area, consists of agricultural lands, and 3,903,000 ha, or 30 percent of the overall land area, is forest cover.

A 2002 study conducted under the E.U.'s PHARE program by the Sofia Energy Center estimated the total annual potential for biomass resource as follows:

- Fuelwood: 2,146,761 tons

- Wood Waste: 942,232 tons
- Agricultural Solid Waste: 4,912,000 tons
- Agricultural Liquid Waste: 494,860,000 m^3 (as biogas)
- Biofuel: 60,000 tons
- Energy Crops: 2,000,000 tons

It is estimated that there are approximately 720 landfills in the country, and an annual waste generation rate of 3 million tons. The distribution of landfills in Bulgaria is shown in the following figure:



Household Waste at Landfills Served By Organized Disposal, 1996 (US DOE, 1997).

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

Biomass Potential by Sector.

Sector	Potential	Remarks
Biomass from Clean Wood Harvesting		
Existing energy potential	~ 6,861,000 MWh/yr	Estimated on the basis of: - forested area: 3 329 000 ha - clean harvesting rate: 1% per year - efficiency of burning equipment: 75%
Biomass from Energy Crops		
Energy potential	N/A	Sufficient studies have not been completed
Biomass from Industrial Wastes		
Energy potential - wood processing industry	~ 1,100,000 MWh/yr	Estimated on the basis of: - harvested wood material - manufactured wood products - imported wood material - exported wood material
Utilized energy potential - wood processing industry	~ 960,000 MWh/yr	Estimated on the basis of the information for wood waste utilization from the larger wood processors
Existing energy potential - other industries	no information available	Sufficient studies have not been completed
Biomass from Landfill Biogas		
Existing energy potential	N/A	Sufficient studies have not been completed
Biomass from Animal Wastes		
Existing energy potential electricity heat	~ 1,587,000 MWh/yr ~ 2,268,100 MWh/yr	Estimated on the basis of: - biogas installations 3-10% solids concentration - including animals in private farms (small and large scale)
Notes: 1- Data courtesy of Thermoconsult of Sofia 2-The above calculations are estimated potentials. It is necessary to further evaluate the true potential through more detailed studies.		

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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. The table below displays the solar thermal installations by region.

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

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 %

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.

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

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

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6. Geothermal

Bulgaria has a sizable reserve of geothermal energy and is rich in low enthalpy geothermal waters. The country has been utilizing approximately 30 percent of its total potential, or about 107.2 MWt producing some 1.637 TJ of energy per year, for use in space heating,

greenhouses, drinking water, and for balneology purposes (Geothrmie, 2000). At the present there are no geothermal reserve sites that generate power.

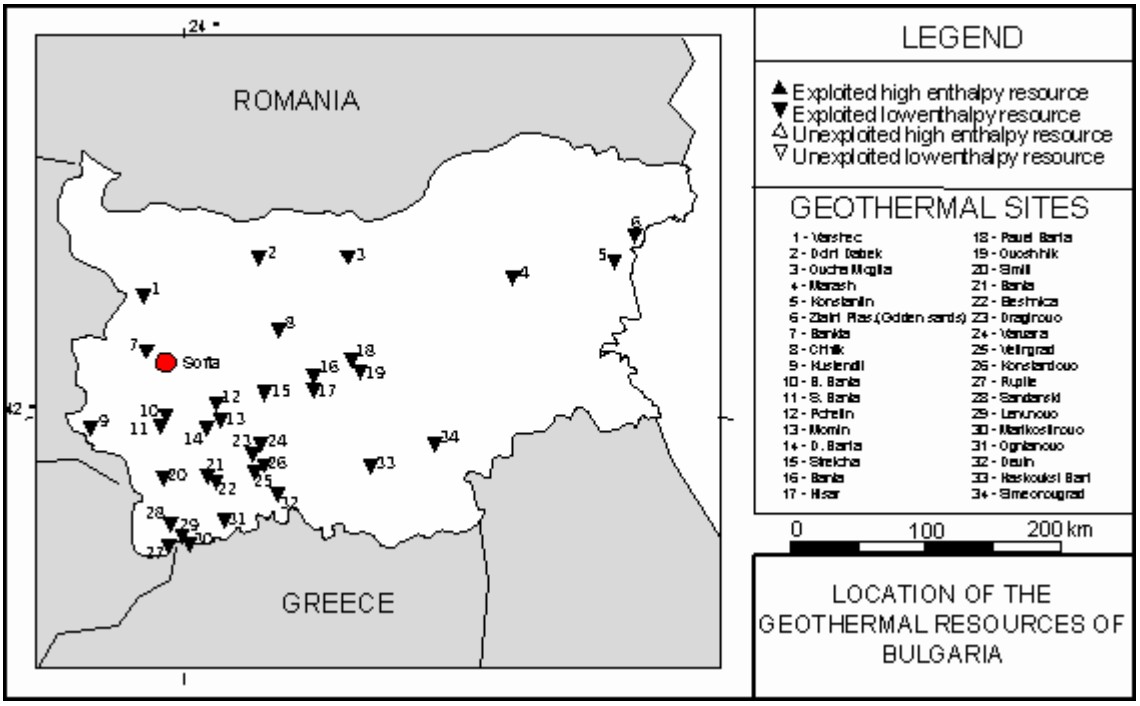
There are a number of state organizations that have performed research into the exploitation of Bulgaria's resources. All activities regarding the use of the reservoirs for energy purposes is channeled through governmental agencies such as the Ministry of Energy and Energy Resources (MEER), State Energy Regulatory Commission (SERC), State Energy Efficiency Agency (SEEA), and the Ministry of Environment and Waters. Recent legislative reorganizations have led to the possibility of foreign investment to develop geothermal sites. While there is not specific legislation regarding the exploitation of geothermal reservoirs there are a series of regulations which dictate the relevant permits and licenses as well as the requirements for developing geothermal reservoirs for energy purposes (INEEL, 2001).

Resource Information

There exist approximately 1000 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.

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).

The figure below shows the areas of geothermal site development:



Bulgarian Geothermal Resources (EC, 1999).

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 200MWe.

Investigations by the Sofia Energy Center under the FEMOPET program have led to estimates that the theoretical potential of geothermal sources in Bulgaria to be 482,000 toe per annum, with the technical potential being 95,000 toe per annum.

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7. Hydroelectric

Bulgaria has been utilizing its hydrological resources for over two centuries. The country currently has a total of 1,937 MWe of installed capacity which is mainly generated by the larger commercial hydroelectric power plants (HPP's), while a total of 63 MWe is generated from small and micro HPP's (Sofia Energy Center, 2002). This installed hydroelectric capacity equates to approximately 15 percent of the total installed commercial capacity for the country (US DOE 2002c). However, many of the existing HPP's are over 30 years of age and are in need of some sort of rehabilitation to be restored to their true peak capacities.

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. 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 are 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 m3, and for a dry year can be as low as 9.3 billion m3 (Center for Integrated Regional Assessment, 2000).

Recent studies have indicated that approximately 35 percent of the hydroelectric capabilities of the country have already been developed. Further estimations have put the new opportunities for HPP construction to an annual output 10,000 GWh, much of which may be in the form of small HPP's (D. Tafrov, 2001).

The Sofia Energy Center places the total theoretical potential of HPP's with less than 2 MWe of installed capacity at 133,000 toe per annum. Additional estimates put forth in the 2nd Edition of the UNFCCC Climate Change Report for Bulgaria have stated that micro HPP's can reach a total installed capacity of 212 MWe by the year 2020.

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8. Relevant Links

Bulgarian Energy Efficiency and Renewable Energy Credit Line

Sofia Energy Center

Bulgarian Academy of Sciences

Energy Efficiency Agency

Thermoconsult

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10. Country Contacts

Contacts made in the preparation of this assessment are gratefully thanked for their contribution to this report. Contacts include: