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Emilia Mihaylova

*Technological University Dublin, emilia.mihaylova@tudublin.ie*

Anna Garo Aladjajian

*Agricultural University of Plovdiv, anna.garo@gmail.com*

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*Dublin Institute of Technology*, emilia.mihaylova@dit.ie

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*Agricultural University of Plovdiv*, anna.garo@gmail.com

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# Research in Bioenergy and Other Renewable Energy Sources in Bulgaria

Emilia Mihaylova and Anna Aladjadjian

*Agricultural University – Plovdiv*

## *Abstract*

*The interest in Renewable Energy Sources (RES) in Bulgaria reflects the changes in the field of energy policy worldwide and in Europe. The key to successful development of renewable energies in Bulgaria requires a combination of political commitment and decision making as well as support mechanisms including well-defined government targets, technological advances and public acceptance. The renewable energy sources (RES) theoretical potential in Bulgaria is considerable. It is evaluated to 14387 J/year for geothermal energy; 77156,7 J/year for solid agricultural waste; 478,4 J/year – biomass from paper waste; 9605,2 J/year –biomass from wood for heating; 79,8 J/year –biomass from natural fibers; 11381,83 J/year –liquid agricultural waste; 25766 GWh/year – big and small HPS; 1450-1500 kWh/m year – solar radiation. The geothermal and wind energy sector's potential is considered the highest, while larger-scale utilisation of solar and biomass energy may also be attractive. The research in bioenergy and other RES in Bulgaria is carried out mainly in the following organisations in Bulgaria: National Centre of Agricultural Science (NCAS), University of Forestry Sofia, Agricultural University Plovdiv, University of Rousse, Trakia University – Stara Zagora, Technical University Sofia, Technical University Varna.*

## **1. Introduction**

Bulgaria's economy is currently in transition moving from central planning to a market driven economy. Since 1988, the Bulgarian energy profile has changed considerably. Between 1988 and 2000, the total primary energy supply decreased by more than 40 per cent. The consumption of oil products fell by 61 per cent and electricity consumption fell by 32.4 per cent. In 2002, the most important energy sources were coal (40 per cent) and crude oil (37 per cent), followed by natural gas (12 per cent) and nuclear energy (9 per cent). Biomass, hydropower and other renewable energy sources accounted for less than 2 per cent. In 2002, two of the six units of the only nuclear power plant in Bulgaria (Kozloduy 1 and 2) were shut down, resulting in a substantial decrease in the share of nuclear energy in the total primary energy supply (22 per cent in 1999, 9 per cent in 2002). During the last several years, the country has had surplus power capacity and has been a net exporter of electricity.

The interest in Renewable Energy Sources (RES) in Bulgaria reflects the changes in the field of energy policy worldwide and in Europe. The key to successful development of renewable energies in Bulgaria requires a combination of political commitment and decision making as well as support mechanisms including well-defined government targets, technological advances and public acceptance.

The renewable energy sources (RES) theoretical potential in Bulgaria is considerable. According to the PHARE Project Report "Technical and Economic Assessment of the Renewable Energy Resources in Bulgaria", the RES theoretical potential in Bulgaria is considerable. It is evaluated to 14387 J/year for geothermal energy; 77156,7 J/year for solid agricultural waste; 478,4 J/year – biomass from paper waste; 9605,2 J/year –biomass from wood for heating; 79,8 J/year –biomass from natural fibers; 11381,83 J/year –liquid agricultural waste; 25766 GWh/year – big and small HPS; 1450-1500 kWh/m year – solar radiation. The geothermal and wind energy sector's potential is considered the highest, while larger-scale utilisation of solar and biomass energy may also be attractive. There are no wind farms in Bulgaria, although recent wind analysis shows that wind speeds at certain locations along the Black Sea would justify the use of wind turbines.

In the current phase of Bulgaria's economic development, renewable energy cannot replace conventional energy resources. It can only play a supplemental role as an additional energy resource in rural areas.

## 2. Legislative Background

### *Ministry of Economy and Energy*

The Ministry of Economy and Energy is working on the development of the economic and energy policy of the Bulgarian state. The common trends in this policy are increasing the competitiveness of the national economy and the various institutions, encouraging investments, innovations, entrepreneurship, exports, modernization of the industrial base, stimulating measures on energy efficiency in the industry and the use of renewable energy resources. It also takes part in the implementation of the integration policy and effecting foreign economic cooperation.

The Ministry of Economy develops the objectives and priorities of the state strategy and implements the state policy in the field of industry, trade, tourism, privatization and state interest management in these fields. It participates in the implementation of the integration policy and the foreign economic cooperation.

### *Energy Efficiency Agency*

The establishment of an Energy Efficiency Agency (EEA) of the Ministry of Economy and Energy is an important element of the national policy in support to development of RES and energy efficiency in Bulgaria. The EEA drafted the first National Program on Renewable Energy and real action plan at the same time since it comprises of concrete investment projects and project proposals for the large-scale application of the renewable energy sources (RES).

The Energy Efficiency Agency (EEA) was established in 1992 to implement projects of the EU's Phare programme. It has the status of an executive agency. According to the enforced in November 2001 Energy and Energy Efficiency Law (EEEL) EEA has important responsibilities on training and information for separate experts and target groups, as well as for the large public on different energy effective and renewable technologies and RES international programmes and projects.

### *Energy Strategy (2002)*

A new national energy strategy was adopted by the Parliament in July 2002. This lays down the basis for introducing market mechanisms and transforming the sector, including improving Bulgaria's energy efficiency. The revised Energy Strategy also plans to strengthen the autonomy of the State Commission for Energy Regulation.

The Energy Strategy 2002 states as overall principles of the energy policy:

The main objectives of the energy policy are

- liberalization of the energy market
- establishment of a privatization program
- reduction of costs
- promotion of renewable and alternative energy sources
- energy efficiency
- nuclear safety
- positioning of Bulgaria as a reliable country for the provision of future transit of oil, natural gas and electric power and as a dispatching and market center in the region.

### *Energy Act (2006)*

The Energy Act contains provisions for:

- Energy policy
- Regulation of energy sector activities
- Licenses
- Public obligations
- Electricity industry
- Heat supply
- The promotion of production of renewable electricity from renewable energy sources and from cogeneration

Some of the principle purposes of the Energy Act are listed below:

- High-quality and secure supply of electricity and heat energy and natural gas to the general public;
- Energy development and the energy security of the country through efficient utilization of energy and energy resources;
- The generation, import, export, transmission, distribution and trade in electricity, heat, natural gas, crude oil and petroleum products shall be carried out while guaranteeing the protection of the life and health of citizens, property, the environment, the interests of consumers, and national interests;
- Creation and development of a competitive and financially stable energy market;
- Supply of energy at minimal costs;
- Sustainable development in the utilization of renewable energy sources, including generation of electricity from renewable energy sources in the interests of environmental protection;
- Promotion of the cogeneration of electricity and heat energy;
- Development of infrastructures for the transmission of electricity, natural gas, crude oil or petroleum products within and through the national territory.

#### *Energy Efficiency Act 2007*

The energy efficiency policy shall be implemented by the Ministry of Economy and Energy. The Energy Efficiency Act provides for:

- national long- and short-term programs for energy efficiency
- the preparation of measures for the harmonization of the Bulgarian legislation with EU legislation in the area of energy efficiency
- the international collaboration of the Republic of Bulgaria in issues of energy efficiency and renewable energy sources, etc.

The Act further lays down the provisions for Energy Efficiency Programs, Energy Efficiency Measures, and the establishment of an Energy Efficiency Fund.

#### *Renewable and Alternative Energy Sources and Biofuels Act (2007)*

This new act on RES was adopted in June 2007 for diversifying energy supply, environmental protection, to set the terms for sustainable local and regional development, and to increase the capacity of SMEs and RES producers etc. Suppliers are required to purchase all renewable electricity that has a certificate of origin. The public utility company and the end suppliers, respectively, shall purchase the entire quantity of energy generated from renewable and alternative energy sources, except for the power generated by hydroelectric power plants with installed capacity of over 10 MW, at preferential prices.

The Renewable and Alternative Energy Sources and Biofuels Act provides for:

- State policies towards encouragement of use of renewable and alternative energy sources, biofuels and other renewable fuels
- Production of energy from renewable and alternative energy sources
- Encouraging production of electricity generated from renewable energy sources
- Encouraging the use of biofuels and other renewable fuels in the transport sector;
- Prices of electricity generated from renewable energy sources; etc.

The basic objectives are:

- to promote development and implementation of technologies for production and use of energy generated by renewable and alternative energy sources;
- to promote the use and development of technologies for production and consumption of biofuels and other renewable fuels in the transport sector;
- to diversify energy supplies;

- to increase the output of small and medium-size enterprises generating energy from renewable and alternative energy sources, and producers of biofuels and other renewable fuels;
- environment protection;
- to set the grounds for sustainable local and regional development.

### 3. Renewable and alternative energy sources

RES targets according to the European Commission “Energy and Climate change” Package:

- 11 % share of the RES electricity in the gross final energy consumption for 2010.
- 5,75 % share of the biofuels in the fuel consumption in transport sector for 2010.
- 16 % share of the RES energy in the gross final energy consumption for 2020;
- 10 % share of the biofuels in the fuel consumption in transport sector for 2020.

#### 3.1. Energy from biomass

At present, biomass accounts for 80 percent of Bulgaria’s renewable energy production, which is 4 % of the total energy production. The majority of biomass energy consumption exists in rural areas, where fuel wood, followed by wood briquettes produced from forest wastes and sawmill byproducts are used for heating.

There is a large potential to utilise biomass as an energy source: 60% of the overall land area consists of agricultural lands, and approximately 30% is forest cover (fig. 1).

The amount of agricultural waste in Bulgaria is estimated to 7.4 million tons per year of which 3.6 million tons of wheat waste, 0.8 million tons of barley waste, 2.4 million tons of corn waste, 0.6 million tons of sunflower stems. Wood waste amounts to 1.1 million tons per year.

The country has the possibility to capitalize on the generation of landfill biogas (over 3 Mt of municipal solid waste per year) and other biogas sources.

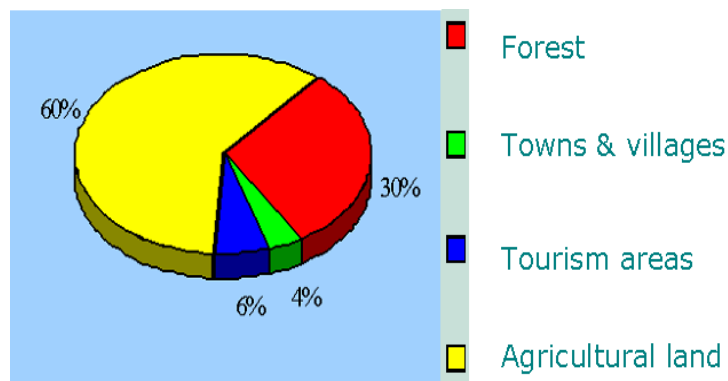


Fig. 1. Biomass production resources in Bulgaria

#### Biomass Research in Bulgaria

The research in biomass production is carried out mainly in the following organisations in Bulgaria:

- National Centre of Agricultural Science (NCAS)
- University of Forestry Sofia
- Agricultural University Plovdiv
- University of Rousse
- Trakia University – Stara Zagora
- Technical University Sofia

The main area of research in the technical universities is the development of technologies for biomass processing and construction of appropriate apparatuses.

*Research projects in the National Centre of Agricultural Science:*

- Development of alternative energy sources in the agriculture: new technologies for utilising of horticulture biomass and animal manure
- Technologies for biomass production
- Biological biomass production

*Research projects in the Rousse Technical University:*

- Plant Agricultural Waste Potential for Energy purposes
- Prospects Of Wooden Biomass Production In Southeastern European Agricultural Areas
- Bioenergetical Resource Analysis in the Agricultural Sector

*Research projects at the Trakia University – Stara Zagora:*

The Agricultural Faculty in the Trakia University is a partner in the Leonardo da Vinci project: “*Pro Aere*”. As a result a textbook “Renewable Energy Sources in the Agriculture” was published in 2006.

*Research projects at the Agricultural University Plovdiv:*

- Let’s give the floor to farmers”, Contract Altener No.XVII/4.1030/Z/99-092
- BIGPOWER -“Improvement of the S&T research capacity of TUBITAK-MRC IE in the fields of Integrated Biomass Gasification with Power Technologies” - FP6 SSA project – 2006
- INTERREG IIIA 2006, Action 3.4 “Cooperation among Educational & Research Institutions” - Project: "Development of a common Postgraduate Curriculum for Graduates from Geotechnical and Polytechnic Faculties in the field of RES”
- FP7-KBBE-2007-1- Integrated European Network for biomass and waste reutilisation for Bio-products – AquaTerre
- RADAR – Raising Awareness on renewable energy Developing Agro-energetic chain models –INTELLIGENT ENERGY EUROPE 2006
- CEUBIOM - Classification of European Biomass Potential for Bioenergy Using Terrestrial and Earth Observations. IEE 2007 SAVE – ALTENER – STEER – INTEGRATED INITIATIVES. Project 213634

*Research projects at the Technical University of Sofia:*

- Studies on waste management, improvement of the state of the landfills and on the possible energy usage in the municipalities of Sofia, Bourgas, Devin, Panagourishte, etc.
- Participation in the design of an industrial installation 430 kWfor briquettingof wood waste with capacity 6000 t/y. The applied technology by theshowed schema is wood waste treatment to sawdust and pressing in briquettes (Q=5860 KJ/kg) without combine substances.
- Investigations and applications for briquettingand pelletisationof waste lignocelluloses biomass (lop-pings, bark, saw-dust, sanding dust, etc.)
- Methane emission reduction of landfills by extracting, flaring and utilisationof the gas with production of electricity
- Anaerobic digestion of organic waste as attractive biological treatment under conditions with deficient oxygen
- Upflowanaerobic sludge blanket treatment of the waste water from food, agro, paper and other industries, etc.

Table 1. Contact details of the biomass research institutions in Bulgaria:

Institution	Contact
National Centre of Agricultural Science	<a href="http://www.ncan.info">www.ncan.info</a>
Agricultural University	<a href="http://www.au-plovdiv.bg">www.au-plovdiv.bg</a>
Trakia University	<a href="http://www.uni-sz.bg">www.uni-sz.bg</a>
University of Rousse	<a href="http://www.ru.acad.bg">www.ru.acad.bg</a>
University of Forestry Sofia	<a href="http://www.ltu.bg">www.ltu.bg</a>
Technical University Sofia	<a href="http://www.tu-sofia.bg">www.tu-sofia.bg</a>
Technical University Varna	<a href="http://www.tu-varna.acad.bg">www.tu-varna.acad.bg</a>

### 3.2. Solar energy

The geographical layout of Bulgaria makes the country suitable for solar energy utilization: around 80% of the territory of Bulgaria is suitable for utilization of solar energy. The annual mean radiation for Bulgaria is 4.2 kWh/m<sup>2</sup>/day. According to data by the Ministry of Economy and Energy the maximum possible hours of sunlight per year amount to approximately 4,448 (resulting in 2150 h average annual sunshine duration). Currently Bulgaria utilizes a symbolic percentage of the total potential. The main obstacle is the relatively high initial investment in solar energy utilization equipment.

### 3.3. Wind energy

The wind energy potential of Bulgaria is significant. This statement is supported by the preliminary results of wind speeds. There are 119 weather stations in Bulgaria that register wind velocity and direction. Data going back to more than 30 years is available and the country has historical experience with utilizing wind energy for water pumping applications. The most economically feasible option would be to construct wind farms in the plane parts of the country where the average wind velocity is more than 6 meter/second. In 2007 the generation of energy from wind power plants is negligible.

### 3.4. Energy from geothermal sources

Bulgaria has a sizable reserve of geothermal energy of more than 840 geothermal sources with temperature up to 103 °C in about 140 sites. The average capacity in the country per source is about 28 l/sec. The total thermal capacity freely flowing geo-thermal waters is estimated to about 488 MW. At present in Bulgaria the installed capacity of geothermal direct-use systems is about 94.5 MW. Currently a large amount of geothermal energy is used for balneology and swimming pools. There are a significant number of companies and institutions working on the geothermal energy field, which are delivering investigations, design, installations, operation and service of geothermal equipment and installations. Bulgarian technologies for geothermal installations include heat exchangers, thermal pumps and pipelines. Estimated theoretical potential for direct-use geothermal systems (for already known sources) is about 4000 GWh/year.



## 5. Conclusions

The renewable energy sources theoretical potential in Bulgaria is considerable. It is evaluated to 14387 TJ/year for geothermal energy; 77156,7 TJ/year for solid agricultural waste; 478,4 TJ/year – biomass from paper waste; 9605,2 TJ/year – biomass from wood for heating; 79,8 TJ/year – biomass from natural fibers; 11381,83 TJ/year – liquid agricultural waste; 25766 GWh/year – big and small HPS; 1450-1500 kWh/m year – solar radiation. The geothermal and wind energy sector's potential is considered the highest, while larger-scale utilisation of solar and biomass energy is also attractive.

Bulgaria has the resources, the researchers, the engineers and the technical experts to achieve the RES targets listed below:

- 11 % share of the RES electricity in the gross final energy consumption for 2010.
- 5,75 % share of the biofuels in the fuel consumption in transport sector for 2010.
- 16 % share of the RES energy in the gross final energy consumption for 2020;
- 10 % share of the biofuels in the fuel consumption in transport sector for 2020.

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