1. STUDY AND ANALYSIS OF THE CURRENT SITUATION REGARDING THE IMPLEMENTATION OF "GREEN ECONOMY" POLICIES AT THE CROSS-BORDER REGION RUSE – GIURGIU

I. STUDY

I.1. Wind power

Previous studies of the potential of wind energy indicate that there are objective conditions for development of wind energy both in Bulgaria and Romania. According to the data and rate of the average wind speed, measured for a few years, the territory of Bulgaria and Romania at a height of 10 meters above the earth's surface can be divided into several regions (Fig. 1 and Fig. 2).

The main advantages of wind energy are the following:

- It does not pollute the environment;
- It can be used on a decentralized basis;
- It does not require the construction of a large infrastructure, such as that for supply of oil or natural gas.
- It is the fastest renewable energy source worldwide.

***Figure 1**. Wind energy density in Bulgaria at a height of 10 meters above the earth's surface*

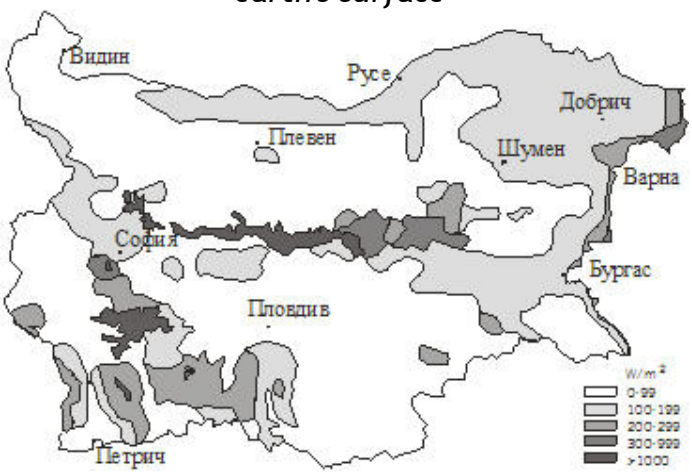


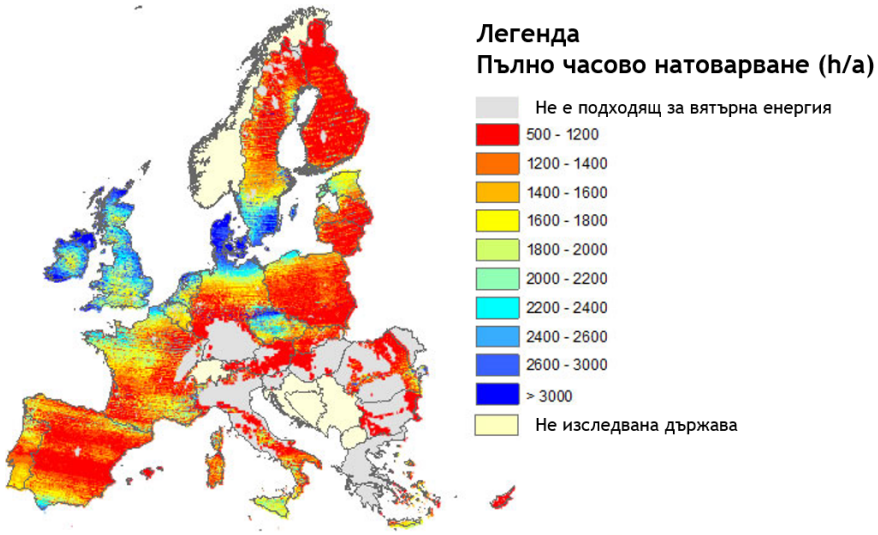
***Figure 2**. Energy potential of wind energy in Europe*[1]

Key:
Full time working

not suitable for wind power

There were no studies in the particular country

[1] Held, 2011, Assessment of the potential of wind coastal energy



I.2. Hydropower

Hydropower - or water energy - is produced by water flow when a wheel or similar device is turned. It is a renewable natural resource due to the periodicity of the water cycle. We can use hydropower because of the fact that there are built dams and respectively the use of potential energy of water. When the water stored in the dam is released under high pressure, its kinetic energy is redirected to the turbine blades and so it is used to generate electricity. Running water creates energy that can be trapped and converted into electricity. That is called hydropower. The most common hydropower station uses a dam that is built on a river, so to be able to store water in a reservoir. The water released from the reservoir flows through a turbine which rotates, and thus activates the generator that produces electricity. However, hydropower does not always need a large dam. Some hydropower plants use just a small canal to drain water from rivers through turbines.

Hydropower plants convert the kinetic energy contained in the flowing water into electricity through the use of hydraulic turbines and generators. The energy potential of the stream is a function of the amount of water and the height of the drop.

When water drops from one level to another it performs mechanical work. This is a kind of energy from renewable sources. Exactly, this is hydroelectricity produced by the movement of water from the differences in the two water levels. The "power" of water is actually a combination of pressure and flow. Energy production depends on both of them. The pressure created by the vertical distance between where the water enters the turbine and the surface of the water is measured in mH_2O or P_a or N/m^2.

The flow rate is the amount of water that passes through the pipeline over a period of time and it is measured in m^3/s. The water is collected in a micro-basin and then drained through a pipeline directly to the turbine. The height of the water column creates the necessary pressure at the lower end of the pipeline to drive the turbine. The higher the water column, the higher the pressure at the entrance of the turbine and so more power is received. The values of these two parameters are very important for the right determining of the energy capability of the site for the installation of the hydro turbine and the implementation of the hydraulic system.

It was made an assessment of the capability of small Hydropower plants which could generate energy from the systems of water-supply, irrigation, discharge connections of dam and river valleys at table 1.

***Table 1**. Theoretical capability of small Hydropower plants at cross-border region Ruse - Giurgiu*

Region	Theoretical capability, GWh/r	Theoretical capability, ktoe	Technical capability, GWh/r	Technical capability, MW
Ruse district	274	21,92	158,3	50
Giurgiu county	25	2	12,6	4
Total:	**299**	**23,92**	**170,9**	**54**

I.3. Geothermal power

Geothermal energy is a result of the extraction of heat contained in the molten earth core, with the radioactive processes arising therein, and also with the potential and kinetic energy of the tectonic processes. The extraction of heat to the surface of the earth can also occur through thermal waters, volcanoes, or by forcibly introducing and heating water or other energy carriers into heated rock masses or into the earth.

The practical importance of geothermal energy depends on the location of the source, its flow rate, temperature, proximity to consumers, climatic conditions and the infrastructure of the particular place.

The main parameters, such as temperature and chemical composition of the geothermal sources determine their usefulness.

Geothermal gradient - expresses the temperature rise in depth towards the earth's core.

Chemical composition - the content of chemical elements in geothermal sources is important in the use of liquid energy carriers (warm mineral water, groundwater, etc.). It directly affects the resource usage patterns.

Geothermal sources in both Bulgaria and Romania, according to their temperature potential, are divided into three main groups:

- Low-temperature – with temperature of water up to 25°C;
- Medium-temperature – with temperature of water up to 60°C;
- High-temperature – with temperature of water up to 80°C.

Their application in heating can be divided as follows according to the above mentioned classification:

- Low-temperature geothermal sources are used for heating systems which include heat pump units;
- Medium-temperature geothermal sources are used for the so called direct heating systems (which are without heat exchangers)
- High-temperature geothermal sources are used for the so called indirect heat systems (which include heat exchangers).

The above-mentioned heat systems can be used for heating (in residential buildings, industrial buildings, and greenhouses), drying installations, water heating (for domestic use, swimming pools, etc.).

A major disadvantage of this environmentally friendly technology is the frequent deposition of salts in pipes and heat exchangers, due to the higher concentrations of minerals and chemicals in geothermal water.

Sometimes, there can be hydrogen sulfide (H_2S) in geothermal reservoirs, which at very high concentrations could be toxic. If it is detected, it is removed

from the water in the geothermal reservoirs using appropriate equipment.

Geothermal tanks also contain a small amount of carbon dioxide (CO_2), which is released when hot water is converted to steam.

In this regard, the use of geothermal energy finds application in two main areas - electricity production and non-electrical purposes. The main source in both spheres is hydro geothermal energy extracted from the earth's core. The geothermal energy can reach the earth's surface through natural discharge and through drilling. The available potential allows the use of these two resources mainly for non-electrical purposes - thermal energy production. Currently both in Bulgaria and Romania geothermal energy derived from water resources is mainly used in the system of specialized healthcare institutions for rehabilitation, prevention and recreation - the physics and chemical properties of water, for the needs of domestic hot water supply in hospitals, hotels and sanatoriums as well as for the needs of the heating systems, both of the above consumers and of schools, municipal and state-owned buildings. The use of this resource in agriculture is not widespread, but it has a significant energy saving effect.

Generation of electricity through a conventional steam turbine requires the presence of a source with a temperature of at least 150°C, with appropriate pressure and flow. Using steam turbines is the simplest and cheapest way to generate energy. The way of work is the following: steam, or dry saturated steam, directly from the field or after separation, in wet steam fields, is fed to the energy-generating turbine.

Generation of electricity from low and medium temperature geothermal sources or from the heat generated by the separation processes can be achieved by using binary / two-component / technology or Freon turbines. These systems use a secondary fluid, most often an organic fluid, which has a low boiling point and high pressure evaporation at low temperature. The secondary fluid operates at the temperature and pressure levels of the Rankine cycle. By selecting the appropriate secondary fluid, it is possible to use geothermal water with a temperature range of 85-170°C.

Geothermal energy is other renewable energy source despite the Sun which can be used without construction of large infrastructure. It literally springs from the earth's womb.

The use of technologies for utilization of geothermal energy has the following advantages:

- It is a permanent source of energy;
- It is undependable from climate conditions;
- It is a silent technology;
- It can be directly used;
- The exploration and capital costs are low;
- It can be applied at urban environment.

I.4. Solar power

The most commonly used solar energy conversion systems are the following:

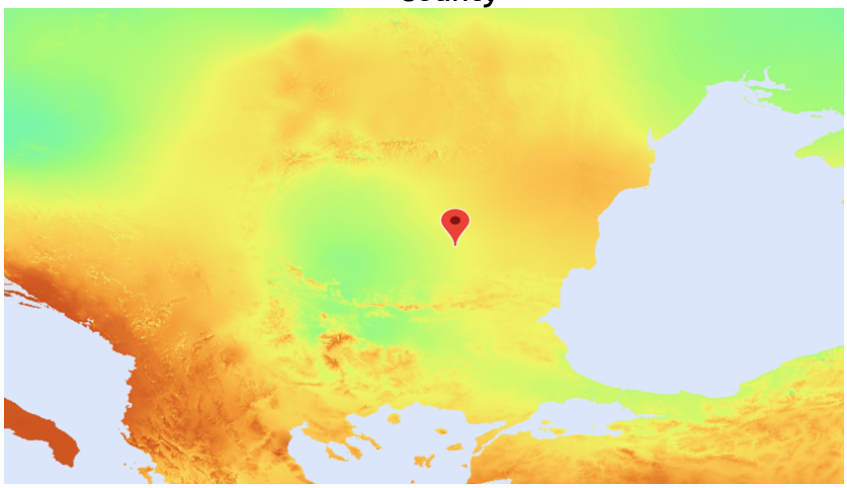
• Solar electricity - the conversion of solar radiation into electricity by means of the photoelectric effect, the so-called photovoltaic.

• Solar thermal energy - solar water heating systems.

Depending on the location of the photovoltaic panels, they can be:

- Ground based;
- Roof-top based.

***Figure 3**. Theoretical capability of solar radiation at Ruse district and Giurgiu County*



Ruse district – there is data that there are 46 energy constructions and 5,28 MW installed power.

Giurgiu county – there is data that there are 33 energy constructions and 195,98 MW installed power.

I.5. Biomass power

I.5.1. The use of biomass from forestry and related industries

The increasing energy use of wood both in Bulgaria and Romania is mainly due to its low cost and insignificant investment in the primitive facilities which are now being used for its transformation into heat. The pricing policy pursued so far, as well as the influence of international energy markets, has led to a continuous rise in retail prices of liquid fuels and natural gas, as well as electricity and heat power, and thus the consumer was put under strong pressure which is in favor of his reorientation towards the use of wood. Expert estimates suggest that the use of wood and its derivatives (under certain conditions) will continue to be economically viable. The difference in the prices of wood and other fuels will remain, or even increase, due to the fact that biomass is a local and renewable resource.

Branches and brushwood are waste from logging. Currently, only a small proportion of them are used because small-scale wood harvesting is considered to be economically inefficient. Small-scale wood extraction technology involves shredding branches and brushwood to refuse wood, at the closest possible point to a clearing (felling area) that can be reached through a forest path.

A more efficient way of utilizing branches and brushwood is to process them into pellets or briquettes. Every type of agricultural and forestry waste can be used, but the moisture content (water content) of the material should be less than 12% and the size of the granules should be less than 5.5 mm. Some of the raw materials that can be used are as follows: peanut shells, shells and stems, wood chip, sunflower stems, wheat straw, forest waste such as bushes, twigs, bark and much more agricultural waste. The transformation of raw materials into briquettes, which is the end product, is made in four steps:

- Fragmentation – this step is necessary because the raw material should be transformed into sawdust;
- Drying – this is step is necessary when the raw materials has moisture content (water content) higher that 13%;
- Briquetting Machine – here the product has a particular type and it is ready

for the next step;

- Carbonization – after that final step we receive the necessary product.

Fragmentation machine, dryer, briquetting machine and a part of the carbonated furnace are the main systems of the installation.

***Figure 4**. Types of utilized wood material*



Wood chips briquettes Sawdust pellets Sunflower husk pellets

***Table 2**. Energy value of briquettes, kcal/kg*

Types of briquettes	Energy value
Briquettes from straw	4 186
Briquettes from wooden peels	4 582
Sunflower husk pellets	4 840

The potential of wood waste is the following:

- **Ruse district:** Q = VxRxq = 120 000 x 0.55 x 2.5 = 165 000 MW/annually.
- **Giurgiu county:** Q = VxRxq = 165 000 MW/annually.

where:

- Q – average calorific capability от = 2.5 MW/t.
- R – average density = 0.55 t/m^3.

I.5.2. The use of biomass from agriculture by sectors - agriculture and animal husbandry

I.5.2.1. Agricultural waste

The types of biomass can be classified into the following 3 groups, basing on the energy utilization methods:

- Vine-stock and branches of fruit tree;
- Straw;
- Corn, sunflower and tobacco stems.

There is a well-known direct combustion technology for the utilization of vine-stocks and branches of fruit trees. The reason for not so widely using these products is the lack of suitable pre-treatment facilities (for example, shredding). Baled straw is a product that is more difficult to use as a fuel.

One of the possibilities for utilization of straw, corn and sunflower stems is to construct briquetting plant for the joint use of raw materials from agriculture and forestry.

***Table 3**. Energy value of different agricultural waste*

Fuel types	Qm0	Qm12	Fuel type	Qm0	Qm12
White pine tree	20,8	19,4	Straw – wheat	15,9	15,2
Spruce	20,2	18,9	Straw – rye	15,4	14,2
Beech	19,7	18,4	Wood chips	16,8	15,6

Oak	19,8	18,5	Hemp	18,3	18,2
Poplar	17,7	16,5	Wood briquettes	19,5	18,0
Willow	16,7	15,3	Liquid fuel	42,7	-
Bark – Coniferous trees	17,2	16	pit coal	29,7	-
Energy chops	17.3	16,8	Brown pit coal	20,6	-
Coniferous tree at Qm50	19,8	17			

***Table 4**. Calculation of the energy capability of biomass in Ruse district*

Agriculture	Sown areas (hectare)	Average output of biomass (tones/hectare)	Production Biomass (tones)	Average calorific capability (kWh)	Energy capability of biomass (sectors) (MWh)
Cereal and industrial crops	92 000	4	184 000	2 000	736 000
Perennials	6 426	250	1 606	2 800	4 500
Pasture ground	20 096	1	2 100	1 900	4 000
Seed-beds	777	250	195	2 800	544
Total:					**750 000**

The energy capability of biomass of agricultural activities is 750 000 MWh.

***Table 5**. Calculation of the energy capability of biomass of Giurgiu County*

Agriculture	Sown areas (hectare)	Average output of biomass (tones/hectare)	Production Biomass (tones)	Average calorific capability (kWh)	Energy capability of biomass (sectors) (MWh)
Cereal and industrial crops	100 000	4	400 000	2 000	800 000
Perennials	6 426	250	1 606	2 800	4 500
Total:					**804 500**

The energy capability of biomass of agricultural activities is 804 500 MWh.

I.5.2.2. Waste from animal husbandry

One of the possible ways of utilizing waste from animal husbandry is based on anaerobic digestion. The products obtained in this process are:

- Biogas - a mixture of methane (40-60%) and carbon dioxide, also containing small amounts of hydrogen and carbon sulphide;
- Acidic decomposition residue - an organic substance containing lignin, chitin

and a number of mineral components. It can be used as compost or as an ingredient for building materials, such as fiberboards

- Lye (Lixivium) - rich in nutrients, in some cases can be used for fertilization.

According to the energy potential biogas is the most important of the above mentioned 3 products.

It can be used as a fuel for boilers or for reciprocating engines for combined generation of heat and power. The amount of biogas generated depends on a number of factors. If the installation is properly operated, it is possible to produce biogas with an energy equivalent of 2150 kcal/kg dry mass of fertilizer. This corresponds to the production of 1 tone of dry mass of fertilizer per 500 m^3 of biogas with 50% methane content (the lower methane combustion heat is 35 818 MJ/m^3).

There is a large concentration of livestock farms such as pig breeding farms at Slivo pole municipality, which makes it possible to utilize the waste from animal husbandry.

Table 6. Calculation of the energy capability of waste from animal husbandry at Ruse district

Animals	Calculation	Energy capability
Cattles – total	20 000 бр. x 3 t/	60 000 t
Pigs – total	120 000 бр. x 1 t/г	120 000 t
Sheep – total	35 000 бр. x 0.3 т/г	10 500 t
Goats- total	8 000 бр. x 0.27 т./г	2 160 t
Poultry – total	420 000 бр. x 0.04 т/г	16 800 t
Total		**210 000 t**

210 000 tones x 2.2 MW = 462 000 MW territorial capability.

There are many livestock farms and due to this fact there is a capability for utilization of waste from animal husbandry.

Table 7. Calculation of the energy capability of waste from animal husbandry at Giurgiu county

Animals	Calculations	Energy capability
Cattles – total	21 600 бр. x 3 т/г	64 800 t
Pigs – total	32 800 бр. x 1 т/г	32 800 t
Sheep – total	70 000 бр. x 0.3 т/г	21 000 t
Goats- total	44 000 бр. x 0.27 т/г	11 880 t
Poultry – total	506 000 бр. x 0.04 т/г	20 240 t
Total		**139 000 t**

139 000 tones x 2.2 MW = 305 800 MW territorial capability.

I.5.2.3. Use of biomass from domestic waste

The areas of the two landfills on the territory of the municipalities of Ruse and Byala are defined by protocols from 1995 which is before the promulgation of Regulations №7 and №8 about the requirements for the sites for construction of facilities for waste treatment and for landfill operation. However, they continue to be used. The grounds for non-using them anymore are based on the facts that a Ruse regional landfill for non-dangerous, inert and dangerous waste is put into operation and also the defined requirements and measures for a construction of a shaft at the center of the landfill according to the National Waste Management Program. It will be constructed together with the waste heaping during their

collection at the particular property. There has been no intermediate earth filling over the years and it is not expected that there will be a problem with the release and capture of biogas in the shaft.

Due to the above mentioned, construction of gas drainage is unprofitable and would further unnecessary increase the cost and overload the construction of the landfill.

***Table 8**. Calculating the energy capability of biomass from domestic waste at Ruse district*

Parts
Paper
Cardboard
Garden
Wood
% 56

The expected energy capability of usable waste in a case of separate collection is about 50 000 tones for Ruse district and in case of an average calorific value of 1 600 kWh/kg. **Energy capability is 80 000 MWh.**

***Table 9**. Calculating the energy capability of biomass from domestic waste at Giurgiu county*

Parts
Paper
Cardboard
Garden
Wood
% 56

The expected energy capability of usable waste in a case of separate collection in Giurgiu county is about 70 000 tones and in case of an average calorific value of 1 600 kWh/kg. **Energy capability is 112 000 MWh.**

II. CONCLUSION

As a result of the held study and analysis of the current situation regarding the implementation of "green economy" policies at the cross-border region Ruse - Giurgiu, the following findings can be made:

- It was found that there is not developped a common strategic document for energy utilization from renewable energy sources at the cross-border region Ruse – Giurgiu.
- There are plans and programs that have been adopted, such as district strategy, municipal development programs, strategies and plans for energy efficiency development, strategies and plans to promote the use of renewable energy sources and biofuels and other types of documents.
- It is required more than a review of the implementation of EU policies and legislation to be able to meet the targets that are set out in the adopted local strategies for green economy utilization. The analysis of the adopted documents shows that they meet the formal requirements and contain some common parts.
- According to the official data, it has been achievd an increase in the share of used renewable energy sources in some municipalities, but for the cross-border region Ruse – Giurgiu this percentage is still relatively low.

- It is proposed to be made a better monitoring of renewable energy policies by allocating additional financial resources in order to assess more appropriately their relevance and to update it in line with the nowadays European and national documents.
- However, there are other management issues (lack of sufficient administrative capacity, as well as the capacity to manage large investment projects, data unreliability or insufficient control and monitoring), which is responsible for increasing the implemenantion gaps in the field of renewable energy.
- There are a number of good examples of implementing energy efficiency improvement and use of renewable energy sources.
- The implementation of renewable energy policies will reduce the dependence on primary energy imports; also it will lead to creation of new market opportunities; improved competitiveness; achieving sustainable energy development and improving environmental performance.
- Due to the implementation of the "Green Economy" principles it will be achieved energy efficiency and resource efficiency through the use of renewable energy, zero-emission buildings, greener transport, water and waste management, and carbon reduction.
- Applying the principles of the "Green Economy" as a policy approach will contribute to the economic growth of the region by improving the quality of life of people and leading to establishment of more job opportunities, better environmental quality, enhancing ecosystems and much more.
- The principles of "Green Economy" can be seen as an approach for achieving sustainable development in the entire cross-border region Ruse – Giurgiu.