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THE USE OF WOOD BIOMASS IN THE REGIONAL SYSTEM OF RENEWABLE ENERGY SOURCES AS A CHANCE FOR THE REGION

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Abstract. The world needs energy. It is an obvious truth you do not need to prove. The modern world needs the electricity. With advancing civilization and the rate of consumption, and the demand for electricity is growing. At the same time, conventional resources are running out. This situation leads to the search for new renewable sources of energy. Therefore a crucial role of forests should be taken into consideration. The study shows that, in the relatively short term, the wood biomass (mainly forest) will play a significant role in the regional energy system.

Keywords: forest, ecology, district Bilgorajski.

1. INTRODUCTION

In scientific thought on the relationship of man to nature, it is not enough to draw attention to the issue of energy, but it should be exposed as well. The relationship between the issue of energy and ecology is obvious, and it is shown in detail in this submission.

The human being is closely connected with the natural environment in which he lives and develops. There is a special relationship between human and natural environment [1]. This environment largely determines the existence of itself and its quality [21]. Although some contemporary anthropologists rightly do not limit the natural environment of the human being to nature [22; 23], without a doubt, it is the special part of it [25]. A man because of his body belongs to the natural world; and - qualitatively different from the others, but always remains the same part of nature, which, according to the scheme of biology is placed inside the animal kingdom [24].

Man as one of the creatures living on Earth, is an integral part of biological sphere existing in the world. Therefore, he naturally falls with her in various relationships. One of the essential elements of the biosphere - because of the importance of tourism as well as educational, recreational or economic aspects- is a forest, and in particular the forest as a natural source of energy used for thousands of years. It is important that thinking about the forest as an energy resource has been an ecological thought, and it will keep the natural order and allow each element of human-nature relation fulfill natural needs [2].

Energy, among many sectors of the national economy is a special area. Products in this sector have a major impact on the efficient functioning of other sectors of the economy and economic growth which is measured by increase in GDP (gross domestic product).

The modern world needs energy while global consumption continues to rise (Figure 1) [3]. The main reason for this growth is the progressive development of civilization which forces an increase in energy expenditure, necessary for the effective operation of all sectors of the economy. The development of civilization also affects the growth of consumption, which necessarily implies a growing consumption of energy [4; 5].

The production and use of electricity is linked to greenhouse gas emissions, and the devastation of the environment, which contribute mainly to gas emissions arising from the combustion of fossil fuels, especially coal. The natural progress of civilization and so-called technological development, especially in countries such as Poland, whose power is based mainly on fossil fuels, have led to a rapid and increase of carbon dioxide emissions in recent years (Figure 2) what has intensified the greenhouse effect [6].

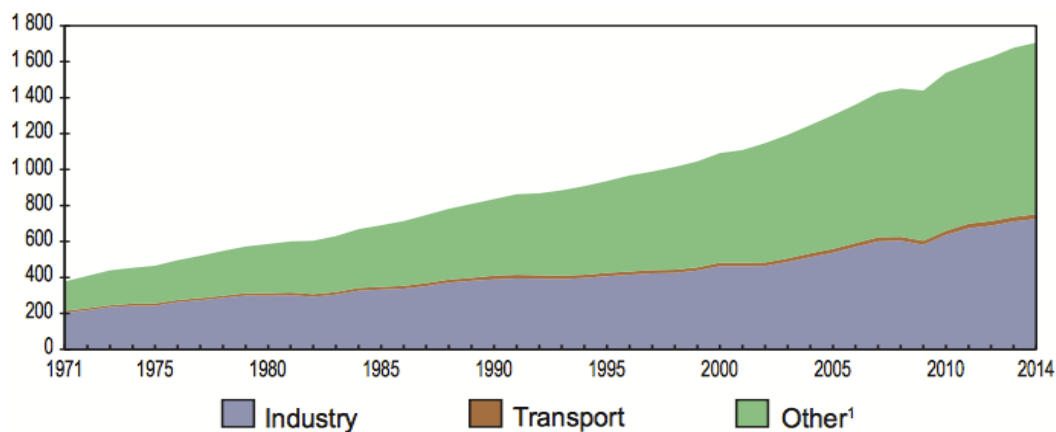


Fig. 1. Total final consumption electricity from 1971 to 2014 by sector (Mtoe).

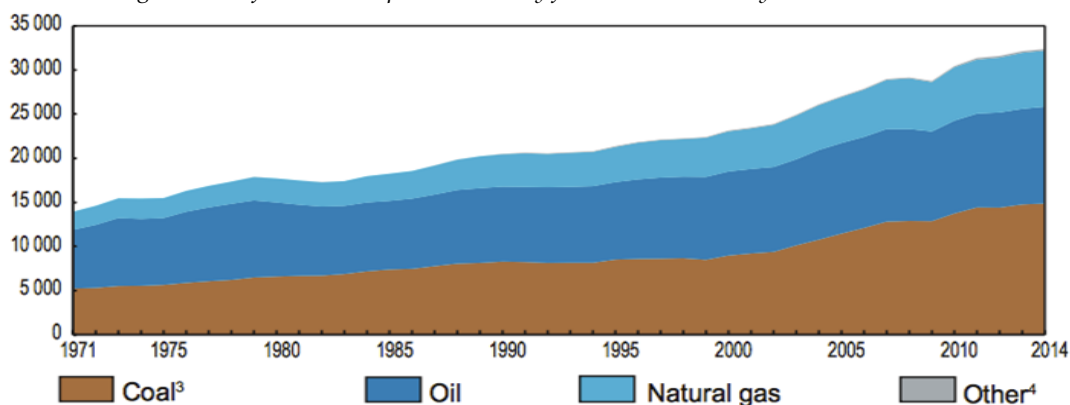


Fig. 2. World's emission² CO₂ from fuel combustion from 1971 to 2014 by fuel (Mt of CO₂).

To reduce emissions, it is necessary to search for and use highly efficient and cost-effective sources of energy, including renewable energy sources and associated, as well as effective and energy-efficient solutions in industry and construction. Unconventional energy sources are an alternative to fossil resources, not only because of depletion (and rising extraction costs), but also as a way to reduce the destruction of the environment. They perfectly fit in the concept of sustainable development and a closed-circuit management [5].

¹ Includes agriculture, commercial and public services, residential, and other non-Specified. Source [3].

² CO₂ emissions from fuel combustion are based on the IEA energy balances and balances on the 2006 IPCC Guidelines, is excluding emissions from non-energy.

³ In These graphs, peat and oil shale are aggregated with coal.

⁴ Includes industrial waste and non-renewable municipal waste. Source [3].

⁵ World includes international aviation and international marine bunkers.

Currently, the region is seen not only as a space where you can find resources and capital, but as a territory offering new energy system. It is worth recalling that the European Commission's Communication of July 2015 relating to the new organization of the economy, from which can be deduced an announcement about resigning from the large-scale, centralized units based on fossil fuels in favor of small, distribution system, largely from the RES sector [7].

2. METHODOLOGY

These reflections arise the following questions: Is it possible to create the regional energy system and how would affect the region? What role in this system would play the woods?

This text is a response to these questions. The analyses described below and synthetic conclusion are made on the example of Bilgoraj county. The analysis of the source material is the primary method. An important part of it is also the enumeration of specific data on the investigated region.

Primary sources are the national statistical data of the Central Statistical Office (GUS). Important research data is also the Bureau of Forest Management and Geodesy (BULiGL).

2.1. ANALYSIS AND DISCUSSION: THE ENERGY POTENTIAL OF THE REGION BILGORAJ

Bilgoraj county is located in the Lublin province and covers an area of 168 111 hectares of forest cover is 38.7% and in some municipalities (Tereszpol) exceeds 71%. Farmland represents 56.6% of the area. Population is 102,941 thousand [8].

Production of electricity in the region takes place mainly in two small hydro-electric power stations Zwierzyniec Rudka on Wieprz river with a power 1.3MW and Gorecko Koscielne on Szumy river with power 0.2 MW, a photovoltaic farm in Dlugi Kat with a capacity of 1 MW, and a few scattered installations of photovoltaic power up to 4 kW. In total, locally produced electricity is not a significant strategic element in the local energy system and does not affect the economy of the county.

These calculations, given the technical potential of biomass, assume primarily the use of biomass for purposes other than energy (nutrition, food, industry, etc.) because of the need to ensure food security of the regions and the country. Only a surplus of biomass can be considered as a potential energy resource.

The potential wood biomass consists of: wood biomass from forests for energy purposes (assortment S4, M1 and M2)¹, wood resources from afforestation, waste wood from orchards, the resources of wood waste from wood processing. During the processing of wood there are wood resources produced which are available for energy purposes. These resources are estimated on the basis of timber harvest from national forests (merchantable timber) and private (log wood). It is assumed that the wood waste (edgings, sawdust, chips, shavings, etc.) is an average of 20% of the initial wood intended for processing and can be calculated with the following equation [9]:

$$Z_{TP} = P * 0.20 \text{ [t / year]},$$

where:

Z_{TP} - wood resources from processing wood for energy purposes,

P - timber harvesting for industrial purposes [t].

Assuming the energy value of dry wood at 18,72 GJ / t and wood moisture during harvesting at approx. 50%, the estimated resources can be converted to energy units. In 2015, they were obtained from private forests and communal a total of 35 694 m³ of merchantable timber [10], which gives about 7138,8 m³ of possible waste obtained for energy purposes. Assuming the calorific value per 1 m³ of small-sized wood of coniferous, the average rate is 875 kWh [11]. The amount of energy that can be

¹ Classification of timber [17]:

S4 - Oversized wood - firewood,

M1 - the Small wood – pole wood,

M2 - the Small wood - branch wood.

achieved is 6246 MWh. At the same time in 2015 in the Forest Districts Bilgoraj obtained about 7780 m³ of wood (M1 and M2), most of which was left in the forest [12]. The coverage area of the Forest Districts and territorial district (area of forest districts beyond the territorial area of the county) would allow it to produce approximately 4706 MWh of energy. In total, only wood waste and left in the woods in the Forest Districts of the State Forests could get a 10 952 MWh of energy in 2015.

Waste wood from orchards is obtained by cutting down sick, broken trees, the elimination of old plantations. In order to calculate the amount of waste wood from orchards, the average waste timber at 0.35m³ per hectare per year [13] is taken into account.

$$Z_{RW} = A * 0.35 \text{ [m}^3 \text{ / ha / year]},$$

where:

Z_{RW} - resources of wood waste from orchards for energy purposes,

A - area of orchards [ha].

Possible amount of wood from orchards for energy purposes in the county Bilgoraj is difficult to estimate due to the lack of verifiable data concerning the size of orchards. In the bilgorajski district which is the administration part of Lublin province, there was 79 732 ha of orchards in 2015. In various sources, the size of the orchards in the county Bilgoraj oscillates around 1,400 ha [14] which could raise about 490 m³ / year of wood for energy purposes and about 428 MWh.

Wood resources from afforestation, limiting them only to a wood from the care of roadside trees (because of the difficulty in getting wood from areas with diverse ownership structure) can be calculated with the following equation [9]:

$$Z_{WR} = 1.5 * L * 0.3 \text{ [t / year]},$$

where:

Z_{WR} - wood resources from afforestation,

L - length of roads [km]

1.5 - the amount of wood possible to raise the 1km roadside plantings [t / year]

0.3 - an indicator of trees by the roads.

According to the Central Statistical Office, in the county there is over 526.9 km of paved roads [10], where you can get around 237 t of wood for energy purposes in the year. Assuming an average 4.2 kWh / kg [15], we can get around 995 MWh of energy.

The balance of realizable energy from woody biomass is as follows:

biomass from	processing Z_{TP} [m ³ /year]	orchards Z_{RW} [m ³ /year]	afforestation Z_{WR} [t/year]	forestry M1/M2 [m ³ /year]
size	7138,8	490	237	7780
energy [MWh]	6246	428	995	4706

It should be noted that the availability of forest biomass for energy purposes in the county Bilgoraj is much greater. For calculations only biomass assortment of M1 and M2 is used, which is mostly waste leaves in the forest, and it does not include the typical assortment of wood, which according to the new law RES can be used for energy purposes [16]. Forest land on the basis of which you can estimate the amount of wood for energy purposes is as follows:

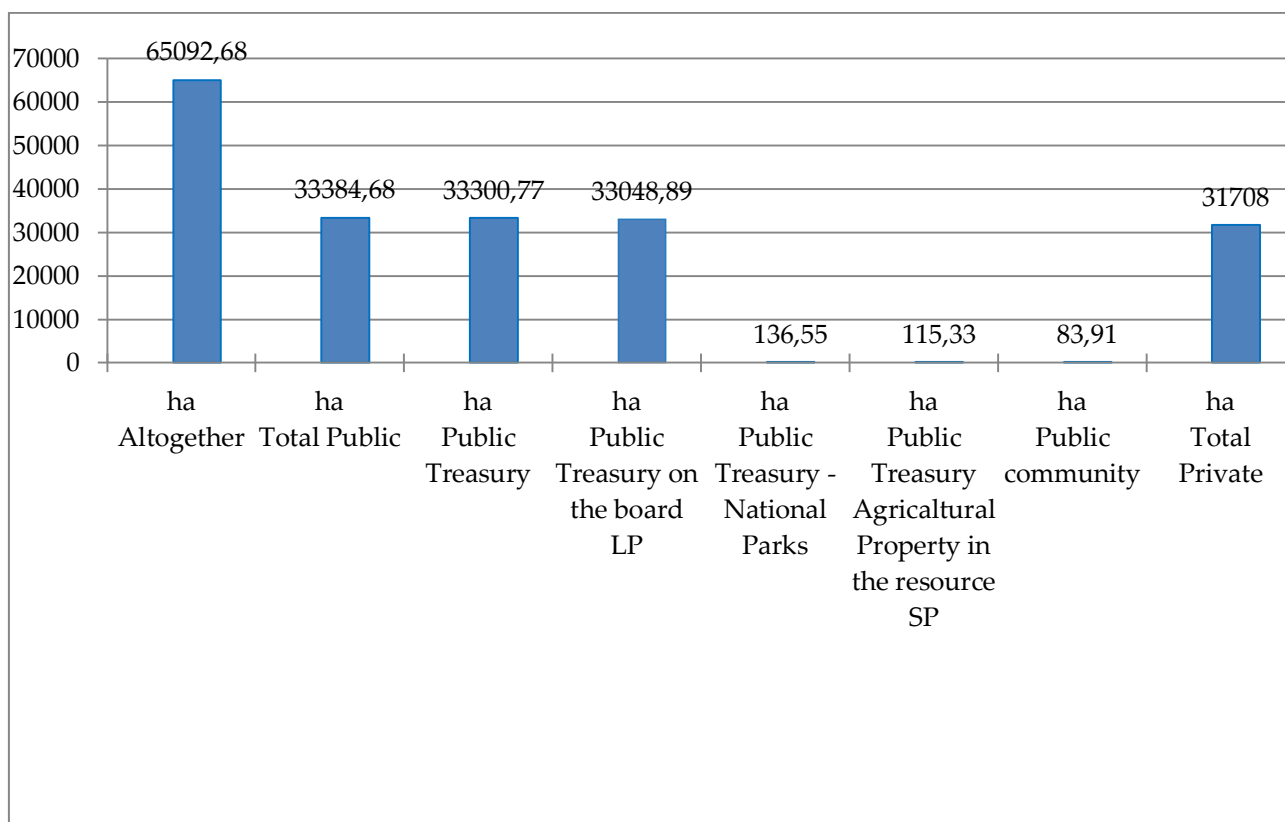


Fig. 3. Forest resources in the county Bilgoraj. GUS in 2015 [10].

For the calculation of wood resources from forests for energy purposes, you can use the methods based on increments and obtaining wood from forests. According to the Data Bank on Forests [17] the annual growth on forest land in 2015 was as follows:

annual growth [m ³]	
public forests	private forests
8 384 471	6 552 056

Tab. 1. The thickness of the stands of forest land in the district Bilgoraj as of 1 January 2015 year. Data Bank on Forests in 2015.

Assuming that the average public forests can allocate 18.5%, and from private forests about 23% [18] of wood harvested for energy purposes, we can obtain, respectively:

Biomass for energy purposes [m ³ / year]	
public forests	private forests
1 551 127	1 506 972

Tab. 2. Theoretically available biomass for energy purposes in the county Bilgoraj. Own elaboration.

Assuming calorific value 1700 kWh (for pine), with humidity of 15-18% of 1 RM [1], we get a total of about 5 198 GWh. This value will depend on the moisture content and system performance of power unit at the electrical power a heating plant.

3. CONCLUSIONS

With the progress and the growth of civilization, a rate of consumption, the demand for electricity is growing. At the same time, with conventional energy sources are running down, the EU norms and directives on green energy, there is a necessity to seek new sources of renewable energy. Due to the location and forestation of Bilgoraj county, a special role in a few, maybe a dozen years, can play the origin of wood biomass, mainly forestry in the regional energy system. As shown, only the management of waste biomass so far unused for energy purposes, can provide 12,375 GWh, almost 17.6% of the annual electricity demand of households in 2010 amounting to 70.2 GWh [19]. The usage of wood biomass, theoretically available from public and private forests, can provide enough amount of energy to meet the energy needs of local households in the entire county.

An important problem whose solution can have a significant impact on the amount of wood allocated for energy purposes is to determine the optimal amount of wood, which should remain in the forest, among others, due to the preservation of biodiversity and protection of forest ecosystems.

In order to estimate the exact amount of available wood biomass for energy purposes, it is necessary to balance the analysis of the energy inputs and energy effects and the total CO₂ emissions. An important factor influencing the final energy balance and profitability of processes of acquiring forest biomass for energy purposes, which at the same time could be clearly modified, is the distance of biomass transport to power plants. The significant advantages of the use of local wood biomass for energy purposes must include: energy independence of the region, improvement of air, creating additional jobs; development of agricultural wasteland, waste wood; clean renewable energy and the availability of cheap electricity and heat.

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У сучасному світі потрібна електрика. З розвитком цивілізації та темпами споживання, зростає попит на електроенергію. У цей же час звичайні ресурси закінчуються. Така ситуація веде до пошуку нових поновлюваних джерел енергії. Тому слід враховувати вирішальну роль лісів. Дослідження показує, що в порівняно короткий термін деревна біомаса буде відігравати важливу роль у регіональній енергетичній системі.

Ключові слова: ліс, екологія, район Білгорайський.