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Bioenergy in Poland

Bartłomiej Igliński*, Anna Iglińska, Wojciech Kujawski, Roman Buczkowski, Marcin Cichosz

Nicolaus Copernicus University, Gagarina 7, 87-100 Toruń, Poland

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ABSTRACT

In this article we presented the current state and prospects for development of bioenergy in Poland. There are over 100 energy crop plantations of the area of at least 5 ha each, 44 pellet and/or briquette producers, over 100 biomass thermal power plants of power of at least 0.5 MW, 40 biomass and coal cofiring thermal power plants, 39 biofuel producers of capacity of 1 million dm^3/year, 80 biogas power plants located at municipal waste sites, 56 biogas power plants located at sewage treatment works, 8 agricultural biogas power plants, one municipal waste incinerator, and 46 medical waste incinerators. In the near future it is planned to further develop renewable energy based on biomass.

Contents

1. Introduction

Fire is one of the fundamental discoveries of the prehistoric era of our civilisation and the oldest way of harnessing bioenergy. Wood, vegetable oils as well as other plant resources were used to produce heat and light. This situation continued until the Industrial Revolution, since when coal and crude oil became the main energy carriers. Even though the Industrial Revolution limited the importance of biological resources as energy sources, it did not eliminate them totally [1]. Furthermore, in recent times there has been a noticeable return to bioenergy. Bioenergy is a cheap, renewable and environment-friendly energy source [2].

Poland is a country where energy is mainly obtained from coal and lignite [3]. An access to the EU imposed a duty on Poland to adjust emission parameters to those binding in all EU countries.

* Corresponding author. Tel.: +48 56 611 4331; fax: +48 56 654 2477.
E-mail address: iglinski@chem.umk.pl (B. Igliński).

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Consequently, in 2001 the Ministry of Environment launched a special programme aiming at harmonization of Polish and European standards on pollution emission and percentage of alternative (renewable) energy per total electric power production in the country. This programme was named "The Strategy for the Development of Renewable Energy Sources" [4]. The strategic aim was to increase the percentage of renewable sources energy in the country fuel and energy balance to 7.5% in 2010 and to 14% in 2020 in the structure of primary energy carriers' usage.

In this article we presented the results of sociometric research describing the current state and future prospects of renewable energy in Poland, using the example of the bioenergy. For this reason the research was carried out using surveys: "The Energy Crop Plantations in Poland" [5], "The Briquette and Pellet Production in Poland" [6], "The Biomass Combustion and Cofiring in Poland" [7], "The Biofuel and Biocomponent Production in Poland" [8], "The Biogas Power Plants in Poland" [9] as well as using the data obtained directly from the bioenergy producers. This is the continuation of the survey research from 2008, when the surveys were sent to the renewable energy producers in the area of Kujawsko–Pomorskie Voivodeship [10].

2. The climate and soil conditions for plant cultivation in Poland

The climate in Poland has a transitional character between the maritime and continental climates. It happens to have years with a higher amount of precipitation, even exceeding 750 mm, and drier years with precipitation of about 500 mm [11].

It is favourable for an energy crop cultivation if that 2/3 of precipitation falls during the plant vegetation period. The duration of vegetation period, which is counted from the last spring ground frost to the first autumn ground frost, is fairly constant and oscillates between 230 days in the west of Poland to 190 days in the east. This time is sufficient for the growth and development of the most of energy plants. The daily temperature amplitude does not usually lead to any loss in biomass crop during its growth. Basing on many years of observation, monthly average of daily temperature amplitude for July is 7.1 °C. Another favourable factor is that Poland is mainly a lowland country. The majority of agricultural areas are located at the level not exceeding 300–350 m above the sea level and the slope gradient is not higher than 10° [11,12].

The soil types that cover the biggest area of Poland are podzolic and brown soils (80%). The highest accumulation of these can be found in Wielkopolska Region, Mazurian Lake District, and Podlasie Region. The alluvial or fen soils take up about 4–5% of the country area and are located in the Vistula Marshlands as well as along the following rivers: the Vistula, Odra, San, Bug, and Warta [12].

The highly fertile black-earth (chernozem) soils cover about 1% of Poland's area. They can be found in Lublin Upland and Sandomierz Basin as well as in the southern part of Kielce-Sandomierz Upland. Black soil is formed in a wet, boggy area. This type of soil takes up about 1–2% of the country area and mainly occurs in Kujawy Region. Boggy soils, which also include peat soils, cover about 9% of the country area. They are found near the rivers Biebrza and Narew in Polesie Lubelskie Region [12].

3. Biomass production in Poland

The definition of biomass which is in force in Poland is quoted in Section 2.1 of the Ordinance by the Minister of Economy and Work [13], which is fully correspondent with the definition of biomass in article 2b of 2001/77/EC Directive [14]. This definition states that "biomass is solid or liquid substances of plant or animal origin, which undergo biodegradation, substances obtained from the products, waste or remnants of agricultural and forestry production as well as of the industries processing their products, and a part of remaining waste that also undergoes biodegradation."

3.1. Waste biomass

Poland has vast bioenergy resources [15]. The best opportunities for energy production are found among cereals and rapeseed straw, agricultural and food industry waste, and forest timber waste. The General Directorate of State Forests [16] estimates that the total technical potential of forestry timber which could be directly used for energy production is about 6.1 million m^3 of wood, which is equivalent to 41.6 PJ. A high amount of this type of waste is created in the timber industry [17]. According to the analysis by the Institute of Wood Technology [18], the technical potential of waste timber from timber industry as well as from other sources can be estimated at around 58.1 PJ.

Until recently the most common method of managing waste slash was to pile it up and burn. However, this practice has been restricted since 2004 by the decisions of the General Directorate of State Forests [18]. More and more forest inspectorates have the special machines for grinding the remaining post harvesting site. Waste biomass is a rich source of nutrients for newly established plantations and could be a potential energy source as well [19].

In the recent years the Polish agriculture has been dominated by cereal crops [3], from which straw could be obtained for energy purposes. The highest crops are yielded by wheat, rye, and barley cultivations. Poland produces about 25 million Mg of straw per year. Over the decades it has been mainly used to meet the needs of animal production as a bedding material and fodder. Straw has also been used for mound covering, insulation of buildings, and bedding mats preparation in horticultural farms. Since 1983 the straw yield has been higher than the agricultural demand for it. Between the years 1983 and 1990 the annual mean surplus over the agricultural consumption was 5 354,000 Mg, and in the period between 1995 and 2001 it amounted to 10 881,000 Mg. This estimate takes into account the use of straw for skim ploughing, to maintain a stable balance of organic substances in the soil. An increase in the straw surplus meant that an effective way to manage it had to be sought [20].

One of the possible solutions was to use straw in energy production. Its calorific value is between 14.3 and 15.2 MJ/kg, which in terms of energy means that 1.5 Mg of straw is equivalent to about 1 Mg of hard coal. It is possible to use straw as a fuel not only to heat houses and livestock buildings on agricultural farms, but also in communal boiler plants [21].

3.2. Energy crop plantations

Among many energy crops that can be grown in the Polish climate, basket willow (*Salix viminalis* L.) is the most common plant to be cultivated in Poland [22] (Table 1).

Fig. 1 represents the localisation of energy crops plantations of the area of at least 5 ha in Poland. It is worth pointing out that a few tens of plantations producing biomass "for their own use" cover the area of about 1–2 ha each. The highest area designated for energy crops cultivation is in the north-west of Poland (Szczecinek region), the south-east (Zamość region), the south (Kielce, Kraków) as well as in Brodnica region [5,24,25].

Even though it is mainly common osier that is cultivated in Poland, there are also attempts to use other energy crops. For example, in Nowy Dwór Gdański (close to Gdańsk – Fig. 1), a plantation of Virginia Mallow (*Sida hermaphrodita*) was established, covering the area of 750 ha. The plantation will provide bioenergy to the