

DETERMINANTS OF BIOMASS PRODUCTION FOR ENERGY PURPOSES IN NORTH-EASTERN POLAND

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Abstract. Development of renewable energy sources and efficient use thereof are universal indicators of responsible environmental policy. It is estimated that in the EU countries, biomass can provide approx. 2/3 of the declared share of energy generated from RES in 2020. Energy derived from RES is favourable for both, the reduction in pollutant emissions to the atmosphere and water, and the reduction in the volumes of waste generated. This paper identifies, on the basis of the example of north-eastern Poland, both - the existing producers of biomass and operators involved in the processing and purchase thereof. Furthermore, an attempt was made at assessing local determinants affecting the development of the production trend concerned, with account taken of sustainable development of agriculture and rural areas. In order to identify the producers and processors of biomass for energy purposes, it being a useful GIS tool for processing, visualization in a form of tables and thematic maps is presented.

Keywords: biomass, GIS, energy policy, RES, agriculture field crops.

Introduction

Globally, biomass is the third largest natural renewable energy source. Biomass means the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste [1]. Biomass includes green plants, lignified plants, woodchips, sewage sludge, livestock manure, organic residues from agri-food industry, etc., and is a huge reservoir of energy. Biomass is either burned in household stoves or converted into biofuels or electricity and heat energy in technologically advanced biomass power plants, biogas plants and biorefineries.

Poland is a country with conditions for obtaining energy from water, wind, sun, geothermal sources and biomass [2]. However, biomass and wind energy offer the most extensive opportunities for their use [3]. Rural areas, which in Poland represent ca. 93 % of the total area of the country, are the main locations for renewable energy sources. The fact that ca. 65 % of the country area is arable land and land under green use, including 34 % of class V and VI soils of low suitability for agriculture, represents an argument in support of agricultural space use optimisation for energy production. For many farmers, renewable energy sources represent the hope for production rationalisation.

As follows from the agreed objectives of the energy policy of Poland until 2030, the international commitments on the implementation of the EU climate and energy package compel the diversification of energy generation sources, and a special role in this respect is being attributed to the development of energy generation from renewables. Implementation of that priority will involve supporting projects making use of available local resources of renewable energy sources (RES), including mainly by-products derived from agriculture, and residues from the agri-food sector [4].

Agriculture and energy policy are two closely related elements. In the future, energy crop cultivation may become the strategic direction of agricultural production, and may thus contribute to an increase in the share of biofuels and energy supplies, as well as to achieving the objectives of the current energy policy [5]. It must be noted, however, that further development of energy crop cultivation, frequently considered to be an antidote to problems associated with the improvement in profitability of agricultural production, or the improvement of socio-economic situation in rural areas, must take account of environmental conditions. This is because not all areas, including less favoured areas identified as optimal for biomass production, may be used for that purpose. In the long term, energy farming will offer Polish rural areas the possibility of inclusion in one of the immense areas of innovation economy [6].

As of 2000, the share of renewable energy sources in the energy balance of Poland has been increasing gradually. It is expected that the trend will continue. Large heat and cogeneration plants

contribute to that as their demand for biomass combustion and combined combustion is increasing continually. Households using biomass as a substitute of fossil fuels also have significant influence on the biomass market development [7].

According to the data by the Central Statistical Office, in 2011, the share of energy from renewable sources in the total energy balance of the country was 11.2 %. That was one percent point more than in the preceding year. Biomass has become the basic renewable energy source in Poland. In 2011, it represented 85.57 % in the total production of energy from renewable sources. Liquid biofuels (derivatives of agriculture) represented 5.54 %. According to the energy policy assumptions, the share of renewable energy sources in the total energy consumption will increase to 12.9 % by 2017 [8].

Introduction of biomass to the energy generation industry results not only from the legal regulations such as the Regulation by the Minister of Economy of 14 August 2008 but also the requirement of decreasing carbon dioxide emissions to the atmosphere [7]. In Poland the waste biomass, i.e., pieces of wood, timber waste from forestry, timber industry, paper industry, surplus of cereal straw and rape straw, biogas from landfills and wastewater treatment plants, is used as the main biomass source. The energetic potential of unused agricultural biomass is estimated at 104 JP a year [9].

According to Jasiulewicz [10], biomass production is mostly dependent on both, the prices of raw materials used for energy purposes and the guaranteed multiannual market for biomass. The acquired biomass should primarily originate from local sources, i.e., from agriculture, but industrial waste, municipal waste, sewage sludge, slaughterhouse waste, catering waste, and vegetable and animal waste, both liquid and solid, should also be taken into account. Basically, biomass acquiring models as tested on a large scale must be applied, where traditional crop cultivation for energy purposes or establishing energy crop plantations are the basic options for acquiring agricultural biomass.

The biomass potential estimate should be supported by the detailed analysis of the area and structure of land under agricultural use, climatic and soil conditions, structure of crops, yields generated, demand for agricultural raw materials for food and feed production as well as the number of livestock heads [11].

Materials and methods

The aim of the paper is to present the conditions influencing biomass production for energetic use. The analysis covers the area of Warmińsko-Mazurskie voivodship in north-eastern Poland. Particular attention was focused on local conditions influencing the biomass market. Based on the opinions of the biomass producers and processors from the region, an attempt was undertaken to determine the biomass market development level and the SWOT analysis concerning the biomass market in the region was applied. The SWOT analysis allows indicating the strengths and weaknesses of the biomass market in the region as well as the opportunities and threats involved in development of renewable energy sources, in particular in the biomass market development. The analysis was prepared based on the opinions of biomass producers and processors from the region and the *Programme of renewable energy sources development in Warmińsko-Mazurskie voivodship for the years 2013-2020*, drafted by Warmia and Mazury Energy Agency [12]. Using the GIS technology, the thematic map of the distribution of biomass producers and processors and the map of time required for access from the producer to the processor considering the local road infrastructure were prepared. The MapInfo Professional application was used to generate the maps.

For the purpose of the study, the producers and processors of biomass for energy purposes from the region were identified. The list of entities was generated based on the information obtained from the advisors of Warmia and Mazury Agricultural Extension Service Centre in Olsztyn, dealing with the development of renewable energy sources in the voivodship. In 2012, 123 farmers declaring biomass production for energetic purposes and 30 entrepreneurs purchasing and processing biomass for energetic purposes were identified in the region. Ultimately, after verification of the results obtained, the data originating from 108 farmers and 27 entrepreneurs were used for the analysis.

Results and discussion

Warmińsko-Mazurskie voivodship, because of the local conditions, is clearly privileged in biomass use. The biomass potential in the energetic balance is large and it is assumed that it will be increasing. Energetic crops and straw have the major share in that potential [13]. The region offers excellent conditions for cultivation of energetic crops, particularly because of the large area of land that temporarily is not used for agricultural purposes. The area of land lying idle according to the Central Statistical Office was 26877 ha representing 6 % of the total area of agricultural land in 2012. Moreover, the region has appropriate scientific-research facilities as well as satisfying human potential. The area structure of the farms is also favourable. The average farm area is more than twice larger than the national average. The number of farms with the area exceeding 20 ha is five times higher than the national average.

The agricultural nature of Warmińsko-Mazurskie voivodship offers the possibilities for development of renewable energy sources based on agricultural biomass production. There are many biomass producers in Warmińsko-Mazurskie voivodship. They deal mainly with cultivation of energetic crops. According to the data of 2010, the area under energetic crops in Warmińsko-Mazurskie voivodship was 1244 ha. The energetic willow plantations have the largest share at 51 % followed by Miscanthus at 43 %. The plants such as Virginia fanpetals, poplar and reed Canary grass do not exceed 6 % in the total area of energetic crops.

Heat plants and biomass fired boiler houses as well as units producing wood chips, briquettes and pellets are the main buyers and processors of biomass. The largest numbers of such entities can be found in Braniewo, Elbląg, Olsztyn, Lidzbark and Ostróda counties. Elbląg County plays an important role as concerns the volume of biomass processed. At the same time, it is the largest buyer of the raw material.

Table 1

SWOT analysis concerning biomass in Warmińsko-Mazurskie voivodship

Strengths	Weaknesses
<ul style="list-style-type: none"> • appropriate climatic and soil conditions for energetic crop cultivation, • large areas of lands lying idle, • favourable farm area structure, • large labour resources, • active support of Agricultural Extension Service Centre and scientific-didactic base, • significant potential of biomass from agriculture and forestry • significant potential of waste from agricultural and agricultural-food industry production, • appropriate potential of raw materials. 	<ul style="list-style-type: none"> • technical limitation to biomass energy use coupled with high potential for its use, • low level of education of residents, • low energetic awareness, • insufficient knowledge on renewable energy sources, • unstable biomass market, • absence of large biomass buyers except the heat and power plant in Elbląg, • dominating position of coal in energy generation (over 90 %), • imperfection of legal regulations, • competition from furniture, boards and windows and doors production industries, • long time for obtaining permits for construction of new biomass using installations.
Opportunities	Threats
<ul style="list-style-type: none"> • necessity of limiting CO₂ production, • necessity of increasing energetic security, • statutory duty to purchase energy generated from renewable sources, • higher environmental awareness of the public, • additional income in the agricultural sector. 	<ul style="list-style-type: none"> • fears of farmers related to the innovative agricultural production, • fluctuations in biomass prices, • absence of the certificates of origin for heat generation.

It is important that processing plants should be adjusted appropriately to the potential of the local biomass production market. Aiming at defining the magnitude of potential characterising production units situated in the nearest vicinity of the processing points, the access zones were determined around each of them taking into account the network of roads. It is accepted that the optimal biomass transport distance to the processing point is ca. 20 km.

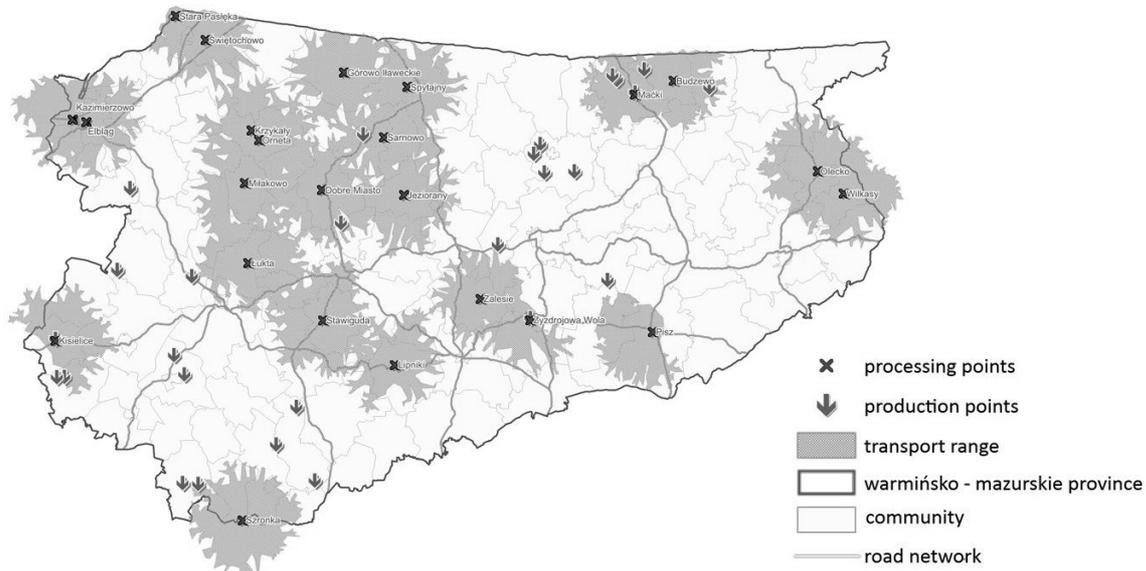


Fig. 1. Distribution of biomass producers and processors in Warmińsko-Mazurskie voivodship

Based on the map of spatial distribution of biomass producers, processors and buyers in Warmińsko-Mazurskie voivodship (Fig. 1), it can be noticed that the biomass market is developed the best in the western part and in the belt of north-eastern communes of the region. The majority of buyers and processors are concentrated there. A number of plants manufacturing fuels using biomass (mainly pellets and wood briquettes) are situated in Warmińsko-Mazurskie voivodship. The more important of them are situated in Braniewo, Olecko, Orneta and Bartoszyce. There are also some tens of installations using biomass from energetic crops plantations, among others straw, wood waste and chips for heat generation. The largest of them are situated in Pisz, Frombork, Jonkowo and Łukta. The largest number of producers is also situated in that part of the region. Ostróda County is characterised by the largest number of biomass producers from energetic crop plantations. Energetic crops are also cultivated in the area of Elbląg, Braniewo, Iława and Olsztyn counties. There are areas, however, where the biomass market does not exist in practical terms. In that group we have the counties of Szczytno, Pisz, Ełk, Gołdap and Bartoszyce as well as a significant part of Olsztyn County. In those areas there are no biomass producers. This is caused by significant afforestation of those areas and absence of large agricultural farms.

Appropriate use of Warmia and Mazury region potential would require balanced distribution of biomass producers and processors across the entire area of it. For economic reasons, the distance between them should not be too big. The average distance from the farm to the buyer in the region is ca. 70 km. Biomass is characterised by a low value of the energy that can be obtained from a unit of its volume. For that reason, it should be used as close to the place of production as possible [14]. Long-distance transport results in unfavourable financial consequences as well as environmental ones resulting from means of transport operation. The optimal distance between biomass production and delivery locations should be 20-30 km [7]. The map of spatial distribution of the producers, buyers and processors shows clearly that the majority of biomass buyers (processors) are located at a significant distance from the producers.

The next analysis (Fig. 2) aimed at location of areas from which transport of biomass to the nearest processing location would be the most arduous within Warmińsko-Mazurskie voivodship. For that purpose the distance from each locality within the studied area to the nearest processing location was determined. The distances determined were used as the data for generating the map of access by road. The dark areas in the map identify the areas from which transport of biomass to the processing

location takes the longest. The light areas located the closest to the processing locations indicate very good road connections between the individual points of the grid.

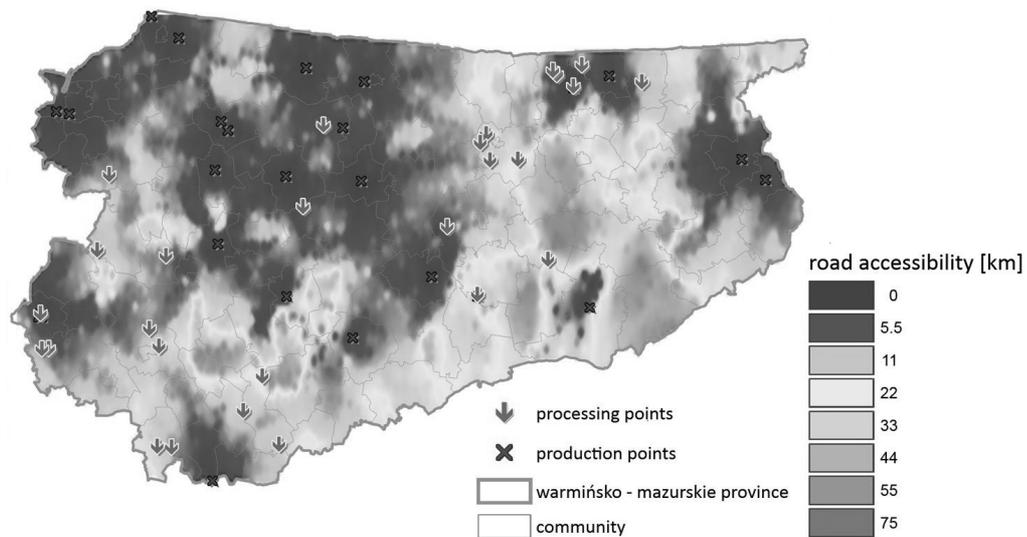


Fig. 2. Travel time from producer to processor (grid – warmer colours mean longer travel times)

Conclusions

Development of renewable energy sources depends not only on the dynamics of changes taking place in the field of technology or pressure by various pressure groups on reduction of greenhouse gases emissions. The opportunity for success depends significantly on development of the integrated system for biomass production, biomass processing and energy distribution. Effective biomass use in the energy generation sector would be supported by creating local, scattered energetic centres located in rural areas.

1. The region has very good conditions for biomass production. However, the potential is not used fully. Areas exist where the biomass market does not exist in practical terms (the south-eastern part of the region). Significant afforestation and absence of large area farms could be the reason for that.
2. The biomass market is developed the best in the western part of the voivodship. This results from the level of urbanisation of that part of the region and the higher demand for electricity and heat.
3. Warmińsko-Mazurskie voivodship does not have the capacity for using the entire biomass produced. There are no large biomass buyers there. For that reason the production is focused for use outside the region. Biomass surplus is transported to large entities purchasing biomass outside the borders of the voivodship.
4. Sustainable energy management represents an important component in local development. This is of particular importance in agricultural regions where biomass resources are just inexhaustible. The influence of biomass on the agricultural market will be rather moderate. It can lead, however, to gradual changes in land use.

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