

BIOMASS AS THE MAIN SOURCE OF RENEWABLE ENERGY IN POLAND

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Abstract

EU member states are obliged to introduce measures in order to meet objectives regarding minimum share of energy from renewable sources in gross energy use, as prescribed in Directive 2009/28/EC of the European Parliament and of the Council adopted on 23rd of April 2009. The present paper contains an overview of main aspects of renewable energy production in Poland with specific perspective of agriculture interests. Starting with a summarizing analysis of shares of renewable energy in total domestic energy production and consumption, structure of renewable sources used for energy production is given and analyzed. Specific attention is given to main source of renewable energy in Poland – solid biomass along with its historical and present quantification in the context of production methods used. Based on this, conclusions are drawn for perspective of meeting domestic target shares of renewable energy in total energy use by year 2020.

Key words: renewable energy, bioenergy, solid biomass, Poland.

Introduction

Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources, adopted on 23rd of April 2009, sets a number of tasks for the EU member states. The main task is focused on compulsory national general objectives in relation to total share of energy from renewable sources in gross end use of energy. General objectives set by the directive in scope of share of energy from renewable sources in gross end use of energy in 2020 for respective EU member states are given in Table 1. For comparison, share of renewable energy sources in gross end use is also shown for 2005.

Data from 2005 indicate large variation of renewable energy sources among EU member states. Member states with largest share of energy from renewable sources include Finland, Latvia and Sweden – these countries in 2005 had twice the share of renewable sources (28.5, 34.9 and 39.8% respectively) of the 2020 target shares of countries like Germany, Poland and Great Britain (18.0, 15.0, 15.0%). The objective for Poland is to increase the share of renewable energy in the general energy use up to 15% by 2020. The framework for development of renewable energetics in Polish energy policy was elaborated even before accession to the EU in the form of a governmental document titled “Strategy for development of renewable energetics”, adopted by Polish Parliament on the 23rd of August 2001. The document was refined on the 10th of November 2009 by the Government in “Energy policy for Poland to 2030”. It has been stated there, that the strategic objective of domestic energy policy is an increment of use of renewable energy resources, so renewable energy would make up a share of 15% of total gross energy use by 2020. Moreover, general objectives were adopted in scope of share of electrical energy from renewable resources in total

electrical energy production and share of biofuels in fuel use in general. According to these assumptions, share of electrical energy obtained from renewable sources in the general use of energy in Poland should reach 7.5% in 2010; 10.4% in 2012; 10.9% in 2013; 11.4% in 2014 and 12.9% in 2017. Share of liquid biofuels should account for 10.0% in 2020, and in the preceding years, according to the 2011 regulation of the Government, under the act of 25th of August 2006 on biocomponents and liquid biofuels it should make respectively:

| | | | |
|--------|---------|--------|---------|
| 6.20 % | in 2011 | 7.55 % | in 2014 |
| 6.65 % | in 2012 | 8.00 % | in 2015 |
| 7.10 % | in 2013 | 8.45 % | in 2016 |

It should be noted, that the adopted assumptions for years 2008, 2009 and 2010 of respectively 3.45%; 4.60% and 5.75% have all been achieved. Contribution of biocomponents in fuels used in transport in 2008, 2009 and 2010 was respectively 3.66%; 4.63% and 6.46%.

Obtaining of primary energy in Poland, including production of energy from renewable sources in years 2001-2010, is shown in Table 2. Production of primary energy in Poland in that time decreased, which along with increasing GNP indicates larger effectiveness of energy use by Polish economy. With decreasing production of energy in general, production of energy from renewable sources was increasing systematically. It increased from 4.1 share to 6.8 Mtoe in years 2001-2010, while share of energy from renewable sources in primary energy in general increased from 5.1% to 10.2%.

Energy from renewable sources in Poland is produced mainly from solid biomass (Table 3). Despite production of energy from biomass is increasing, the

Table 1

**Share of energy from renewable sources in gross end use of energy in EU member states
in 2005 and the set target share for 2020**

| EU member states | Share of energy from renewable sources in gross end use of energy (%) | | EU member states | Share of energy from renewable sources in gross end use of energy (%) | |
|------------------|---|------|------------------|---|------|
| | 2005 | 2020 | | 2005 | 2020 |
| Belgium | 2.2 | 13.0 | Luxembourg | 0.9 | 11.0 |
| Bulgaria | 9.4 | 16.0 | Hungary | 4.3 | 13.0 |
| Czech | 6.1 | 13.0 | Malta | 0.0 | 10.0 |
| Denmark | 17.0 | 30.0 | The Netherlands | 23.3 | 34.0 |
| Germany | 5.8 | 18.0 | Austria | 7.2 | 15.0 |
| Estonia | 18.0 | 25.0 | Poland | 20.5 | 31.0 |
| Ireland | 3.1 | 16.0 | Portugal | 17.8 | 24.0 |
| Greece | 6.9 | 18.0 | Romania | 16.0 | 25.0 |
| Spain | 8.7 | 20.0 | Slovenia | 6.7 | 14.0 |
| France | 10.3 | 23.0 | Slovakia | 28.5 | 38.0 |
| Italy | 5.2 | 17.0 | Finland | 39.8 | 49.0 |
| Cyprus | 2.9 | 13.0 | Sweden | 1.3 | 15.0 |
| Latvia | 34.9 | 42.0 | Great Britain | | |
| Lithuania | 15.0 | 23.0 | | | |

Source: GUS, 2011a

Table 2

Obtained primary energy (including energy from renewable sources) in Poland in years 2001-2010

| Specification | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|--|------|------|------|------|------|------|------|------|------|------|
| Obtained primary energy in total (Mtoe) | 80.2 | 80.0 | 79.9 | 78.7 | 78.4 | 77.7 | 72.6 | 71.3 | 67.3 | 67.2 |
| of which energy from renewable sources (Mtoe) | 4.1 | 4.1 | 4.1 | 4.3 | 4.5 | 4.8 | 4.9 | 5.4 | 6.0 | 6.8 |
| Share of renewable sources energy in total primary (%) | 5.1 | 5.2 | 5.2 | 5.5 | 5.8 | 6.1 | 6.7 | 7.6 | 9.0 | 10.2 |

Source: GUS, 2011a

Table 3

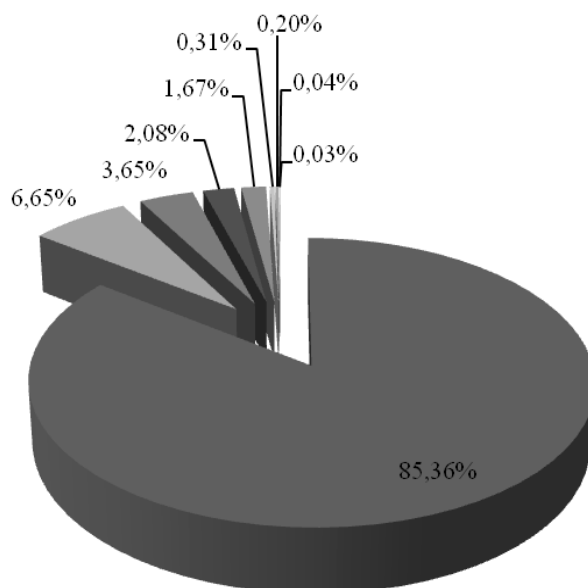
Sources of renewable energy in Poland in years 2005-2009

| Specification | (Mtoe) | | | | | (%) | | | | |
|-------------------|--------|------|------|------|------|------|------|------|------|------|
| | 2005 | 2006 | 2007 | 2008 | 2009 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Solid biomass | 4.12 | 4.36 | 4.49 | 4.73 | 5.17 | 91.6 | 90.8 | 91.6 | 87.7 | 86.1 |
| Water power | 0.19 | 0.18 | 0.19 | 0.18 | 0.20 | 4.2 | 3.7 | 3.9 | 3.4 | 3.4 |
| Wind power | 0.01 | 0.02 | 0.04 | 0.07 | 0.09 | 0.3 | 0.5 | 0.9 | 1.3 | 1.5 |
| Biogas | 0.05 | 0.06 | 0.06 | 0.10 | 0.10 | 1.2 | 1.3 | 1.3 | 1.8 | 1.6 |
| Biofuels | 0.12 | 0.17 | 0.10 | 0.30 | 0.42 | 2.6 | 3.5 | 2.1 | 5.5 | 7.1 |
| Geothermal energy | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 |

Source: GUS, 2011a

share of this type of energy source in total renewable energy production dropped from 91.6% in 2005 down to 85.6% in 2010. This resulted in larger increments of shares of energy obtained from biofuels, as well as larger shares of wind energy. Moreover, there is also a significant contribution of water power in sources of

renewable energy. Renewable energy sources listed in Table 3 are the primary renewable energy media in Poland. Apart from them, in the recent years, renewable energy is also obtained from sources like heat pumps, municipal waste and solar radiation. However, share of these media is much less significant.



Source: GUS, 2011a

Figure 1. Share of renewable energy sources in total production of renewable energy in Poland in 2010

Table 4

Share of electrical energy obtained from renewable sources in gross domestic use of electrical energy in years 2005-2010

| Specification | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|-------|-------|-------|-------|-------|--------|
| Use of electrical energy in Poland (TWh) | 145.7 | 150.8 | 154.0 | 153.4 | 149.5 | 156.1 |
| Production of electrical energy from renewable sources (TWh) | 3.761 | 4.222 | 5.230 | 6.493 | 8.604 | 10.895 |
| Share of electrical energy obtained from renewable energy sources (%) | 2.58 | 2.80 | 3.40 | 4.23 | 5.76 | 6.98 |

Source: Ministry of Economy, 2010

The structure of renewable energy media contribution in 2010 is shown in Fig. 1. The largest portion falls to biomass energy with 85.36% of renewable energy in 2010 being obtained from this medium. Following renewable media and their share in total renewable energy output in 2010 are as follows: liquid biofuels – 6.65%, water – 3.65%, wind – 2.08%, biogas – 1.67%, heat pumps – 0.31%, geothermal energy – 0.20%, municipal waste – 0.04%, solar radiation – 0.03%.

Production and use of electrical energy in Poland have been systematically growing. In the recent years, use of electrical energy increased has by 7.14% from 145.7 TWh in 2005 up to 156.1 TWh in 2010 (Ministry of Economy, 2010). Production of electrical energy from renewable sources during that period increased from 3.761 TWh up to 10.895 TWh, that is almost threefold, while share of renewable electrical energy in total renewable energy went up from 2.58% to 6.98%, which is almost the assumed target share of 7.5% for 2010. In 2010, the largest share of renewable electrical

energy was that of solid biomass (53.1%). Dynamic development of wind power has nevertheless been noticed in this context as well.

Production of electrical energy from wind power increased more than thirteen times during 2005-2010, electrical energy obtained from solid biomass went up four times and energy obtained from biogas by three times. Lowest increase of 34.0% in share was that of water power energy. Up to 2006, water was the largest source in Poland, and from 2007 up to now – second largest source of renewable source of electrical energy (Table 5).

Biomass remains the main renewable source of energy in Poland. In 2010, share of biomass in total renewable energy production accounted for 85.36% and 53.1% for electrical energy. Up to now, main source of biomass energy is co-incineration of forest biomass with other fuels. Estimated share of this biomass source in the general biomass use for energy purposes accounted for 47.8% in 2010. Supply of forest biomass for energy production is limited. In face of significant deficit of

Table 5

Size and structure of renewable sources for electrical energy production in Poland in 2005-2010

| Specification | (GWh) | | | | | | (%) | | | | | |
|---------------|-------|------|-------|-------|-------|-------|------|------|------|------|------|------|
| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| Solid biomass | 1345 | 1818 | 2343 | 3313 | 4 888 | 5 788 | 35.8 | 43.1 | 44.8 | 51.0 | 56.8 | 53.1 |
| Water power | 2176 | 2030 | 2 253 | 2 153 | 2 376 | 2 922 | 57.9 | 48.1 | 43.1 | 33.2 | 27.6 | 26.8 |
| Wind power | 135 | 257 | 472 | 806 | 1 045 | 1 822 | 3.6 | 6.1 | 9.0 | 12.4 | 12.1 | 16.7 |
| Biogas | 105 | 117 | 162 | 221 | 295 | 363 | 2.8 | 2.8 | 3.1 | 3.4 | 3.4 | 3.3 |

Source: Ministry of Economy, 2010

Table 6

Wood production in Poland in 2010

| Specification | Total wood obtained (m ³) | of which firewood (m ³) |
|-----------------------------------|---------------------------------------|-------------------------------------|
| Total wood production | 35 467 471 | 4 124 415 |
| Large softwood timber | 25579421 | 1364383 |
| Large hardwood timber | 7988866 | 1352191 |
| Small sized softwood and hardwood | 1 899 123 | 1 407 841 |

Source: GUS, 2011b

Table 7

Agricultural land area (thous. ha)

| Specification | 1990 | 2005 | 2010 | 2020 estimate |
|---------------------------------|-------|-------|-------|---------------|
| Total area of agricultural land | 18720 | 15906 | 15534 | 15600 |
| of which: arable land | 14388 | 12222 | 10931 | 11800 |
| orchards | 272 | 297 | 363 | 350 |
| meadows | 2475 | 2529 | 2635 | 2380 |
| pastures | 1585 | 858 | 619 | 700 |
| others | - | - | 986 | 370 |

Source: GUS, 2011b

wood for various branches of economy in Poland (e.g. the furniture industry) and increasing wood prices along with necessity for maintaining of a balanced and multi-functional forest policy, energy purposes cannot consume quality wood. Therefore when estimating forest wood supply for energy production, only stock like firewood (both softwood and hardwood) and small sized firewood should be considered – and in 2010 this accounted for 11.6% of wood obtained in Poland (Table 6).

Poland is considered in the EU as a country of large potential for biomass production for energy purposes with the use of arable land, which allows to estimate its area per capita in 0.41 ha (GUS, 2011b). In the past 20 years (1990-2010) arable area decreased by over 3.0 mln ha (Table 7). This drop resulted from transferring of arable land for non-agriculture purposes,

including afforestation of roughly 250 thous. ha, as well as from other changes in its classification. Low yield levels of most crops allow relatively easy enhancement of per-hectare productivity and obtaining of production volume necessary for food and feed purposes, using smaller arable land area. In this situation, land “freed” from food and feed production could be used for energy biomass production. Estimates and analysis results in this scope show, that arable area, which could be transferred for energy biomass production in Poland may account even for 4.0 mln ha (Wisental, 2006; Kuś et al., 2009).

In Poland it is estimated that by 2020 the demand for solid biomass energy will be around 10 million tonnes of dry matter. Assuming that forestry can provide around 2 million tons of waste wood and that agriculture would yield about 3 million tons of straw,

Table 8

Crop areas for various crops for energetic purposes (ha)

| Specification | 2009 | 2010 | Specification | 2009 | 2010 |
|---------------------------------|---------------|----------------|------------------------|----------------|----------------|
| Perennial plants | 6786.7 | 11022.2 | Annual plants | 22411.3 | 14643.5 |
| <i>Salix viminalis</i> | 5140.7 | 8534.4 | Cereals | 5695.1 | 3448.2 |
| <i>Rosa multiflora</i> | 3.5 | 5.5 | Sugar beets | 114.4 | 4540.2 |
| <i>Sida hermaphrodita</i> | 27.6 | 80.0 | Winter and spring rape | 16331.2 | 6285.5 |
| <i>Miscanthus giganteus</i> | 1157.6 | 1929.9 | Soybean | 17.3 | 140.5 |
| <i>Helianthus tuberosus</i> | 58.6 | 38.1 | Others | 253.3 | 229.1 |
| <i>Reynoutria sachalinensis</i> | 0.0 | 1.0 | | | |
| <i>Phalaris arundinacea</i> | 236.9 | 215.0 | | | |
| Others | 161.9 | 218.4 | | | |

Source: GUS, 2011b

the remaining 5 million tonnes of biomass would be sourced from energy crops such as *Salix viminalis*, *Miscanthus giganteus* and other species of perennial grasses like *Sida hermaphrodita* (Kuś and Faber, 2007). With an average yield of around 10 tonnes of dry matter per 1 ha, the area for energy crops will be about 500 thousand hectares. National Indicative Target adopted by the Ministry of Economic Affairs aims to increase the share of bio-components in liquid fuels from 5.76% in 2010 to 10% in 2020. For the assumed consumption of diesel and the required biodiesel additive, it will be necessary to process nearly 2 million tons of rapeseed. With a yield of about 3.2 t/ha for rapeseed, about 550 thousand hectares of areas will have to be dedicated to this oilseed. A similar area of about 600 thousand hectares must be used to acquire grains, potatoes, sugar beet, etc. required for bioethanol production (Kuś and Faber, 2007). A dynamic development of biogas plants on farms is also observed in Poland, and their target number may reach 2 thousand facilities. Assuming that half of the substrates would be derived from waste materials and the other half from biomass of field crops (150-200 ha corn or others species) the necessary area for their cultivation would have to be around 300-400 thousand hectares. Restructuring and intensification of production in Polish agriculture and an on-going growth of crop as well as livestock production, allows allocation of around 2 million ha out of 16 mln ha of total crop areas for energy purposes. The remaining crop areas would still more than suffice to meet up-to-date goals pursued by agriculture sector in Poland.

In the recent years Poland has witnessed crop production of both perennials and annuals for energetic purposes. Perennials have been grown for combustible biomass and annuals for liquid biofuel production and biogas production (in case of maize). Crop areas for energetic perennials and annuals are

shown in Table 8. Comparison of estimated demand for biomass production by cropping energy plants with actual crop area indicates that energy crop agriculture is still in the early stage of development. Area of the highest energy efficiency crop like *Salix viminalis*, *Miscanthus giganteus* is still very small and in 2010 it accounted for 8534.37 and 1929.93 ha respectively. Both crops were dominating in the group of energetic perennials. It should be stressed that in 2010 crop area for perennials increased by 4236.5 ha, that is by 62.4%, compared to 2009. On the other hand, crop area for energetic annuals decreased to 14643.48 ha in 2010, compared to 22411.28 ha in 2009. The main reason behind this is lower production of rapeseed biodiesel.

Conclusions

Development of renewable energy in Poland, similarly to other EU member-states, is of significance in context of fundamental goals of Polish energy policies. Increasing of energy production from renewable sources would allow broader independence from imported energy, as well as would yield positive ecological effects.

Main goals for the development of renewable energy sources in Poland encompass increasing of share of renewable energy in total energy use by no less than 15%, and increasing of biofuel share in the transportation fuels market by 10% in 2020 and further increments of these shares in following years.

Increasing of diversification of means to obtaining renewable energy sources and establishing of optimal conditions for development of distributed energetics based on locally available resources should be considered the two main, immediate tasks. In case of biomass as source of renewable energy, primary concern should be protection of forest resources from overexploitation, as well as introduction of larger, sustainable involvement of agricultural areas for this purpose. It is indispensable to intensify production

of biomass for energy purposes on agricultural areas, both through cropping of perennials and annuals, respectively for obtaining of biomass for combustion and for liquid fuel and biogas production. This should result in competition between energy production and agriculture, as well as promote ecological biodiversity. Large share of agricultural land in total area of Poland, together with intensification of production in Polish agriculture, should allow to assign part of agricultural areas for energy crops.

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