ISSN 1644-0722
DOI: 10.17306/J.AFW.2015.1.3
www.forestry.actapol.net
www.acta.media.pl

*Acta Sci. Pol.*
*Silv. Colendar. Rat. Ind. Lignar. 14(1) 2015, 31–38*

# DEMAND FOR FOREST BIOMASS AND POSSIBILITIES FOR ITS HARVESTING IN POLAND

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**Abstract.** The rising demand for energy and the need to acquire ever more energy quantities from renewable sources call for seeking energy sources in forestry. The analysis presents a simulation of wood quantities needed to meet the obligation to produce electricity from woody biomass. Three sources of energy were specified, which can be delivered to power plants: medium dimensional round firewood, small dimensional firewood and logging residues. The calculated quantity of wood required by the industrial energy sector will reach 15 million cu. meters. Forestry will be able to directly supply about 5.8 mill. cu. meters of wood for energy purposes, including 3.1 mill. cu. m of medium dimensional roundwood, 1.4 mill. cu. m of small dimensional wood and 1.35 mill. cu. m of woody material in the form of logging residues. The largest quantities of woody material will come from western and northern parts of the country. Taking into account the fact that considerable quantities of wood suitable for energy purposes are currently utilized for heating by rural communities, not much will be left for the industrial energy sector.

**Key words**: energy wood, biomass, logging residues, small dimensional wood

## INTRODUCTION

The problem of supplying communities with energy sources is becoming more and more important. The need to prevent adverse climate changes, running out of fossil energy sources and the necessity to maintain energy security call for a more intensive use of renewable sources of energy. Biomass, including the material coming from the forestry sector has a unique position among these sources. Forests fulfill various functions, they provide habitats for many animal and plant species, stabilize climate and water conditions, supply oxygen, provide economic gains and recreational values for

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people and they are a vital source of esthetic and spiritual experience. Forests also play important productive functions by supplying wood to the marketplace. The last of the above mentioned functions is very significant, because it supplies materials for the manufacturing of furniture, paper and construction timber, thus creating workplaces in wood processing industry.

The need to mitigate climate changes by limiting greenhouse gas emissions has aroused much interest in biomass as a vital renewable source of energy. Forests have acquired a new function – a source of biomass for energy purposes. The problem, how to agree different functions of forests poses a serious challenge. How should the energy raw material be harvested in forests without causing any negative ecological effects resulting from removing biomass from the environment. In what proportion can the harvested wood be directed to energy plants instead of wood processing industry.

In order to answer the question, how much wood can be utilized for energy purposes, tree biomass must be assessed and it should be specified which parts of the trees can be used for the production of energy. Studies on the quantities of pine tree biomass have shown that branches and tree tops of adult trees make about 13% of total tree biomass (Kubiak and Grodecki, 1992). A part of the roundwood, as well as branches and tree tops, can be used for energy purposes. The underground biomass, which makes about 18-20% of total pine tree – the most common forest canopy building species – is not even considered a raw material for the production of energy.

The possibilities for acquiring energy from forest biomass depend, to a large degree, on the assessment of resources of the raw material that can be used for energy purposes. Although, theoretically speaking, any type of wood can be used for the production of energy, practically only certain wood assortments are considered reasonable for energy use. Especially, medium dimensional round firewood (S4), small dimensional roundwood (M) and logging residues in the form of branches and tree tops harvested in final fellings are used for the production of energy. Other wood assortments are regarded as wood of full value, which according to current regulations is not allowed to be used as a source of energy (Rozporządzenie..., 2012). There are publications presenting assessments of wood quantities that can be used for energy purposes (Zajączkowski, 2013). Such reports give approximate quantities of wood that can be used for energy purposes, specifying geographical regions and types (forms) of the raw material.

The purpose of this publication was to calculate the demand for energy wood in the coming years, resulting from adopted obligations and quantities of round firewood, small dimensional wood and logging residues that can be harvested in different regions of the country.

## MATERIAL AND METHODS

The quantities of wood that are currently being harvested or could be harvested for energy purposes were based on statistical data (Leśnictwo, 2010; 2011; 2012; 2013; 2014) from the latest 5 years as well as on earlier research results (Jabłoński and Różański, 2003). Based on the statistical information on the current harvest of wood assortments (incl. S4 and M) approximate quantities, that can be harvested in different

voivodeships, were estimated. The quantities of logging residues were assessed based on data on the clearcut area in the last 5 years, and based on previous studies on forest biomass in the form of logging residues (Jabłoński and Różański, 2003).

Obligations specifying the production of electricity from renewable sources of energy that have been adopted as well as stipulations limiting the use of forest biomass, included in a regulation from 2012 (Rozporządzenie..., 2012), made it possible to present a rough simulation of the forest biomass quantities, that can be planned for energy production. Percentages of electricity from renewable sources of energy, that were demanded by the regulations (Rozporządzenie..., 2012), would continually increase up to 20% in 2012. At the same time the minimum shares of biomass of agricultural origin (agro), which must be used in biomass burning installations will rise. In the case of hybrid installations and installations in which biomass only can be burned, the shares of the "agro" biomass will continually go up, which means that the allowable forest biomass shares will be diminishing.

The simulation presented below assumes a constant 56% share of solid biomass in the production of electricity (Energia..., 2013), a rise in the production and use of electricity of 1.5% annually (Aktualizacja..., 2011) and the efficiency rate of power plants at a level of 33% (Guła et al., 2012). The production of electricity in 2013 was 164.4 TWh (Energia, 2014). Moreover, wood will probably be used in its fresh condition, with a humidity of 50% and calorific value of 7.5 $GJ \cdot t^{-1}$. These assumptions enabled us to calculate the probable demand for forest biomass for energy purposes in the coming years.

## RESULTS

The calculated demand for energy wood in the 2015–2021 is presented in Table 1. The obligatory share of energy produced from renewable sources will be rising by 1% yearly, reaching 20% in 2021. Despite the increasing expected production of electricity and the required amounts of renewable electricity, the use of energy wood will be on the same level. This is caused by the fact, that in the coming years the share of non-forest (agro) biomass to be used by big energy producing installations will be growing and will reach 50% in 2019–2021. So, although the total amount of energy from solid biomass will grow, the amount of energy from wood will remain on the same level, about 10 TWh (9.13–10.71) or 36 PJ, which would cover the demand for 5 mill. cu. m. Considering low conversion efficiency of wood into electricity, a demand of 15 mill cu. m should be expected. It is more than twice the available forest biomass quantities presented in Table 1.

The results of the research, presented in Table 2 show that 16% of the total yearly harvest of 36.5 mill. cu. m, that is 5.9 mill. cu. m will be available for energy purposes. This amount is dominated by round firewood (over 3 mill. cu. m) and small dimensional wood (1.5 mill. cu. m). Logging residues, which can be harvested at a level of 45 tons per ha, would give 1.35 mill. cu. m (about 0.9 mill. tons) of energy material. Although the data presented in Table 2 can vary from year to year, no significant changes should be expected in the nearest future.

Table 1. Estimated required quantities of forest biomass for energy production until 2021
Tabela 1. Przewidywane niezbędne ilości biomasy leśnej do wykorzystania energetycznego do 2021 roku

| Specification<br>Wyszczególnienie | Years – Lata | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| Estimated electrical energy production, TWh<br>Przewidywana produkcja energii elektrycznej, TWh | 169.4 | 171.9 | 174.5 | 177.1 | 179.8 | 182.5 | 185.2 |
| Mandatory share of electrical energy from RES, %<br>Obowiązkowy udział energii elektrycznej z OZE, % | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Mandatory share of "agro" biomass for dedicated installations of 20 MW and above, %<br>Obowiązkowy udział biomasy „agro" w instalacjach dedykowanych o mocy >20 MW, % | 20 | 30 | 40 | 40 | 50 | 50 | 50 |
| Estimated electrical energy from wood, TWh<br>Przewidywana ilość energii elektrycznej z drewna TWh | 10.71 | 10.19 | 9.46 | 10.20 | 9.13 | 9.79 | 10.46 |
| Minimum wood quantity (at 33% conversion rate of power plants), mill. cu. m<br>Niezbędna ilość drewna (sprawność elektrowni 33%), mln $m^3$ | 15.6 | 14.8 | 13.8 | 14.8 | 13.3 | 14.2 | 15.2 |

Table 2. Estimated quantities of woody material for energy purposes form state-owned and private forests in different voivodeships, $m^3$
Tabela 2. Szacunkowe ilości surowca do celów energetycznych w lasach państwowych i prywatnych z podziałem na województwa, $m^3$

| Voivodeship<br>Województwo | Round firewood<br>Drewno okrągłe opałowe | Small dimensional wood<br>Drewno małowymiarowe | Logging residues<br>Pozostałości zrębowe | Total woody material for energy<br>Razem surowiec energetyczny |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| Dolnośląskie | 257 702 | 127 144 | 123 173 | 508 019 |
| Kujawsko-pomorskie | 133 759 | 71 405 | 73 303 | 278 467 |
| Lubelskie | 165 831 | 69 104 | 50 527 | 285 462 |
| Lubuskie | 201 678 | 117 168 | 128 342 | 447 189 |
| Łódzkie | 95 283 | 48 105 | 45 145 | 188 533 |
| Małopolskie | 121 284 | 49 064 | 31 890 | 202 238 |
| Mazowieckie | 170 932 | 82 693 | 74 499 | 328 125 |
| Opolskie | 98 579 | 50 208 | 49 474 | 198 261 |
| Podkarpackie | 253 507 | 94 337 | 62 824 | 410 668 |
| Podlaskie | 154 268 | 76 174 | 71 183 | 301 625 |

Table 2 – cont. / Tabela 2 – cd.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| Pomorskie | 237 728 | 120 408 | 118 323 | 476 459 |
| Śląskie | 153 286 | 79 874 | 77 841 | 311 001 |
| Świętokrzyskie | 95 786 | 47 340 | 44 833 | 187 959 |
| Warmińsko-mazurskie | 331 598 | 145 046 | 123 746 | 600 390 |
| Wielkopolskie | 237 970 | 125 708 | 128 412 | 492 090 |
| Zachodniopomorskie | 363 709 | 166 559 | 149 974 | 680 243 |
| Total – Razem | 3 072 900 | 1 470 338 | 1 353 491 | 5 896 730 |
| Share in total harvest, %<br>Udział w całkowitym rozmiarze pozyskania, % | 8.4 | 4.0 | 3.7 | 16.1 |

An analysis of energy wood that can be harvested in different parts of the country, shows that central regions are rather poor in biomass. Most energy wood can be harvested in northern parts of the country (Zachodniopomorskie, Warmińsko-mazurskie, Pomorskie) in the west (Wielkopolskie) and in the south-west (Dolnośląskie).

## DISCUSSION

The results obtained in course of the analysis are close to the results presented in other similar studies. The analysis, aiming to estimate the supply of energy wood until 2030, made by Głaz (2005) showed that it would be possible to harvest 7.7 mill. cu. m of energy wood, including 2.3 mill. cu. m medium sized firewood, 4.1 mill. cu. m small dimensional wood and 0.3 mill. cu. m logging residues.

The problem of harvesting forest fuel has many aspects. Covering a considerable demand for forest biomass requires availability of this biomass on the one hand, and proper machines and work organization on the other one. The problem of energy biomass in Poland is, according to the authors, still unsolved. Opinions have been expressed so far, saying that once the biomass resources have been found, the problem of using forest biomass for energy purposes will be solved. It looks though that such a view provides only a partial solution to the problem, as it must be remembered that forest biomass for energy purposes is intensively (at least in some regions) utilized by local rural communities, who cannot be denied purchase of that wood fuel, especially if they cut and collect the wood in the forest by themselves. The biomass quantities presented above, are already utilized by local communities, and not much is left to be used by industrial energy installations. A solution to the problem of satisfying the demand for energy from forest biomass calls for such a supply system that would be economically interesting to entrepreneurs investing in technical equipment, used in current technologies of forest biomass harvesting.

Undoubtedly, forest biomass in the form of logging residues is a vital source of nutrients, indispensable for the growth of tree stands. Hence, removing this type of biomass from the forest site is often opposed by forest managers. However, when the logging residue harvesting technology is properly designed and organized, keeping the biomass on the clear cut area for several months, in order to let it dry up and the twigs and needles to fall off, the removal of this biomass has very little effect on the growth of the next generation tree stands that are established on clear cut areas (Lundborg, 1998). Moreover, in order to compensate for any negative effects of removing biomass from the forest, ashes, left behind after burning the biomass, can be spread all over the clear cut area (Väätäinen et al., 2011).

As it was mentioned earlier, in order to use forest biomass for energy purposes, and at the same time supplying the more valuable wood to the wood processing industry, the forest biomass resources should be utilized more intensively. Apart from that, in order to increase the amount of energy from forest biomass not only research into harvesting technologies must be continued, but also clear stipulations in sectoral strategic action plans should be developed.

## CONCLUSIONS

1. At present, it is possible to harvest about 6 mill. cu. m of wood for energy purposes in the country, which corresponds to 16% of total yearly wood harvest. This wood quantity is dominated by round medium dimensional firewood, with over 50%.

2. Rising needs for producing electricity from renewable sources and limitations in using wood for that purpose, determine the demand for energy wood at a level of 15 mill. cu. m (considering low efficiency of the electricity production process).

3. The calculated quantity of energy wood includes firewood, traditionally used by local communities for heating. The energy wood that is available to satisfy the needs of the energy industry is largely available in the form of logging residues, with less than 1.5 mill. cu. m per year.

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## ZAPOTRZEBOWANIE NA BIOMASĘ LEŚNĄ I MOŻLIWOŚCI JEJ POZYSKIWANIA W POLSCE

**Streszczenie.** Wzrastające zapotrzebowanie na energię oraz konieczność pozyskiwania coraz większych ilości energii ze źródeł odnawialnych zmuszają do ich poszukiwania w leśnictwie. Przeprowadzona analiza stanowi symulację ilości drewna koniecznego do sprostania obowiązkowi wyprodukowania energii elektrycznej z biomasy drzewnej. Wyróżniono trzy źródła biomasy drzewnej, mogącej trafiać bezpośrednio do energetyki: drewno opałowe, drewno małowymiarowe oraz pozostałości zrębowe. Ustalono, że niezbędna ilość drewna, przeznaczona dla energetyki przemysłowej będzie wynosić około 15 mln $m^3$. Leśnictwo będzie mogło bezpośrednio dostarczyć około 5,8 mln $m^3$ surowca do celów energetycznych, w tym 3,1 mln $m^3$ drewna okrągłego opałowego, 1,4 mln $m^3$ drewna małowymiarowego oraz 1,35 mln $m^3$ surowca w postaci pozostałości zrębowych.

Największe ilości surowca do celów energetycznych będą pochodzić z zachodnich i północnych części kraju. Biorąc pod uwagę, że znaczne ilości drewna nadającego się na cele energetyczne są obecnie wykorzystywane przez społeczności wiejskie do celów grzewczych, niewiele pozostanie dla energetyki przemysłowej.

**Słowa kluczowe:** drewno energetyczne, biomasa, pozostałości zrębowe, drewno małowymiarowe

Accepted for print – Zaakceptowano do druku: 2.03.2015

For citation – Do cytowania: Jabłoński, K., Stempski, W. (2015). Demand for forest biomass and possibilities for its harvesting in Poland. Acta Sci. Pol. Silv. Colendar. Rat. Ind. Lignar., 14(1), 31–38. DOI: 10.17306/J.AFW.2015.1.3