

## Stump wood as an element of forest biomass to be used for generating energy

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**Abstract:** *Stump wood as an element of forest biomass to be used for generating energy.* Polish obligations concerning the increase in the share of renewable resources in final energy consumption at least up to 15% by 2020 and excluding the possibility of using wood of standard value and its derivatives (for example chips) for energy purposes impels to verify a so-far used practice of leaving stump wood in forests. Even though it's a problematic material and difficult to refine and use it constitutes a significant amount of wooden biomass available for processing into fuel. In the article it has been shown that in such situation a systemic popularization of utilizing for those purposes so far unused elements of forest biomass that is post felling residue and the potential of wood left underground becomes especially significant. Such solution goes in line with the national energy policy in relation to the development of utilization of renewable energy sources.

*Keywords:* forest biomass, fuel stump wood, renewable energy sector

### INTRODUCTION

In accordance with the objectives of Energy Policy, Poland as an EU country has a part in creating community Energy Policy as well as implements its main target in its specific domestic environment taking into account the protection of recipients' interests, its energy potential, as well as technological determinants related to the process of energy generation and distribution.

As a consequence main priorities and targets of Polish energy policy had to be set out, among them there are: [Polityka Energetyczna 2009]:

1. Improvement of energy efficiency.
2. Enhanced security of fuels and energy supplies.
3. Diversification of the electricity generation structure by introducing nuclear energy.
4. Development of the use of renewable energy sources (RES) including biofuels.
5. Development of competitive fuel and energy markets.
6. Mitigating the environmental impact of the power industry.

Under the priority of development of renewable energy sources including biofuels a sustainable utilization of individual sources of renewable energy is to be promoted. Within the use of biomass especially fostered solutions will be those most energy efficient among others using various techniques of converting them into gas or liquid fuels, especially the biofuels of second generation.

The main energy policy objectives in the field are as follows:

- Increasing the use of renewable energy sources in the final energy use to at least 15% in 2020 and further increase in the following years;
- Increasing the share of biofuels in the market of transport fuels to 10% by 2020, and increasing the use of second generation biofuels;
- Protecting forests against overexploitation in order to obtain biomass, and balanced use of agricultural areas for production of renewable energy sources, including biofuels, so as not to allow competition between renewable energy production and agriculture and to preserve biodiversity;
- Using the existing weirs owned by the State Treasury for power generation;

- Increasing the diversification of supply sources and the creation of optimal conditions for distributed power generation based on locally available resources.

#### LEGAL REGULATIONS CONCERNING USING BIOMASS FOR ENERGY PURPOSES

Following main legal acts appropriate ministers issued executive directives systematically increasing percentage share of electric energy generated from renewable energy sources sold to final recipients (Table 1). The most recent: *Directive of the Ministry of Economy from 18 October 2012 concerning detailed list of tradable green certificates to be obtained and redeemed, payment of alternative fee, purchase of electricity and heating generated from renewable energy sources and the obligation to confirm the volume of energy generated from renewable resources* – so called RES Directive [Directive 2012] for a few years was just a draft which objectives have been intensified in finally issued document.

**Tab. 1** The share of renewable electricity in comparison with the amount of electricity sold to final users introduced by consecutive Directives

Year	Projected share in accordance with individual Directive:								
	15.12.2000	13.05.2003	9.12.2004	19.12.2005	3.11.2006	14.08.2008	17.02.2011 project	18.10.2012	8.05.2013 proposal
2001	2,40%								
2002	2,50%								
2003	2,65%	2,65%							
2004	2,85%	2,85%							
2005	3,10%	3,10%	3,1%	3,1%					
2006	3,60%	3,60%	3,6%	3,6%					
2007	4,20%	4,20%	4,3%	4,8%	5,1 %				
2008	5,00%	5,00%	5,4%	6,0%	7,0 %	7,0 %			
2009	6,00%	6,00%	7,0%	7,5%	8,7 %	8,7 %			
2010	7,50%	7,50%	9,0%	9,0%	10,4 %	10,4 %			
2011			9,0%	9,0%	10,4 %	10,4 %	10,4 %		
2012			9,0%	9,0%	10,4 %	10,4 %	10,4 %	10,4%	
2013			9,0%	9,0%	10,4 %	10,9 %	10,9 %	12,0%	
2014			9,0%	9,0%	10,4 %	11,4 %	11,4 %	13,0%	14,0%
2015						11,9 %	11,9 %	14,0%	15,0%
2016						12,4 %	12,4 %	15,0%	16,0%
2017						12,9 %	12,9 %	16,0%	17,5%
2018							13,4 %	17,0%	19,5%
2019							13,9 %	18,0%	21,0%
2020							14,4 %	19,0%	25,34%
2021								20,0%	

Source: own elaboration on the basis of [Directives: 2000, 2003, 2004, 2005, 2006, 2008, 2011- project, 2012, Propozycja 2013]

In RES directive there have been numerous legal regulations concerning forest biomass. The document introduced, among others, the definition of wood of standard value<sup>1</sup>, at the same time not securing any aid for the energy generated from it. It also postulates increasing the accessibility of forest biomass– other than wood of standard value – for energy purposes and it allows for energy production from wooden residue being left as by-product following production process at various plants from this sector of economy without the need to use required share of so called agro biomass. The Directive also extended till 31<sup>st</sup>

<sup>1</sup> Wood that meets quality requirements set forth in regulations determining normative standards for large size deciduous and coniferous wood and medium size wood from the following groups: S1, S2 i S3 as well as wooden material generated as the result of intended grinding of that wood

December 2015 the deadline for reconstruction or launching for use the installations which use biomass for energy purposes.

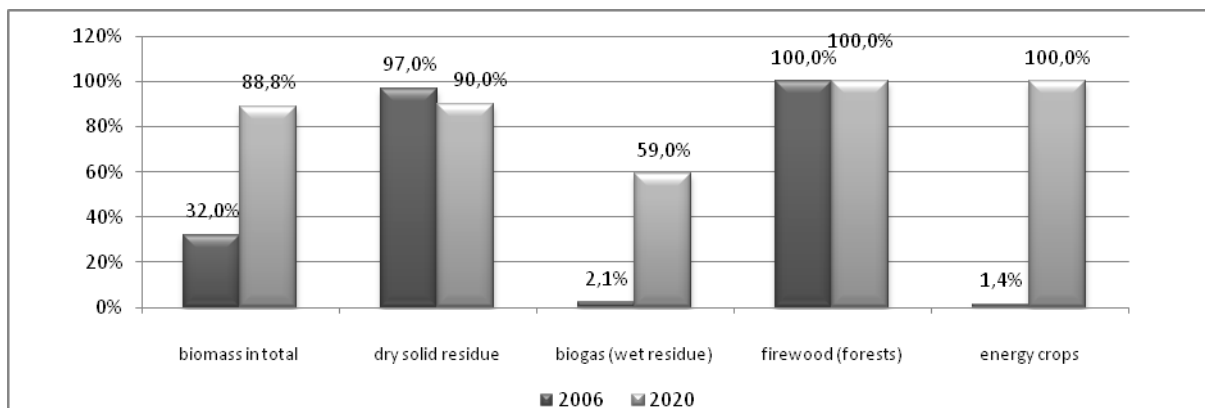
Despite the increase, in comparison with the preparatory phase, of the obligatory share of renewable energy sources in energy production the volumes proved to be too low so as to restore balance on the market of green certificates. As the result Department of Renewable Energy of the Ministry of Economy plans additional increase in those shares. (Table 1) [Propozycja 2013].

#### BIOMASS ECONOMIC POTENTIAL. FOREST BIOMASS

Biomass constitutes the third largest natural source of energy in the world. It's overall potential is estimated at  $3 \times 10^{15}$  MJ/year, out of which only 7% is used (35% in developing countries and 3% in industrialized countries). [Ligus 2010]

Real economic potential<sup>2</sup> of biomass in w Poland (52% of RES potential) is estimated at 600 PJ annually out of which almost 50 % comes from energy crops the majority of which are cellulose crops (willows, poplars etc.), almost 1/3 is dry solid residue, while the smallest share comes from firewood from forests - about 4% [Możliwości wykorzystania 2007].

In 2006, 32% of available economic potential was used. Firewood supply was fully used (Figure 1). High level of utilization also embraced dry solid residue – 97%. However, only 1,4% of the potential of energy crops was used and only in the group of sugar crops for the production of bioethanol and in the group of cole crops used in the production of biodiesel. The potential of cellulose crops wasn't used. Reaching 15% share of renewable energy sources in the final gross energy consumption in 2020 requires intensification of exploitation of those resources.



**Fig. 1** Level of usage of available economic potential of biomass and its individual types in 2006 as well as forecast for 2020

Source: own elaboration on the basis of [Możliwości wykorzystania 2007]

Forest biomass originates in forests. It consists of deficient wooden raw material, as well as post-production residue from forest and wood industry. Individual categories of forest biomass along with their brief characteristics in respect to their usability for generating energy were show in Table 2.

<sup>2</sup> Contrary to its technical potential, apart from technological possibility of utilizing renewable resources it also accounts for legal and economic circumstances

**Table 2.** Characteristics of elements of forest biomass

<b>Elements of forest biomass</b>	<b>Energy characteristics</b>
Post-felling residue, green chips, stumps	high level of contamination (mainly sand) –up to 10% and chlorine, calorific value: 7 – 14 GJ/t, stumps – up to 16 GJ/t
post felling residue in a form of neat and tight packages	comparatively low level of contamination, calorific value: 10 – 15 GJ/t, ease of storing, need for grinding
pulpwood, firewood and so on	low level of contamination, calorific value: 12 – 16 GJ/t, ease of storing, need for grinding
Sawmill post-production residue ( sawdust, chips and bark)	low level of contamination – do 4%, low level of chlorine, calorific value: 8 – 20 GJ/t

Source: Own research based on [Warchoł 2012]

### POSSIBILITIES OF USING STUMP WOOD

Following tree felling process a significant volume of branches, needle-cover, leaves and cut-of tree tops remains on the surface. Those are so called post-felling leftovers among which there are often included boles up to 1 m in length with defects excluding them from industrial utilization as well as stumps<sup>3</sup>. Stumps are the source of stump wood.

Depending on its further usage one can distinguish [Użytkowanie lasu 2005]:

- seasoned stump (KP) – heavily bled duramen part of root system, extracted following decay of alburnum in order to yield tannin (in Poland mariginal),
- Fresh stump used to generate heat (KO) – possessed mainly for energy purposes, immediately after tree felling

Average weight of fresh stump is estimated at 10-15% of the total mass of merchantable bole and approximately 10% of sawmill raw material [Encyklopedia. Lasy polskie 2013]. Such estimates are supported by research which proved that stumpwood constitutes the second largest share of biomass from trees fell during thinning and fellings which amounts to 16% [Gornowicz 2008].It show high potential of that source of energy which unfortunately in Poland remains unused [Sadowski J., Moskalik T., Zastocki, D., Wrona T. 2012].

Therefore, the debate concerning the accessibility of forest biomass should also focus on the utilization of underground wood – stump wood systems. Even though it is problematic material and difficult for processing and final utilization (problems with extracting, high level of mineral contamination), it makes a substantial volume of forest biomass that may be processed into energy. Those problems may be eliminated using appropriate technology of excavating and processing underground wood, embracing implementation of the following procedures:

- Extracting roots using special head,
- Seasoning of extracted stumps,
- Primary chipping on a recycler,
- Letting the material through a set of sieves,
- Final chipping on a recycler,

What limits the share of sand in raw material to 8-10 %.

Lack of interest in obtaining stumpwood is also the result of foresters' fear of environmental damage and loss which might occur during excavating root masses from soil. There is also an argument of hypothetical decreasing the value of forest grounds through

<sup>3</sup> Root system of growing tree and following tree felling – trunk with attached woody roots

removal of valuable biogenic nutrients. It seems however that those fears are irrelevant as during mechanical processing of post felling material a large volume of small branches and assimilating systems is cut off and left in the forest. Taking into account a very high level of utilization of forest biomass economic potential (Figure 1), also including post-production residue, it has to be stated that its main element is stump wood.

Potential source of stump wood for energy purposes apart from regular administrative fellings, is felling trees on investment grounds: airports, roads, housing etc. and clearing areas following natural disasters. Typically local character of that fuel indicates that from economic and logistic point of view the most efficient way is using it in the vicinity of the place of its production.

## CONCLUSION

Steady increase in the supply of forest biomass used by energy sector is relatively too low in comparison with far more dynamically growing demand. Additionally, *Directive on RES* excludes the possibility of using wood of standard value and its derivatives (for example chips) to generate energy. Hence energy sector apart from fully used post-production wooden residue may also use elements from S4 category (firewood) as well as group M (small size wood including post felling residue).

Therefore it is especially important to popularize using not yet used elements of forest biomass such as post-felling underground stump wood. Such solution is convergent with the implementation of at least three out of the five above mentioned objectives of energy policy in respect to using RES.

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**Streszczenie:** *Karpina jako składnik biomasy leśnej do zagospodarowania energetycznego.* Zobowiązania Polski, dotyczące wzrostu udziału odnawialnych źródeł energii w finalnym zużyciu energii co najmniej do poziomu 15% w 2020 roku oraz wykluczenie możliwości stosowania drewna pełnowartościowego i jego pochodnych (np. zrębków) na cele energetyczne skłania do zweryfikowania dotychczasowej praktyki pozostawiania w lesie karp korzeniowych. Choć jest to materiał problemowy i trudny w przerobie i finalnym wykorzystaniu stanowi znaczącą ilość biomasy leśnej możliwej do przerobu na paliwo energetyczne. W tej sytuacji szczególnego znaczenia nabiera systemowe upowszechnianie wykorzystania na te cele niepozyskiwanych dotychczas składników biomasy leśnej – pozostałości zrębowych oraz drewna podziemnego. Takie postępowanie wpisuje się w realizację celów polityki energetycznej państwa w zakresie rozwoju wykorzystania odnawialnych źródeł energii.

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