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## ASSESSMENT OF ENERGETIC POTENTIAL OF BIOMASS

### OCENA POTENCJAŁU ENERGETYCZNEGO BIOMASY

**Abstract:** In the paper the authors present the algorithm of the evaluation of energetic potential of green biomass and animal wastes for specific geographical area. Main assumptions of the algorithm have been presented as well as interrelations between different kinds of potentials. On the basis of statistical agricultural data about area of particular tillages, wastelands, forests and the number of hogs the energetic potential of biomass has been computed for the exemplary rural district of Opole province. For the chosen kinds of green biomass and animal wastes theoretical and technical potentials of energy has been found on the assumption that energy conversion takes places during process of firing biofuels in order to produce heat. Technical biomass potential has been shown with reference to heat demand of the rural district.

**Keywords:** green biomass, energetic potential, assessment of the potential

Usage of energy potential of biomass, both on large (global) and small (local) scale, depends on a number of factors. The most crucial is economic factor that determines development of installations of energetic usage of biomass as a fuel. Extent of biomass usage on small scale (for instance in rural district) results from proper assessment of biomass production of analyzed area [1].

The process of computing the quantity of energy that is likely to be produced from biomass is called evaluation of energetic potential of biomass.

#### Methodology of evaluation of energetic potential of biomass

According to the Energy Law local authorities are obligated to work out heat, electricity and gaseous fuels supply plans that should also include possibilities of usage of local alternative energy resources. Unfortunately, it is prevalent that local authorities are not well prepared to make a proper assessment of renewable energy resources due to lack of suitable procedures, methods and data [2]. Each kind of biomass requires specific method of evaluation of energetic potential according to its physical and chemical quality, accessibility and efficiency of usage final energy product for a specific technology. For the reason of big variety of biomass usage technologies the evaluation of energy potential of biomass has been done according to the kind of biomass. The unit of energy has been standardized to GWh per year for heat alike the electricity. It makes preparing quantitative comparisons more convenient for the sake of different kinds of biomass as well as for comparing biomass potential of different analyzed areas (for example rural districts).

According to practical usage of derived results it is reasonable to classify energetic potential of biomass as follows:

- theoretical potential - energy amount achieved from biomass on the condition that efficiency of energy conversion processes equals 100% (energy losses and processes flaw in devices are not taking into consideration). It is also assumed that potential at this level is used exclusively for energetic purposes;

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- technical potential - a portion of theoretical potential. The efficiency of technical processes of energy production as well as internal energy demand of the processes is included. Computing this kind of potential requires running accurate technical analyses for the most part;
- economical potential (economic, market) - depends on fuel and energy prices, taxes, financial structure and economic indexes such as payback time and others. This is the portion of technical potential that can be used taking into consideration economic criterions;
- usable potential (operational) - amount of energy that can be finally used for energetic purposes;

Deriving of theoretical and technical potential is the quick and simple way to obtain the general information on how to fulfill energy demand of the district. However, presented method has a serious disadvantage due to necessity of generalizing and approximating both at the stage of taking assumptions and while computing [3].

### Evaluation results

On the basis of input data and assumptions (tables 1-3) the value of theoretical and technical potential of biomass has been derived for specified kinds of biomass for the district. The calculations have been made for three different kinds of conversion of chemical energy of biomass: conversion via burning in water boilers, conversion via alcoholic fermentation and conversion via anaerobic fermentation.

Statistical agricultural data (tillage and land area, quantity of animal farming), crop yield and accessibility of particular kinds of biomass as well as its physical and chemical quality, efficiency of conversion of chemical energy to the heat has been presented in tables 1-3.

Table 1  
Assumptions and input data for calculating technical energetic potential of biomass fired in water boiler

Green biomass	Area	Accessibility	Crop yield/ Increment	Yearly logging	Low heating value	Efficiency of energy conversion
	A [ha]	D [%]	I	P [%]	$W_d$	$\eta$ [%]
Salix - fallow lands	469	60	11 Mg · ha	100	13.5 GJ/Mg	85
Salix - meadows	1 537	60	11 Mg · ha	100	13.5 GJ/Mg	85
Miscanthus grass - meadows	1 537	60	10 Mg · ha	100	14.2 GJ/Mg	85
Corn seeds	9 596	20	4 Mg · ha	100	14 GJ/Mg	80
Straw	9 596	62	4 Mg · ha	100	17.8 GJ/Mg	80
Forest wood	7 690	16	7.73 m <sup>3</sup> · ha	56	12.2 GJ/m <sup>3</sup>	80

Value of technical potential of biomass has been derived by multiplying each quantity placed in tables 1-3, according to each kind of biomass. In case of potential of biomass transformed in anaerobic fermentation of animal wastes (table 3) density of excrements has been taken into account. Results of calculation have been presented in tables 1-3 and in figure 1.

Table 2  
Assumptions and input data for calculating technical energetic potential of biomass used for alcoholic fermentation to produce biogas as a fuel for water boiler

Biomass	Area	Accessibility	Crop yield	Bioethanol production	Low heating value	Efficiency of energy conversion
	A [ha]	D [%]	I [Mg/ha]	S [dm <sup>3</sup> /Mg]	$W_d$ [GJ/dm <sup>3</sup> ]	$\eta$ [%]
Beets	431	10	40	80	23,4	85
Potatos	302	20	25	80		
Corn seeds	9 596	15	4	330		

Table 3  
Assumptions and input data for calculating technical energetic potential of biomass used for anaerobic fermentation to produce biogas as a fuel for water boiler

Biomass wastes	Number of cattle	Accessibility	Unitary excrement production	Organic dry matter content	Biogas production	Low heating value	Efficiency of energy conversion
	Z [animal]	D [%]	O [dm <sup>3</sup> /animal · day]	ODM% [%]	B [m <sup>3</sup> /kg of ODM]	$W_d$ [GJ/m <sup>3</sup> ]	$\eta$ [%]
Stock	3 003	60	30	12	0.40	21.5	85
Swine	9 480	70	6	5	0.45		
Poultry	47 449	60	0.066	17	0.46		

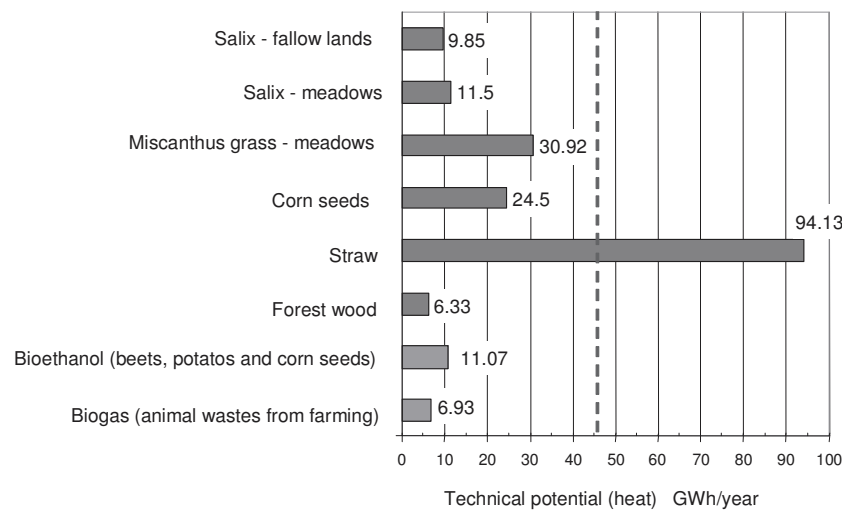


Fig. 1. Technical energetic potential of different kinds biomass derived for specified rural district

Derived values of technical potential of biomass shown in Figure 1 have been referred to the heat demand of the analyzed rural district. This demand is equal to 45 GWh and is marked with dashed line. It can be noticed from the figure that potential of straw is twice more bigger than demand.

## Conclusions

On the basis of the analyses it can be stated that:

1. Created evaluation algorithm can be a useful and convenient tool for computing energetic potential of biomass at theoretical and technical level.
2. Utility value of estimating energetic potential of biomass at theoretical and technical level is low for the reason of a big difference between theoretical level and economical and usable ones.
3. Results obtained by means of presented method are the basis for farther research made for specified areas (for instance for a rural district) with use of economic instruments and technical and economical analyses for investments oriented for biomass production and its conversion into usable forms of energy.
4. Evaluating of biomass should take place for closed area (for exemplary for rural district) taking into consideration possibilities of local production of biomass as well as local consumption of generated energy.

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## OCENA POTENCJAŁU ENERGETYCZNEGO BIOMASY

**Abstrakt:** Przedstawiono algorytm szacowania potencjału energetycznego biomasy pochodzenia roślinnego i zwierzęcego dla określonego obszaru geograficznego. Zaprezentowano zależności pomiędzy różnymi rodzajami potencjałów oraz koncepcję algorytmu szacowania. Na podstawie przyjętych informacji o areale poszczególnych upraw, nieużytków, obszarów leśnych oraz liczbie trzody chlewnej dokonano obliczeń wartości potencjału energetycznego dla jednej z gmin województwa opolskiego. Dla wybranych rodzajów biomasy zielonej i pochodzenia zwierzęcego wyznaczono potencjał teoretyczny i techniczny energii możliwej do uzyskania w wyniku jej odpowiedniego przetworzenia do nośnika energii w postaci ciepła. Wartość potencjału technicznego dla poszczególnych rodzajów biomasy odniesiono do całkowitego zapotrzebowania na ciepło grzewcze analizowanej gminy.

**Słowa kluczowe:** biomasa zielona, potencjał energetyczny, szacowanie potencjału, algorytm, zapotrzebowanie na ciepło