

## **Economic benefits of bio-energy generation from wood waste**

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**Abstract:** *Economic benefits of bio-energy generation from wood waste.* The article describes the production technology of wood pellets based on a production line of medium capacity and presents basic parameters of wood pellets depending on the type of the used raw material. Economic and ecological benefits of bio-energy production using wood waste are presented. It was shown that wood pellets, as a fuel, are characterized by a low production cost per 1 kWh energy (bio-energy) in comparison to other commonly used fuels.

*Keywords:* bio-energy, renewable energy sources, pellets, wood waste, effective costs of generation

### INTRODUCTION

In the course of combustion of fossil fuels waste products, particularly gases, are formed in large amounts. When released to the atmosphere they have a negative effect on the natural environment. Concern is voiced in the scientific community comprising conservationists first of all in connection with CO<sub>2</sub> emission, occurring as a result of combustion of hard coal, brown coal or oil. It disturbs the balance of this gas in the Earth atmosphere. This may be a significant factor having a negative impact on climatic conditions on Earth, which changes have been recorded for at least a decade.

In order to reduce the threat resulting from CO<sub>2</sub> emission it is recommended to replace fossil fuels with renewable energy sources. In accordance with the legal regulations of the European Union sellers of energy are obliged to purchase energy coming from renewable energy sources. In Poland by the end of 2010 the proportion of energy coming from renewable energy sources in the total energy consumption should exceed 7.5%. In the next years this proportion is to increase regularly so that it reaches at least 15% in the year 2020. According to the data of the Energy Regulatory Office of June 2010, a total of 1 229 installations using renewable energy sources were operating in Poland, at a power of 2 282 GW, including 15 power plants using biomass and generating 252 MW ([www.ure.gov.pl](http://www.ure.gov.pl)).

Bio-fuels produced from natural organic raw materials (biomass) constitute important renewable energy sources. Due to their origin, energy obtained from biomass is called bio-energy. Among numerous types of biomass considerable interest is focused on wood, particularly wood waste, from which wood pellets are produced. The German and Austrian standards define pellets as granulated (pelleted) material produced from pure sawdust coming from hardwood species. In contrast, in Poland this term is usually applied to pelleted wood material produced from any wood species, or it may even refer to pelleted product produced from any organic raw material. Due to the economic and ecological advantages of wood pellets the demand for this type of bio-fuel has been increasing both on the national and international scale. Production of wood pellets has been developing so intensively that shortages of raw material, particularly of the highest quality, have been observed.

### TECHNOLOGY OF WOOD PELLET PRODUCTION

Wood pellets are produced from sawdust and chips coming from rough mills where it is a waste product, or from chips specially produced from leftovers. The raw material is pressed under high pressure with no additional binding agents used. As a result of this process

the material takes the form of cylinders with a diameter from 6 to 25 mm. The size of the diameter for pellets is specified by the European standard.

The technological process of wood pellet production occurs in five stages. It is realized in production lines composed of several machines. Figure 1 presents a diagram of a medium-sized wood pellet production line. The first stage of the process is drying of the raw material. Wood waste in the form of sawdust, particles or chips, constituting the basic production material, may be characterized by moisture content of over 20%, which considerably exceeds the level required for the technological process. Thus additional drying of the material is required. This process is run until the raw material has a moisture content ranging from 10% to 14%. Drying is performed in belt driers or rotary driers, which are heated with a mixture of combustion gas, air and steam.

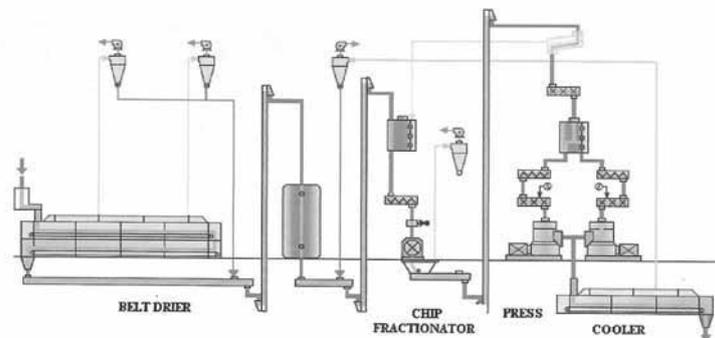


Fig. 1. A diagram of a medium-sized wood pellet production line - producer: Amandus Kahl (Germany)  
Source: based on [www.akahl.de](http://www.akahl.de), modified by the author.

The next stage of the technological process comprises disintegration of the wood material. This process is run until grains of max. 4 mm in diameter are obtained. This procedure is applied in order to produce a semi-product being uniform in size. Milling is performed in beating mills. In the next stage of the process such prepared material is pressed and pelleted (Fig. 2).

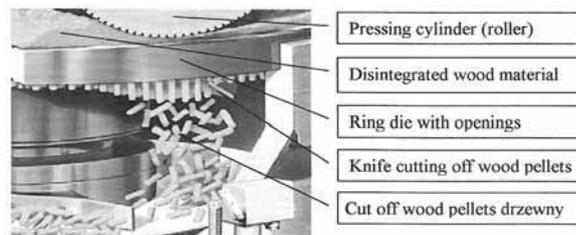


Fig.2. A fragment of the press for pressing and pelleting of wood material  
Source: based on [www.akahl.de](http://www.akahl.de), modified by the author.

For this purpose a press with a ring die is used. Depending on the diameter intended for the final product, a die with openings of 6 mm or 8 mm is used. Disintegrated wood material is next pressed through die openings using pressing cylinders (rollers) mounted on the head over the die. Material pressed to form these cylinders is pushed from the die. Cylinders are divided using a cutting knife into sections of several centimeters in length, typically 2 - 4 cm. Thus produced wood pellets are cooled in counter-current coolers. As a result of this procedure shape and strength parameters of the final product are stabilized. In the last but one stage too small wood pellet fractions are sieved off on fraction sieves. In the

end the final wood pellet product is packaged into bags of 10, 15 and 20 kg, or 1000 kg (the so-called Big Bag). For bulk buyers it may also be supplied in tanks. The basic properties of wood pellets depending on the wood species are presented in Table 1.

Table 1. Basic parameters of wood pellets depending on wood species

Type of fuel	Bulk density [kg/mp]	Moisture content [%]	Ash content [%]	Calorific value [MJ/kg]
Pellets from pine sawdust	667,6	9,61	1,29	17,67
Pellets from beech sawdust	598,4	7,04	0,80	17,81
Pellets from oak sawdust	608,7	7,95	0,40	18,03
Pellets from willow	592,3	8,78	2,15	17,09

Source: a study by the author based on Stolarski et al. 2007.

## BENEFITS OF ENERGY GENERATION FROM WOOD PELLETS

Wood pellets are an attractive fuel both from the economical and ecological point of view. They are characterized by a relatively good calorific value (see Table 1) in comparison with other bio-fuels and have a heating value exceeding 70% calorific value of the best coal grades. Their purchase price is competitive (650 – 750 zł/t), which results in low heating costs. Moreover, it is easy to use in heating boilers (Kryłowicz et al. 2004).

A comparison of effective costs (i.e. taking into consideration boiler efficiency) of the generation of 1 kWh energy obtained from combustion of wood pellets (0.17 zł/kWh) shows that it is similar to the cost of production of energy from carbon in the form of pea coal (0.16 zł/kWh). Higher costs of energy production are incurred in case of coke (0.30 zł/kWh), fuel oil (0.27 zł/kWh), liquefied petroleum gas – propane (0.22 zł/kWh) and natural gas (0.21 zł/kWh) (Tabert, Lis 2009).

Combustion of wood pellets does not introduce new pollutants to the natural environment. Carbon dioxide, released when burning wood in the form of pellets, enters the natural cycle of this gas in nature, as a result of its absorption by green plants, particularly forests. Forests are ecological systems, which are regenerated naturally and continuously as a result of absorption of solar energy. In photosynthetic processes green plants transform CO<sub>2</sub> captured from the atmosphere into organic substances, first of all cellulose (C<sub>6</sub>H<sub>10</sub>O<sub>5</sub>)<sub>n</sub>. It is the primary component of wood, which is next a raw material for the production of pellets. As a result the amount of carbon dioxide in the natural environment remains unchanged, circulating in the natural cycle. For this reason wood pellets are considered to be a valuable source of bio-energy (Tabert, Lis 2009).

Ecological advantages of wood pellets include also the emission of only trace amounts of SO<sub>2</sub> during combustion and the production of slight amounts of ash, containing no pollutants harmful for the environment. Ash contains non-organic compounds, mainly potassium and calcium carbohydrates. These compounds are good quality mineral fertilizer, which may be used in agriculture in crop nutrition (<http://www.pellets.pl>). The pelleted form facilitates automatic feeding to heating boilers. Modern boilers fueled by wood pellets practically require no manual operation. Ash is removed up to several times a month. In this respect maintenance of pellet-fueled boilers is similar to the operation of oil or gas-fueled boilers. However, it is almost two times cheaper.

An advantageous property of wood pellets is connected with its capacity to be safely stored, since this fuel exhibits no tendency to spontaneous ignition. In turn, it has a higher flash-point than coal, which facilitates the combustion process. It takes up thirty times less space than the raw material from which it was produced, which considerably reduces storage

costs. The reduced weight of pellets also results in the costs of transport being up to seven times lower in comparison to the transport costs of the original raw material. It may be stored for a longer period, since it has a lower moisture content and is resistant to natural putrefaction processes, in contrast to raw biomass. Pellets have a smooth surface, which well protects them against moisture absorption from the air. Increased interest in wood pellets observed in Poland, due to the energy and utility value, has also resulted in an increased demand for heating boilers fueled by wood pellets. There are approx. 20 producers and importers of these boilers on the market. Their offer is varied in terms of the class of this equipment, power, efficiency and price. Gross prices of Polish boilers range from 12 000 zł for boilers with a power of 15 kW to 30 000 zł for boilers with a power of 100 kW (Tabert, Popyk 2009). Boilers fueled by wood pellets are characterized on average by a two-fold higher efficiency than that of coal-fueled ones.

#### CONCLUSIONS

Wood pellets are attractive substitutes of traditional fuels, despite their lower calorific value. Effective cost of generating 1 kWh from wood pellets is lowest. The amount of 2.1 kg wood pellets is an equivalent of 1 l of fuel oil, while 1.4 t wood pellets are equivalent of 1 t of hard coal. It is an environmentally friendly fuel, as it emits practically no pollutants harmful for the environment. Wood pellets are convenient in transport, storage and use. They are most suitable for small heating installations, such as boiler rooms in small service and production workshops (e.g. bakeries) or detached houses.

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**Streszczenie:** *Ekonomiczne korzyści wytwarzania bioenergii z odpadów drzewnych.* W artykule przedstawiono technologię wytwarzania granulatu drzewnego na przykładzie linii produkcyjnej o średniej wydajności oraz scharakteryzowano podstawowe parametry granulatu drzewnego w zależności od rodzaju surowca. Wyznaczono ekonomiczne i ekologiczne korzyści wytwarzania energii z odpadów drzewnych. Wykazano, że granulaty drzewne, jako paliwo cechuje się niskim kosztem pozyskania jednej kWh energii (bioenergii) w porównaniu do innych powszechnie stosowanych paliw.

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