WBA fact sheet

PELLETS – A FAST GROWING ENERGY CARRIER

SUMMARY

Pellets are a solid biomass fuel, mainly produced from wood residues but also from agricultural by-products such as straw. They have a cylindrical form with a diameter of 6 – 12 mm. Specific advantages of pellets as compared to unprocessed biomass include: standardized properties, high energy content, high density and therefore reduced costs for transport, storage and handling. Pellets are used for residential heating in pellet stoves and pellet boilers, for the generation of heat, steam and electricity in the service industry, manufacturing and power generation. Main pellet producing regions in 2014 are Europe and North America. WBA expects a strong growth in the pellets consumption in Europe, North America and Asia.

INTRODUCTION

Bioenergy is the most important renewable energy and covered around 14% of the global final energy demand in the year 2011. When compared to other types of bioenergy, the pellet sector is one of the fastest growing.

Pelletizing technology was invented in the USA in the 1930's for the production of feed pellets. Bark was pelleted in the United States in the 1950's as a way to reduce waste volumes in the sawmill industry. Production of wood pellets for the heating market took off in USA in the 1970s by the time of the first oil crisis followed by Swedish start-ups ten years later.

Saw mills in northern Sweden introduced pellets into the market around 30 to 40 years ago in order to reduce the cost of transport from Northern Sweden to the main consumption regions in the South. Since then, the use of pellets grew continuously for residential heating, power generation, and for heat generation in the manufacturing and energy sectors.

In 2013, 22 million tonnes of pellets were produced worldwide in approximately 800 plants with individual capacity over 10 000 tonnes (FAOSTAT, 2014) (Biofuels International, 2014). The annual growth of the pellet production has been close to 20 %.

Figure 1. Photo: www.propellets.at/de/presse/fotos/

PELLETS – A HIGH QUALITY FUEL FROM BIOMASS

Pellet is a term used for a small particle of cylindrical form produced by compressing an original material. The term is used in a variety of contexts. In the context of energy, we distinguish between wood pellets and agro pellets based on the feedstock used. At present, pellets are mainly produced from wood residues, though the volume of pellets produced from agricultural by-products such as straw, husks of sunflower seeds and stalks and leaves of corn etc. is increasing.

A key advantages of pellets compared to unprocessed biomass is the high density and high energy content per unit volume (Table 1). This leads to significantly reduced costs for transport, storage, handling and use.

Another advantage is that they can be produced with standardized properties. This enhances their usability because boilers, stoves or pellet burners can be designed and constructed taking into account the standard fuel properties.

As a rule of thumb it can be said: 3m³ pellets ~ 2 ton pellets ~ 1 000 l heating oil.

Standardized quality is also a precondition for trading. ISO standards for pellets have recently been adopted that specify different quality classes for industrial use and for use in devices for residential heating (ISO 17225-2). In addition, a quality certification scheme has been introduced by the European Pellet Council,

TABLE 1. KEY PROPERTIES OF PELLETS FOR SMALL SCALE CONSUMER SYSTEMS

Pellet size	Length	20 – 30 mm
	Diameter	6 – 12 (9) mm
Moisture content		Less than 10 %
Calorific value		4.7 – 4.9 kWh/kg
Bulk density		600 kg/m³
Ash content		Less than 1 %

Source: European Pellet Council, 2013

ENplus, (Figure 2) that guarantees consistent quality of pellets for residential heating purposes by introducing standardized quality management procedures for production and trade. This so-called ENplus certification is now widely used both in Europe and North America.

HOW ARE PELLETS BEING PRODUCED?

Compared to other technologies of upgrading biomass, pelletisation is a fairly efficient, simple and low cost process. The four key steps within this process are:

- pre-milling of raw material
- drying of raw material
- milling of raw material
- densification of the product

These steps enable the production of a homogeneous fuel with low humidity and high energy density. In case dry raw materials are available, only milling and densification is necessary.

Currently about 80 % of globally produced pellets are made from woody biomass (EPC & WBA, 2014). In most cases, by-products from saw mills such as sawdust and shavings are used. Some large pellet mills also use low value wood as raw material. An increasing volume of traded pellets are being made from such materials as empty fruit bunch (from oil palm), bagasse, and rice husk.

Large scale production technology

The world's largest pellet plant in terms of pellet output is the Georgia Biomass Plant (USA) constructed by Andritz (Figure 3). This plant uses fast growing wood logs produced in pine plantations. The logs are debarked, chipped, dried and milled before densification in pellet mills. The Georgia Biomass Plant capacity is about 750 000 tonnes of pellets a year (Georgia Biomass, 2010). The wood demand of this plant is similar to that of an average paper mill.

Photo: Andritz

Figure 3. The 750 000 Tpa Georgia Biomass pellet plant, constructed by Andritz. View of the milling and pelleting halls.

Photo: Andritz

Figure 4. PBE wood pelleting plant in Vietnam supplied by Andritz. View of pelleting and cooling section.

Figure 2. The ENplus label on certification guarantees high pellet quality for end consumers.

Small-scale production technology

Small-scale technology for pellet production is typically based on sawdust shavings and off-cuts from sawmills or wood processing industries (Producers of floors, doors and furniture etc.) which adds value to their by-products by converting into pellets. Dry raw material is milled, and if needed, adjusted to precisely the right amount of humidity and the optimum temperature by pre-conditioning with steam prior to entering the pellet mill where it is densified. A cooler after the pellet mill reduces the temperature of the hot pellets after which the pellets are sifted before being bagged, or conveyed to finished product storage.

Figure 4 is an example of such plant in South East Asia This plant is able to produce 60 000 tonnes of pellets per year.

ENERGY EFFICIENCY OF PELLET PRODUCTION

A pelleting plant needs electric energy mainly for the milling and the densification of raw material. The amount of electricity needed can vary between 100 to 200 kWh per ton of produced pellets, depending on the raw material used and

the efficiency of the plant (EUBIA, 2014; Obernberger & Thek, 2010). If the product needs to be dried, additional thermal energy is necessary. Most plants use bark as a renewable fuel for generating the necessary heat. The heat demand depends on the humidity of the raw material and can amount up to 1 000 kWh per ton if wet saw dust is used (EUBIA, 2014; Sjoding, Kanoa, & Jensen, 2013).

The energy content of one ton of pellets is approximately 4 700 - 4 900 kWh. Consequently, the energy needed to produce the pellets can vary between 2 % and 25 % of their energy content. (EUBIA, 2014; Hansen, Jein, Hayes, & Bateman, 2009).

Energy is also needed to transport the fuel from the producer to the user. The amount of energy required for transportation depends on the type of transport technology used. For a given distance, the lowest energy demand is related to ship transport, the highest energy demand is for truck transport.

Transporting pellets in a truck over 200 km needs an amount of energy equivalent to 1 % of the energy contained in the pellets. Transporting pellets in a large ocean vessel over 5 000 km needs an amount of energy equivalent to 1 – 2 % of the energy content. (EPC & WBA, 2014)

As the major part of energy demand (which is used for drying) is usually provided by renewable energy (bark), the CO_2 balance of using pellets is very positive. CO_2 reduction by conversion of a heating system or a power plant from using fossil fuels to fuelling by pellets is typically between 80 and 90 % (Hansen, Jein, Hayes, & Bateman, 2009). In case of short transport distances from local pellet producers to residential consumers, CO_2 reduction compared to use of heating oil can reach 95 %.

PELLETS – A FUEL FOR MANY USES

Europe is currently the largest market for pellets. As Figure 5 shows, pellet use in Europe has increased by around 25 % per year over the last decade.

About half of the pellets are being used for power generation plants that have been converted from coal to pellet use or to partially replace the coal as fuel (co-firing). The other half of pellet consumption is used mainly for the generation of heat in households – either by pellet stoves or pellet boilers, for heating residential blocks, public or commercial buildings and for industrial steam demand.

The possibility to use pellets at almost any scale of demand, from small domestic appliances with few kW of output all the way up to huge power plants with hundreds of MW of power is one of the big advantages of pellets.

Development of pellet consumption in Europe (Million tonnes)

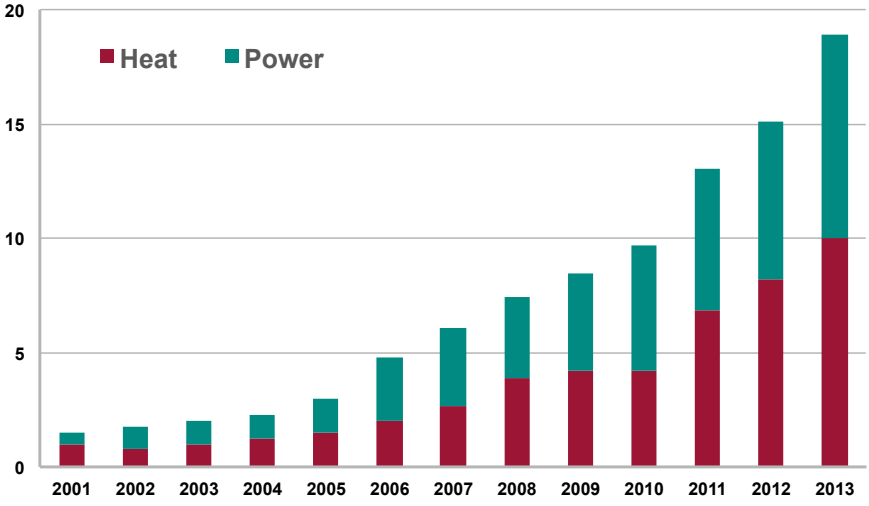

Figure 5. Development of pellet consumption in Europe (Million tonnes)
Source: Pellet atlas and AEBIOM statistical report, European Pellet Council, May 2014.

Figure 6. Pellet stove. Photo: www.propellets.at/de/presse/fotos

Figure 7. Pellet boiler. Photo: Ökofen

PELLET STOVES

Pellet stoves are highly efficient clean-burning devices that offer automatic operation and heat at very competitive prices (Figure 6). They can be purchased for 1 000 to 2 000 Euro and lead to annual savings of heating costs of 400 – 900 Euro (EPC & WBA, 2014), depending on the country and the replaced fuel. If pellets replace electric heating or heating oil, a payback of 1- 2 years can be achieved. Pellet stoves were invented in the USA during the first oil crisis and are currently extensively used in the USA, Italy, France, Spain, Greece and a number of other countries.

In developing countries like India, pellets are being used for cooking. They are

usually sourced from agricultural residues and they help replace the burning of firewood in rural communities. This has many advantages including: cheap fuel, improving health and economic conditions of rural communities.

RESIDENTIAL PELLET BOILERS

Residential pellet boilers offer even more convenience than pellet stoves (Figure 7). They use large bulk storage and offer fully automated heat supply. They are frequently used in countries with cold climates, such as Austria, Germany, Denmark or Sweden. More recently, pellet boilers are also starting to be successfully introduced in the U.K., France and Italy.

Pellet boilers for the heating of large buildings or industrial facilities are particularly economic but have only recently started to be more widely used in the mentioned markets.

PELLET USE IN POWER PLANTS, COMBINED HEAT AND POWER PLANTS AND INDUSTRIES

The advantage of using pellets in coal-fired power plants is that only minor modifications of the power plant need to be realized to use pellets as a fuel. This enables a plant to produce large amounts of renewable electricity with comparatively low investment costs. Usually plants being converted are adapted for co-firing which use pulverised coal as fuel. Pellets are milled and turned into wood powder, which is either burned together with coal dust or burned alone. The largest pellet fired power plant is DRAX power plant in the U.K. (DRAX, 2014). This plant alone uses 4.5 million tonnes of pellets per year for generating renewable electricity. The pellets used at DRAX reduces CO_2 emissions by 80% when compared to coal alone.

Pellets have great possibilities to replace fossil fuel in large industries, for example in the pulp industry. Pellets are normally pulverized (ground) into wood powder, which can be burned as such or together with oil, gas or ground black coal.

WHERE ARE PELLETS BEING PRODUCED?

As Figure 10 shows, most pellets are currently being produced in Europe. This is due to the fact that European policies aimed at increasing the use of renewable energy have led to a significant demand for pellets. More recently, growth of European pellet production has slowed down while

Figure 8. Drax power station: 2 of 6 blocks have been converted to firing woodpellets.


Figure 9. Domes for pellet storage at Drax power plant. Each dome can store 70 000 tonnes of pellets.

Global production of wood pellets (tonnes)

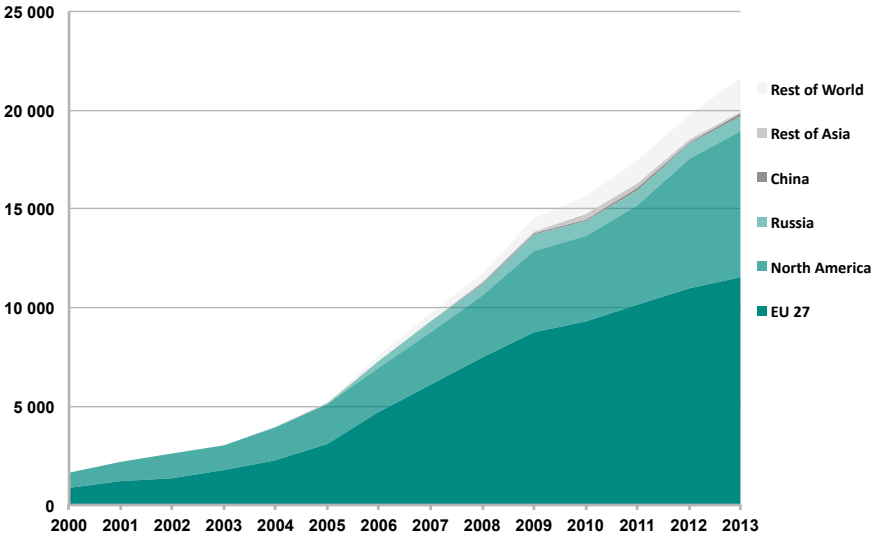

Figure 10. Global production of wood pellets.
Source: P. Lamers et al. / Renewable and Sustainable Energy Reviews 16 (2012) 3176– 3199
Source: FAOSTAT

North American pellet production has accelerated.

As demand for fibre wood in the U.S. has declined by almost 100 million tonnes over the last 15 years – due to the decreased demand for paper production – ample raw material is available at low prices (EPC & WBA, 2014). This creates a very attractive situation for pellet production. A major part of U.S. pellet production is exported to Europe, mainly for use in power plants. Russia could – in the future – also become a major supplier of pellets, in view of the vast forest resources of this country. Recently China has emerged as a major pellet producer. In China, mainly straw and stalks from corn and other agricultural crops is used as raw material for pellet production. By 2013, Chinese production of straw pellets amounted to approx. 6 million tonnes which is all produced in small scale plants based on agri-by products feed-stock from the local area (EPC & WBA, 2014).

THE ECONOMICS OF USING PELLETS

Pellets are more expensive than coal but significantly cheaper than heating oil.

Consequently, pellets replacing coal for use in power plants needs to be subsidised while its use in the heat market is economic on its own, without subsidy in most European Union countries.

Figure 11 shows the development of fossil fuel prices and pellet prices over the last decade in Austria – one of the main European pellet markets. Pellets cost only half as much as heating oil. This makes the conversion to pellet heating attractive, particularly for buildings with large heat demand. Technically, pellet boilers are more complex than boilers fuelled by heating oil and gas. Consequently investment costs are significantly higher and this may form a barrier for market development. For this reason, investment subsidies have been an important tool to kick off market development for pellet boilers.

Pellet stove markets have been able to develop with or without financial incentives due to the low upfront investment cost.

In the power sector, the use of biomass pellets simplifies and reduces the costs of the conversion of coal fired power stations to use of renewable energy compared to the costs and implication of conversion of the intakes and boiler systems to use of un-processed biomass. Further the boiler capacity is better maintained compared to fuelling by fossil fuels due to the higher energy content and low moisture of the pellets vs. raw biomass.

Average annual prices for heating fuels in Austria

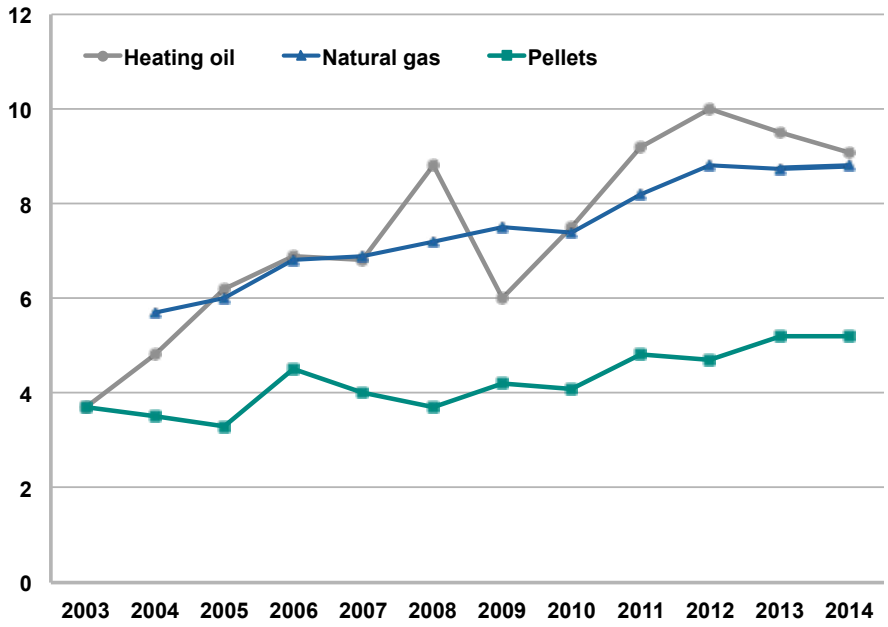

Figure 11. Average annual prices for heating fuels in Austria.
Sources: E - control, IWO, BMWFJ, proPellets, Austria: May 2014.

European pellet demand for heat market (kilo tonnes)

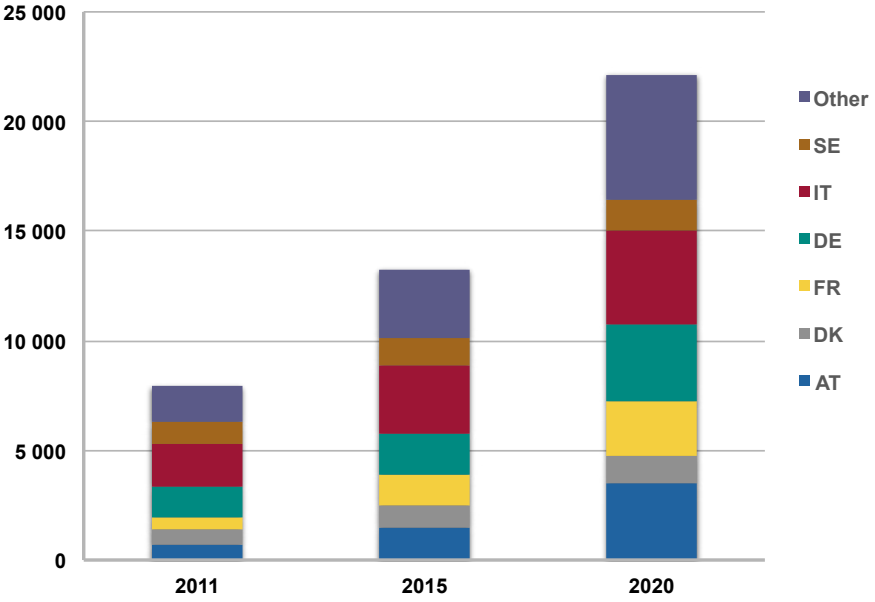

Figure 12. European pellet demand for heat market (kilo tonnes).
Sources: AEBIOM European Bioenergy Outlook 2012. EPC. Ekman

Figure 12 shows the countries in Europe with the largest demand for pellets used for heating.

It is noteworthy that in many countries, market development has hardly started. This is due to the fact that market kick-off usually needs policy initiatives, which have not yet been adopted by many countries. There is an imbalance between the support for renewable electricity – which has been promoted throughout Europe and in many countries worldwide – and the promotion of renewable heat, which has been widely neglected even though the economics of using renewable heat are better than the economics of using renewable electricity. ■

POSITION OF WBA

In 2011, biomass contributed 55 EJ to the global primary energy demand. The share of pellets with a consumption of 22 million tonnes – 0.38 EJ – was less than 1% in this bioenergy mix (World Bioenergy Association, 2014).

Yet, pellets have the potential to become a fuel with a significant importance in the global energy balance. The availability of wood as raw material is substantial and could be further extended by establishment of plantations of fast growing trees. Also, the possibility to use agricultural by-products offers a vast amount of resources. WBA expects a continuing growth of pellet production and suggest that a share of 2-3% of the biomass portfolio within ten years will be satisfied by pellets.

The public policy for the deployment of renewables very often overlooks the significance of the heat market. The heat market is the most important part of the energy market and pellets have the potential to become the "heating oil" of the 21st century. For example: Out of the 200 million dwellings in Europe, 85% are still heated with fossil fuels – mainly imported fossil gas. In Japan and North America, the situation is similar. In the situation where the world is facing climate problems and energy security issues, the WBA favours farsighted government policies such as carbon taxes and financial incentives to promote the use of pellets for combined heat and power and/or heat alone applications. This would reduce the heating expenses for the citizens, decrease the CO_2 emissions and improve the energy security. ■

SOURCES

Figures/Tables:

Table 1. (European Pellet Council, 2013)

Figure 5. (AEBIOM, 2013)

Figure 10. Global production of wood pellets 2012 (Source: IEA Bioenergy Task 40 and Bioenergy International, 2013) (Juninger, Goh, & Faaij, 2014)

Figure 11. This graph shows prices of fossil fuels and pellets. (proPellets Austria, 2013)

Figure 12. Pellet heating demand per country (Rakos, 2013)

AEBIOM. (2013). 2013 European Bioenergy Outlook. Brussels: AEBIOM.

Biofuels International. (2014). World of Pellets 2014. Stockholm: SBSAB.

DRAX. (2014). Our Business. Retrieved from DRAX: http://www.drax.com/about-us/our-businesses/

EPC & WBA. (2014). EPC and WBA calculations.

EUBIA. (2014). Economics, applications and standards. Retrieved from European Biomass Industry Association: http://www.eubia.org/index.php/about-biomass/biomass-pelleting/economics-applications-and-standards

European Pellet Council. (2013). Handbook for Certification of Wood Pellets for Heating Purposes. Brussels: EPC.

FAOSTAT. (2014, July 31). ForesSTAT. Retrieved from FAOSTAT: http://faostat.fao.org/site/626/DesktopDefault.aspx?PageID=626#ancor

Georgia Biomass. (2010). Georgia Biomass. Retrieved from http://www.gabiomass.com/

Hansen, M. T., Jein, A. R., Hayes, S., & Bateman, P. (2009). English Handbook for Wood Pellet Combustion. PelletsAtlas.

Juninger, M., Goh, C. S., & Faaij, A. (2014). International Bioenergy Trade - History, status & outlook on securing sustainable bioenergy supply, demand and markets. Springer.

Obernberger, I., & Thek, G. (2010). The pellet handbook - The production and thermal utilisation of biomass pellets. Earthscan.

proPellets Austria. (2013). Average annual prices for heating fuels in Austria.

Rakos, C. (2013). The European market for pellets in domestic heating - Trends and opportunities. European Pellet Council.

Sjoding, D., Kanoa, E., & Jensen, P. (2013). Developing a Wood Pellet/Densified Biomass Industry in Washington State: Opportunities and Challenges. Olympia: Washington State University.

World Bioenergy Association. (2014). WBA Global Bioenergy Statistics 2014. Stockholm: WBA.

World Bioenergy Association, Holländargatan 17, SE 111 60 Stockholm, Sweden
Tel. + 46 (0)8 441 70 80, info@worldbioenergy.org, www.worldbioenergy.org