The European Wood Pellets Market

A Master´s Thesis submitted for the degree of

"Master of Science"

supervised by

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Vienna 25/04/2009

Affidavit

I, **Thomas Leo Gstrein,** hereby declare

1. that I am the sole author of the present Master Thesis, "The European wood pellets market", 90 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master Thesis as an examination paper in any form in Austria or abroad.

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Abstract

EU set an ambitious program on renewable energies until 2020. Biomass will play an important role.

Within the biomass sector, wood pellets are an upcoming biofuel market. Recently wood pellets are commonly made of by-products of sawmill and wood processing industry, especially for small scale heating appliances.

The availability of sawmill by-products depends on the demand of sawnwood products. Sawmill is the bottleneck in the pellets logistics chain. The question is, in what extent raw material supply is able to meet the rising demand on wood pellets and what are possible alternatives to “classical” wood pellets.

Therefore an assessment of European forestry and sawnwood industry on the basis of several surveys was made. The results are compared with an estimation of pellets demand according to the biomass targets of EU policies.

An analysis of total costs for pellets production shows the influence of raw material costs.

The expected demand for wood pellets for medium scale heating, derived from the objectives of the EU climate and energy package, will not be covered by the standards of corresponding premium wood pellets. Even in the minimum scenario (10% of biomass heat demand is covered by the use of pellets and here again about 50% of that exclusively in small scale heating), 14 million tons of pellets will be required. The pellets supply that was derived from the sawmill industry forecast amounts to 8 million tons.

The raw material supply has to be widened. Pellets have to be produced from forestry residuals, from short rotation plantation on agricultural farmland and from agricultural products like grain, different types of grass, agricultural residuals etc.

New standard for non-wood pellets has to be developed to create a transparent and efficient market for different types of pellets for different purposes.

Boiler technology has to be improved for alternative pellets types to meet the regulations of flue gas emissions and to meet the technical requirements for more aggressive components.

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1 Introduction

Energy is considered to be a basic requirement for economy and for our whole civilization. Especially in highly developed countries, it is of major importance to guarantee a high quality supply of energy with unrestricted availability.
Space heating covers an important fraction of the energy market, at least in the cold and moderately cold parts of Europe. Heating systems for conventional fossil fuels have been on the market for a long time and thus are fairly optimized – this is comparable with cars in the transport sector. In both cases the introduction of alternatives is difficult for economic reasons. New technology for production of fuels and combustion has to be developed, supply chains have to be built up and lastly, consumers have to be convinced.
Twenty years ago a new fuel for heat and electricity was developed: wood pellets. Production and distribution of pellets have changed since the 80´s, more or less starting from scratch. Pellets production technology is well known in other industries (animal food production, garbage disposal). The incineration technology for wood pellets came out of the well-established wood chip combustion, but was developed specifically for the product wood pellets and has nowadays a high degree of mechanisation and comfort standards, comparable to liquid and gaseous fuels. A new market had to be built next to established energy structures dominated by large multinational fuel markets.
Wood pellets as biofuels are a part of European Union policy to reduce greenhouse gas emissions, to reduce dependence on energy imports, to diversify the basis of energy supply and to increase the share of renewable energies.
Biomass as an energy source is renewable and inexhaustible but biomass is not unlimited. Limitations are given by reproductive capacity of natural ecosystems and by competing with other utilisations (food, construction materials, etc.)
A general question arises: can the expectations of the European policy on wood pellets production fulfilled?

1.1 Core question of this master thesis

- How will future supply of pellets meet the growing demand and what are the perspectives of supply and demand in the European pellets market?

The focus of the work lies on the supply chain of industrial biomass. Energy use is competing with material usage. Therefore, the following ancillary questions:

- What is the estimated demand of pellets according to the energy objectives of EU policy up to 2020?
- What are the options on the supply side in order to meet the growing demand for pellets fuel needs?
- How much forestry biomass for energy utilisation will be available in 2020? What are the price components of pellets production and what is the role of raw material costs in the production process?

1.2 Methods:

Analysis of supply side: current and projections of utilization of forest biomass as raw material for pellets production with the focus on sustainable and environmental friendly production. Different surveys on projection of forestry and statistics in Europe are drawn on.
Derived from these projections estimations are made of pellet production in 2020 under current production methods and raw material sources.
The EU set targets on the share of renewable energies in 2020. A calculation of demand for wood pellets was made under consideration of EU biomass action plan and proposals of several NGO´s.
An analysis of costs of pellets production and a sensitivity analysis show the influence of raw material prices.

1.3 Presumptions

Due to the complexity and the dynamics of the pellets market some presumptions and restrictions were made.

- Focus of this thesis is the market for high quality pellets which are commonly used in small and medium scale heating systems. Wood pellets for utilization in power plants are more or less disregarded.
- It is assumed that EU energy targets will be achieved due to enforced policies of the Member States.
- Roundwood imports and exports from countries beyond Europe are not accounted.

2 Technology

2.1 Definition of Biomass

Biomass in a technical sense is a secondary product of solar energy. It is produced in the photosynthetic process by plant biomass. They convert CO_2 and water with the help of solar energy into primary biomass in form of starch, cellulose or hemi cellulose. Besides these main components there are several nutrients such as nitrogen, potassium and calcium and trace elements such as chlorine, sulfur, iron, copper, manganese etc. The proportion of these matters varies in different biomasses.

Biomass is renewable and inexhaustible but not unlimited: the annual rate of utilization is limited by the natural productivity of biomass sources.

2.2 Bioenergy

Biomass is the sun's stored energy. Since time immemorial, humans have used biomass as an energy carrier. After decades of dominance by fossil fuels, the use of biomass as an energy source has gained greatly in importance in the past few years.

Of all the biomass available for energy use, solid bio fuels constitute the most significant share of the market. Although there is an abundance of biomass throughout Europe, it only covers a small part of the total energy demand. By increasing usage, biomass could cover a greater share of energy demand and thus make a greater contribution to environmental protection.

Bioenergy has many advantages as well as drawbacks that must be considered in order to ensure efficient implementation.

Advantages:

- Widespread availability in Europe,
- Security of energy supply due to decreasing dependency on imported energy.
- Generally low fuel cost compared with fossil fuels,
- Technology well-developed, reliable and available all over Europe.

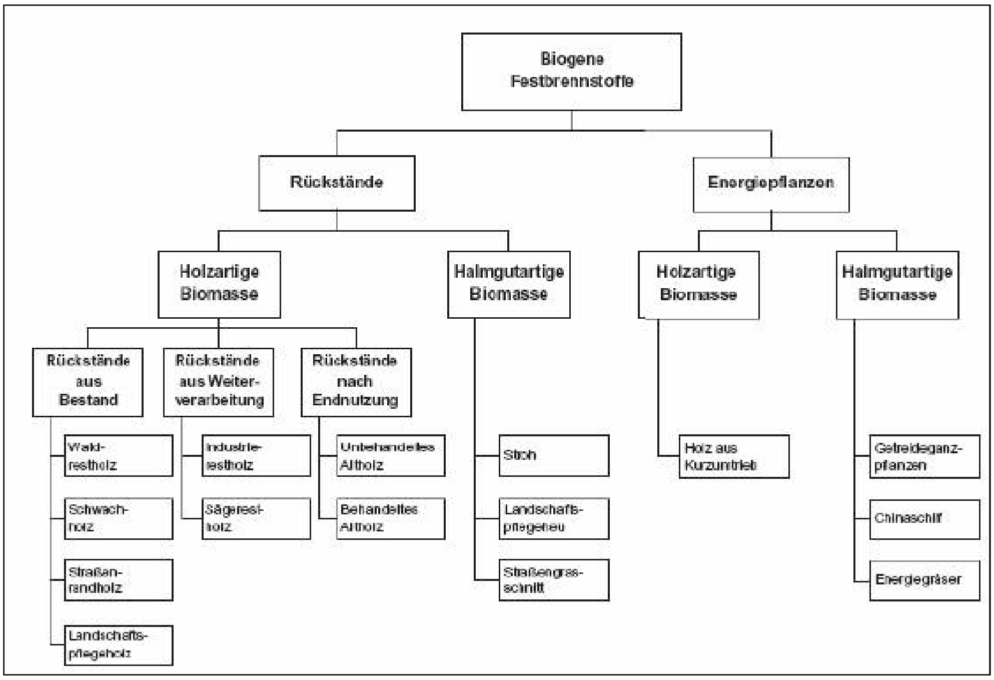
- Biomass can usually be stored in large amounts and can be produced on demand. Bio heat can be produced on demand.
- High conversion efficiency
- Creation of stable jobs, especially in rural areas
- Usually short transportation distances.
- Business opportunities for small companies, decentralised businesses.
- Developing technologies and know-how offer good opportunities for technology exports,
- Carbon dioxide mitigation and other emission reductions (SOx, etc.).

Drawbacks:

- Biomass is not inexhaustible on the local or global level!
- Generally low energy content and energy density
- Competition for the resource with material applications and food production.
- Generally quite a long production chain
- Generally higher investment costs for conversion into final energy in comparison with fossil alternatives.

2.3 Classification of energy biomass

Technically usable solid biomass fuels are divided according to their volume in residual materials and by-products of the material use of biomass and on the other side in energy crops grown specifically for energy purposes.



Source: FNR, 1997

Figure 1: Classification of solid biomass fuels

Furthermore, biomass can be differed to their structural characteristics in woody biomass and biomass from crops.

Generally it can be said that “energy plants” according to the figure above are related to more or less perennial agriculture whereas “residuals” origin mostly from forestry.

2.4 Characteristics of wood pellets

Wood pellets are usually made from dry, untreated, industrial wood waste such as sawdust, shavings or wood chips. The raw material is compressed under high pressure without using any glue.

Wood pellets are cylindrical in shape and usually 6-10 mm in diameter and 10 – 30 mm in length with moisture content of less than 10%.[1]

Pellets are a standardized fuel with easy handling and storage. It enables applications with high grade automation and rather low cost transportation in comparison to other biomass energy.

In comparison to other solid biomass fuels such as wood logs or wood chips wood pellets are more laborious and energy intense in production but have a much higher

[1] AEBIOM, 2007

energy density. This allows longer cost effective transport distances. Reloading occurs mostly by pneumatic systems and is very cost effective. Restrictions are given by abrasion which leads to dust problems and losses.

The net CO_2 balance is neutral: the same amount of CO_2 stored in the photosynthetic process is set free in the combustion. Apart from that energy is required for production and distribution of pellets and therefore in an overall look wood pellets cannot be accounted as a CO_2 neutral bio fuel. The total CO_2 equivalent is about 35 g per kWh[2].

Advantages of pellets utilization:[3]

- Wood pellets have less ash and emissions in comparison to other biomass fuels
- Utilization of Pellets help to reduce Europe´s dependency on oil and gas
- Pellets as domestic fuel resource create local employment and value added.
- Pellets reduce waste as this fuel resource is produced from by-products from wood industry and this reduces costs of disposing waste.
- Pellets are more convenient to store than other types of wood as the product doesn´t degrade due to low moisture content.
- Are more environmental friendly and save than fossil fuels.

Disadvantages:

- The process of pelletizing requires a certain amount of energy input and results in a higher price comparing to wood logs, briquettes or other forms of wood. About 13% of energy content is needed for the production (drying and electric power for production and transportation of raw material and pellets; calculation based on GEMIS) of pellets.[4]
- In comparison with oil, there is a need for larger storage facilities, regular control and removal of ashes.

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[2] www.wikipedia.org, 15.04.2009
[3] According to AEIBIOM, 2007
[4] www.wikipedia.org, 15.04.2009

2.5 Brief history of pellets development

The principle of producing of pellets has been known for 70 years, applied mostly in feeding stuff industry. For utilization as a biofuels, wood pellets development began in the early 70ies.

First efforts in utilization of wood pellets were made in the nineteen thirties. The post Second World War dreams of never ending sources of oil and nuclear power stopped the development. But the seventies energy crisis forced again the innovation of wood pellets production as a reaction to high heating oil prices, in particular in the USA and then in Sweden. The market dropped in the eighties when oil prices decreased again.

While in the USA pellets were also used for newly invented pellets stoves[5], in Scandinavian countries pellets were utilized likely in big CHP plants (Cogeneration Heat and Power plants). In the 80ies Sweden started large pellets co-firing in coal fired plants. In the beginning of the nineties a new tax on carbon dioxide emissions on fossil fuels accelerated the utilization of pellets in big heating plants. Between 1992 and 2001 pellets production increased from 50.000 tons to 670.000 tons a year.[6] In Northern Europe industrial utilization of pellets dominates till now. In the mid 90ies an Austrian wood producer discovered the pellets stove market in the US. After some trials the pellet market developed very fast, due to strong progresses in boiler technologies. A strong driver for expansion was the development of high convenient and low maintenance facilities quite similar to the well established fossil fuels driven technologies.

2.6 Pellets as a multi-purpose fuel

As we can see there are two lines of development. In Nordic countries pellets are used in large scale facilities in district heating and CHP whereas in central Europe pellets are predominantly used in small scale boilers (up to 100 kW). One of the main differentiations is the quality of raw materials.

Nowadays after several years of product, technology and market development we can distinguish between three types of users.[7]

[5] Cf. Janzing, 2004
[6] Cf. Egger et al, 2003
[7] AEBIOM, 2008

2.6.1 Small scale utilization

Small scale facilities are used for heating purposes in residential areas with a central heating boiler furnace or a stove with a demand of less than 10 tons per year.
For a smooth operation pellets of pure wood and with a defined standard have to be used.
Premium pellets are delivered in bulk by trucks with automatic blow in systems or in big bags.

2.6.2 Medium scale utilization

Medium scale utilization has a demand between 10 and 1000 tons of pellets. Typical use of medium scale boilers in commercial buildings (companies, hotels, public and health service etc.) and in multi storage residential units. Well developed heating systems and increasing prices of heating oil are the reasons for an impressive growth of market share in the medium scale.
Medium scale furnaces have lower requirements to quality of fuel. A mix of premium and industrial pellets can be used (for the characteristics of pellet types see below).

2.6.3 Large scale utilization

Large scale utilization has a demand of more than 1000 tons per year, used in power plants, big district heating companies and industries as a single fuel or in co-combustion with coal. These facilities might use several thousand tons of industrial pellets per year. The power plants are often located in the vicinity of harbours and the pellets are delivered by ship.
Large scale utilization is a global market with few market participants.

2.7 Pellets production chain[8]

Usually pellets are made of exclusion of bark. Bark determines the quality of the product regarding to combustion behaviour and slagging. Wood pellets are produced in special wood pellet plants. The production is strongly determined by the raw material (in quality and transportation distance from the raw material supplier. Controlling and quality security plays a key role in the manufacturing process.

[8] The pellets production will be described based on description prepared by Peksa-Blanchard et al, 2007.

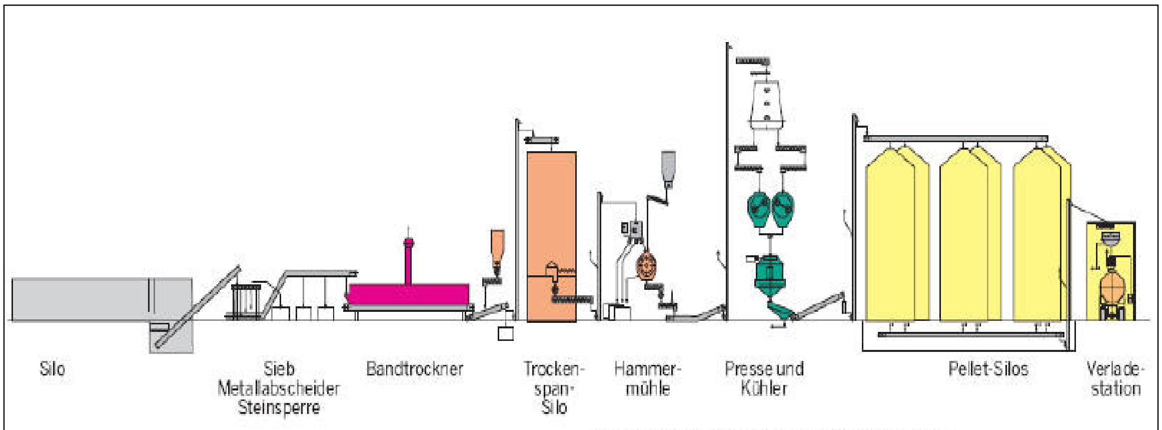
For the production of one ton of pellets will be needed about 7 cubic meter bulk sawdust.

Before sawdust, shavings or chips can be pelletized, it is important that the material is dry and homogeneous. Particles which are too big damage wood pellet quality therefore usually the raw material is pulverized using e.g. a hammer grinder. Also foreign matter has to be removed very carefully. Wet material is dried to a moisture level of about 8-10%. Pelletizing process itself is a very simple technology.

Different types of wood can be processed. However, the different binding capacity of different kind of wood (due to lignin content) and different pressing pressures has to be considered. Binding agents (starch, maize) are added to better for better stability.

The process of manufacturing pellets:

- Raw material handling and intermediate storage
- Drying
- Binding agent adding (starch)
- Raw material grinding: hammer mill, foreign matter separator and wood separator
- Conditioning: humidity regulation and ripening container
- Pelleting press with feed spout
- cooling
- grading and recirculation
- storage and filling station or packaging



Schematische Darstellung der Pelletproduktion
Grafik: nach Seeger Engineering AG

Source: NRW

2.7.1 Raw material delivery und handling:

Raw material management is one of the crucial points in a pellets facility. Saw dust has a low bulk density. It is costly in transportation over long distances. Usually pellets facilities are located near the saw mill or wood processing facility. Given to this, the raw material source determines the pellets plant scale. This leads to a limitation of number of supplier and increases the supplier dependency. Pellets manufacturers are depending on the market conditions for sawnwood industry and decisions of one or very few local wood processors.

2.7.2 Drying:

To qualify the raw material for the pelleting process the moisture content has be reduced to 9%. There are a lot of types of drying systems; the most common are belt dryer and tube bundle dryer.

The drying matter is either steam or hot water. Steam has the advantage of fine control, but a higher temperature level is required for drying and therefore higher operating costs. Belt dryers have by using hot water instead of steam to lower pellet production sequence.[9]

The energy demand for drying is quite high. Drying is one of the most important starting points for cost reduction in the pelleting process (e.g. more efficient drying process with heat removal). For the drying process, approximately 9% of so-called "grey energy" is required. However, internal wood wastes (bark, wood chips) are usable, so that from this side no deterioration of the energy balance results. It has to be noted that drying in the pellet process is not a loss of energy (in other case the drying happens in the incineration) but it is a cost and therefore a competition factor.

2.7.3 Grinding:

Then the chips fed to the hammer mill to a uniform grain size of a maximum of 4-6 mm. Particles of bigger sizes are separated by a sieve. Some raw materials like logging waste must be pre-processed (i.e. chipped) into a more manageable size for the milling equipment. It should be noted that material can be ground too fine, causing the material to lose its ‘fibre’ nature and thus not bind in the pelleting stage.

[9] Obernberger, Thek, 2001

2.7.4 Conditioning:

Crucial to the pressing process is the uniform moisture content of chips. In the conditioner the raw material will be treated with water or steam. For consistent moisture of 10-15%, the raw material is kept in a mature container for a while.

2.7.5 Pelleting:

Pelleting machines, also known as extruders, come in two common forms:

- Flat die: where raw material is pressed through the top of a horizontally mounted die.
- Rotary die: where two (or more) rotary presses push raw material from inside a ring die to the outside where it can be cut into the desired length.

Both systems create a pellet by using a great deal of pressure to force the raw material through holes in the die. As pressure and friction increase so does the temperature of the wood. This allows lignin to soften and the fibre to be reshaped into pellet form.

Wood consists mainly of cellulose and lignin. Under high pressure and temperature lignin becomes viscous and is coating the cellulose cells and leads to a glue effect.

To increase the abrasion resistance, a binding agent is added (maize or corn starch). Usually 0.5% is added.

2.7.6 Cooling

Cooling immediately after pelleting is a crucial part in the process. Leaving the extruder pellets are soft and hot (90 – 95°C). Cooling determines strength and durability of the pellets cylinders. Cooling with air allows the lignin to solidify and gives the pellets a surplus on stability.

2.7.7 Screening:

A vibrating screen is separating fine parts (dust) from the pellets. The dust will be removed to the process for a high yield of raw material. After screening pellets are ready for packaging in bags or filling in trucks.

2.7.8 Storage and Loading:

Pellets can be distributed in bulk form, by truck, rail or ship or bagged in smaller quantities (15 kg bags are a common and practical size).

Bulk delivery of pellets is very similar to a delivery of home heating oil and is carried out by the lorry driver blowing the pellets into the storage space, while a suction pump takes away any dust. Storage solutions include underground tanks, container units, silos or storage within the boiler room.
Wood pellets do not degrade over time, as long as they are stored in dry conditions.

Gentle pellet loading, storage and transport systems are essential to minimize the amount of dust or fines generated during handling operations. Research continues to improve pellet durability to increase resistance to mechanical abrasion. Design of more efficient pellet storage, charging and combustion systems for domestic users is on-going, in order to optimize delivery of wood pellets to residential markets.

2.8 Pellets ≠ Pellets: Premium pellets and industrial pellets

For a market description it makes sense to differentiate the market:

- Utilization of pellets in large scale boilers: industrial pellets
- Utilization of pellets in small scale boilers: premium pellets

The differences are founded in the used raw material and in transportation logistics.

2.8.1 Industrial pellets

Characteristics:
Industrial pellets or brown pellets are 4 – 12 mm in diameter. They are produced with lower pressure and have less or strictly no binding agents. Abrasion by transport and reload is much higher which leads to problems in small and medium scale incinerations.
Industrial pellets contain high shares of mineral components such as potassium, sodium, sulfur, chlorine and nitrogen. In the combustion more ash is produced. Flue gas is more aggressive and this causes corrosion problems and slag on the boiler and heat exchanger. Small scale furnaces are not suitable to handle these problems. Normally boiler manufacturers exclude the utilization of industrial pellets in their warranty provisions.
Industrial pellets are used in power plants or district heating plants with a capacity of more than 100 kW. They are utilized as co-firing fuel in coal power plants or as a mono fuel.
A recent development is the possibility of adding industrial pellets to medium wood chip boilers. The flow properties of the fuel can be improved and thereby

vulnerability of the boiler will be reduced. High energy density helps to reduce costs of transportation and expand the catchment area of supply.

Production:

There are no special requirements on the raw material. Bark and other low-grade wood materials or raw materials from agricultural production processes can be utilized. Industrial pellets have a wider range in diameter. Pelletizing pressures are lower and there are no binding agents added. For these reasons, production costs are much lower than for premium pellets.

Due to lower raw material and manufacturing costs the industry pellets are about 30-50% cheaper than wood pellets within the standards “DIN Plus” or “Ö-Norm M 7136.

Utilization and Trade:

Trade of industry pellets is a wholesale market. In general, they are not available in small quantities. The market is dominated by a small number of market participants on supplier side as well as on customer side.

Usually industrial pellets are utilized in large scale heating plants and cogeneration of heat and power.

Typical utilization is in power plants in the vicinity of harbors with ship cost effective transportation.

Just over half of the used pellets in Europe were used for the power production. In 2007 3.3 million tons to 6.3 million tons were used in power plants.

Raw material:

Raw material comes from wood processing residuals as well as from forest residues and from agricultural residues. Even peat (which is not considered a biomass by the European Commission) or sugar cane residues (bagasse) are utilizable for pellets production.

It is more or less a global market with high flexibility in supply quality.

Main imports from overseas come from Canada (severe problems with mountain pine beetle leads to thousands of km^2 of dead wood, import to Europe 600.000 tons in 2007) and USA. Brazil, Argentina, South Africa, Eastern Asian countries and even China are on the way to step into the pellet market. These countries have a huge theoretical and technical potential on biomass. There are a lot of rumours and vague developments. But the contours are becoming clearer and clearer.

Transport costs play a significant role in overseas trade. Prices for overseas shipments vary greatly. Prices for transportation can reach a share of about 50%, depending on shipment availability.[10]

2.8.2 Premium pellets

For smooth boiler operation pellets of well defined quality are required. In the early days some problems in pellets quality led to imperfect combustion, failures and higher maintenance costs. The aim of cost reduction and rigorous exhaust gas regulations forced the development of standardized pellet qualities ("premium pellets") as defined in ÖNORM, DIN, DIN+.

Boiler manufacturers insist on premium pellets for fulfilment of implied warranty. The defined parameters are also requested for fulfilment of exhaust gas emission thresholds and to prevent damages due to corrosion and slagging. This leads to a necessarily utilization of high quality raw material without any impurities such as shavings from saw mills without bark and any other contaminations.

Table 1: Parameters and thresholds in selected standards for Premium Pellets

	ÖNORM M7135	DIN 51731	DIN+
Diameter	4 ≤ D ≤ 10 mm	4 ≤ D ≤ 10 mm	-
Length	≤ 5xD	< 50 mm	≤ 5xD
Density	≥ 1.12 kg/dm3	≥ 1.00 kg/dm3	≥ 1.12 kg/dm3
Calorific value	≥ 18MJ/kg	17.5 - 19.5 MJ/kg	≥ 18MJ/kg
Water content	≤ 10%	≤ 12%	≤ 10%
Abrasion	2.3%	-	2.3%
Ash content	≤ 0.5%	≤ 1.5%	≤ 0.5%
Additives	< 2%	-	< 2%
Sulfur	< 0.04%	< 0.08%	< 0.04%
Nitrogen	< 0.3%	< 0.3%	< 0.3%
Chlorine	< 0.02%	0.03%	<0.02%

Constraints to ensure high quality:

- In the entire chain from production to combustion high quality standards have to be met. No link in the chain may fall below the quality criteria.
- In small scale furnaces, only pure wood raw materials are used. Avoidance of bark or other "green matter" to prevent damages on boiler equipments.

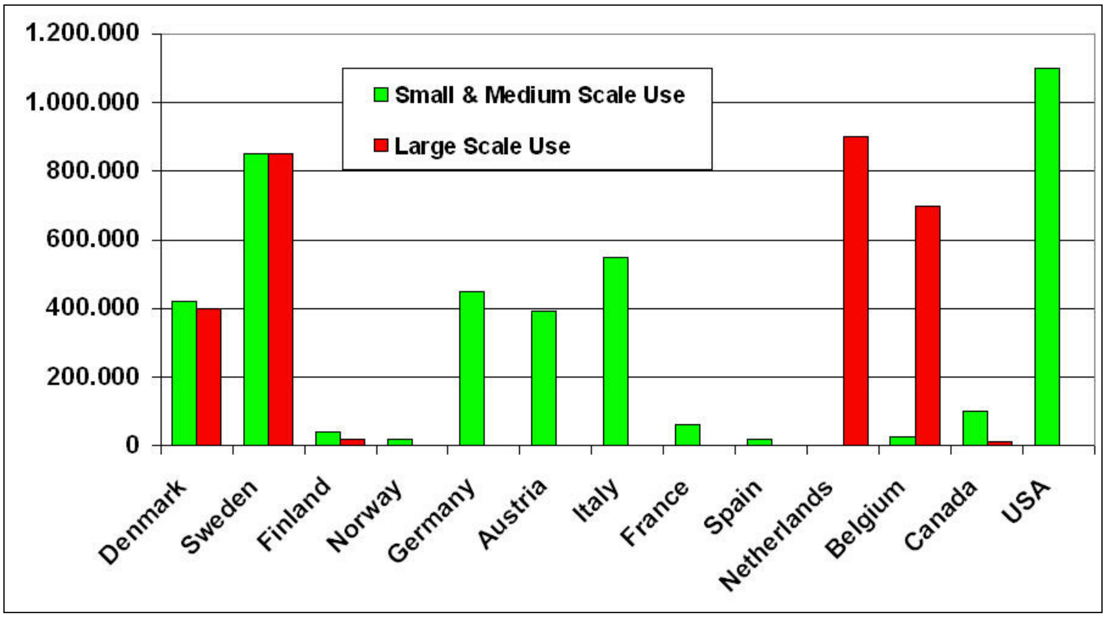
[10] Kassmannhuber, 2009, words by mouth

- Abrasion must be kept in clear and defined boundaries. The fines in the store as the last storage before incineration process must be below 10%.
- Boiler technology must be able to handle slight fluctuations in fuel qualities. Temperature in boiler must be kept under a certain temperature to prevent melting of ash.

The constraints above for a smooth operation of small scale furnaces lead to the exclusive utilization of bark free wood without any foreign matter.

2.8.3 European consumption of premium and industrial pellets

The table shows the distribution of industrial and premium pellets. Industrial pellets are mostly used in power plants; therefore they are mainly used in countries with port facilities.



Source: pro pellets Austria

Figure 2: Pellets utilization in selected European countries in 2007

3 Raw material supply

The following considerations relate to the commodity demand for premium pellets. The objective of this chapter is to draw the line from the potential of Europe´s forest to the pellet mill storage and try to make an estimation of available amounts for pellet production.

3.1 Forestry in Europe

This chapter gives an overview of the theoretical availability of forest biomass. The productivity of forests is the basis for all other uses. The capacity of forests is limited and justified on environmental parameters. Therefore, Europe´s forest biomass for bioenergy has been investigated so we know in theory how much is available and where the additional quantities of biomass can be mobilized.

On the one hand wood from forestry production has always been a main source of raw materials for a variety of material uses and on the other hand it has been traditionally utilized as fuel wood for energy purposes.

The resulting rising demand for bioenergy and the need of wood for paper and board industry, raise the question of the extent to which the demand of all users can be met.

Excursus: Definition "industrial biomass"

In German-speaking countries (e.g. Kranzl et al (2008)) the aggregation of wood fuel and wood residuals from forestry is named biomass from forestry whereas the term "industrial biomass" means residuals from wood processing industry (sawdust, shavings, grinding dust, bark, wood chips of trimmings and off cuts).

In Anglophone countries "industrial biomass" is defined as all biomass treated and used for material or energetic use. This work uses the Anglophone definition.

Forests cover 30% of Europe. Traditionally forest biomass is both, a major raw material resource for utilization of wood such as wood for buildings, carpentry and paper as well as wood fuel for heating purposes.

On a worldwide look the rate of utilization of forest resources varies from country to country. Overuse utilization, poor forest management and a lack of forest conservation policy based on sustainability on one hand and sensitive forest

biospheres on the other hand can lead to serious problems such as deforestation, desertification and loss of tropical forests.
But in other parts of the world a sustainable utilization of forest wood can be increased without harming the biodiversity and productivity of forests.

3.1.1 Trends in forestry under aspects of conservation

The aspects of the conservation of biological diversity and productivity are central arguments when considering the sustainable use of solid biomass for energy purposes. Over-exploitation leads to reduction of the efficiency of resources. The work provides an assessment of the technical potential for the use of forest biomass for EU 25 in the light of sustainability and environmental aspects: additional pressures on biodiversity, soil and water resources and the potential are in line with current and potential future environmental policies and objectives.
It does not include the cost of felling and haulage and does not include the mobilization / immobilization of biomass, due to specific ownership or ownership decisions.
(EAA, 2006) made in a survey an assessment based on the consideration of environmental guidelines. These guidelines ensure that no additional environmental pressures are created.

As essential factors for the conservation of biological diversity and performance have been identified:

- **Biodiversity:** Forests are habitat for a wide range of different organisms: fungi, plants, animals. A high degree of diversity promotes stability of the stocks and the ability to take control of interference. The modern forest management will be increasingly seen as free use of productive forces identified and promoted. Excessive extraction of residuals thus affects negative impacts of flora and fauna through habitat homogenization and more intense soil disturbance.
- **Fertility**: The removal of biomass is also a removal of nutrients, which are not available for the subsequent generations anymore. The nutrient content of woody plants in the various parts of plants varies. Leaves, needles, twigs, fine branches and bark contain the highest proportions. This is especially the case for xylem (the highest proportions of cellulose and lignin).

- **Soil erosion**: Diminished coverage caused by enforced logging and removal of logging residues and rational use of machines increase erosion effects caused by rain and wind.
- **Water protection**: Logging residues and deadwood have positive impacts on water regulation and act as filters to improve water quality.

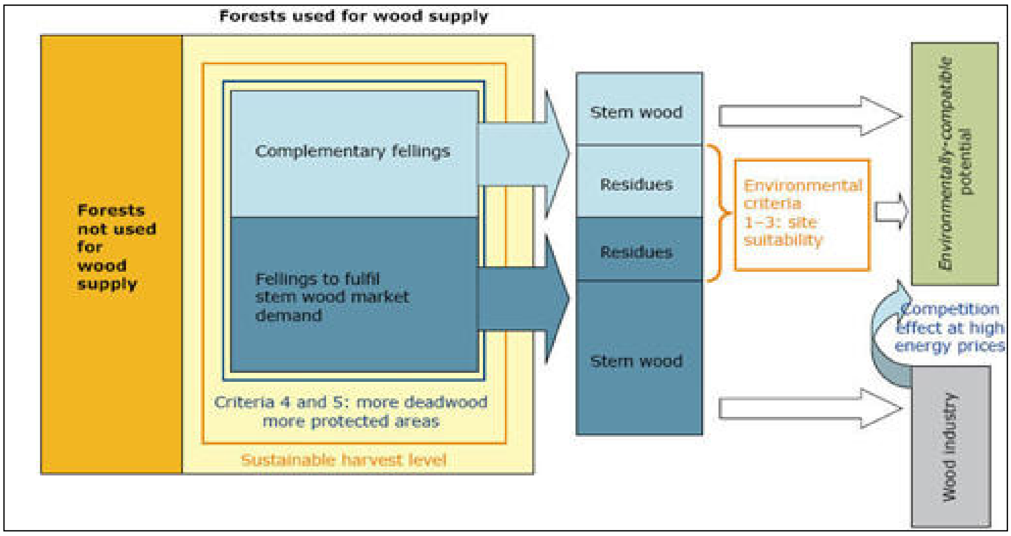
Under consideration of these parameters EEA (2006) suggest measures to avoid increasing environmental pressures on forests

1. No intensification of use on protected areas.
2. Foliage and roots are always left on site.
3. The extraction rates for residues from stem and branches are limited according to the suitability of site.
4. A reduction of the area available for wood supply in each member state by 5% in order to allow for an increase in protected areas.
5. A set-aside of 5% of wood volume as individual and small groups of retention trees after harvesting in order to increase the amount of large diameter trees and deadwood.

   In combination, the above two factors reduce the total maximum sustainable harvest volume by 10%.

It is assumed, that the amount of forest residues is directly dependent on the demand for stem wood. The demand is based on FAO statistics with a slow increase in the next 20 years. The scenario suggests an increase in wood demand of 20% between 2000 and 2030.

On the other hand, the complementary fellings are inversely-proportional to the demand for stem wood. Thus, this is the most important driver behind the available forestry potential.



Source: eea

Figure 3: Schematic presentation of the approach for forestry biomass flows

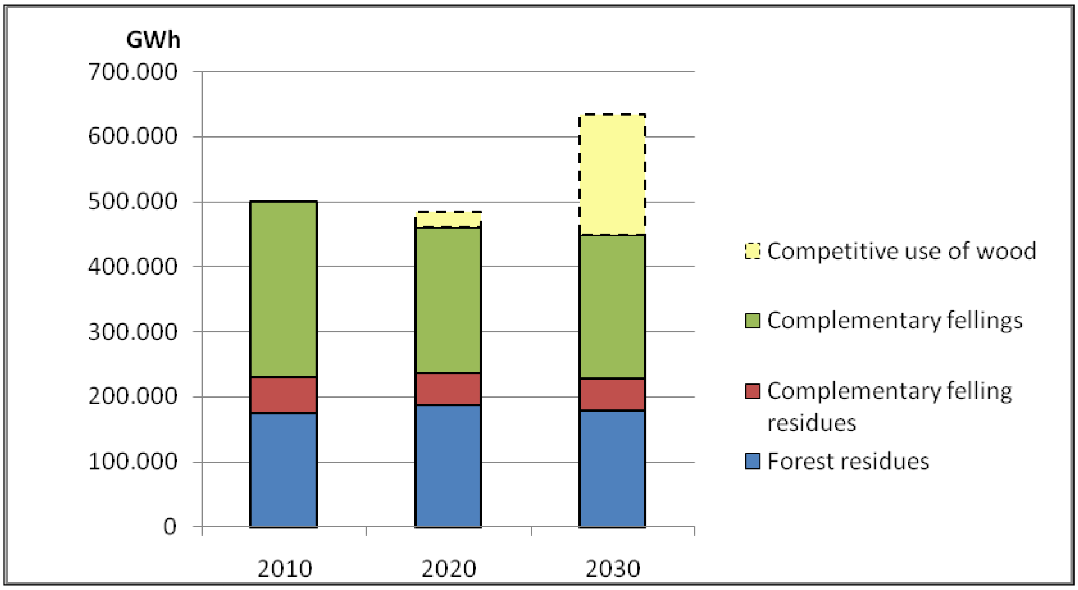
The study is based on the assumption that the bioenergy potential for additional uses of roundwood (despite the felling for wood processing) can be described as the difference between the maximum sustainable harvest level (in German so called "Nachhaltigkeitshiebsatz") and actual fellings.

The maximum sustainable harvest level was reduced by 10% to account for an assumed increase in protected forest areas as well as of large diameter trees and deadwood managed forests.

The study takes into account in its estimate the additional use of these resources. The estimate is based on a classification threshold of site suitability for forest residue removal.

The survey (EEA Report 2006) estimates an environmentally compatible potential of about 86 million m3 wood for the EU25 (excl. Greece, Lux., Malta and Cyprus). It does include the utilization of wood residues from harvesting, complementary fellings and the residues of complementary fellings. Not included is the increase of forest land in Europe. Between 1990 and 2000, the annual afforestation rate in the EU was about 360.000 ha each year. Short rotation and new plantation are not included either.[11]

[11] EAA, 2006, S. 41



Source: EEA, 2006, elaborated by the author

Figure 4: Technical Potential for energetic use of forestry in EU 25

Results of the survey (EEA, 2006) given for the EU 25

- The study considers the technical potential, taking into account the conservation and sustainability aspects. It is also assumed, that higher prices for energy would lead to a mobilization for bioenergy from other wood processing industries. However it does not include the willingness from land owners to harvest their wood potentials.
- The environmentally-compatible bioenergy potential from forestry residues is estimated to be around 190,000 GWh in 2010, increasing to 267,000 GWh in 2030.
- Complementary fellings and their residues are 325,000 GWh in 2010 and 270,000 GWh in 2030.
- If we assume an increase in fossil energy prices, substantial additional amounts up to 185,000 GWh wood biomass resources may be used for bioenergy and not for other competing wood processing industries by 2030, mostly at the expense of pulp and paper production. It is assumed, that pulp and paper production declines by around 38% under the given price assumptions.
- The numbers does not include the new member states Romania and Bulgaria. It can be estimated, that in the purpose of this study Bulgaria has a bioenergy from forestry potential of about 20,000 GWh, Romania has a potential of 21,000 GWh.

- The costs of harvesting residuals and pelletizing them are quite high. Utilization for wood chips is much cheaper and will be the common utilization mode.
- At beneficial preconditions (full mechanized harvesting and short transportation) a small share on forest residuals will be available for pellet production. It is estimated at 30% of total potential of forest residues. This equals an amount of 15 million tons of pellets.

3.2 Sawnwood production from forestry

The wood processing industry is the supplier of raw materials for pellets production. The question of how many pellets can be produced depends on the production of the wood processing industry, and thus the demand for sawnwood and other wood products.

This chapter gives an overview of how the sawmill and wood processing industry will develop until 2020 and how much sawdust as a raw material for pellets production will accumulate in this period.

3.2.1 Raw material demand for wood processing industry

An important trend in Europe had been the structural change in wood utilization in the last four decades. New innovations and technologies created new wood products. Hence, the rates of growth in panel production (fibreboards and particle boards) had been much higher than the rates of growth in sawnwood and plywood production.

The structural changes in wood product markets and the rapid growth in paper and paperboard markets led to significant changes in the demand of wood raw materials and the availability of different types of wood. Saw log demand declined whereas the demand for small size roundwood and industrial roundwood increased rapidly. At the same time alternative resources such as wood residues, recycled wood and recovered paper became more and more important and partially substituted small size roundwood.

The proportion of exported/ imported wood products represents another important trend in the last four decades. This appears on the global, European and regional level. This is due to new technologies and production streamlining that implicated a more specialized and concentrated production. This trend will continue in future.

The forecast expansion of production, consumption and trade will require a higher level of fellings in all European countries. For Europe as a whole, production and consumption of industrial roundwood are forecast to increase by slightly more than 40 percent from 2000 to 2020[12].

The ratio of fellings to net annual increment, which is a crude indicator of the sustainability of wood supply, is expected to rise in all countries, but it is not expected to exceed 100 percent. Furthermore, European production and consumption are expected to remain roughly in balance, with exports from east to west in 2020 at levels that are similar to those valid at present.

The greatest increase in production is expected in the CIS sub-region (states of the former Soviet-Union: Russia, Belarus, Ukraine, Moldavia, the Baltic states), where production in 2020 could double the level recorded in 2000. In Western Europe, production and consumption will expand at the same rate as in the past. In Eastern Europe, production and consumption growth will slow down compared to recent years (i.e. since 1990) as some countries start to reach the limits of available wood supply. However, the forecast rate of growth will be similar to the long-term historical trend for this sub-region.

The share on consumption of classical sawnwood will decline and share of wood-based panels remain almost constant. The consumption of forest products for paper and paperboard industry will grow significantly[13].

Paper and paperboard industry uses wood from forestry as well as products from wood processing industry. Assuming that the industry for paper and wood panel needs a quite constant proportion of sawdust and shaving residues for their production, the demand for by-products will increase at the same rate. In a future scenario there will be less sawdust as a raw material for pellet production available on the market.

[12] UNECE, p.183

[13] Cf. Whiteman, 2006: share of sawnwood on total forest production will decline from 50% in the 1970ies to 25% in 2020.

Table 2: European wood raw material balance in 2020

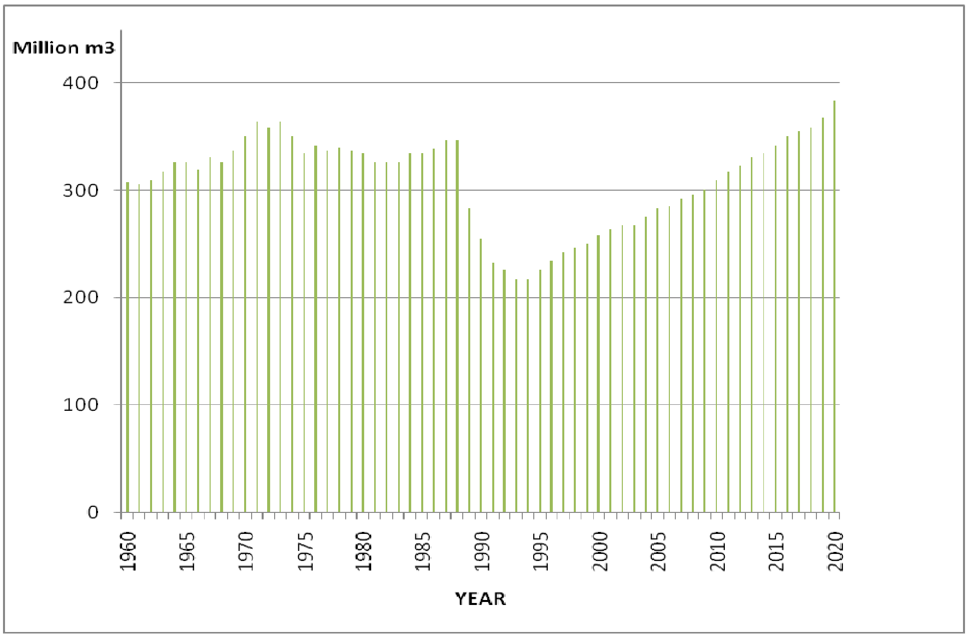
Component	Europe	Sub-regions		
		Western Europe	Eastern Europe	CIS
Derived demand for wood raw materials				
Other industrial roundwood	27.7	6.9	10.1	10.7
Sawnwood, plywood and veneer sheets	383.9	191.8	72.1	119.9
Reconstituted panels	141.8	85.2	32.1	24.4
Net pulp exports	52.1	21.5	3.0	27.7
Paper and paperboard	604.1	465.1	69.9	69.1
Total derived demand	**1,209.7**	**770.6**	**187.2**	**251.8**
Consumption of wood raw materials				
Industrial roundwood	659.4	337.4	130.0	192.0
Recovered paper	315.4	246.5	38.3	30.7
Net pulp imports	83.1	72.3	9.2	1.6
Other	151.8	114.5	9.8	27.6
- net imports of chips, particles and residues	*0.1*	*5.9*	*-4.0*	*-1.8*
- utilisation of wood residues	*151.7*	*108.5*	*13.8*	*29.4*
Total consumption	**1,209.7**	**770.6**	**187.2**	**251.8**

Note: the above figures are expressed in million m^3 WRME. For trade in chips, particles and residues, imports are shown as a positive number and exports are shown as negative numbers.

Source: UNECE

The demand for raw material for sawnwood and plywood production for Western- and Eastern Europe (EU 27 + Balkan + turkey) is about 264 million m3 in 2020. Including the CIS sub region states the demand will be 384 million m3. As shown on the table there will be dominance of sawnwood and plywood in Eastern Europe whereas in Western Europe the demand for wood raw material will be dominated by paper and paperboard.

Comparing the increasing demand of bio fuels in general and especially for pellets in Western Europe together with the future production of sawnwood in Europe we can derive a future perspective of the European trade of pellets. The radius of trade will expand from more or less Western Europe to the borders of the Ural.



Source: UNECE, own elaboration

Figure 5: Raw material demand for sawnwood demand in Europe incl. CIS sub region

In Figure 5 we can see a massive decline in demand for sawnwood in the nineties due to the transition in Eastern Europe. In 2015 it will be on the same level as in the seventies. The increase of production starting at the beginning in the early nineties is a result of the increase in sawnwood production in Eastern Europe and mainly in the CIS sub region.

3.2.2 Net trade in Europe of industrial biomass

In Western Europe Sawnwood production and panel production stagnates or decreases slightly and has to be balanced by imports. Considerable proportions will be imported from the geographically near Eastern Europe and the CIS sub-region (Russia).

Table 4 shows that Eastern Europe is becoming a net exporter of sawnwood. The export rate will increase from 16.3 million m3 in 2000 to 36 million m3 in 2020.

Table 3: Net trade in European sub-region in 2000 and 2020 (in million m3)

Product	Western Europe		Eastern Europe		CIS	
	2000	2020	2000	2020	2000	2020
Sawnwood (in CUM)	-8.8	-8.2	+8.4	+12.5	+7.9	+23.5
Wood based panels (in CUM)	-1.7	-1.2	+0.9	+0.2	+1.2	+3.3
Paper and paperboard (in MT)	+9.3	+6.1	-1.9	-7.1	+1.6	+5.3

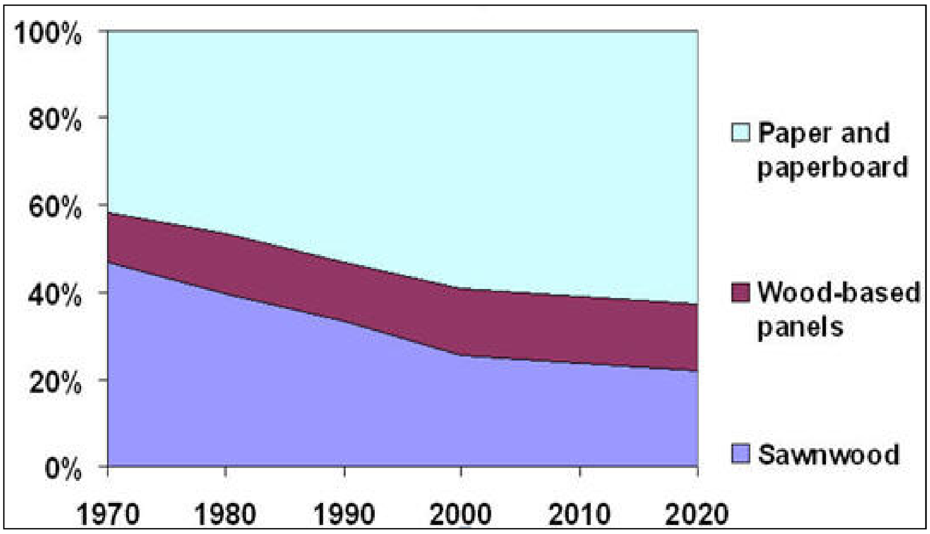
Note: positive values are net exports and negative values are net imports.

Source: UNECE

Normally pellets are produced close to sawmill. Low energy density of sawdust is leading to high transportation costs.

However, pellets have the highest energy density of wood biomass. As it is the case for the development of trade for sawnwood, an increase in pellet production in Eastern Europe and export to Western Europe can be expected. The domestic market for pellets is in Eastern Europe and the CIS region is not heavily developed, so that by 2020 the growing demand from Western Europe will push the trade flow.

3.2.3 Shares of sawnwood, wood panels and paper/paperboard



Source: Whiteman, 2006

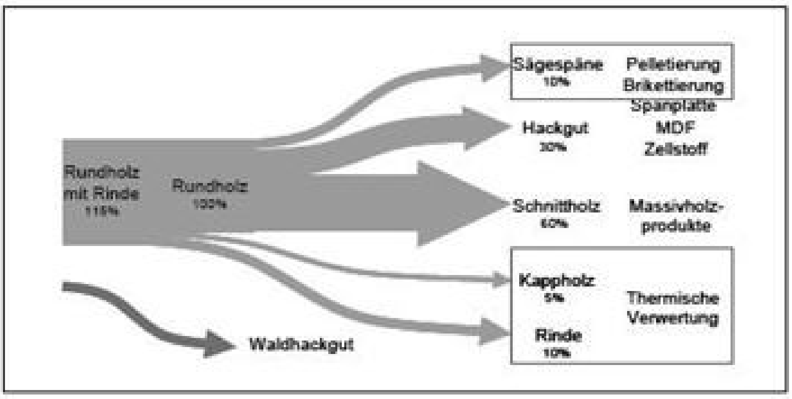
Figure 6: Share of forest products in total consumption of Europe incl. CIS region, business as usual scenario, in % of m3 E.Q

Figure 6 shows that the share in consumption of classical sawnwood will decline and share of wood-based panels remain almost constant. The consumption of forest products for paper and paperboard industry will grow significantly.

The paper and paperboard industry uses wood from forestry as well as by-products from the wood processing industry. Assuming that the paper and wood panel industry needs a quite constant proportion of sawdust and shaving residues for their production the demand for by-products will increase at the same rate.
In a future scenario there will be less sawdust as a raw material available on the market for pellet production.

3.3 Sawdust production

The main raw material for the pellets industry comes from the wood processing industry: from sawnwood production, from production of plywood and veneer sheets and from carpentry.
The quantity of by-products is determined by the demand for the main products. Changing demands for these products implies changing volumes of raw material for pellets production.
There are different utilizations of sawdust. Beside energetic utilization sawdust is also a raw material for particle board industry and, in a smaller amount, in the paper and paper board industry. The particle board industry uses low-value assortments of industrial wood by-products and is therefore in competition with energetic use.
The share of energetic as well as other usages depends on the energy price developments. The higher the energy prices the higher the power to purchase the raw materials, and thus the proportion of energy utilization for the available quantities of by-products will rise. Other utilizations are partly forced out and will be obliged to find other sources of raw material.



Source: Fraunhofer Institut, 2004

Figure 7: Material current in sawmill with internal energy production

3.3.1 Calculation of pellets production from sawmill by-products

Roundwood processing effects 60-65% sawnwood and approx. 10% sawdust, the rest is bark and slab. Related to the produced sawnwood an amount of 15% of this sawnwood are wood shavings and grinding dust.[14]

It is assumed, that conversion factors in sawmill would not change over the projection period.

The importance of energetic use will increase in future. But there is also a strong demand of sawmill by products by paper and fibreboard industry. The crucial point of utilization is the power of purchase. Fibreboard and paper industry are able to switch raw material sources (wood imports, wood residuals from logging etc.). Due to market complexity it is quite difficult to make proper forecasts for shares of utilization. It is assumed, that the share of bioenergy use from sawmills by-products will increase slightly over the next 10 years and that the trend will level of about 50% in the year 2020.[15][16]

Some of the by-products are used for energy production in sawmill, e.g. for drying purposes and power production. It is estimated, that in the best case scenario 80% of saw dust are available for pellets production.

As shown in figures 4 and 5 (- 20 -and page - 25 -) the raw material demand for sawnwood in Western and Eastern Europe is 264 million m3 respective 384 million m3 including the CIS sub-region.

Thus sawdust from saw milling as well as plywood and veneer production is about 26 million m3.

Another 15% of produced sawnwood are by-products from shaving and grinding. It is assumed, that a quarter of this amount is produced in large processing units and utilized in internal energy production facilities. This amount is not calculated for pellets production.

2 m^3 woods (in German so called "Festmeter") are required[17] to produce 1 ton of pellets.

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[14] NÖ LK - Niederösterreichische Landeslandwirtschaftskammer, 2005

[15] Cp. Schellinger, 2008

[16] Röder, 2008

[17] Simplified assumption: 1 m3 wood (absolute dry) = 500 kg; cp. NÖ LK – Niederösterreichische Landeslandwirtschaftskammer, p.13

Table 4: Pellets production potential in Western and Eastern Europe in 2020 (in million tons)

Sawnwood production Western and Eastern Europe in 2020 (million m3)	264.0
of which sawdust 10%	26.4
of which 50% used for bioenergy	13.2
of which 80% used for pellets	10.6
Potential of pellets production (in million tons)	**5.3**

2 m^3 sawdust for 1 ton pellets

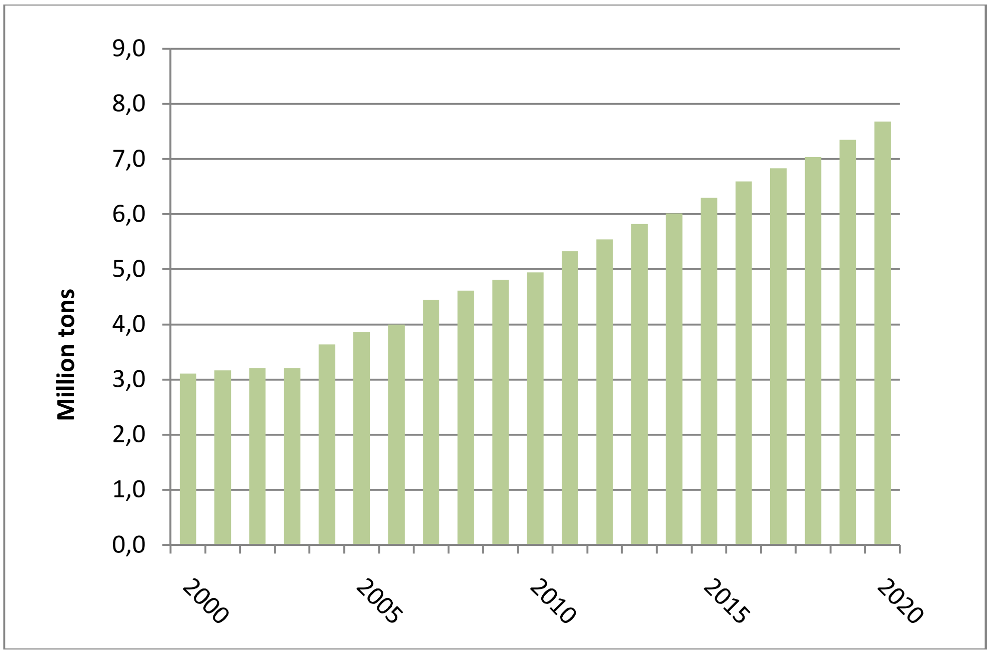
Table 5: Pellets production potential in Russia, Belarus and Ukraine in 2020 (in million tons)

Sawnwood production in Russia, Belarus, Ukraine in 2020 (in million m3)	120
of which sawdust 10%	12,0
of which 50% used for bioenergy	6,0
of which 80% used for pellets	4,8
Potential of pellets production (in million tons)	**2,4**

2 m^3 sawdust for 1 ton pellets

The tables 5 and 6 above shows the development of pellets production potential derived from sawnwood production in Europe including Russia, Belarus and Ukraine. However, the dominance of industrial roundwood and sawnwood production is likely to remain a feature of these two sub-regions for many years to come. It is expected, that domestic market for pellet small scale heating will develop quite slowly until 2020. Most of the produced pellets will be utilized in the EU Member States.

As the figure 8 shows, premium pellets production capacity derived from raw material from sawnwood industry is about 5 million tons of pellets in 2010 and could under increase according to the assumption described above up to 7.7 million tons of pellets in 2020.



Source: UNECE, own elaboration

Figure 8: Calculated pellets production capacity derived from wood raw material demand for sawnwood and plywood in Western and Eastern Europe

Peksa-Blanchard et al[18] estimate in their study about global wood pellets markets the worldwide net potential for pellets production from sawmill by-products to be 13 million tons. They assumed the largest parts of this potential to be in Brazil, Russia and Canada. These numbers endorse the assessments for Europe´s potential in pellets production.

3.4 Alternative raw materials

In essence there are three lines of additional sources for a pellets production:

- Pellets from forest residues
- Pellets from short rotation plantation on agricultural farm land (willow, poplar).
- Pellets from agriculture products: straw, various energy plants.

[18] Peksa-Blanchard et al (2007)

3.4.1 Wood residuals (residuals from logging)

Those are the residuals that are not suitable for sawmills, such as treetops, crown wood and small wood (diameter under 15 cm) as well as wood from thinning. Coppice, which is a traditional wood fuel, could be utilized for pellets production.
EAA (2006) is working on the assumption that there is a technical potential of approx. 235.000 GWh taking in consideration the ecological aspects.[19]

For the production of pellets that conform to standards, the following additional steps are essential: the material must be free of bark, chopped and ground in order to reach the particle size necessary for pelletizing. These processing procedures and the corresponding handling of the raw material have a significant influence on the costs of pelletisation.

Wood from forestry residue contains a high proportion of bark. This high proportion of bark reduces the abrasion resistance of the pellets and creates a greater amount of ash during burning. Bark removing causes additional costs in the production process.

However, it is not possible to adhere to the prescriptive limits of the norms (e.g. ÖNORM M7136, DIN+). For this reason, these pellets are graded as industrial pellets and are not suitable for common small scale systems (up to 100 kW).

The costs of gathering forest residues are decisive to their availability. Forest residues are currently harvested together with stem wood which keeps the costs low. The amount of forest residue accumulated is thus linked to the quantity of stem wood harvested.
The higher the demand and the shorter the supply of forest residue, the higher the attainable price will be. Mobilising forest residue is thus dependent on price development and the rising demand. This also means, however, an increase in the cost of raw material for pellets manufacture.

There is competition for these kinds of forestry residuals from the panel and paper industry as well as from heating stations using wood chips. The future BtL-industry will also utilize more and more these kinds of resources.

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[19] EEA (2006), p. 38

3.4.2 Mixed biomass pellets (MBP)

MBP can be produced from grains, from different types of grasses and straw, fruits and residuals from agricultural plant feed stocks. Also a mixture of different plants is possible.

Abrasion resistance of pellets from agricultural biomass is generally lower. The fuel does not fulfil the quality standards that are in force for bark-free pellets. However, work is being done on standards and guidelines for the quality of agro pellets as a requirement for the marketability of the energy fuels.[20]

Alternative fuels are currently mainly used in larger burning systems where the specific requirements for ash production are lower, where there is control over the particular characteristics of combustion (slagging and corrosion) and where emission control techniques are more cost-effective.

3.4.2.1 Estimate of potential:

There is an enormous potential from agricultural biomass.

In its study, the EEA (2006) calculated the available amount of land for the production of bio-energy considering the environmental aspects and the production of foodstuffs and animal feed. It assumes that enough food and fodder will be cultivated to be self-sufficient. This model determined the amount of land needed to produce food and fodder to fulfil domestic demands, respecting the described environmental criteria. It was therefore assumed that self-sufficiency rates of food supply in the EU-25 should be ensured while direct and indirect subsidised exports are gradually phased out. The potential land availability for bioenergy crop production is then calculated by subtracting the future land requirements for food production from the land requirements in 2000. This result was then reduced by an amount equal to an estimate of the land that would be needed to respect the environmental criteria and for urbanisation and other non-agricultural activities".[21]

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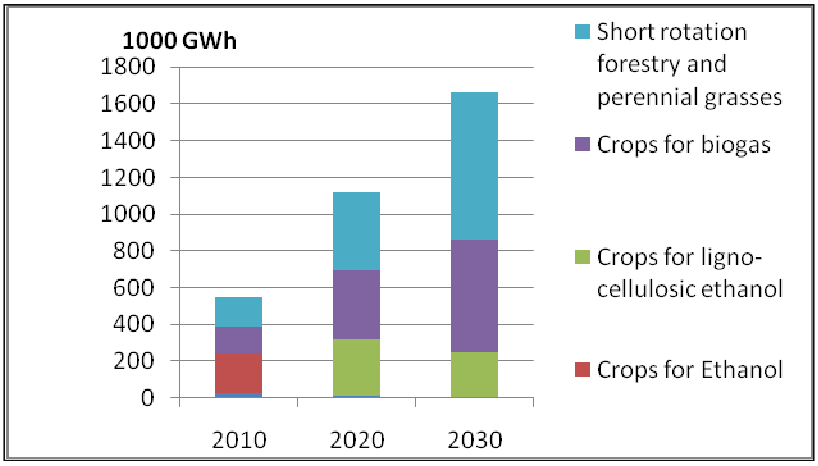
[20] Hartmann, 2007

[21] EEA (2006) p. 21



Source: EEA

Figure 9: Environmental-compatible agricultural bioenergy potential in Europe

Total available arable land for bioenergy production for the EU 22 increases from 13 million ha in 2010 to 19 million hectares in 2030. This is due to reforms in the agricultural sector in the EU and the increase in efficiency of crop production. The figure does not include the new member states Rumania and Bulgaria, two countries with an enormous potential of available land in comparison to the number of citizens.

"Over time, short rotation forests and perennial energy grasses would increase substantially. These crops combine a generally high energy yield with relatively low environmental pressures. They are phased-in substantially after 2010, reflecting a transition period for the farm sector and the availability of advanced biofuels conversion technologies after 2010. This advanced conversion can make use of a broader range of crops. Crops used as feedstock for biogas installations (e.g. maize or double cropping systems) will increase after 2020 as further technology development increases the efficiency in biogas production. As they require sufficient water, they will be particularly important in the countries of the Atlantic and Continental zone."[22]

3.4.2.2 Short rotation forestry

In field areas, for example on land set aside from agricultural production, rapid growing woody biomass will be cultivated. It is a matter of perennial crops. Mostly

[22] EEA, 2006, p.27

used are poplars, willows or acacia. Planting and harvesting are highly automated with specialised machines.
Up to now, it has been usual to harvest in 3-6 year cycles (diameter up to 8 cm). In the meantime, there are harvesting machines available for a 10-20 year cycle. The older the plantation, the better the wood-bark ratio and thus its preference for pellets production.

The EEA (2006) has calculated for the EU 25 a potential in short rotation plantations of 165.000 GWh for 2010 with a growth of up to around 430.000 GWh in the year 2020 (compare figure 10). Environment and sustainability aspects have been considered as well as the situation of the competitive use of arable farmland for foodstuffs and fodder.

The EEA presumes that, for 2020 and the following years, the main usage will be in 2nd generation bio-refineries to produce fuel. Nevertheless, it can and must be presumed that wood from short rotation plantations will be utilised in “burning” and pellets production. It is assumed that about 50% of the production will be utilized for combustion and that in the year 2020 about 50% of that will be used for the production of wood pellets.

This value will, however, not be reached until this timeframe. Prerequisite for this is a complete and unbroken raw material chain, defined quality criteria for forest wood and short rotation wood pellets as well as adaptations and corresponding developments in boiler technology (ash accumulation, particle matter deposits). A potential of about 107.000 GWh can be deduced from this. This corresponds to a quantity of about 23 million tons of pellets.

3.4.2.3 Agricultural grasses for biomass

Energy crops from agricultural production exhibit several major biological and chemical differences to wood fuels. This has a significant influence on furnaces and on the technology to be applied. In agricultural biomass there is, depending on the plant, a higher content of nitrogen (responsible for NO_x emissions), potassium (causes high amounts of ash), chlorine (corrosion in boilers) and sulphur (SO_2 emissions and corrosion). The presence of these substances is due to their biology, the quantity contained is partly influenced by fertilisers and culture. The negative effects in the combustion process, or rather in the downstream treatment stages, have to be controlled and eliminated.

Ash content:

Ash content is higher due to the higher mineral content in comparison to bark-free wood fuels. Higher ash content means additional work and expense and less ease of use.

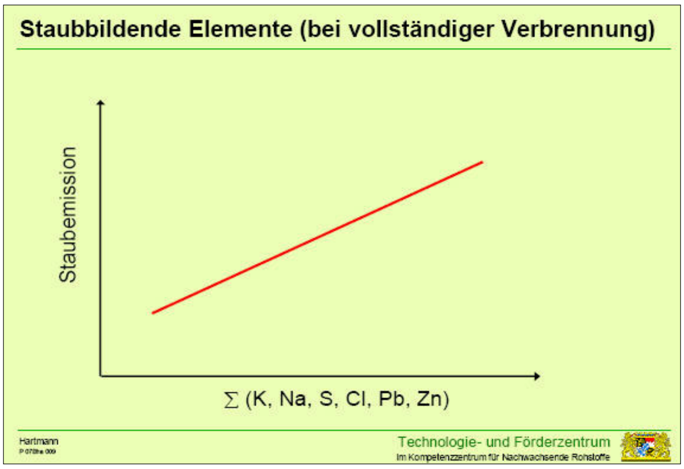
Ash melting

The fusibility points of ash from grass crops (and from corn biomass) show a wide fluctuation. But they are, by all means, considerably lower than for bark free wood.
Ash fusing clogs and blocks parts of the boiler (ventilators, air vents, flue gas ducts and heat exchangers) and leads to lower production efficiency. It can also lead to the system coming to a halt.
Agricultural biomass shows an ash content about 6-20 times higher than for wood pellets.[23]

Corrosion

Agricultural grass crop biomass shows a higher content of sulphur and chlorine. Both sulphur and chlorine have a corrosive effect on combustion systems. To begin with the efficiency of the boiler is negatively influenced. Without being noticed, it gradually leads to so-called pitting corrosion that destroys the boiler.

Dust and fine dust



Source: Hartmann, 2007

Figure 10: Dust forming elements

[23] Eder, 2007, p. 206

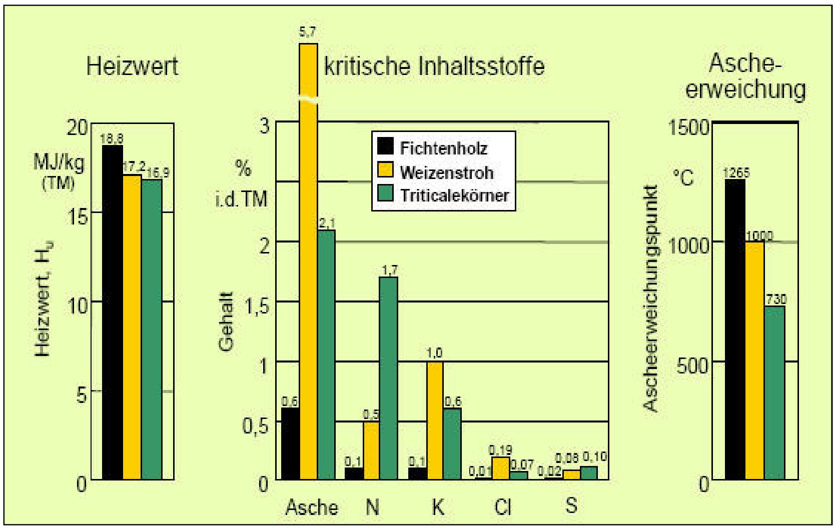
The mineral components in the fuel causes dust to be generated during combustion. Toxic substances bind with the dust. The finer the dust particles, the more toxic substances are deposited.

While about 10 mg/m3 of dust are formed with wood pellets, about 25-75 mg/m3 of dust are created with Miscanthus pellets, and with other biomass this figure is way over 100 mg/m3.[24]

Above all it is the grass crop biomass that creates very fine dust particles that are carried along in the waste gas stream and end up in the atmosphere. It is not possible to simply separate these particles. Special filters are necessary which is not economically feasible for small and medium scale systems.[25]

Nitrogen oxide

Nitrogen is responsible for the high content of nitrogen oxide in emissions. Nitrogen oxides have a 100 times greater effect on greenhouse gases than CO2 and are jointly responsible for building ground-level ozone. Eder (2007) points out that the formation of nitrogen oxide is first and foremost down to the content of nitrogen in biomass. However, test studies have determined that, apart from the quantity of nitrogen, the combustion process also has an influence on the level of NOx content.



Source: Hartmann, 2007

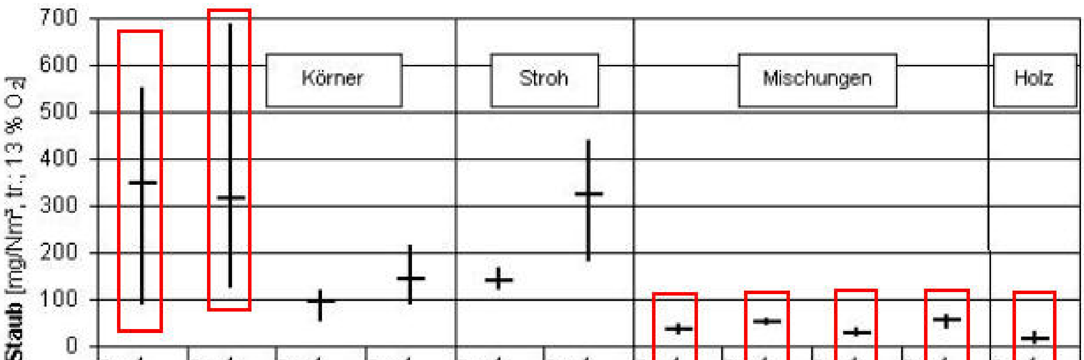
Figure 11: Calorific value and critical components in several biofuels

[24] Eder, 2007, p. 221
[25] Eder, 2007, p. 222

3.4.2.4 Mixed pellets

One possibility to improve unfavourable elements is to mix different raw materials. Unfavourable elements of agricultural grass biomass can be reduced by mixing less problematic biomass. At the same time, the pelletizing processes (moulding pressure, breaking and abrasion resistance of pellets) could be improved.

In the same way as with wood pellets, there are efforts to apply a norm to mixed pellets.[26] Standardising "agricultural pellets" is a prerequisite for attaining constant quality levels in heat value, for maintaining emission limits and for developing a boiler aligned to this. Only as a consequence of this can complementary boiler/fuel systems be brought onto the market.[27]



	n = 4 Wi-Roggen	n = 4 Wi-Weizen	n = 4 Wi-Gerste	n = 4 Wi-Raps	n = 4 WWSP PTG (8mm)	n = 4 WWSP VTI (8mm)	n = 4 HP/WW (70/30)	n = 4 HP/WW (50/50)	n = 4 HP/WR (70/30)	n = 4 HP/WR (50/50)	n = 4 DIN-HP
MAX	549	683	117	212	165	435	43	56	35	66	28
MIN	90	128	56	91	122	182	29	49	24	39	7
MW	347	316	95	143	141	323	36	52	30	56	17

Source: Hering, 2007

Figure 12: Fine particle emissions in several biofuels

As test studies for mixed pellets in small scale systems show, overall emissions do improve but NOx emissions are clearly above those for wood pellets.

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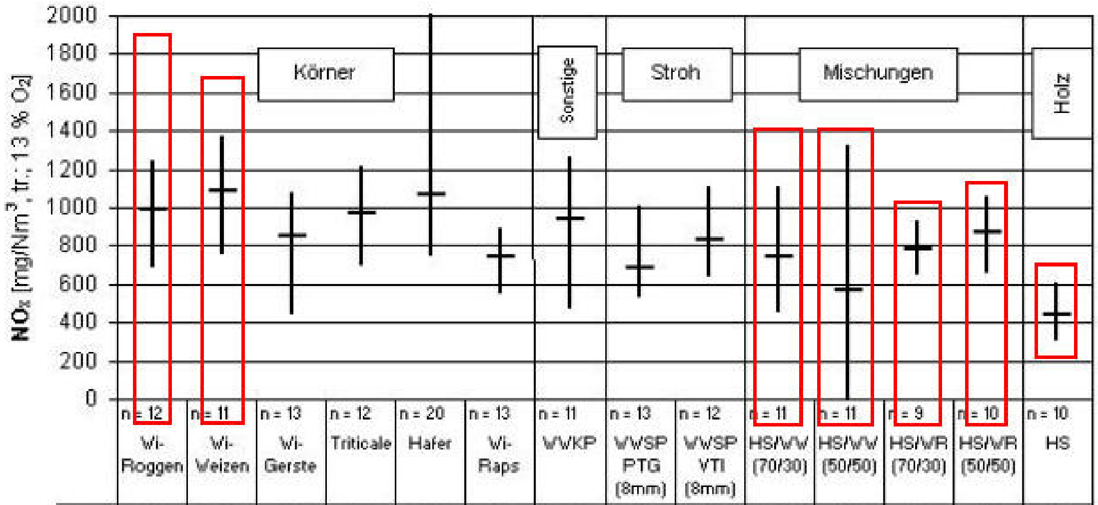
[26] Hartmann, 2007
[27] cp. Eder, 2007, p. 202



	Wi-Roggen	Wi-Weizen	Wi-Gerste	Triticale	Hafer	Wi-Raps	WWKP	WWSP PTG (8mm)	WWSP VTI (8mm)	HS/WW (70/30)	HS/WW (50/50)	HS/WR (70/30)	HS/WR (50/50)	HS
MAX	1231	1361	1072	1210	2002	878	1257	1000	1098	1093	1312	917	1049	600
MIN	701	764	446	706	753	562	481	536	650	466	11	653	666	316
MW	993	1088	850	966	1071	745	943	688	832	750	566	781	870	440

Source: Hering, 2007

Figure 13: Nitrogen Oxides emissions on several biofuels

3.4.3 Conclusions on alternative fuels

- In principle there is a wide range of raw materials available that is suitable for pelletisation.
- The costs of cultivating and harvesting are in many cases lower, but the costs for fuel preparation and combustion are higher.
- The main problem in burning agricultural biomass is the wide dispersion of physical and chemical elements. For combustion to be efficient and environmentally friendly, there have to be strict constraints regarding the quality of fuel. In this case, it is necessary to establish pan-European norms and quality standards, two aspects which have largely been missing up to now.
- In terms of market capability, the standardisation of fuels is a necessary requirement for the market to function. This standardisation is completely lacking and must be developed.
- The abrasion resistance of pellets from agriculture and mixed fuels is lower than for wood pellets.
- Considerably higher ash formation and thus greater maintenance effort.
- Problems from corrosion due to higher chlorine and sulphur content have yet to be solved.
- Pellets from agricultural biomass produce a much higher amount of dust in the emissions. Expenditure in boiler technology and flue gas treatment is

high. Costs for small scale systems will be considerably higher due to additional necessary steps (electric filter, boiler design).

- For small scale systems of up to 100 kW, the use of quality pellets from bark free wood (sawmill by-products) will be continued, and in medium and large scale systems, pellets from short rotation forestry will be implemented. Pellets from grass crops biomass and those from mixed fuels need some research and development expenditure in order to get the operational and emission problems under control.
- Industrial pellets from forest residues or short rotation plantations are preferred for their more favourable combustion and emission qualities.
- Greater expenditure over a longer timeframe for the research and development of the technology and of the standardisation of fuels.

3.5 Production costs of pelletizing

This chapter analyses the influence of raw material costs on the total costs of production. A sensitivity analysis shows the impact of changing raw material costs on the price of pellets. The calculations are based on the analysis of 9 Austrian pellet plants of different sizes, varying from a production capacity between 430 tons/ year and 79.000 tons per year, made by Thek and Obernberger (2001, 2002). The average costs for the components except raw material are adjusted up to 2009. It is assumed that material costs, costs for personnel and costs of energy are constant with a normal interest of 2% per year for the last seven years. The costs for raw material are taken from the commodity exchange Vienna.

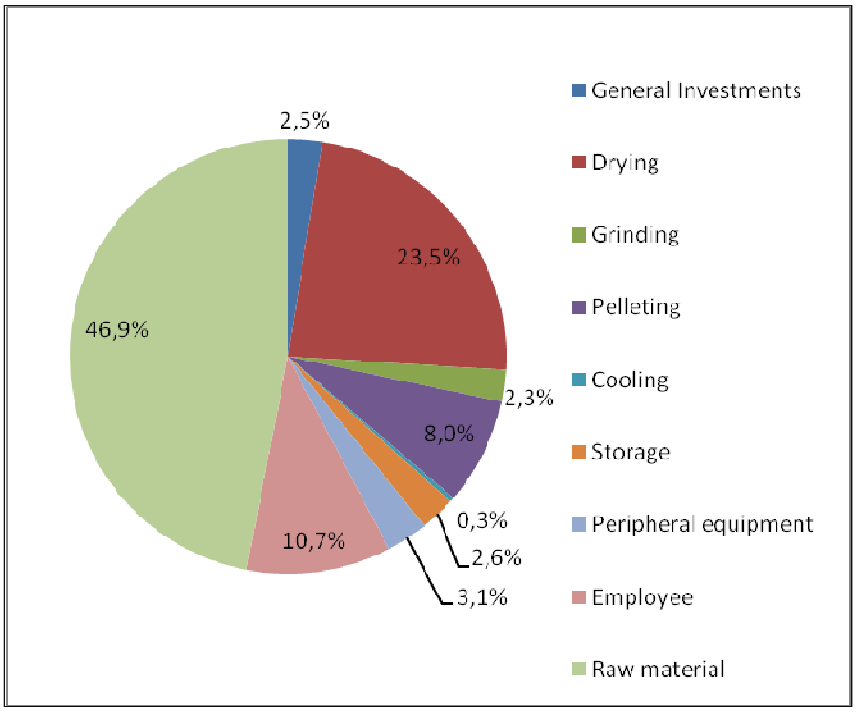
According to VDI 2067, different types of costs are classified into four groups:

- Capital costs
- Consumption costs
- Operating costs
- Other costs

The capital costs include all costs associated with the investment and depreciation (replacement) of the plant. The consumption costs comprise all costs that arise because of production. These costs are directly proportional to output (e.g. raw material costs and energy costs for operating the facility), whereas the operating costs include all costs to make production possible. These costs are independent of output (e.g. personnel costs, administrative costs, overheads).

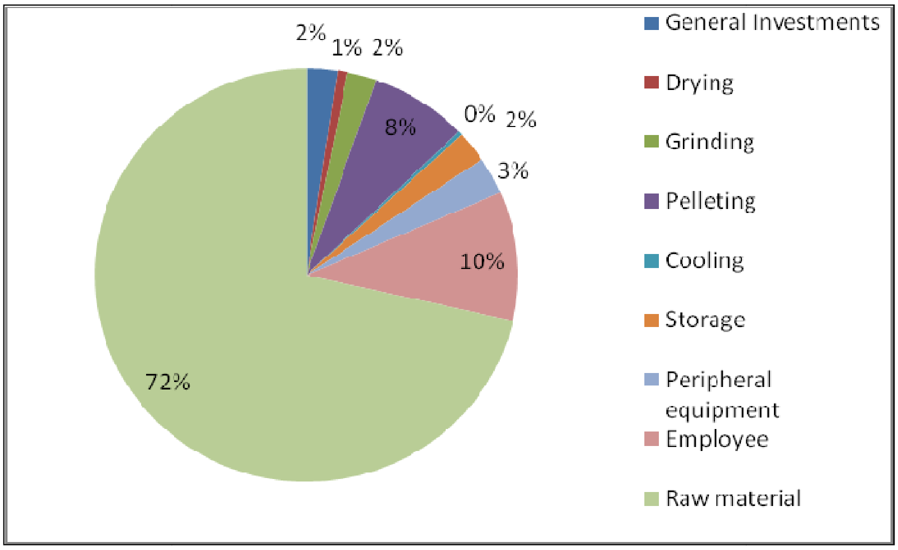
The cost factors were applied to the entire manufacturing process for pellets production transferred:

- Investment costs: comprises the manufacturing construction (building, machinery), costs for administration, building and equipment as well as soft costs such as planning costs and marketing for the start up.
- For the calculation of drying costs Obernberger and Thek (2001) considered for their calculation the most common processes: tube bundle dryer and belt dryer. Furthermore, the possibility of using a fluidised bed dryer operated with superheated steam has been investigated.
- The grinding process usually uses hammer mills. Cost reduction potential can be identified by using a grading process. The oversized fraction could be graded in smaller hammer mills (decreases investment and operating costs) or can be used in the furnace for drying process.
- Pelletizing costs consider the costs for conditioning, costs for the binding agent and the costs for pelletizing itself. As experience shows, smaller pellet mills have higher specific production costs.
- Cooling costs after pelletizing have a low impact on the whole production costs.
- Normally, silo storage facilities are used. Storage costs strongly depend on the type and the dimension of storage. Usually, storage extension is about 10% of yearly production. Storage in a sufficient dimension influences availability of pellets. Costs for storage tend to be low in comparison to other costs.
- Peripheral equipment includes the costs for machinery such as ventilation, conveyors, screens etc.
- Labour costs consider costs for administration, marketing and operational labour. They have a high influence on production costs.
- Another main cost factor is raw material. The most influential aspect is whether the raw material is delivered dry or wet. Material delivered dry costs more but investment costs can be reduced by the removal of drying facilities and thus costs of drying.



Source: own estimations, based on Thek, Obernberger (2001)

Figure 14: Pellets production costs with wet raw material



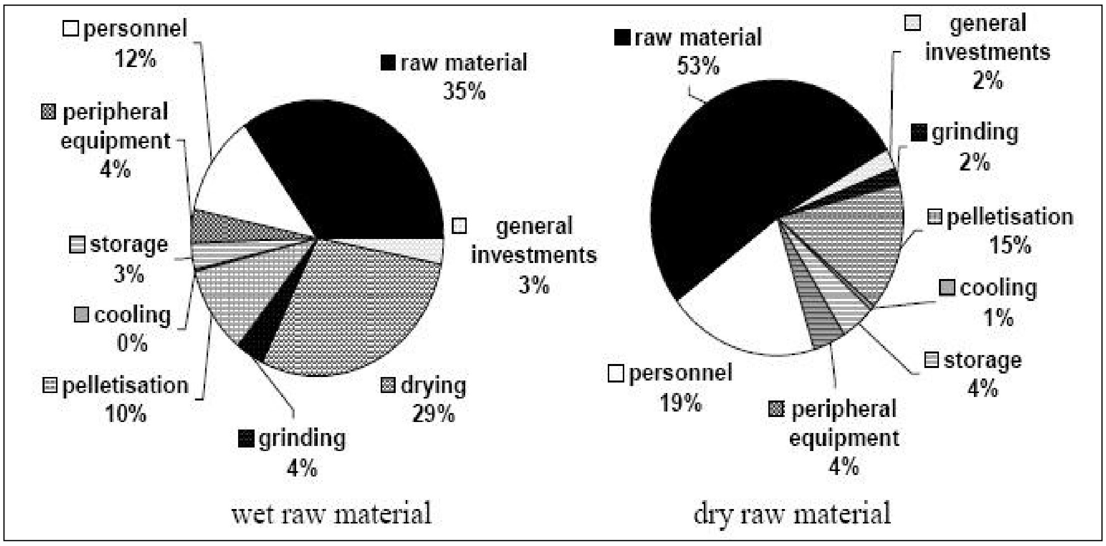
Source: own estimations, based on Thek, Obernberger (2001)

Figure 15: Pellets production costs with dry raw material

The main shares of pelletizing costs are the raw material and the costs for drying if wet raw material is used. These costs can cover about three quarters of production costs.

In this calculation total pellets production costs vary from 119.2 €/ton for facilities with drying of raw material and 127.3 € for facilities with dry raw material.

The availability of dry raw material depends on decisions of raw material supplier whether there are drying facilities or not. In many cases the saw mills utilizes parts of the waste wood for producing heat and power in a CHP. In this case it is likely that only dry saw dust will be available.



Source: Obernberger, Thek, 2002

Figure 15: Share of different cost factors of a pellet plant in total production costs, comparing utilization of wet and dry material.

Thek, Obernberger (2002) are assuming that, based on the prices from 2002, an economically meaningful operation is limited with 110 €/ton pellets. They calculated with average raw material costs of 30.5 €/ton pellets whereas it is assumed that the production of 1 ton pellets requires 7 m^3 sawdust.[28] This equate a purchase of 4.35 €/m^3 sawdust.

[28] Kassmannhuber, words by mouth, Jan 2009

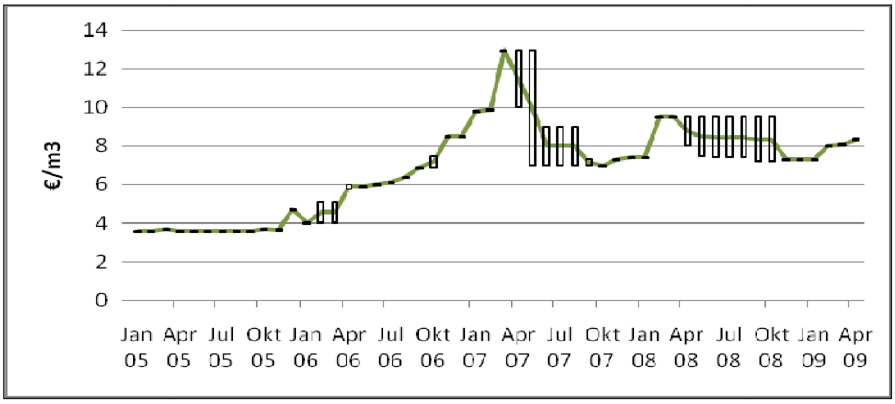
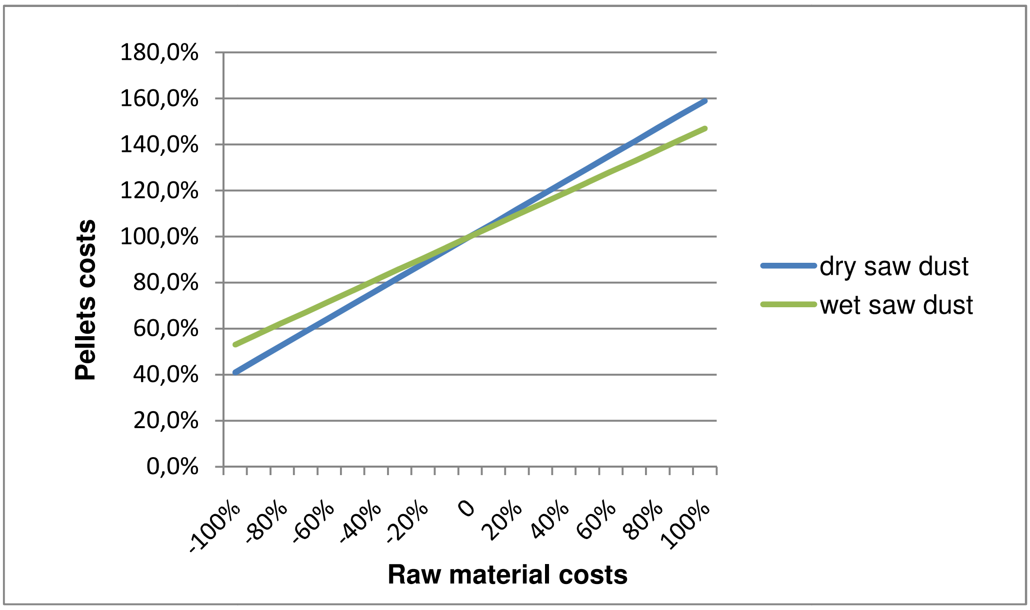


Figure 16: Price of wet sawdust 2005 – 2009 at the commodity exchange Vienna

Fehler! Verweisquelle konnte nicht gefunden werden. shows the development of the price for sawdust on the Austrian commodity market. It has nearly doubled in the last five years with its maximum peak at the beginning of 2007. Reasons for this are the increasing demand for sawmill byproducts and stagnating sawnwood markets.

3.5.1 Sensitivity raw material costs and pellets costs



Source: own elaboration

Figure 17: Sensitivity of different parameters on the total production costs

As we can see in the figure above, a cost increase or decrease of more than 20% heavily influences the whole production costs. Doubling the raw material costs leads to an 80% increase or decrease in production costs.

3.5.2 Additional costs for wood residuals from forestry

The production of pellets from forest residues will require additional investment and operational costs. In essence, these are investments in the storage of log wood, machinery for the manipulation of wood delivered, decortication, chipping and pre-grinding.

Costs for additional handling are estimated at 500,000 € costs for a medium-sized plant (10,000 - 20,000 tons annual production).

- Storage and manipulation of wood 3.5 – 4.0 €/tons Pellets
- Decortication 2.5 – 3.5 €/tons Pellets[29]
- Chipping 2.5 – 4.0 €/ tons Pellets
- Pre-grinding size reduction 3.0 – 4.0 €/tons Pellets

In total, the costs of pellets production increases to 11.5 - 15.5 € / ton pellets. Compared with average production costs for pellets production from sawdust, these lead to higher production costs of about 10%.[30]

3.5.3 Production costs for agro pellets

Compared to pellets production costs from agricultural biomass, there are overall higher production costs. The lowest production costs of pellets are to be found with the energy crop “Miscanthus”. However, the specific conditions of combustion (emissions, corrosion problems, amount of ash and ash melting) have to be taken into account.

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[29] Haneder and Jonas (2004, in Eder, 2007) provide costs for the extraction of wood chips from forest residues with highly mechanized harvesting of about 13,60 € /m3 (bulk) and € 17.44 / m3 (bulk), depending on species and type of forestry.

[30] Kassmannhuber, words by mouth, Jan 2009

Rohstoff	Produktionskosten für 1 Tonne Pellets [€], w=8 %			
	Rohstoff	Rohstoff-transport	Pelletierung	**gesamt**
Waldholz HG	111	14	78	**202**
Pappel HG	52	16	78	**145**
Miscanthus HG	32	18	78	**128**
Miscanthus QB	38	7	78	**123**
Mais-GP QB	75	6	78	**159**
Triticale-GP RB	65	11	78	**154**
Triticale-GP QB	63	6	78	**147**
Energiekorn	113	--	--	**113**
Stroh QB	66	7	78	**151**
Landschaftspflegeheu RB	75	11	78	**164**
Landschaftspflegeheu QB	94	8	78	**180**

source, Eder, 2007

Figure 18: Pellets fuel costs of different raw materials

Some of the problems still haven't been solved and would require higher investment costs for boiler and filter systems.

In the estimation above, a transport distance for raw material delivery of 25 km is considered. Yet the transport costs for Miscanthus play an important role because of the low bulk energy density. It is assumed that in practice, the transport distances of raw material will be substantially larger.

For the remaining raw materials from agricultural biomass, the production costs amount to between 145 € and 159 € / ton pellets. Thus, the prices are far beyond the production costs of pellets from sawmill by-products of 119 € for wet raw material and 127 € for dry material.

4 Demand for pellets in the EU policy context

This chapter examines the pellets market from the point of view of demand. Solid biofuels play an important role in the EU´s energy policy. There are estimations about the share of solid bioenergy in the renewable energy mix, but there are no specifications about the share of pellets. Therefore, an estimation of the demand for bioenergy from solid biomass, and in particular of pellets, will be made and compared with the potential of pellets production from sawmill by-products.

4.1 Turnaround in energy supply

In the past few years the discussion about future energy supplies has gained momentum. The change in climate, independence from imported energy supplies and the gradual expiration of fossil fuels were all reasons to initiate a turnaround in energy supply.

The current system of supplying energy is being scrutinized in several different problem areas:

- The scarcity and finite nature of resources, particularly of fossil fuels and the related increase in energy costs
- Climate change due to the increasing amount of CO2 in the atmosphere, caused by excessive burning of fossil fuels.
- Access to energy and distribution difficulties.
- Dependence on energy and the danger of competition for distributing a resource that is becoming ever scarcer.
- Wide north-south divide in consumption of resources and energy.
- Technology risks (e.g. nuclear power)

Compared with this is the concept of society's sustained development. In general, the term 'sustained' describes the use of a system that can be regenerated in a way that the basic characteristics of the system are retained and the crop can replenish itself naturally. This definition can be projected onto various systems. It can be used to describe ecological, economical, social and even financial-political systems.

The term ‚sustainability' has come into fashion in the past 10 years. In that time it has found its way into all political levels and parties. It must, however, be considered that sustainability signifies a fundamental shift between growth and prosperity. Above all, it is the industrialized nations that are challenged in this respect, if this shift in paradigm is to succeed.

4.2 Policy context in the wood pellets market

Faced with the aspect of sustainable development, the impression of worsening climate change and the dependence on fossil fuels, the EU and its member states have begun to push forward objectives for expanding renewable energy resources.
There are several legislations for promoting renewable energy and renewable heat that have occurred in recent years which have finally led to the climate and energy package in Dec. 2008.

4.2.1 Kyoto Protocol

The main objective of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) is to stabilize the greenhouse gas concentration in the atmosphere at a level that would prevent dangerous human consequences.
It contains legally binding obligations for developed countries to limit the overall emission of six greenhouse gases (carbon dioxide, methane, nitrous oxide, HFC´s, PFC`s, sulfur hexafluoride) to 5.2 % below the 1990 level with specific targets varying from country to country.
The use of bioenergy produced in a sustainable way does not account for the release of CO2 in the atmosphere because the CO2 is absorbed from the atmosphere by growing biomass.
The Kyoto-Protocol allows flexible mechanisms to reach the goals. These mechanisms are known as Emissions Trading, Joint implementation and Clean Development mechanisms.
Emission Trading allows economies to buy or sell emission trading certificates. Bidding and demand for certificates creates a market and a price for CO2 emissions. The idea: the higher the price the more efforts to avoid CO2 should be made. CO2 trading provides the flexibility of investing in places where energy investments produce the best cost-benefit ratio.

Joint Implementation is a mechanism between industrialized countries where emission reduction projects are carried out from one country to a second one and the emission reduction is credited to the first one.
Clean development mechanism is quite the same mechanism as Joint Implementation but projects are carried out in developing countries.

4.2.2 COM (95) 682: An energy policy for the European Union

In the White paper, published on 13.12.1995, the Commission drafted for the first time the importance of an economic and legal framework to define common energy policy objectives. This overall framework can be characterized by four key concepts:

- External dimension – globalisation of markets
- Increasing environmental concerns
- Technology developments
- Community institutional responsibilities[31]

The White paper made a commitment to promote renewable energies to meet the targets of a sustainable energy supply and environmental aspects.
“However, certain forms of energy, like renewables, may need to be supported initially through specific programmes or subsidies in order for them to find a place on the market. Such support should be given in a manner that is least harmful to competition and to this end, the possibility of further policy development in this area may need to be considered.“[32]

> “Given that renewable energy supplies have few hidden costs (they produce little or no pollution) and are in many cases readily available, an increased share of renewables in the Community's energy balance would make a contribution to both its security of supply and environmental protection. In the long-term, they will constitute the main sustainable energy source. In this area, the local level, notably regions and cities, have an important role to play in exchanging experience, know-how and technology transfer, since for many renewable technologies, it is necessary to have an in-depth knowledge of local situations. There is a need, therefore, to exploit the opportunities offered in the Community's RTD programmes and future ALTENER II programme, and to focus on technologies where cost reductions can be substantial and where

[31] COM(95) 2008, p. 8
[32] COM(95) 2008, p. 18

improvements in energy conversion devices can easily be secured by dissemination of technology in the market place and in the developing world. The promotion of renewables, in particular in the present situation of the energy market, needs supportive market regulation permitting these investments to compete with others. It is then important that this energy source benefits from fiscal regulations, from the regimes governing the creation of new electricity capacities and from access to networks. There is scope for action to promote the penetration of renewables; solar, wind, biomass, biofuels, geothermal. The development of renewable energies will contribute to job creation especially in the regions and the resulting economic benefits are likely to remain in those regions. The Commission will come forward, therefore, with a strategy in the form of a Communication."[33]

4.2.3 COM (2005) 628: Biomass action plan

The Biomass action plan is a reaction to the EU´s challenge to high energy prices, the increasing dependency on imported energy and to objectives of growth, jobs and sustainability.

> "Essential elements of this policy are, within the context of stronger economic growth, the need to reduce energy demand1; increased reliance on renewable energy sources given the potential to produce them domestically and their sustainability; diversify energy sources; and enhance international cooperation. These elements can help Europe to reduce dependence on energy imports, increase sustainability and stimulate growth and jobs."[34]
>
> "This action plan sets out measures to increase the development of biomass energy from wood, wastes and agricultural crops by creating market-based incentives for its use and by removing barriers to the development of the market."[35]

The Commission estimates, that the measures in this action plan could lead to an increase in biomass use of about 1,750,000 GWh. This is less than the full potential and in line with the renewable energy targets.

In spite of cheap and simple technology for biomass utilisation, the slowest growth in biomass utilisation is in the heating sector.

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[33] COM(95) 2008, p. 34f
[34] COM (2005) 628, p. 4
[35] COM (2005) 628, p. 5

In the Commission´s opinion this is justified by a lack of confidence in the market. The Commission will tackle this through following measures:

Legislation on renewable energy in heating:

- New specific legislation on renewable energy in heating, based on a critical review of the potential contribution of:
  - measures to ensure that fuel suppliers make biomass fuels available;
  - the establishment of efficiency criteria for biomass and the installations in which it is to be used;
  - equipment labelling to enable people to buy clean and efficient devices;
  - other technical measures;
  - the appropriateness of setting targets;
  - voluntary agreements with industry.
- Amendment of the directive on the energy performance of buildings to increase incentives for renewable energy.
- A study of how to improve the performance of household biomass boilers and reduce pollution, with a view to setting requirements in the framework of the eco-design directive.[36]

In annex 2 the Commission assesses the potential to produce biomass for energy use. They are based on the following assumptions:

- no effect on domestic food production for domestic use;
- no increase in pressure on farmland and forest biodiversity;
- no increase in environmental pressure on soil and water resources;
- no ploughing of previously unploughed permanent grassland;
- a shift towards more environmentally friendly farming, with some areas set aside as ecological stepping stones;
- the rate of biomass extraction from forests adapted to local soil nutrient balance and erosion risks.

[36] COM (2005) 628, p.7

Table 6: Biomass potential in 2010, 2020, 2030 for EU 27 (in Mtoe)

Mtoe	Biomass consumption 2003	Potential 2010	Potential 2020	Potential 2030
Wood direct from forest increment and residues	67	43	39-45	39-72
Wood industry residues, agricultural and food processing residues, manures, organic wastes		100	100	102
Energy crops from agriculture	2	43-46	76-94	102-142
Total	**69**	**186-189**	**215-239**	**243-316**

Source: COM (2005) 628

Table 6Table 6 shows the current biomass production and the potentials for the EU 25 until 2010 (excluding Romania and Bulgaria). For the period from 2010 to 2030 the potential from wood will nearly double whereas potential from wood residues and waste (including sawmill by-products) will remain constant, and the potential from agriculture will triple. This table does not include imports. Potential EU consumption is therefore significantly higher than these figures would suggest.[37]

4.2.4 The EU climate and energy package

In December 2008, the European Heads of State and Government agreed at the EU government summit on a comprehensive climate and energy package; it was agreed by the European Parliament on 17.12.2008.
The climate and energy package was adopted in Dec. 2008. It pays more attention to renewable heat as a crucial point for mitigating climate change and for improving the security of supply.

The general objectives of the EU´s climate protection and energy policy are:

- 20% renewable energies in the EU`s energy mix by 2020 (current share about 8.5%)
- Decreasing of energy consumption by 20%, calculated on the baseline scenario forwarded to 2020.
- Reduction of greenhouse gas emissions by 20% on the baseline 1990.

[37] COM (2005) 628, p.20f

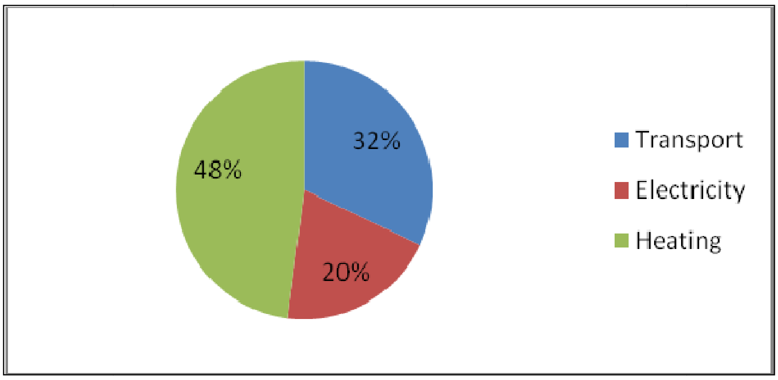
There is a special focus on:

- Effort sharing: Member States' targets for CO_2 reduction
- Revising the EU´s Emissions Trading System
- Equipping power plants to store CO_2 underground
- Less LHG from fuels
- Power plants and energy intensive industry should reduce energy consumption by 21% on the base of 2005. This should be achieved by reducing and effective operating of the Emission Trading System.
- Sectors which are not in the ETS should reduce their emissions by 10% (households, agriculture, etc.). This should be targeted with obligatory national action plans.
- Reducing CO_2 emissions from new cars.
- To achieve the 20% target, the new directive will lay down obligatory national targets to be achieved by the Member States through promoting the use of renewable energy in electricity, heating and cooling, and transport sectors. Member States could meet their targets more easily by promoting energy efficiency and energy savings.

4.3 Energy consumption for heating

4.3.1 Energy consumption in European statistics

In the temperate to cool climatic zones of Europe, heating for buildings, residential housing, industry and public services plays an important role.



Source: Eurostat, EREC, 2006

Figure 19: Final energy consumption by sector

About half of the final energy consumption is used for heating and thus represents the lion's share of energy consumption.[38]

Table 7: Heat consumption in EU 27 for the year 2006

	GWh	share
Residential	6.637	58%
Industry	2.839	25%
Services	1.957	17%
Total	*11.433*	*100%*

Source: EUROSTAT

In 2006 total heat consumption in the EU 27 was 11,433 GWh (41,126 TJ)
The largest share of heat consumption is attributed to households. 58% of heat consumption or 28% of the total final energy consumption is attributed to residential heating.

4.3.2 Heating oil consumption in Europe

In order to estimate the demand for pellets by 2020 it is assumed that mainly oil heating will be able to be replaced by pellets heating. Oil heating has similar delivery logistics (by heavy goods vehicle) and the storage requirements have a similar volume. By examining the consumption of heating oil in Europe, one can gain an insight into the necessary substitute fuels.

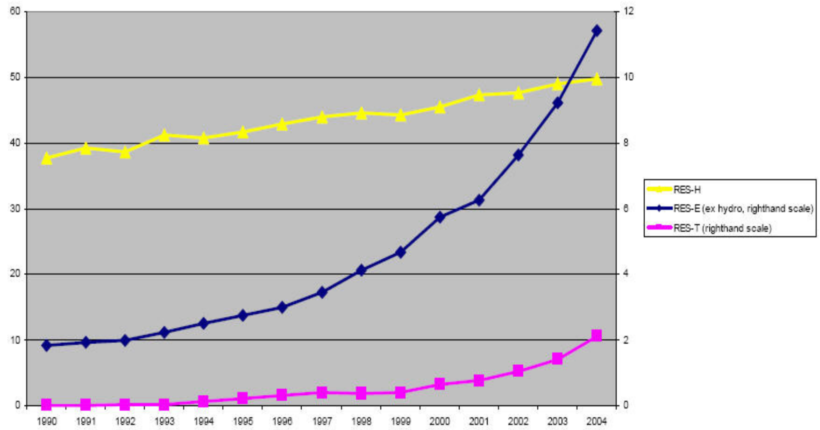
An overview by Eurofuel (The European Heating Oil Association[39]) shows the consumption of heating oil for the EU 15 + Switzerland, Turkey, Iceland and Norway at 94 million tons. Heating oil plays merely a minor role for the new Member States in eastern and south-eastern Europe. In its CEE country portraits, the Austrian Energy Agency[40] states a heating oil requirement for households and services of 8,5 million tons. Under the assumption that space heating in industry consumes about 25% of heating from households, a heating oil requirement of 13 million tons can be supposed for the CEE area. Thus the consumption of heating oil for heating purposes can be estimated in Europe at about 110 million tons. At a ratio of 1 kg

[38] Cp. COM(2006)848, p.9
[39] http://www.eurofuel.eu/eng/facts.asp, 22.03.2009
[40] http://www.energyagency.at/enercee/index.htm , 22.03.2009

heating oil = 2 kg pellets, this would mean an equivalent of 220 million tons of pellets.

4.4 Renewable energy in the heating sector

In the heating sector, renewable energy sources have a share of approx. 10%.[41] There is a huge potential of renewables in the heating (and cooling) sector and recently heat has received too little attention from both the EU and the MS.



Source: COM(2006)848

Figure 20: Contribution of renewable energy (heat, electricity, transport) in mtoe

While the production of electricity from renewable energy sources is experiencing a great increase, the production of heat from such sources is rising only very slowly.

At 95% biomass has the largest share of heat generation[42] and here, too, is wood and its by-products from the wood industry. It is very hard to estimate the share of wood since fuel wood is harvested by many consumers themselves and is thus hard to record statistically.

Biomass boilers and stoves, operated with wood logs, wood chips or pellets have been optimized in the last 20 years regarding their efficiency and emissions. Due to modern control systems and ventilation facilities, modern boilers are environmentally friendly with greatly reduced emissions of fine particles and carbon monoxide. However, more can be achieved in improvement of handling, availability and maintenance as well as emission improvements.

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[41] COM (2006) 848, p.9
[42] EREC, 2007

A great variety of wood combustion systems were developed in the last two decades with a constant drive for improved efficiency, achieving more than 90% for automatic systems, and reduced emissions of particles. Several systems can be considered, depending on the size. Small-scale heating systems for households typically use wood logs or pellets. Medium-scale users typically burn wood chips or pellets in grate boilers while large-scale boilers are able to burn a larger variety of fuels, including wood waste and refuse derived fuel. Heat can also be produced through cogeneration which provides both bioelectricity and bioheat for industrial processes in the form of vapour and can supply district heating networks.[43]

4.5 Assessment of bioenergy demand at target scenario 20%

But how much bioenergy is needed in 2020 to reach the target of 20% share of renewable energy?
In an impact assessment (model calculation on the basis of PRMES and GREEN-X for the EU 25 without Rumania and Bulgaria) by the EU Commission, it is presumed that at least 230 mtoe of energy from biomass[44] will be needed for the 20% share[45]. Assuming a net import of 15%[46], 195 mtoe would have to be procured in Europe itself.

The EC roadmap contains a number of assumptions and expectations for development in the next 10 years. The most important assumptions are:

- The energy efficiency target of 20% less energy consumption than in a business-as-usual scenario in Europe will be achieved. The 20% renewable energy share is calculated under the assumption of reaching the target of 20% less energy consumption.
- Of all renewable energy sources, the main share is achieved by energy carriers other than biomass. About 40% should be raised by solid biomass sources[47]. This comprises biomass from forestry (forest wood residuals, industrial wood residuals), agriculture and its refuse, food production and communal waste.

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[43] AEBIOM (2007), p. 2
[44] 1 mtoe = 11,630 GWh
[45] SEK(2006) 1719
[46] Own estimation according to UNECE
[47] CEPI, p.4

- Within the biomass sector, the use of agricultural biomass is granted an important role. The development of production in this sector must be accelerated.
- The share of CHP from biomass will be available by 2020 to produce energy in the most efficient way[48]

The European Environment Agency study concludes, "…that a significant amount of biomass can technically be available to support ambitious renewable energy targets even if these strict environmental constraints are applied."[49] According to the study, a technical potential of 235 mtoe (2,700,000 GWh) is available for the year 2020.
The AEBIOM (2007), in its "Biomass for Heat Action Plan", is proposing to reach 120 mtoe biomass for heat in 2020. AEBIOM made a differentiation in biomass for heat and biomass for cogeneration. It is based on the assumption that heat production in power plants is utilized for heating purposes.[50]

Table 8: Targets for bioenergy in EU 25 without transportation biofuels (in mtoe)

	2002	2003	2004	2010	2020
Biomass as primary energy	62,7	68,1	71,9	130,8	180
Biomass for heat		48,2		74,8	120
Biomass for cogeneration and electricity		20,6		56	60

EUROSTAT
Biomass Action Plan
AEBIOM proposal for 2020

Source: AEBIOM, 2007

Quality pellets are principally used on a small and medium scale for heating (individual boilers and stoves in houses, small and medium district heating plants). In the same way they are deployed in cogeneration for the production of electricity and heat.
In terms of small scale and medium scale, pellets will gain more importance. In favour of this are:

- Compared to conventional heating systems, a similar comfort and degree of automation (little manual work needed)

48 CEPI, 2007, p.4
49 EEA, 2006, p. 53
50 AEBIOM, 2007, p.5

- Sophisticated fuel burning technology with a high degree of efficiency and controlled emissions.
- Lower particulate matter levels in comparison to other wood heating systems.
- Easy to transport.
- Well-developed logistics chain.
- High energy density.

While the traditional use of wood logs has been stagnating in the last few years (private consumption is difficult to record statistically), greater progress has been made in boiler and combustion technology (more efficient and lower emission boilers, greater comfort, new fuel pellets) and supply logistics (distribution logistics, district heating with biomass).
Therefore pellets have a high replacement potential as a substitute for fossil energy sources as well as classic firewood.

According the UNO prognosis, by 2050 up to 70% of Europeans will be living in cities[51]. In densely populated cities the use of district heating will increase.
Small scale pellets boilers (capacity up to 50kW) are normally used in central heating for single-family houses or as stoves in flats. Whereas pellets central heating systems are usually located in central and northern Europe, in Mediterranean countries the focus is on stoves (pellets stoves are replacing heating oil stoves, room gas heating and electric heating).

Table 9: Calculation of pellets demand in 2020 under the baseline of 120 mtoe for RES-Heat

		Mtoe	GWh	Mt Pellets
Heat	min	12	140.000	29
	max	24	280.000	58
Cogeneration	min	3	35.000	7
	max	9	105.000	22
Total	min	15	175.000	36
	max	33	385.000	80

1mtoe equates to 11,630 GWh. Source: own estimations

[51] http://www.un.org/esa/population/publications/wup2007/2007wup.htm, 22.03.2009

In Eastern Europe, the share of district heating networks is traditionally high. Most networks and boiler systems are, however, very outdated and urgently need to be replaced. In the process of changing over the system (especially systems using coal) it is possible to introduce industrial pellets. Compared to other biomass such as woodchips, they possess higher energy density and are logistically easier to handle due to their structure.

Thus the author can make the assumption that, in the sector biomass for heat, 10% (minimum scenario) to 20% (maximum scenario) will be covered by pellets. For the sector of combined heating and power (CHP) from biomass about 5 to 15% will be covered by pellets.

5 Comparison of pellets supply and demand

In the comparison of the quantity of bark free pellets (quality pellets) and the demand for wood pellets, the distribution of supply and demand becomes clear.

Table 10: Comparison of pellets production and demand in 2020 (in million tons)

Estimated demand for wood pellets in 2020		Mt Pellets
Heat	min	29
	max	58
Cogeneration	min	7
	max	22
Total	**min**	**36**
	max	**80**

Estimated wood pellet production potential in 2020	Mt Pellets
wood industry by-products	6 - 10
short rotation plantation	17 - 29
residuals from forestry	11 - 19
Total	**34 - 58**

Source: own elaboration

Table 10 shows the comparison of production potential in 2020 as calculated in chapter 3.3.1 and the estimated demand on wood pellets based on the forecast for utilisation of bioheat in EU.

The estimated wood pellets production describes a minimum and maximum scenario as a range of 25% plus and minus to calculated values in chapter.

Production potential for pellets from wood industry by products is based on the sawnwood production (see chapter 3.3.1). The value for pellets production capacity is based on the survey of EAA (see chapter 3.4.2).

There is a huge gap between wood pellets from saw mill by products and the demand for heating purposes in small and medium scale heating. Even the heat demand in the minimum scenario is three times as high as the estimated maximum production potential derived from sawnwood and industrial wood processing.

In this survey the focus is on woody biomass. There are no data for pellets production from energy crops (straw and grain, perennial crops). There is a huge technical potential all over Europe with several utilisations paths. It is difficult to estimate the shares and economic potentials of pelletizing crops. In addition there are a number of problems to be solved for utilization in small scale heating according to slagging, corrosion and emissions. It is expected that pellets made of crops will be used in large scale heating.

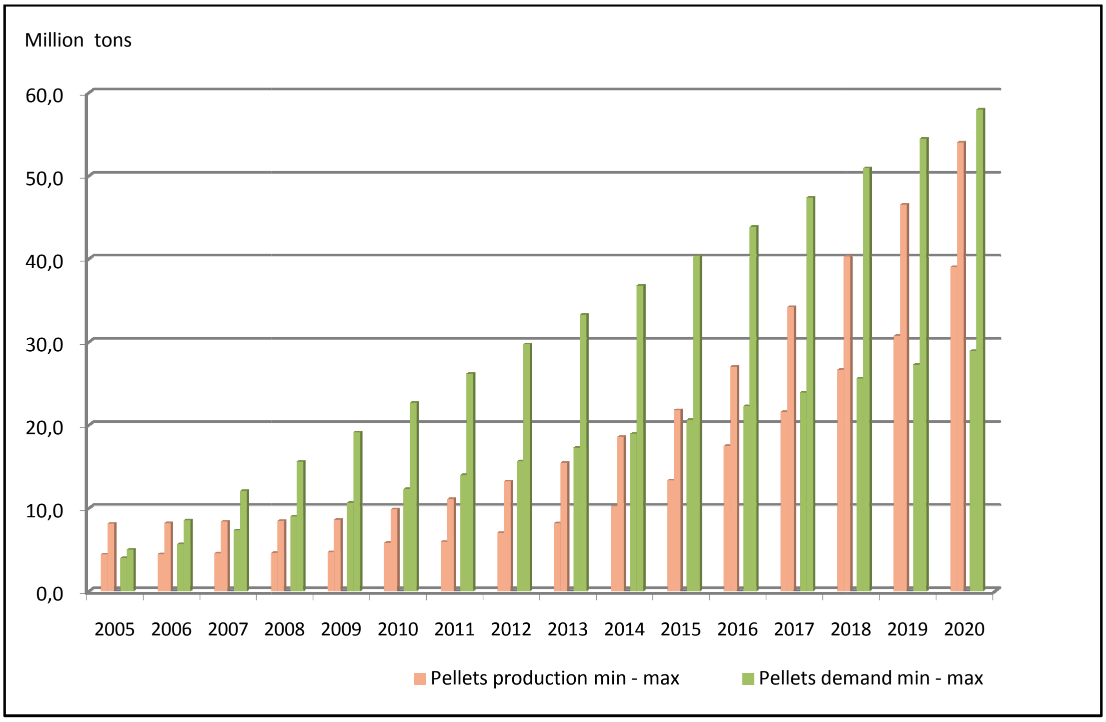


Figure 21: Estimated Pellets production and demand 2005 – 2020

Figure 21 shows the estimated development of pellets production from woody biomass (sawmill by-products, short rotation plantation and pellets production from forestry residuals) compared with the assumed demand on pellets, based on policy scenarios of biomass utilization in the EU.

Results:

- The expected demand for 2020 can only be attained through the consequent use of the potential from short rotation plantation and from forest residuals.
- The expected demand for wood pellets can in no way be covered by sawmill by-products. This represents the smallest share of production potential.
- Potentials from short rotation plantation and residuals are much higher than potential from sawmill by-products.

- The share of short rotation plantation and wood residuals will be much higher in 2020.
- The MBP aren´t considered in this calculation but they will play a crucial role in future.

6 European Pellets market

6.1 Preface to market development

The focus of the European pellets market is in several countries. In Austria, Germany, Sweden, Finland, Denmark, Italy, Belgium and the Netherlands, the market is well-developed although the terms and conditions for the market vary greatly in each country.

In general, three main markets can be identified:

- The use of pellets in small scale heating devices for heating in residential or commercial buildings: This is the case in Germany, Austria and Italy.
- The use of pellets in large power plants as the sole fuel or as mixed fuel in coal-fired power plants. This market is to be found above all in the atlantic nations such as Belgium, the Netherlands and Great Britain.
- The use of pellets in small, medium and large scale devices.

These main markets can be sub-divided into highly developed sub-segments and emerging markets. The market for small scale heating is widely developed in Austria, Germany and Italy while in France, the market is at an early stage of development but is showing a high rate of growth.

Furthermore, the method of transport for pellets can be differentiated. In Mediterranean areas stoves are predominantly used for residential heating, therefore pellets are delivered in bags. In the countries of central and northern Europe, central boilers are mostly used and bulk delivery is the general rule.

The fact that only a few countries are currently using pellets extensively is due to the dedicated policies supporting market developments. It is a common experience that new energy technologies cannot penetrate existing markets without significant political support. Existing barriers are usually too high and competition from fossil fuel industries too strong to allow strictly market driven diffusion."[52]

Building up the pellets market cannot be compared to building up a market for new consumer goods. The pellets market as a segment of the energy market is in

[52] AEBIOM, 2008, p.10

competition with highly developed and differentiated market participants, dominated by politically and economically highly influential multinational concerns.
Energy is an important factor for the productivity of a society. Energy is essential and must be available at any time in an adequate amount. The energy market is controlled by a few, but large, participants. Alternatives are not generally welcome and can therefore only develop slowly.

Conditions for building a pellets market:

1. Well developed technology from generation to distribution and to combustors (heating devices), this needs uniform standards and appropriate quality control.
2. Consumers' belief that they have a reliable, economical and ecological alternative.
3. Support through a policy that can set out a framework (demands, legal stipulations).

Ad 1:
When it comes to small scale heating in particular then pellets face well established technology. Fuels are standardised and normed. Thus the manufacturer of boilers and the customer both have the guarantee that he will be supplied with the same quality irrespective of the dealer and that the system will function faultlessly (heating value, emission content etc).
In some countries (Germany, Austria) standards have been established for premium pellets. Other countries base their quality requirements of pellets on these norms. Work is currently in progress on a pan-European standardisation that is aligned to these existing norms.
It is crucial for distribution that pellets have a certain solidness so that abrasion is kept to within narrow tolerances.
Vital for maintaining standards is an appropriate internal quality management and to retain confidence in the market suitable external controls are required. These take care of maintaining standards and can issue certification reports.

Ad 2:
In order to establish a new product, customers must be convinced about the advantages of the product. In the case of pellets, the ecological and economical advantages are obvious. They have been presented in the previous chapter. The

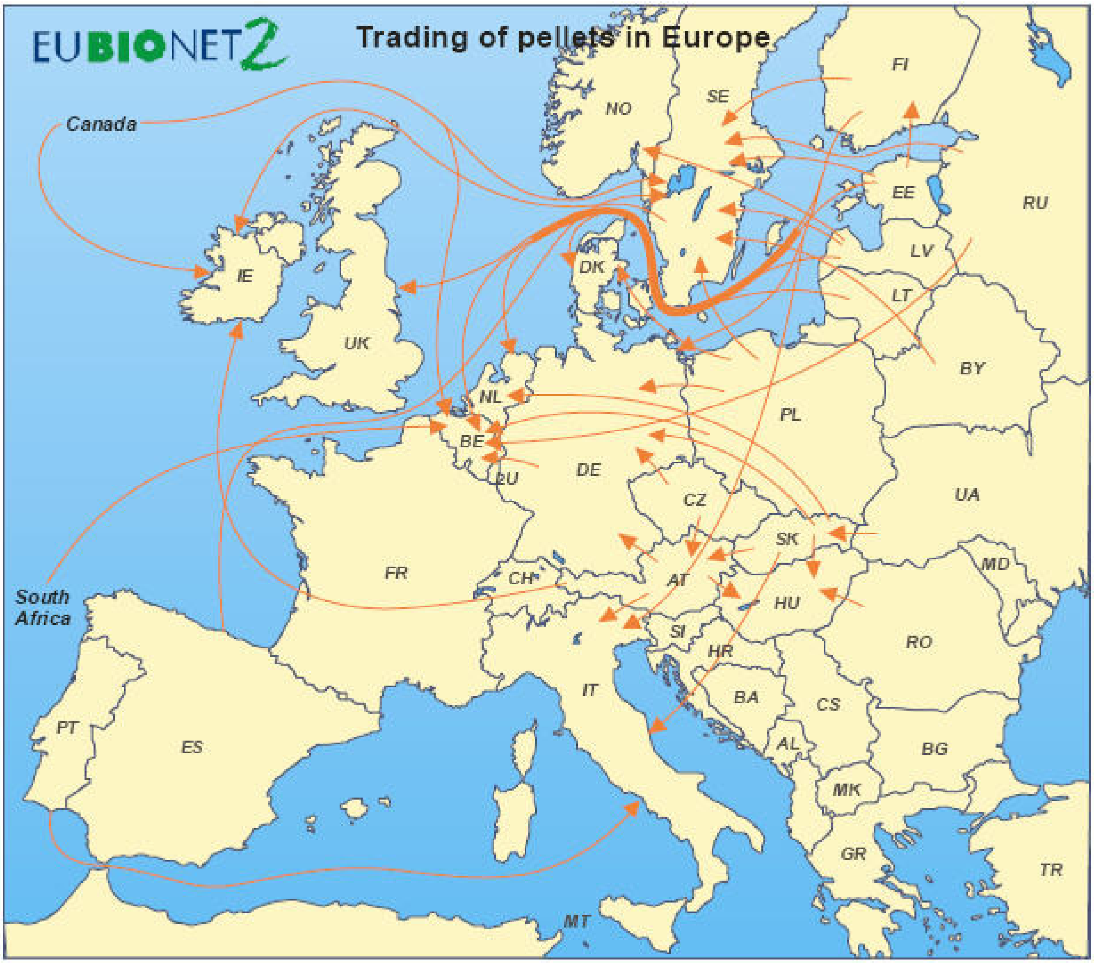
authenticity of the argument is important. It's not only the customers who have to be convinced but also important multipliers such as plumbers, architects and building planners and other decision-makers.
Establishing a clear market strategy and clear image is part of building the market. It is precisely in the pellets sector where many small companies have come onto the market. Cooperation is a key advantage in order to be able to compete against large and well-established trade rivals.
Cooperation ranges from mutual R&D to development of distributive channels (contracting) to organization of collectives that administrate marketing functions.

Ad 3:
It is very hard for new products to establish themselves in the current economic conditions. The specific production costs of small production units are very high. Development has only just begun and experience must first be gathered. Procedures first have to be optimized. The risk of the projects is high, capital procurement for financing is hard and expensive.
Politics can be supportive here in the form of direct subsidies for heating devices which contributes to their dissemination.
Support programs and calls for best demonstration projects have shown to be successful tools. To gain experience in supporting the dissemination of pellet heating systems, research and dissemination projects should be initiated and funded.
Continual and forseeable support is of decisive importance. A rash change in the type and extent of support unsettles the market and leads to loss of confidence. On this note, tax relief for pellets as an environment friendly, CO2 neutral and domestic fuel could safeguard the continuity of support in the long term.

6.2 European pellets market and trade

In 2006 wood pellets production was about 4.5 million tons and consumption is accounted for around 5.5 million tons, which means a significant import of 1 million tons (from Russia and Overseas).[53]

[53] Peksa-Blanchard et al, 2007



source: VTT, 2007

Figure 22: Trading paths of pellets in Europe

In the year 2008 the production of pellets in Europe was about 5.9 million tons.[54] Main producers and consumers are Sweden, Germany and Austria.

As figure 20 shows, one of the main trading centres is the Baltic (Finland, Lithuania, Estonia, Poland, Denmark and Sweden)

The current pellet production is about 3 million tons. The Baltic sea is also a main trading route for pellets from Russia. Johanson[55] estimates the production capacity in this area (including North-West-Russia) at about 5.5 million tons.

Main export countries are Austria, the Baltic States of Lithuania, Latvia and Estonia as well as Russia and Finland.

[54] http://www.pelletsatlas.info/cms/site.aspx?p=9176, 15.04.2009

[55] in: VVT, 2007

This can be explained by the country-specific situation in relation to manufacturing capacity of forestry and sawmill industry as well as the consumption of pellets.
The central, eastern and northern European countries have large areas of forest at hand, while the countries of central and northern Europe also possess a highly developed and consolidated sawmill industry. In contrast, countries in the Mediterranean and Atlantic areas have a relatively small area of forest and in comparison, high consumption of pellets.
The Baltic countries have almost no inland consumption. Total production is exported to Sweden, Denmark, the Netherlands and Germany.

Pellets are also imported from overseas. According to Junginger[56] about 400.000 tons are imported from west Canada for Dutch and Belgian power plants.

6.2.1 Information and data about European pellet trade

The following shows portraits of the most important countries. Source material is, however, not consistent. Various sources differ in their information, above all about production and consumption.
In terms of market transparency, it is of decisive advantage to have uniform and certified data records.
A significant step is the "Pellets@las", a project of „Intelligent Energy for Europe".
The aims of the project are:

- to facilitate pellet trade,
- to remove market barriers, mainly information gaps but also local supply bottlenecks, production surpluses and uncertainties in quality assurance management.
- to contribute to the implementation of future European legislation which is hindered by lack of market confidence and attitudes rather than costs
- to provide pellet market data on wood pellets, such as prices, available quantities and qualities in Europe
- to support market participation and increase of energetic utilisation of pellets by the permanent availability of market information within a real-time European PELLETS@LAS.[57]

A website was set up to disperse the information: http://www.pelletsatlas.info.

[56] In VVT, 2007
[57] http://www.pelletsatlas.info, 03.04.2009

The project will run to the end of 2009, results so far are promising but not yet complete.

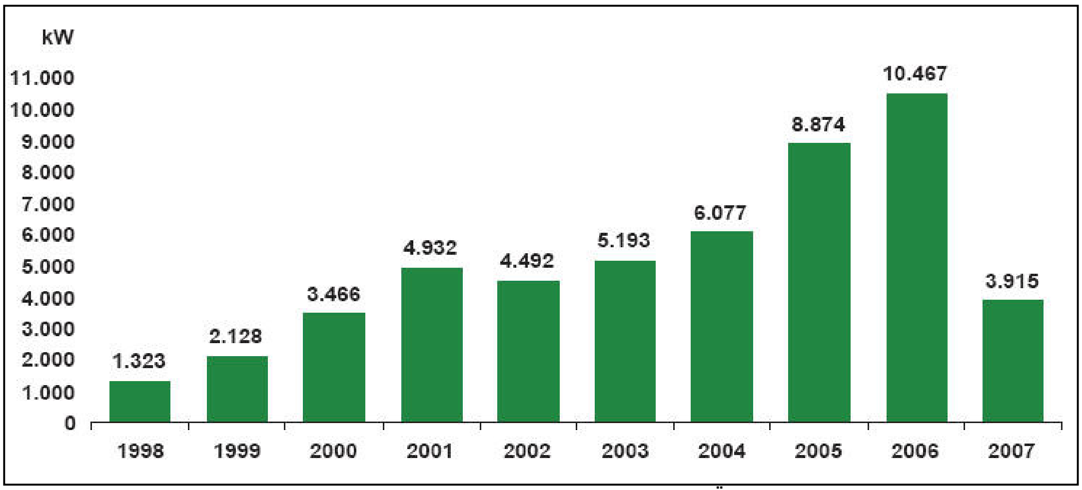
6.2.2 Austria

Production capacity 2008:	978.000 tons
Production 2008:	626.000 tons
Domestic consumption 2008[58]:	513.000 tons

Development of the pellets market began in 1997 and proceeded rapidly. This is why Austria is one of the most highly developed markets in Europe. The reasons can be put down to the traditionally heavy use of wood for heating purposes, a strong, industrialised wood industry that was looking for new uses for sawmill byproducts and to the development of pellets stoves and furnaces through an already existing biomass boiler manufacturing industry.

Due to the central location of the country and the high quality of pellets, Austria is a major exporter of pellets. However, the high demand leads to significant imports. In total it amounts to a net export of about 100.000 tons.

Exports are mostly to Italy (150.000 tons in 2005) and Germany (45.000 tons in 2005)[59]. The share of exports on total production is about 40% with an increasing tendency.



source: NÖ Landeslandwirtschaftskammer, 2007

Figure 23: Annual installed capacity for small scale devices in Austria

58 All data for country portraits from: http://www.pelletsatlas.info/cms/site.aspx?p=9176, 04.04.2009, except other indication

59 Peksa-Blanchard, 2007, p. 46

6.2.2.1 Excursus: Sudden price increase for pellets in 2006/07

In 2007 there was a general decline in the installation of boilers. Next to oil and gas heating there was, for the first time, less biomass heating installed than the year before. The enormous growth in the number of pellet heating systems in 2006 could not be repeated in the following year.

The combination of several factors led to a rise in the price for pellets in the heating season of 2006/2007:

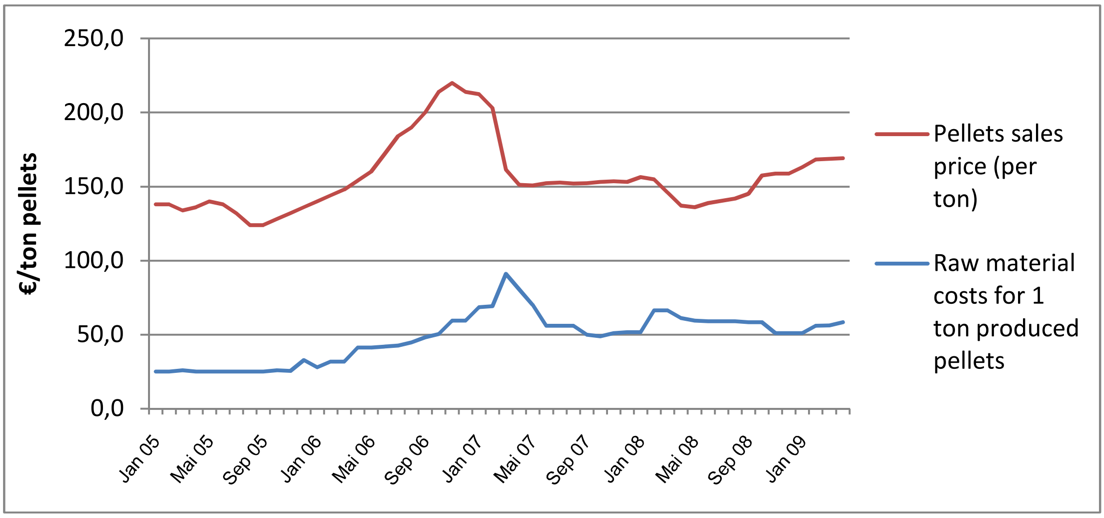
Previously in 2005 there was a significant rise in systems installed due to rising oil prices and improved State subsidies. The severe winter that followed in 2005/2006 reduced the supply of raw material from sawmills and raised the demand for pellets.

The growth in the number of pellets stoves also greatly increased in Italy and the anticipated demand for pellets caused rising prices and pellets imports mainly from Germany and Austria occurred.

Production capacity could not hold pace with the demand. Delivery bottlenecks occurred due to insufficient stocks (pellets storage) and several contracts that had to be fulfilled with large power stations in the Benelux countries. Related to that were delays in delivery and at least one considerable increase in price. It is noticeable, that prices only in Austria and Germany increased, whereas the prices in northern Europe kept stable.

The beginning of Spring and the mild winter of 2006/2007 led to improvement in the situation with raw material and the high demand subsided. Prices settled down to a lower level and it was possible to maintain these through the following winter.

The consequence of the short-term rise in price was a massive loss of confidence on the part of consumers and a decline in boiler sales. So the emerging and thus fragile market was seriously disrupted. Customers thought they had been cheated out of one of the main arguments for pellets, that is the lower and stabile price of fuel. Consequently they decided in favour of other heating systems.



Source: Austrian commodity exchange, pro pellets Austria

Figure 24: Saw mill by products prices compared with pellet sales price in Austria 2005 – 2009

In the previous year some boiler manufacturers started a campaign to stabilise the price of pellets with a delivery and price guarantee for three years, as well as an expansion of production capacities; this led again to a reduction in price to the level of earlier years and in spring 2008 the recovery of the boiler market followed.

6.2.3 Germany

Production capacity 2008:	2.333.000 tons
Production 2008:	1.353.000 tons
Domestic consumption 2008:	900.000 tons

Germany is one of the largest European markets. This concerns the potential for pellets production as well as the heating market.

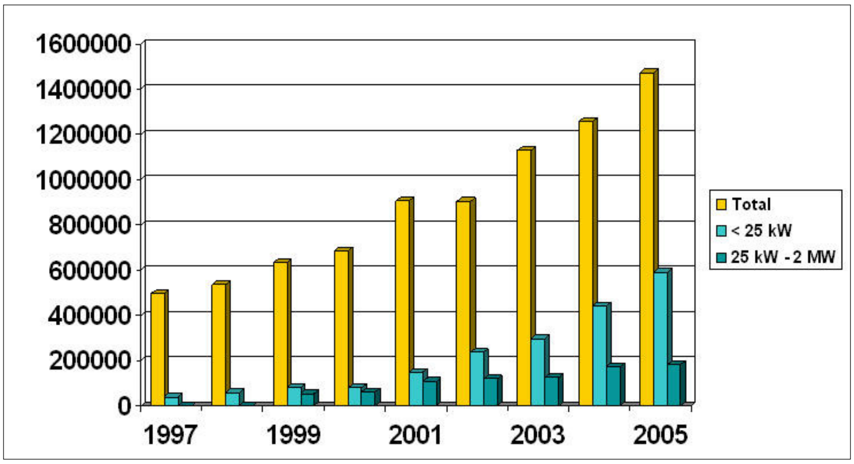
Experts estimate that between 800,000 and 1,100,000 tons of raw material are annually available for pelletizing. If pellet demand increases in the future, wood residues from the woodworking industry will be re-routed for pellet production. Whether wood residues will be used for energy or non-energy purposes will depend to a large extent on the prices that suppliers can achieve for their products. However to safeguard against possible shortage of cheap residues, large scale pellets plants are designed to also use round wood for raw material."[60]

6.2.4 Sweden

Production capacity 2008:	2.200.000 tons
Production 2008:	1.405.000 tons
Domestic consumption 2008:	1.850.000 tons

Sweden is the largest producer as well as consumer in Europe. Markets vary widely: there is small scale utilization with a well-developed network of distribution as well as utilization in large scale power plants, using mostly ship imported pellets.
Wood pellet production in Sweden started in 1982. The Swedish Government introduced a tax on fossil fuels. This made pellets systems more competitive and they experienced a real boom. It is a good example of how taxes can be effective in steering a market. Pellets mainly substitute heating oil. In 2004 the sale of heating oil decreased by 18% and at the same time, pellets sale increased by 34%.

The Swedish market is characterised by high turnover. While around 350.000 tons of pellets were imported in 2005 for power stations (mostly industrial pellets from Canada, less from Finland and the Baltic States), during the same time 130.000 tons were exported.



source: pro pellets Austria

Figure 25: Pellets sales in Sweden (in tons)

[60] Peksa-Blanchard et al, 2007; p.36

Last year there were definite rises in the price of pellets in Sweden too. These were certainly more modest than in Germany or Austria, but it still came to a significant decline in the demand for pellets heating. Swedish experts put this down to the fact that pellet prices for end customers in Sweden are, at around 200 Euro per ton including VAT, clearly higher than the central European prices. On the other hand, high taxation means that costs for oil in Sweden are also distinctly above the level in the rest of Europe. In Sweden, pellets currently show a price advantage over oil of more than 50%[61].

6.2.5 Finland

Production capacity 2007[62]	550.000 tons
Production 2006[63]:	350.000 tons
Consumption 2006:	100.000 tons

There are no data from pellets@las available.

Finland has a highly developed sawn wood industry. A substantial share of raw wood is imported which means by-products originate from overseas forestry. Production: About 22% of wood based energy production is produced from imported raw wood.[64]

Domestic consumption is about 100.000 tons. This is due to competitive prices of coal. However, the price difference in the total heating costs between pellets and fossil fuels is relatively small, which has retarded the growth of the domestic consumption of pellets.[65]

Around 80% of pellets produced are exported, mainly to Sweden and Denmark.

6.2.6 Denmark

Production capacity 2008:	400.000 tons
Production 2008:	200.000 tons
Domestic consumption 2007:	870.000 tons

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[61] Rakos, 2008, Manuscript from the Biomasse conference Graz, January 2008

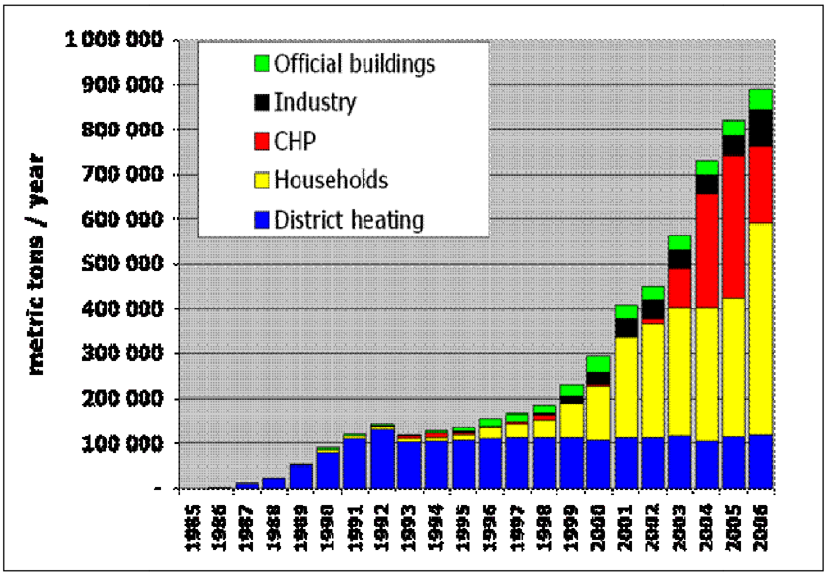
[62] Ljungblom, Lennart: The PelletsMap2007. In: Bioenergy International No6. Dec. 2007, Stockholm

[63] Peksa-Blanchard et al, 2007, p. 52

[64] VVT, 2007, p.46

[65] Peksa-Blanchard et al, 2007, p. 52

Data of “pellets@las” is of medium quality.



Source: Jonas Daal, FORCE 2007

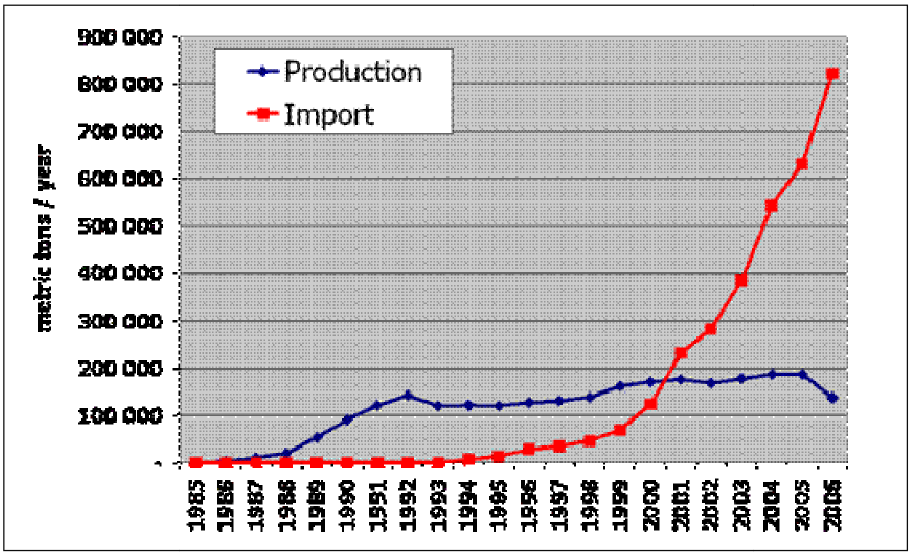
Figure 26: Danish pellets consumption

Only quite recently have new data been available in Denmark that show a clear rise in the use of pellets in small systems. Between 2004 and 2006 the demand for pellets in this market sector rose about 200.000 tons. This is a remarkable development considering the Danish market for small systems has largely stagnated since 2001. In contrast, the use of pellets in the power station sector has declined considerably.

And lastly, due to technical problems, the domestic production of pellets dropped.

Imports in 2006 were around 800.000 tons and now show a sharply rising tendency.

The main supplier countries are the Baltic states, Sweden, Finland and Canada. There is a trend toward market consolidation of large importers. Importers with more than 20.000 tons annually accounted for 83% of the total imported amount in 2004.



Quelle: Jonas Daal, FORCE 2007

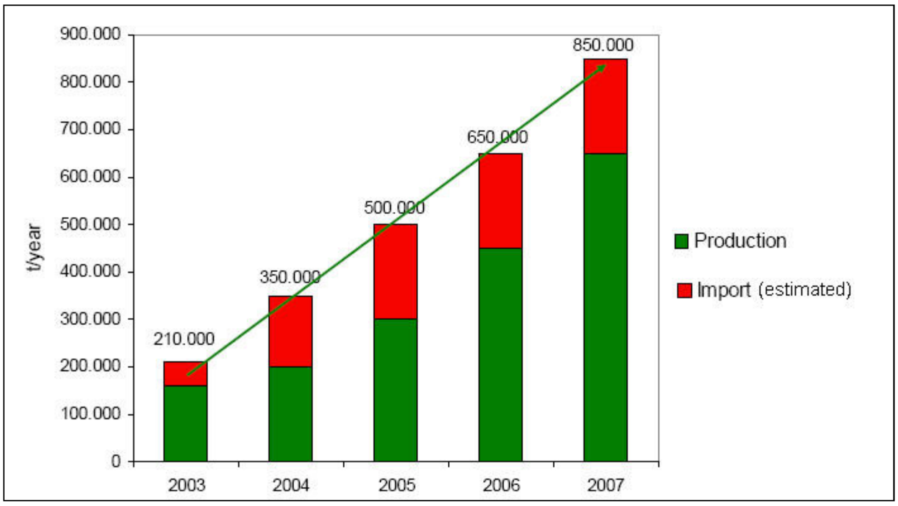
Figure 27: Domestic production and imports of pellets in Denmark

The price level in Denmark is very high (268 Euro per ton including 25% VAT for bulk goods). As in Sweden, the high taxation means that costs in Denmark for competitive energy carriers are clearly above the level of most other European countries.

6.2.7 Italy

Production capacity 2008:	643.000 tons
Production 2008:	530.000 tons
Domestic consumption 2007:	850.000 tons

For the first time there are precise figures for the development of pellet stove sales in the past three years on the Italian market. These figures were researched by the Italian stove manufacturers themselves and relate to data that was collected from the component suppliers. They are considered to be reliable and are probably slightly below actual sales rather than above. According to these data, 90.000 pellet stoves were sold in Italy in 2005, and in 220.000 were sold in 2006. Stock is rising every year by more than 10.000 stoves. Predominantly pellets in sacks are used.



source: AIEL

Figure 28: Pellet production and import in Italy

The size of the Italian pellet market is remarkable. It is evidently by far the largest market for pellet stoves in Europe, even worldwide. Currently about 800,000 stoves are installed.[66] The rapid growth of the Italian market at 144% was caused by the huge rise in prices in the winter of 2006/07 (compare country portrait Austria). The price for pellets in bags rose within a few weeks by 54%.[67]

One problem with the Italian pellet economy is the small scale sawmill and wood-processing industry. This means that production is spread across numerous small producers so that it is difficult to put consistent quality pellets on the market. Imports of high quality pellets thus play an important role which will continue to grow. The volume and speed of growth of the Italian market show how great a potential there could be for pellet stoves if the economic parameters are suitable. In Italy this is the case for pellets due to the high taxation on oil and gas. "[68]

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[66] Paniz, A. and Berton M., Presentation at: Europäisches Pelletsforum, Wels, 2008
[67] Cp. Paniz, A. and Berton M., 2008
[68] Rakos, 2008

6.2.8 France

Capacity: 1.400.000 tons

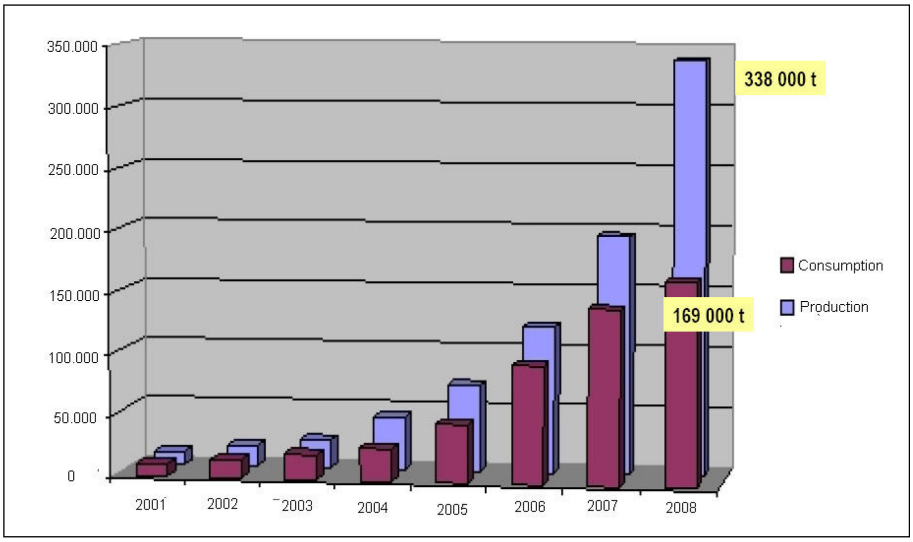
Production 2007[69]: 270.000 tons

Domestic consumption 2007[70]: 170.000 tons

Pellets@las gives for capacity a number of 1.400.000 tons and a production of 240.000 tons. This huge gap has to be reviewed.

For the first time in France, the French energy agency ADEM has published official statistics for the sales of pellet heating systems in France. According to these statistics, 210 pellet boilers were sold in 2004, 895 in 2005 and 4690 pellet boilers were sold in 2006. The demand for pellet boilers, which at first was limited mostly to the eastern part of the country, is now extending to the central and western areas.

Numerous established manufacturers are already appearing on the French market and even the political conditions are favourable. 50% of boiler costs are subsidised by the possibility to write the costs off against tax. In addition, there are also regional allowances. The small scale sawmill and wood industry, which makes it difficult to get enough raw materials, poses problems and structural weaknesses for the French market. The electricity industry is concentrating on promoting the heat pump. One obstacle is the generally low price of energy in France, above all the low price of electricity.



Source: ITEBE

Figure 29: Production and Consumption of Pellets in France

[69] Keel, 2008
[70] Keel, 2008

Agricultural economics has great influence in France. There are efforts being made to establish pellets produced from farming as a fuel.[71] To this end, the first standards have already been formulated.[72]

6.2.9 Belgium:

Production capacity 2008:	450.000 tons
Production 2007:	325.000 tons
Domestic consumption 2007:	860.000 tons

Belgium is a typical example of a country where pellets are used in large power stations to produce green electricity. Of the 860.000 tons of pellets consumed, 93% were used in two power stations. Imports came mostly from Canada and the USA (about 40%), the Baltic States and Scandinavia (45%) and others.[73]
The market for small scale heating is growing but at a ver low level.

6.2.10 The Baltic States

Production capacity 2007[74]:	940.000 tons
Production 2007	250.000 tons

There is no data from “pellets@tlas” up to date available.

Production plants in the Baltic States have an extraordinarily high production capacity in relation to the area of the country. This can be explained by the major imports of round wood from Russia that is used in Lithuania, Latvia and Estonia to be further processed to sawn wood and exported on to the West. Correspondingly there are large amounts of byproducts which find their way to western and northern Europe.
Domestic consumption is negligible. Pellets are exported to Sweden, Belgium and Germany.

6.2.11 Russian Federation

Production capacity 2008:[75]	200.000 tons

[71] Cp. Rakos, 2008
[72] Cp. Douard, 2008
[73] Peksa-Blanchard et al, 2007, p. 57
[74] The PelletsMap2007; In: Bioenergy International No6. Dec. 2007, Stockholm

Production 2007: approx. 50.000 tons
Domestic consumption 2007: negligible

Russia is a special case. The country has enormous reserves of forest at hand where the potential has nowhere nearly been exhausted. There was a sharp decline in forestry in the 1990s and there is a long way to go before reaching the felling rates from the 1950s-1970s.

Forestry is an important economic factor in Russia. They still export a great deal of round wood but the trend is moving toward domestic wood processing. In this area, there is a relatively high potential for pellets production.

The potential markets for pellets are, however, not in Europe. Efforts are being made to enter the markets in China and Japan.[76]

At the moment, the existing systems are found in north west Russia for which Peksa-Blanchard et al (2007) state a production of 50.000 tons. Rakitova[77] estimates the annual production in the whole of Russia at about 300.000 tons.

There are several plants currently in planning which will come into service in the course of the the next few years.

Obstacles in the way of using pellets are the long transport distances and the lack of a domestic market.

Domestic use is to date. There are currently some minor attempts being made to implement pellets in power stations.

[75] Peksa-Blanchard et al, 2007, p. 65
[76] The Bioenergy International, No 6., Dec. 2007
[77] In: The Bioenergy international, No 6, Dec. 2007

7 Discussion

7.1 Raw material basis for wood pellets

The European Union has ambitious goals set for energy policies to be reached by 2020. Member States are invited to set up appropriate national roadmaps.
Biomass as a domestic energy carrier with great theoretical potential will be given major importance especially in the area of low temperature heating.
The structural requirements from transport, turnover and storage make pellets suitable for replacing oil heating systems. Pellets heating systems offer the same convenience in terms of operation, automation and control. Thus pellets will be an important factor in reaching the goals by 2020.

The expected demand for wood pellets for medium scale heating, derived from the objectives of the EU climate and energy package, will not be covered by the standards of corresponding premium wood pellets. Even in the minimum scenario (10% of biomass heat demand is covered by the use of pellets and here again about 50% of that exclusively in small scale heating), 14 million tons of pellets will be required. The pellets supply that was derived from the sawmill industry forecast amounts to 8 million tons. There is a gap here of almost 100%!

Assuming that industrial pellets intended for use in power stations can be used mostly from overseas supplies, then 29-58 million tons of pellets must be produced within Europe. The long-term demand for pellets will be bigger than the supply.
The question of procuring raw material will play a key role.

Already these days in Europe there are no available quantities of sawmill and wood shaving by-products. The whole range of by-products are processed further (panel industry, paper industry) or they are used for energy. With an increase in demand, the price for by-products will rise.

The range of sawmill by-products is very different across Europe. In eastern Europe the quantity of by-products will rise due to the upturn in sawmill industry, while in western Europe the supply is stagnating.

The gap between production and demand for pellets in each country is balanced out by domestic European trade. Above all, trade between the countries of eastern Europe and Russia with the large customer countries of the west.

Raw material is the most important cost factor in pellets production. Barely 50% of the manufacturer costs are accredited to the raw material sawdust. Rising costs of raw material must be reflected in the pellets price.

In order to cover the demand for pellets that is created by suitable policies, other kinds of raw materials will have to be found. This will mean, however, additional expenditure (harvesting and preparation costs) and thus higher production costs. The additional expenditure in manipulating the raw materials (without costs for acquiring raw materials) can be estimated at about 10-12 €/ton of pellets, based on the prices from 2009, about 5%. These additional costs will also be reflected in the price of pellets.

Costs for harvesting wood residuals from forestry are way above those of sawmill by-products. The potential from this source will only be utilised if the prices for energy and the revenues from the pellets market show a definite increase.

7.2 Alternatives to saw mill by-products

In order to cover the total demand for pellets, other kinds of raw materials must be found.

7.2.1 Pellets from forestry residuals

One source of raw material for pellets production is forestry residuals. The supply of forestry residuals is linked to the harvest of round wood. By harvesting residuals at the same time as harvesting the high quality timber, the costs are lower than if only the residuals were to be harvested for energy production. But in this case the better value production of raw materials from forestry residuals is linked to the needs of the wood industry.

The estimated potential of 15 million tons of residuals from forestry is a possibility according to sustainability criteria. The economic potential is dependent upon price factors and internal decisions made by the forest owner. For example, considerable areas of forest are owned by people who do not live near to the forest, who have no economic interest in using the forest. These reserves are very hard to mobilise.

7.2.2 Pellets from short rotation plantation

There are higher returns using wood from short rotation plantation but there is also a high content of tree bark. If this resource is supposed to contribute to covering demand then boiler technology must be adapted to suit this fuel. The problem of slagging in the furnace must be satisfactorily solved. There is still a great deal to be done in research and development in this case. Costs for cultivation, harvesting and additional grinding (in German "Nassvermahlung") will have effects on pellets prices.

7.2.3 Pellets from agricultural biomass

There are some European wide efforts in developing Mixed Biofuel Pellets(MBP). This is a new and upcoming market.
The use of pellets from agriculture brings with it high emissions and the danger of problems with corrosion. The specific costs for avoiding environment related emissions and corrosion problems are very high for small scale heating devices.
Therefore in most of the European countries a wide spread and transparent market for small scale applications does not exist. Activities are happening between producer and consumer in the same way as for industrial pellets utilized in large scale heating.
All in all the market of MBP is very small but developing. The technical potential all over Europe is very high. Costs for raw material are relatively moderate. But there are strong barriers for market development: legal aspects with the requirements for emission limits as well as technical aspects like corrosion and slagging. Due to the special characteristics of MBP (the mixture of different raw materials) a third barrier will be the necessity of a standardization and harmonization of the trading market. Also new production standards have to be established.
Here too, there is the need for more research and development.

7.3 Market trading

The increase in supply cannot keep pace neither in dynamics nor extent with the rising demand for pellets. The bottleneck is the quantity of sawdust that is linked to the conditions of the sawnwood market.

The gap between supply and demand for pellets leads to an expansion of the catchment area. Pellets are imported from various parts of the world. This is above all true for the large scale power plant sector. Thus the argument of not being dependent on imports is partly invalidated.

International trade with bioenergy will increase. Due to their density, pellets are suitable for transporting over longer distances (compared to other kinds of wood bioenergy). For example, from Russia to central and western Europe (also for power plants). The greater the distance and the more they are handled, the higher the costs of transport become compared to the product. If the demand (due to increased demand and stagnating supply) can be satisfied from a greater distance then the price is clearly increased in order to compensate for the transport costs.

With increasing international and global trade, defined and controlled quality standards for fuels becomes increasingly important. In a similar way to trading with fossil fuels, uniform, international standards are essential for the trading on the market to function.
Key issues are security of supply and price stability. These are the customer´s main drivers to invest in pellets heating system.

Uniform standards for building up a market are of key importance. This makes the product tradeable. The pellets market is becoming a global market that needs the same instruments of trade as have the established global energy carriers. This is true above all for agricultural and mixed pellets.

The volatility of pellets prices could disrupt the market over a long time. Customers will not accept fluctuations in the price of fuel pellets. As the case example of 2006/2007 shows, short term increases in price of 25% cause a great loss of confidence in the pellets market, which can only slowly be restored. Price stability is the key factor in market development.

8 Conclusions

In future terms pellets from sawmill by-products cannot cover the demand for premium quality pellets for small scale heating.

The basis of raw material has to be widened to cover growing demand (caused by strong efforts for renewable energy policy eg. subsidising pellets boilers).

Price for pellets will be volatile due to constant increasing demand. A developed and transparent market will ensure that volatility will be kept in small ranges.

Boiler technology for small scale application has to be improved for a wider range of pellets fuels and to meet legal requirements for emission limits (fine particle emissions, NOx emissions etc.).

It is expected that total costs of small scale pellets firing systems will increase.

International and overseas trade will play a greater role to cover the demand for biofuels and to balancing the market.

A market on the basis of national and international standards for mixed biomass pellets must be developed.

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